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NOTES.

Patents in 1914.

THE annual report of the Comptroller General of Patents, of which an abstract appears elsewhere, deals largely with the unprecedented patent situation created by the war. This is seen even in the trend of invention, which has been marked by ideas for prosecuting aerial warfare, by shields for protection against bullets, by the detection of submarines, and by similar subjects. The introductory part of the report deals with the steps taken to suspend patents owned by alien enemies under certain conditions. These have been duly reported in our columns from time to time, as also the proceedings to which they have given rise. It is interesting to note that steps have been taken to permit alien enemies to file documents beyond the due date, where it can be shown that the applicant is prevented from doing the required act owing to the state of war, or when the doing of such an act would be prejudicial to the rights of the applicant. The main policy has been to attempt to carry on, as far as possible, all applications before the Patent Office, and even to receive further applications from alien enemies. No patent rights, however, are granted. The object has been to avoid destroying or confiscating patent rights owned by alien enemies, and the rules provide means by which pending applications, where alien enemies are concerned, may be resumed at the conclusion of war, and proceeded with in due course, provided that proper reciprocity is given to British subjects in enemy countries. It is also interesting to note that, at the request of the Council of the Chartered Institute of Patent Agents, a record department has been opened at the Patent Office, where documents which cannot under present conditions be forwarded to their destination abroad may be deposited, so as to show that it was the intention on the part of the depositor to do some required act within the required time. No guarantee, however, is given that this procedure will be recognised by the foreign Patent Offices concerned. Nevertheless, no less than 815 notifications of this kind were deposited last year, and it is curious to note that such action has not been restricted to documents intended for the countries with which we are at war.

Municipal Extensions.

IT is being felt increasingly that the action of the Government in limiting the extension of municipal electricity undertakings may lead to considerable difficulties. At a recent meeting of the Central Executive Committee of the Employers' Association at Manchester a resolution was unanimously passed to the effect that permission should be given to the Manchester Corporation, and to other Corporations similarly situated, to raise loans for the purpose of extensions, owing to the fact that so many firms engaged on Government contracts are dependent upon such bodies for their supply of motive power. When it is a matter of extensions for, say, street lighting, no harm is done in refusing the desired permission, for it is rather a question of convenience than of necessity. But when we are concerned with the supply of power, the case is altogether different. In this direction difficulties are being experienced not merely in Manchester, but in many other large towns. For example, in Sheffield, the steel works, which are, of course, heavily engaged in Government work, are putting down further electric furnaces which take considerable amounts of power, and if this power is not forthcoming their work will obviously be hampered. It is much the same with engineering works. We trust, therefore, that the Local Government Board will look more carefully into the whole question, for, if the present policy is followed unduly, there will be great difficulty in coping with the situation in the near future.

Engineer Volunteers.

THERE are many engineers at the present time who, either on account of their age being beyond the limit or by reason of their occupation necessitating their presence in

this country, are perforce unable to join the colours and take an active part in military operations now in progress. Such engineers, however, are perfectly willing to act as a reserve in case of need. But up to the present there has been a considerable difficulty in obtaining the necessary status and the desired training. This difficulty is gradually being overcome, and the Institution of Electrical Engineers has now been approached by Sir O'Moore Creagh, V.C., Military Adviser to the Central Association of the Volunteer Training Corps, to raise an Engineer Volunteer Corps from members of the engineering profession. A circular has been sent out to members, and we do not doubt there will be a ready response. The main difficulty appears to us to be the fact that members joining are required to provide their own uniforms and probably some part of the equipment. At a time when individual financial resources are liable to be strained this may present some difficulty to those wishing to join. If, however, this objection can be overcome, it appears that the sacrifice of leisure is comparatively small. Instruction and training is to be given in military engineering, with special references to telegraphs, telephones and searchlights, in addition to the usual military operations proper to an engineer unit. The work, therefore, should be interesting, and we trust there will be a ready response to this appeal.

Special Reserve of Officers.—Eastern Telegraph Reserve: Second Lieut. Peter Tait has resigned his commission, and Fredk. Brown has been appointed Second Lieutenant.

Royal Engineers (T.F.).—The following appointment has been made:

Electric Lights Company, Renfrewshire (Fortress) Engineers: Cadet Wm. MacNicol Adam (from Inns of Court O.T.C.) to be Second Lieutenant.

Shortage of Labour for War Material.—In view of the shortage of skilled labour for the manufacture of war material, the suggestion is put forward by the Society of Model and Experimental Engineers that use might be made of men who are possessed of a certain amount of mechanical ability and experience, but are not professionally occupied in engineering. As a means of effecting this, the formation of an Industrial Branch of the Royal Engineers is suggested, in which such men could enlist without having to conform with the existing military standards. It is thought that there are numbers of capable men who would come willingly forward under a scheme of this sort, as they would then feel they were part of a recognised force taking part in the defence of the country.

Electrical Energy Exported from Canada.—Of the hydro-electric energy generated along the international boundary in Canada more is exported to the United States than is used in Canada, according to a report issued by the Dominion Government. The total production of electrical energy in 1913 by Canadian companies with transmission lines extending into the United States was 1,543,464,097 kw.-hour, of which 772,597,049 kw.-hour was exported and 770,867,048 kw.-hour was used in Canada. The total amount exported by the various companies is shown in the accompanying table.

	Exported from Canada.	Used in Canada.
[illegible] Power Company	100,214,908 ...	14,420,020
[illegible] Company	282,123,004 ...	412,497,896
[illegible] Company	42,154,000 ...	191,885,670
[illegible] Company	23,213,891 ...	39,339,239
[illegible] Power Company	21,649,327 ...	868,856

Telegraphs in War Time. Mr. Charles Bright, F.R.S.E., M.Inst.C.E., contributes to the April number of the "Nineteenth Century" an article under this title, in which he deals with the importance of direct and secret telegraphic communication by "all-British" submarine cables between the different parts of the Empire, with special reference to the experience of the present campaign.

Mr. Bright describes how the five German cables with shore ends at the island of Borkum, in the North Sea, and communicating with Brest (France), Vigo (Spain), Teneriffe (Canaries), and Fayal (Azores) to New York, were cut very early in the war, and shows that oversea communication, so far as Germany is concerned, is practically limited to the wireless service. The visit of the German cruiser "Nürnberg" to Fanning Island is described, and some interesting particulars are given as to how the s.s. "Kestrel," despatched by the Pacific Cable Board, was able to repair the cable. Incidentally it may be mentioned that a strong feeling against the British Government was created by this affair, in view of the fact that no protection was afforded to the island where this important cable was landed. When the "Nürnberg" and her coaling ship were sighted flying the French flag it was naturally assumed that they were friendly. Besides this untimely visit, Mr. Bright gives a good account of the visit of the German cruiser "Emden" to the Cocos Islands. The lessons to be learned from the experience so far gained in regard to submarine cable facilities in war time are fully discussed, and Mr. Bright renews his advocacy of the establishment of a connecting link with the "all-British" system via the Atlantic.

The value of wireless in war time is also described and its usefulness indicated. Mr. Bright proceeds:—

> "Wireless" has, however, also proved to be a somewhat uncertain and distinctly two-edged weapon to rely upon. The very first day after the declaration of war revealed the apparent ease with which a wireless system may be "jammed." This was effected by the enemy's wireless station at Swakopmund, German West Africa, which station was able to smother the Cape Town messages at a distance of 850 miles.

Mr. Bright laments that the German wireless station at Togoland (West Africa), the largest station in the world outside Europe, was destroyed by the Germans before we captured Togoland. This put us out of possession of a means of listening to communications from the main German wireless headquarters at Nauen, near Berlin, 3,450 miles distant from Togo. The use made by the German Press Bureau in wirelessing false versions of war occurrences for the particular benefit of the United States and other neutral countries is referred to, and Mr. Bright calls attention to what appears to be a singular lack of use of the great Eiffel Tower station for the purposes of disseminating accurate particulars of the war for the benefit of all neutral countries able to receive wireless communications. Reference is also made to the misuse of wireless in America by the Germans. On the whole, however, Mr. Bright is of opinion that this method of communication has served a very useful purpose during the war. Its liability to easy tampering is shown, and the author hints at the necessity for discovering a means by which a more complete control can be obtained over wireless "stations." Mr. Bright is favourable to the establishment of a single Government Control Board in this country for the combined administration of our Imperial system of cables and of wireless. The author fully agrees with the view held by the great majority of electrotechnical men that radiotelegraphy will never become a suitable substitute for cable telegraphy wherever the latter is available.

A few interesting statistics relating to wireless stations throughout the world complete a most informative contribution to a subject which is of daily increasing interest to the public.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. W. E. Burnand contributes an article on the "Cost and Efficiency of Transformers" (p. 10).

A Paper on "Electro-Percussive Welding," by Messrs. C. E. Skinner and L. W. Chubb, is given in abstract (p. 5). Our Leading Article deals with this subject (p. 18).

We reproduce an abstract of the annual report of the Comptroller-General of Patents, Designs and Trade Marks (p. 6).

An article on the "Characteristics of Contact Rectification with a Silicon Carbon Contact," by Mr. R. A. Hartsough, is abstracted (p. 9).

An abstract of a Paper on "Telephone Engineering Economics," by Mr. H. A. Smith, appears on p. 14.

We give an account of the last three of the six lectures on "Recent Researches on Atoms and Ions," delivered by Prof. Sir J. J. Thomson, O.M., F.R.S., at the Royal Institution (p. 20).

An account of the discussion which took place at Manchester on Mr. W. R. Cooper's Paper on "Electric Cookers" is given (p. 22).

We abstract a Paper on the "Reorganisation of the Board of Trade and British Consular Service," by Mr. C. H. Lake (p. 25).

Companies' Meetings and Reports. Meetings of the Aldershot Gas, Water & District Lighting Co., Barton-on-Humber Electric Supply Co., Braunton Electric Light & Power Co., Brixham Gas Co., Cleveland & Durham Electric Power Co., Clyde Valley Electrical

Power Co., Galashiels & District Electric Supply Co., Wm. Griffiths & Co., Listowel Electric Light Co., Liverpool District Lighting Co., Salt Union, Slough & Datchet Electric Supply Co., Stewarts & Lloyds and Woking Electric Supply Co. are reported. The directors' reports abstracted include those of the Arbroath Electric Light & Power Co., Bromley (Kent) Electric Light & Power Co., Burnham & District Electric Supply Co., Cork Electric Tramways & Lighting Co., Isle of Wight Electric Light & Power Co., Lancashire Dynamo & Motor Co., Northern General Transport Co., &c. (pp. 37 and 38).

OBITUARY.

DR. HENRY LEWIS JONES.—It is with regret that we learn of the death of Dr. H. Lewis Jones, M.A, M.D., F.R.C.P., A.I.E.E., which occurred at his residence in Harley-street, London, on Sunday, the day preceding his 58th birthday, he having been born at Sheerness on April 5, 1857. Dr. Jones was consulting medical officer to the electrical department at St. Bartholomew's Hospital, and was, perhaps, the best known exponent of the electrical treatment of disease in this country. He was the immediate past-president of the British Electrotherapeutic Society, an honorary Fellow of the American Electrotherapeutic Association, and a member of the French Société d'Electrothérapie et de Radiologie. In 1907 he was president of the Electrical Section at the annual meeting of the British Medical Association at Exeter, and was much interested in the establishment of an Electrotherapeutic Section of the Royal Society of Medicine. He was the author of "Medical Electricity," a book which has gone into its fifth edition. Dr. Jones entered Bart's. in 1879, and was elected to the charge of the electrical department in 1891. He became an associate of the Institution of Electrical Engineers in 1900. Besides his book on "Medical Electricity," he was the author of many Papers on subjects relating to medical electricity.

JAMES HARGREAVES. We regret to record the death at the age of 82 of Mr. James Hargreaves, who was well known in chemical circles as a most prolific inventor. His greatest achievement was the evolution of the Hargreaves-Bird process for the production of alkali and chlorine direct from salt.

PERSONAL.

Mr. W. E. Miller, one of the representatives of the electric cooking and heating department of the Carron Company, has been granted a commission in the 16th Battalion Highland Light Infantry. Up to the present about 60 per cent. of the staff of the department have enlisted since the war commenced.

APPOINTMENTS VACANT AND FILLED.

The Governing Body of Battersea Polytechnic invite applications for the position of principal of the Polytechnic. Commencing salary £800, increasing to £1,000 by £20 per annum. Particulars from the Clerk to the Governing Body, Battersea Polytechnic, London, S.W. *See advertisement.*

A number of sub-station attendants are required with experience in the operation of rotary converters and h.t. three-phase systems. Applications by April 19. *See advertisement.*

A shift engineer is required with good training in electrical and mechanical engineering. Salary, £175 to £200 per annum. Applications by April 19. *See advertisement.*

An engineer is wanted to take charge of shift in large power house in London district. *See advertisement.*

A chief switchboard operator is wanted for a large 11,000-volt three-phase power station. *See advertisement.*

Instrument testers are required by the British Westinghouse Co., Trafford Park, Manchester. *See an advertisement.*

Junior engineers are required by a firm of dynamo manufacturers.

Darjeeling (India) Municipality require an engineer, with electrical and sanitary experience. Salary Rs. 500 (rising to Rs. 700) a month with free house, &c. Applications to J. T. Rankin, Esq., I.C.S., Chairman Darjeeling Municipality.

Mr. H. Oswald has been appointed engineer-in-charge at Wimbledon electricity works, at £104 a year, rising to £156 by annual increments of £13.

Mr. W. L. Chubb, of Horsham, has been appointed deputy electrical engineer at Stafford.

INSTITUTIONS AND SOCIETIES.

Benevolent Fund of the Institution of Electrical Engineers.—An appeal has been issued by Sir John Snell on behalf of the Institution's Benevolent Fund. The Committee of Management have before them three urgent cases, which it is felt should be dealt with by the brother members of those whose families are in need of help. In all these cases there are no relatives able to assist, and the Committee feel that each of these cases properly falls within the scope of the Benevolent Fund. There are, in addition, other cases of members and of families of members who are in receipt of assistance from the Fund, and it is anticipated that further deserving cases will in the near future come before the Committee. Considering the size and importance of the Institution, it is felt that a Benevolent Fund which has been in existence for some 25 years ought to have a larger accumulated capital than £4,640, and a larger income from investments than £175 per annum. During the year 1914 the annual subscriptions from members amounted to only £87, and donations of single sums amounted to £93, that is a total of £180, which is considerably less than could fairly be expected from an institution of over 7,000 members. It is hoped that a ready response will be made to the appeal to increase the resources of the Benevolent Fund in order to enable the Committee to relieve the distressed and to assist the dependents of those of our members who have fallen by the way, as the amount at the disposal of the Committee is at present entirely insufficient to meet adequately the demands made upon it.

Institute of Radio Engineers.—A record number of over 200 attended the March meeting of this Institute, at which Mr. E. H. Armstrong presented a Paper on "Recent Developments in the Audion Receiver." Mr. Armstrong described in detail the regenerative receiver with which his name is identified, and outlined its use both as an amplifier and a "beats" receiver for sustained waves. At the meeting held on April 7th, Dr. I. Langmuir presented a Paper on "Applications of Thermionic Currents to Radio Telegraphy and Radio Telephony."

Junior Institution of Engineers.—A lecture was given recently by Mr. R. J. Mitchell before this Institution on the "Electric Vehicle," in which the author observed that the phenomenal progress which the petrol vehicle had made during the past 15 years had obscured the fact that on the Continent of Europe, and more particularly in the United States, an immense advance in quite another line of commercial carrying vehicle had been made—that is, in the use of accumulator commercial vehicles. This was surprising, in view of the great disabilities under which these vehicles operated, as compared with conditions in this country, for in the States roads were bad, energy dear, labour dear, first cost of the machines rather heavy, whilst petrol was cheap, petrol chassis also fairly cheap, and produced under conditions of manufacture quite unknown in this country. Nevertheless, in the States the growth of the electric had been phenomenal, and the secretary of the Electric Vehicle Association stated that there were now in operation in the American Union nearly 75,000 accumulator propelled vehicles. Of these, rather more than two-thirds were pleasure cars, the remainder being engaged in commercial work, varying in size from a 700 lb. waggon to a 10-ton coal truck. Immense improvement had been made on the mechanical side during the past 15 years as well as on the electrical side. Accumulators, electric motors and controllers, &c., were rapidly nearing perfection. In fact, it might be said that for practical purposes the modern electric vehicle would remain an exceedingly useful machine even if it were not improved for the next 20 years. The advantages of the electric were manifold, and included very low cost of operation, a safe speed, very slight damage to road surfaces, great handiness of operation, little floor space, total absence of fire risk, smoke, smell, &c., and the fact that they can be driven by relatively unskilled labour with a minimum of tuition. As showing the economy of the electric from a fuel-consumption standpoint, it should be mentioned that an average machine would give the equivalent of 4 gross ton-miles (G.M.T.) of work for 1 unit input of energy. This compared exceedingly favourably with the 30 to 35-ton-miles of energy in commercial work obtainable from a gallon of petrol only on a very well tuned commercial petrol chassis. The mechanical wear and tear of the electric was infinitesimal as compared with that of an internal-combustion machine. Already in this country municipal vehicles, electric 'buses, commercial trucks, vans, platform trucks, tower waggons, tipping waggons and the like were in active operation in many quarters, giving unqualified satisfaction. One firm alone in London employed nearly 50 electric vehicles, having started less than two years ago with one machine.

Diesel Engine Users' Association.—At the March meeting of the Diesel Engine Users Association the questions of the insurance of Diesel engines against breakdown, and the rates charged for this

class of risk, were discussed. It was reported that particulars had been obtained in connection with a large number of Diesel engine plants and these showed that in a considerable proportion of cases no insurance against breakdown had been effected in consequence of the high rates charged by the insurance offices. In nearly all cases in which insurances had been effected, these included damage to surrounding property. The proportion of the amount insured to the total value of the plant concerned varied from about 18 per cent. to 66 per cent., the average being 35 per cent., or about one-third of the total value of the engine. The ratio of the annual premium paid to the total value of the engine insured varied from about 1 per cent. to 3 per cent., and the ratio of the annual premium to the actual amount insured varied from about 3 per cent. to 7½ per cent. Some figures were given of the actual cost of repairs arising from mechanical breakdown during the last two years, but in many cases it had not been possible to obtain the exact figures and it was suggested that in future members of the Association should keep careful account of the cost of such repairs, as these would be of considerable assistance to the Association in dealing with the general question of insurance against breakdown. A scheme of insurance against breakdown was then outlined under which members of the Association would be able to obtain advantageous terms. One important advantage mentioned in connection with this proposal was that arrangements would be made for periodical inspections of the plant and advice and reports by a fully qualified Diesel engine expert. At the present time the inspectors sent to make examinations by insurance companies, though thoroughly qualified as steam engineers, were usually not acquainted with the peculiarities of Diesel engines. After some discussion the proposal was referred to the Committee of the Association for further consideration. It was understood that a standard Diesel engine policy would be submitted, as well as more definite particulars as to the rates which it was proposed to charge.

Electrical Association of Australia.—Mr. O. W. Brain, M.I.E.E., chief electrical engineer of the New South Wales Railways and Tramways Department, has been elected president of the Association, and the Council includes the following: Mr. W. H. Alabaster (president of the Victorian Section) and W. H. Myers (president of the N.S.W. Section) (vice presidents), Prof. Hy. Payne and Messrs. W. J. Newbigin, H. R. Forbes-Mackay and A. C. F. Webb.

EDUCATIONAL NOTES.

University of Liverpool.—In the faculty of engineering complete courses of instruction are provided in civil, mechanical and electrical engineering, naval architecture, physics, chemistry, &c. There are well-equipped laboratories and good facilities for research and practical work. Prospectuses may be obtained from the registrar, Mr. Edward Carey.

University College, London.—The annual report of the University College (London) Committee was recently submitted to the University Senate.

The total number of students for the session 1913-14 was 2,206, distributed as follows: Faculty of arts, 193 men, 194 women; department of fine arts, 77 men, 200 women; faculty of science, 148 men, 50 women; faculty of medical sciences, 138 men; faculty of engineering, 134 men; faculty of laws, 32 men; postgraduate and research students, 313 men, 128 women. Evening students: (a) Faculty of arts, 242 men, 300 women; (b) faculty of science, 22 men, 29 women. For the current session (1914-15), owing to the war, there has been a decline in the total number of 335; there has been an increase in the number of part-time and special students, the decline in full-time students up to the present date being 162. The faculty of engineering has been most affected, nearly all the second and third year men having either taken commissions or have enlisted. The fall in numbers will involve a decrease in fees of not less than £10,000. The report contains a summary of the work of last session, and also some particulars of the war activities of the college. The Pro Patria List already issued contains 600 names, and is divided as follows: Army, 423; Navy, 30; Officers Training Corps [illegible] 60; Red Cross work, women [illegible] 17; Volunteer Aid Detachment, ready for service, 20. A large number of refugee students has been received at the college, each student [illegible]. A former student of the college, Capt. [illegible], has gained the Victoria Cross in the East Africa campaign, and [illegible] has also received the Military Cross for conspicuous gallantry at Givenchy. The completion of the new engineering laboratories has been delayed by the war. A [illegible] of the cost of the equipment and building, and Lord [illegible] H.R.H. Prince Arthur of Connaught, appealed to the [illegible] of the sum necessary for the completion of the [illegible]. The sum still needed for this purpose is [illegible], and [illegible] is required for the special [illegible] and electro-chemical laboratories. The national need of improved facilities for chemical education emphasises the desirability of completing the equipment of these new laboratories. Some important changes and additions have been made in the staff of the faculty of engineering. Prof. Ernest Geo. Coker has succeeded Prof. J. D. Cormack in the chair of civil and mechanical engineering, and Mr. Ernest R. Matthews, the new Chadwick professor of municipal engineering, has taken up the duties of his chair.

ARRANGEMENTS FOR THE WEEK.

MONDAY, April 12th.

WESTERN SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

2 p.m. Visit to Messrs. Christ. Thomas & Bros.' Factory, Bristol.

4:30 p.m. Annual general meeting at the Merchant Venturers' Technical College, Unity-street, Bristol. Discussion on "Electric Heating and Cooking."

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C. Paper on "Electrical Heating and Cooking Apparatus," by Mr. S. M. Hills.

TUESDAY, April 13th.

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting at the Engineers' Club, 17, Albert-square, Manchester. Paper on the "Power Supply of the Central Mining-Rand Mines Group," by Mr. J. H. Rider.

SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C. Paper on "Main Roads, Past and Present, and Modern Methods of Construction and Maintenance," by Mr. F. Grove.

SCOTTISH SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at the Rooms, 207, Bath-street, Glasgow. Paper on "Power Plant Testing," by Mr. W. M. Selvey.

WEDNESDAY, April 14th.

YORKSHIRE SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Meeting at the Technical College, Bradford. Lecture on "Good Lighting and its Immediate Effects from the Economic Standpoint," by Mr. V. H. Mackinney.

BIRMINGHAM SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting at the University, Edmund-street, Birmingham. Paper on the "Power Supply of the Central Mining-Rand Mines Group," by Mr. J. H. Rider.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

7:30 p.m. Meeting at St. Bride Institute, Fleet-street, London, E.C. Paper on "Autogenous Welding," by Mr. L. M. Fox.

STUDENTS' SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:45 p.m. Meeting at the Institution, Victoria Embankment, London, W.C. Paper on the "Electric Drive of Rolling Mills," by Mr. J. M. Heslop.

THURSDAY, April 15th.

INSTITUTION OF ELECTRICAL ENGINEERS.

§ *p.m.* Meeting at the Institution, Victoria Embankment, London, W.C. Paper on the "Power Supply of the Central Mining-Rand Mines Group," by Mr. J. H. Rider.

FRIDAY, April 16th.

INSTITUTION OF MECHANICAL ENGINEERS.

§ *p.m.* Meeting at Storey's-gate, St. James's Park, London, S.W. Presidential Address by Dr. W. C. Unwin, F.R.S.

THE NATIONAL RELIEF FUND.

(Treasurer H.R.H. The Prince of Wales.)

This great National Fund, for the relief of those amongst the needier classes who are widowed, orphaned and otherwise affected by the fighting in which our troops and ships are now taking part, urgently seeks contributions however small. These can be sent with the following note, which can be cut out, filled in, put in an envelope and sent *unstamped*, addressed H.R.H. The Prince of Wales, Buckingham Palace, London.

Date.....

I enclose £ *s. d. toward the Prince of Wales'*

NATIONAL RELIEF FUND.

Name .....

Address.....

ELECTRO-PERCUSSIVE WELDING.*

BY C. E. SKINNER AND L. W. CHUBB.

Summary. The authors describe a method of welding, employing the discharge from an electrolytic condenser to generate the heat at the ends of the wires at the moment of impact. The properties of the welds so obtained and the possible applications of the method are discussed.

The soldering and welding of aluminium has always given trouble, and the satisfactory joining of small wires has been very difficult if not impossible. In the last few years the substitution of aluminium wire for copper wire has demanded a good means of joining aluminium and the electro-percussive method of welding was developed primarily for this purpose after a very thorough investigation into the available methods of soldering and welding of aluminium.

With aluminium the natural oxide, which always covers the surfaces of the two pieces to be welded, prevents the metal from flowing together after the ends have been melted in the usual way. Large wires and rods of aluminium can be welded by melting the metal under the oxide film and then suddenly pushing the ends of the two pieces together. Small wires cannot be joined satisfactorily by this method, or in air by any other prolonged heating method, because of the skill required, and also because such joints in small wires, if made, are oxidised to such an extent that they are brittle and weak.

In 1905, while experimenting with electrolytic condensers and rectifiers, one of the authors noticed that wires could be connected to the aluminium plates by the condenser spark when the cells were discharged. It was noticed that copper wires could be attached to aluminium or that two pieces of aluminium could be joined together by the condenser spark. It was therefore decided to try this method on a larger scale. From the first, the same principle of a simultaneous condenser discharge and percussive engagement has been used, but during the tests and development of welding tools it was found that the best results depend upon several variables, such as the condenser

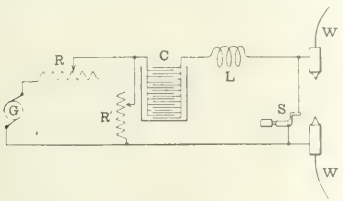


FIG. 1.

capacitance, the velocity and force of impact, the voltage and the resistance and inductance in circuit. After constructing an apparatus with wire grips on hinged arms which were pulled together by a rubber band, a second apparatus was built similar to a pile driver, with one stationary and one moving wire grip. With this arrangement the force and velocity could be varied independently by the separate adjustment of the drop and mass of the moving part. The welding circuit (Fig. 1) consists of a direct current line, or a generator (G) which charges an electrolytic condenser (C) through a high resistance (R). Adjustment of the voltage of the charged condenser is obtained by field control of the generator or by varying the resisters R and R'. The wires (WW) to be welded are secured in the wire grips of the welding tool which are connected to the terminals of the condenser through an inductance (L) of from 2 to 10 turns of cable. A spring switch (S) with carbon contacts, normally held closed, is connected across the jaws of the welder so that their P.D. will be zero while the wires are being put in or the finished product is being removed. The welder is connected to the auxiliary apparatus by means of long flexible cables which allow welding within a radius of about 50 ft. without moving the condenser and other heavy apparatus.

The process of welding is as follows: The wires are secured in the wire grips and the ends cut off as short as possible with a suitable pair of cutters. The switch (S) is then opened which charges the condenser to the proper voltage, a catch is then released which lets the sliding member fall and bring the ends of the two wires into percussive engagement. At the instant of contact, the short circuit current of the condenser builds up to such a value that the ends of the wire are melted by the explosive discharge and instantly forged together by the blow of the falling mass. The weld is then complete, and after being removed from the machine will be found to have the strength of the original wire.

* Abstract of a Paper read before the American Electro-chemical Society.

The generation of the heat is so localised, so sudden and so intense, that there is no time for unequal heat conduction through the shanks of the wire, and the ends will be melted and even vaporised whether the melting point is high or low. For this reason metals of different kinds can be welded together independent of their electrical resistance, melting point or heat conductance. Any combination of metals, which has so far been tried, will weld together, but the joints will not be permanent with such combinations as aluminium and tin, or lead and iron. The generation of heat at the point of contact depends upon an appreciable resistance being offered to the current between the wire ends, and it is therefore necessary to cut the ends of the wires in such a way that they will make a point contact preferably at the centre, so that the energy of the condenser will vaporise the small section of metal and wet the rapidly approaching surfaces with the intense heat of the arc. To do this the wires are cut with ordinary cutters which give a chisel edge. The two wires are cut off in such a way that the two chisel edges are at right angles and the point of first contact will be at the intersection at the centre.

The time between the first contact and the finished weld is of such short duration that the exact action cannot be recorded. The curves of Fig. 2, drawn to scale, show the current through and the voltage across the weld during the operation of welding a No. 18 B. & S. gauge wire. These curves were taken direcly from an oscillogram, and the power or product curve has been figured and drawn in. Electrically the weld is complete in 0·0012 second, and although 23 kw. are being dissipated between the ends of the wire at a certain instant, the total energy used at the weld is only 0·00000123 kw.-hour. The cost of this amount of energy at 5d. per kilowatt-hour would be 24 millionths of a penny.

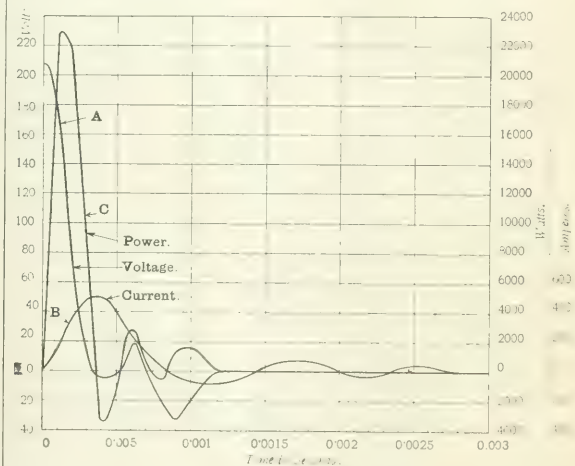


FIG. 2.

It will be noticed that the watt curve is oscillatory and that the negative values would indicate a return of stored energy. Such a thing would be impossible from a metallic arc, but can be explained by saying that the voltage was measured above and below instead of between the wire chucks, and the storage and return of energy is from the magnetic flux produced in the steel chucks set up by the current of 500 amperes flowing through them. The electrolytic condenser has high absorption if the current through it is reversed in an attempt to change its polarity. For this reason any tendency toward an oscillatory discharge will be quickly damped by the internal losses of the condenser, and the energy of the charge will be partly lost.

Enough resistance cannot be maintained at the weld to prolong sufficiently the current and heating until the final contact, and the very high frequency oscillation due to the small inductance of the circuit will cause an explosive snap at the weld, the current will suddenly be damped by the absorption of the condenser, the arc will go out before final contact, and the wires will not be hot enough to form a good weld. In order to maintain the arc until final contact, it is therefore necessary to lower the frequency of the discharge and prevent the sudden rise of current at the first instant of contact by inserting additional inductance in the discharge circuit. This inductance prevents the explosive and wasteful discharge, prolongs the current, and apparently maintains the heating until final contact is effected. The inductance will, of course, increase the tendency toward oscillation, and although the total energy dissipated at the

weld may be diminished, it is more efficiently used and not wasted in noise or thrown out in metallic vapour.

The equations expressing this interesting transient are not as valuable as the ear in telling what adjustments are best for any particular weld. The mass and drop of the falling chuck must be sufficient to forge the wire slightly, and then all that is necessary is to change the voltage and inductance so that the discharge sounds like a splash or thud instead of a sharp crack. Generally, the operator can guess at the settings and no trials need be made. When the same work is to be repeated, the machine once set will make a perfect weld every time, and the rate of welding will be limited only by the mechanical handling of the product. The new process has some distinct advantages over the usual methods of working metals, and is especially adapted to welding small sections of like or unlike metals. In many cases a saving of expensive material can be effected; in other cases work can be done which cannot be done by other methods; joints can be made without overheating the metals, and the welds will be ductile and strong.

Properties of the Weld.—Many of the alloys of most metals are very hard and brittle. As an example, there are alloys near both ends of the copper-aluminium series which are unworkable, and yet electro-percussive welds between these two metals are so ductile that they may be worked in a die, forged, or rolled into thin foil. Any alloy formed at the weld must range from 100 per cent. copper on one side to 100 per cent. aluminium on the other; but possibly the brittle combinations are so thin that the joint as a whole is flexible and ductile. This joint between aluminium and copper is of great importance, as copper lead wires which solder and connect easily can readily be attached to aluminium coils. At first it was feared that a diffusion of the two metals in service would finally result in a brittle joint, but tests show that after four years the joints are practically as strong as when first made. Similar ductility has been noted in almost every combination of metals when first welded, but diffusion, disintegration and loss of ductility eventually result in such welds as silver to tin, or aluminium to tin.

Metals which are either hardened or softened with heating and sudden cooling can be welded together without appreciable change in the physical properties of the material. Tempered spring steel welded, reduced to uniform diameter and tested, has shown equal or greater strength at and near the weld without any noticeable change in temper. Metals such as hard drawn copper, silver, aluminium, &c., which soften with heat can be welded together without causing any local annealing, and these metals and steel when soft can be welded together without detrimental local hardening. Several possible explanations of the constancy of the mechanical properties before and after welding can be given. First, such sudden heating and cooling may not allow change in molecular structure. Second, with hard steel, the heated metal at the weld is so suddenly cooled by conduction of heat into the two shanks of metal that it is again hardened. Third, with hard copper, silver, aluminium, &c., the heating and sudden cooling would ordinarily soften the metal, but the cold forge of the blow in welding possibly hardens it again. Fourth, the metal subjected to the sudden cycle may be hardened or annealed (depending upon the characteristics of the material welded), but the amount of material affected may be too small to be detected. The authors show micrographs of welds by this process and discuss the deductions which can be made from them.

With regard to the electrical resistance of two wires of different material welded together, this will not be appreciably increased by the small film of high resistance alloy which may be formed in welding. Tests of a wire of 85 alternate pieces of aluminium and copper joined with 84 welds in a total length of 23·5 cm. showed an increase of 0·56 per cent. in resistance in three years. This test was made to determine whether or not diffusion would occur. The increase is small and may be due to a change in the joints or may be due to error of observation or oxidation of the wire. The sample was recently rolled, and its malleability indicated no appreciable change.

While the development of this welding method was brought about primarily by the necessity for the successful joining of aluminium wires and the joining of copper leads to such aluminium wires, it is evident that the method is capable of an extremely varied application. Since metals varying as widely in characteristics as platinum and tin may be easily welded, it follows that almost any metals may be joined where the joint is within the limits of the capacity of the machine specified. While the apparatus up to this time has been made only for the welding of wires, 0·072 in. diameter and smaller, the application to larger sizes is merely a question of the design of machine required. Enough has also been done to show that welding of metals other than wires may be successfully accomplished; as for example, the welding of points to plates and small pieces to irregular shaped objects or flat surfaces. Electro-percussive welding has already been used to a considerable extent in the joining of aluminium wires; the welding of copper and aluminium wire; platinum and nickel; platinum and copper; and the welding of various types of thermo-couple wires. It has also been used for the reclamation of short pieces of wires of various kinds, such as aluminium, platinum, spring steel, &c. The electro-percussive method is suitable for many applications in the jewellery trade, such as the joining of platinum without showing any solder line; the welding of sterling tips to table forks without annealing; the welding of pins to badges, and many other similar applications. The attachment of contact points of platinum, tungsten, silver, &c., for various electrical purposes is also very readily accomplished. In conclusion, the authors believe that the electro-percussive method of welding opens up a wide field of welding hitherto impossible. It also overlaps, to a certain extent, some of the present methods, but it will probably never supersede the existing methods for the welding of very large sections.

PATENTS IN 1914.

We give below an abstract of the thirty-second report of the Comptroller-General of Patents, Designs and Trade Marks, Mr. W. Temple-Franks.

The War and Legislation. Upon the outbreak of the war in August last it became apparent that its effect upon all forms of industrial property in which an alien enemy had any interest would be serious and far-reaching. There was a cessation of the import of patented goods from belligerent countries; and the sale and manufacture of such goods in this country by alien enemy firms were equally affected. In many cases manufactories and businesses owned by alien enemies were entirely abandoned. The same effects were noticeable in the case of goods sold under a registered trade mark or bearing a registered design owned by an alien enemy. Many of such goods were of the utmost importance to the nation's trade, and it became necessary to consider how far their manufacture and sale in this country could be properly fostered and encouraged. In order to meet these difficulties the Patents, Designs and Trade Marks (Temporary Rules) Acts, 1914, were passed in the early days of August, giving power to the Board of Trade to make rules during the continuance of the war for the avoidance or suspension of any patent or licence, the person entitled to the benefit of which was a subject of a state at war with His Majesty; for avoiding or suspending the registration of any design or trade mark, the proprietor whereof was a subject as aforesaid: for avoiding or suspending any application made under the Patents and Designs Act, 1907, or the Trade Marks Act, 1905; for enabling the Board to grant licences in respect of any patent or design and for extending the time for doing any act or thing required to be done under the Acts. Following upon these Acts the Board of Trade passed a series of rules:—

1. As regards patents, these rules provide that the Board of Trade may, on the application of any person, and subject to such terms and conditions, if any, as they may think fit, order the avoidance or suspension, in whole or in part, of any patent or licence granted to a subject of any state at war with His Majesty, and the Board, before granting any such application, may require to be satisfied on the following heads: (*a*) That the patentee or licensee is the subject of a state at war with His Majesty: (*b*) that the person applying intends to manufacture or cause to be manufactured the patented article, or to carry on, or cause to be carried on, the patented process; (*c*) that it is in the general interests of the country or of a section of the community, or of a trade, that such article should be manufactured or such process carried on as aforesaid. In practice such applications have been heard at the Patent Office before a committee consisting of the Comptroller-General and Sir Cornelius Dalton, K.C.M.G., C.B., who after hearing the applicant, the agent or representative of the patentee (if any), and any witnesses called by either side, have made a detailed report to the Board recommending the course to be pursued. In the majority of cases licences to manufacture under the patents have been granted to proper applicants on the condition of paying a royalty to the Public Trustee until the Board order otherwise. Such licences, if not revoked, will continue until at the conclusion of the war, a reasonable licence has been offered to the licensee by the patentee. The ultimate destination of the royalty will no doubt be carefully considered by the Board of Trade at the end of the war, when all the circumstances, including the treatment of British industrial property in alien enemy countries, will be taken into account. Under these Acts and Rules, 250 applications for the avoidance or suspension of patent rights have been made up to the end of the year. In the case of 172 applications licences have been granted, or are in course of being granted. On two applications the patents have been avoided, and in one case the patent has been suspended. 20 applications have been refused and 39 withdrawn. In 10 cases the applications were returned as not being required by reason of the patent having expired or for some other cause; five applications were allowed to stand over; and one licence under a patent was avoided.

2. One application only has been made in respect of a registered design and in this case the registration has been suspended in the applicant's favour and the licence granted.

3. Applications for the suspension or avoidance of trade marks have been heard before the same tribunal as those in respect of patents, and the principles upon which the Board have acted were publicly notified in the

"Official Journal" in the following terms: "Suspension will, as a general rule, only be granted in the following cases: (1) Where the trade mark is the name of a patented article, and a licence is granted under the patent protecting it. (2) Where it is the only name or only practicable name of an article manufactured under an expired patent. (3) Where it is the name or the only practicable name of an article manufactured in accordance with a known process or a formula which has been published and is well known in the trade. Generally speaking, "suspension will not be granted in the case of pictorial devices." It follows from these principles that avoidance or suspension of a trade mark has only been granted in cases where the trade mark would not be recognised as legally valid or registrable, and where the registration would probably be avoided if an application were made to the Court. Up to the end of the year 91 applications had been made. Of these, 33 were refused and 17 withdrawn, while in 21 cases registration was suspended, and in 12 cases registration was avoided. The remaining applications are pending.

4. To meet the difficulties arising in the case of applications and proceedings by alien enemies actually pending before the Patent Office, the Comptroller was, by Rules 2 and 3 of the Patents, Designs and Trade Marks (Temporary) Rules, 1914, given power at any time during the continuance of the rules to extend the time prescribed by the Patents and Designs Act, 1907, or the Trade Marks Act, 1905, or any rules thereunder, for doing any act or filing any document in the following cases: (*a*) Where it is shown to his satisfaction that the applicant, patentee or proprietor, as the case may be, was prevented from doing the said act, or filing the said document, by reason of active service or enforced absence from this country, or any other circumstances arising from the present state of war, which in the opinion of the Comptroller would justify such extension; (*b*) Where the doing of any act would, by reason of the circumstances arising from the present state of war, be prejudicial or injurious to the rights or interests of any applicant, patentee or proprietor, as aforesaid.

In the main the policy upon which the Comptroller has acted in dealing with applications made by alien enemies, has been to attempt to carry on as far as possible all applications before the Patent Office and even to receive further applications from alien enemies. No patent rights are, however, granted, and the question of extending the time for the doing of any act or the payment of any fees is considered only when the applicant is in a position to pay the fees or carry on the proceedings. As regards the whole of this emergency legislation and procedure it may be noted that the policy has not been to destroy or confiscate the patent rights, or rights arising from the registration of designs or trade marks, owned by alien enemies. The course taken has been to foster the sale and manufacture of goods by giving to the manufacturer or merchant an effective security against any legal proceedings for infringement hereafter. The grant of licences to British citizens and the suspension or avoidance of certain trade marks have secured the continuance of manufacture and sale in this country of articles which are necessary for public use and for the public welfare. The Acts and Rules provide means by which pending applications and other proceedings before the Patent Office where alien enemies are concerned may be resumed at the conclusion of the war and proceeded with in due course, provided that proper reciprocity be given to British subjects in enemy countries.

Deposit of Documents relating to Foreign Patents, Designs and Trade Marks.—At the request of the Council of the Chartered Institute of Patent Agents a Record Department was opened in the Patent Office on Aug. 22, 1914, where notifications and documents relating to foreign patents, designs and trade marks, which, owing to the war, could not be forwarded to their destination abroad, might be deposited, so that the intention on the part of the depositor to do some act or to file some document on a certain date at a foreign patent office might be recorded here for what it was worth. It was made clear, however, to depositors that no guarantee could be given that this procedure would be recognised by the foreign patent office. The institution of the Record Department has evidently met a want, and many patent agents have filed documents here in regard not only to belligerent states, but also to other countries the postal service of which was disturbed or interrupted. Up to the end of the year no less than 815 notifications were deposited, as follows: Germany 286, Belgium 162, Austria 136, France 101, Hungary 64, Russia 19, Luxemburg 10, Sweden 7, Switzerland 5, Italy 5, Norway 3, Roumania 3, Australia 2, Holland 2, Japan 2, Spain 2, Turkey 2, Argentine Republic 1, Denmark 1, Portugal 1, U.S.A. 1.

Trend of Invention in 1914.—The subject of locomotion in general maintains its pre-eminence in the field of invention. The flow of applications relating to the many branches of this subject was maintained at about the same rate as in the previous year until the outbreak of war, after which a considerable fall took place. The great activity noted during the last few years in the motor-vehicle industry appears to have passed its zenith, the number of applications in connection with motor-vehicles and internal-combustion engines, although still great, showing a notable falling-off as compared with the previous year's total. Considerable attention has been given to the cycle type of vehicle, including motor attachments of the "auto-wheel" type to cycles. Tractors for agricultural and military purposes, and signals for indicating to a following vehicle an intention to turn or stop, are also noteworthy features. The interest in railway signalling has been well maintained, but no marked departures from known types of apparatus are revealed. As a further instance of the interest taken in the safety of railway passengers, a great amount of inventive ingenuity has been applied to the problem of simultaneously locking all the carriage doors of a train from the guard's van. The outbreak of war naturally provided a stimulus to inventions connected with military and naval subjects, particularly aerial warfare and submarine mining. Bombs and their projection from aircraft have claimed considerable attention from inventors as also have means for detecting submarines and torpedoes, and for protecting ships therefrom. Applications for darts, mechanical means for throwing bombs and other projectiles, and body-armour provide an interesting side-light on the revival of ancient methods of warfare. Amongst other inventions in connection with military matters may be mentioned bullet-proof shields; periscopes for enabling observations to be made while the observer remains under cover in a trench; sleeping bags; and combination knives, forks and spoons. The issue of Treasury notes of small denomination was the occasion of a considerable number of applications for purses for holding paper currency. Toys and games, particularly of a warlike nature, are responsible for a large number of applications. Dolls' heads and eyes, previously largely made abroad, and "foot-cycles," now so popular amongst the juvenile section of the community, may also be worthy of mention in this connection. The disaster to the submarine A 7 directed attention to the problem of locating wrecked submarines, and signalling to and rescuing their occupants. In the field of aeronautics, in which invention has been very active during the last few years, a marked falling-off is observed. The interest in visual signal-indicators for mines has been well maintained. The electrical industry as a whole is very prominent, although few outstanding features call for comment. There has been continued progress in automatic and semi-automatic telephone systems. Attention has also been given to receiving arrangements for cable telegraphy, and to ionised-gas relays for use in telephony and wireless receivers.

The number of applications for patents in 1914 was 24,820, as against 30,077 in 1913, and 30,089 in 1912. There were 16,590 provisional and 16,443 complete specifications as compared with 19,673 and 19,309 in 1913, and 19,825 and 18,853 in 1912. The patents sealed were 15,036, as against 16,599 and 15,814 in 1913 and 1912 respectively. For designs there were 34,354 applications, of which 33,362 were registered. In 1913 these figures were 40,429 and 39,275, and for 1912, 43,015 and 42,077 respectively. There were received 8,317 applications for trade marks, of which 4,408 were registered. In the two previous years 9,689 and 10,014 applications were received, and 5,071 and 4,942 registered.

The receipts from patents fees were 287,118, as compared with £307,054 in 1913, a decrease of £19,936; from designs fees £7,585, as compared with £8,166, a decrease of £581; and from trade marks fees £16,439, as compared with £17,741, a decrease of £1,302. The receipts from the sale of Patent Office publications (which are paid over to the Stationery Office) were £11,551, as compared with £13,362, a decrease of £1,811. The total receipts were £322,829, as compared with £346,324, a decrease of £23,495. The total expenditure on behalf of the office was £194,767, as compared with £194,423, an increase of £344. The surplus of receipts over expenditure was £128,062, as compared with £151,901, a decrease of £23,839.

The number of readers who made use of the library was 140,418, as compared with 158,220 in 1913. The number of volumes added to the library was 6,078, of which 977 were volumes of patent specifications or patent journals, and 798 were trade catalogues. The remaining 4,303 volumes were scientific text-books or periodicals, 2,974 being obtained by purchase and 1,329 by gift or exchange. The number of works in the library at the end of the year was 51,131, and the approximate number of volumes (exclusive of duplicates) was 154,000. Since the outbreak of the war the library has been closed to the public after office hours. Recently, however, an arrangement has been made by which readers, who are unable to attend during office hours and are engaged upon work in connection with which access to the books and records in the library is important, may obtain special tickets of admission for Saturday afternoons between 1 p.m. and 6 p.m. The new "relative" shelf classification of the library has been extended from GN to GP Light. Classes S Medicine and T Natural History have been completed; PM—Q Military and Naval Sciences, and R Sanitary Engineering and Public Hygiene, have been set up in part in the new class order. Progress has also been made in V Agriculture. The following section of the library series was published during 1914; CK15—CO17. Enamelling, Art Metal work, Furniture, Costume and Hair Dressing and Working. The duplicate sets of foreign patent specifications continue to be largely used, and 312 searches were made through the German specifications in 1914 as compared with 263 in 1913. During the year 245,118 patent specifications, 5,888 abridgment volumes, 53,251 "Illustrated Official Journals," and 32,680 "Trade Mark Journals" were sold, as compared with 287,942, 8,303, 52,254 and 34,198 respectively in 1913. The number of deposit accounts increased from 488 to 518. Of the depositors, 49 live in London, 144 in other parts of the United Kingdom, and 325 abroad. The number of specifications of expired patents reprinted at the cost of the office under the arrangement recommended by the Departmental Committee of 1900 was 643, and the net cost was about £940. In addition to these, 3,010 specifications were reprinted for official purposes.

Patents.—The renewal fees amounted to £185,074, as compared with £188,033 in 1913, a decrease of £2,959, and the sealing fees to £14,681, as compared with £16,668, a decrease of £1,987. The applications accompanied by provisional specifications fell from 19,673 in 1913 to 16,590, a decrease of 3,083, and those accompanied by complete specifications fell from 10,404 to 8,230, a decrease of 2,174. The total number of applications was thus 24,820, as compared with 30,077, a decrease of 5,257. The complete specifications filed on previous provisionals fell from 8,905 to 8,213, a decrease of 692; and the total number of complete specifications received was thus 16,443, as compared with 19,309, a decrease of 2,866. The proportion of complete to provisional specifications filed on application was nearly 50 per cent. as compared with 53 per cent. in 1913. The total number of specifications (provisional and complete) received was 33,033, as compared with 38,982, a decrease of 5,949. The above

comparisons show that there has been a very considerable decrease in the number of specifications of all kinds received in 1914 as compared with 1913. This result is, of course, due entirely to the outbreak of war at the beginning of August. Up to that date there had been a normal increase of about 3 per cent. in the number of applications. During the last five months of the year, on the other hand, there was a decrease of 41 per cent. in the applications accompanied by provisional specifications, and a decrease of 67 per cent. in those accompanied by complete specifications. The complete specifications filed after provisional specifications also decreased, but not to the same extent. These even in the first seven months of the year showed a small decrease of nearly 2 per cent., which rose to 17 per cent. after the outbreak of the war. The total number of specifications (provisional and complete) received before the beginning of the war was 2 per cent. more, and afterwards 40 per cent. less, than during the corresponding period of 1913. So long as the war continues there is little chance of any revival of patent business, and it is probable that the figures will fall even below their present level. The largest number of applications made on any one day was 221, on June 23rd, and the smallest 27, on August 29th and again on September 7th. The applications received from women inventors numbered 347, as compared with 497 in 1913. The applications made by way of communication from abroad numbered 1,291. Of these 729 came from the United States of America, 300 from Germany, 41 from Belgium, 38 from France, 15 from India, 13 from Italy, and 12 from Canada. The number of applications made in this country under the provisions of the International Convention for the Protection of Industrial Property by the various States of the Union in 1914 was 2,909, a decrease of 764, as compared with 1913. The number of applications post-dated in consequence of disconformity between the complete and provisional specification was 286, and the number of applications for patents of addition 715, as compared with 296 and 888 respectively in 1913. The number of cases in which complete specifications were filed in respect of cognate provisional specifications was 455, as compared with 495 in 1913. Typical specimens were furnished in connection with applications for chemical inventions in 14 cases; 163 sample bottles and 211 dyed or printed specimens being filed.

As a result of examination of complete specifications filed upon applications made in the year 1913, 1,002 were reported as wholly anticipated, 10,401 as partly anticipated, and 5,305 as not anticipated. Of those anticipated, 10,422 were amended without a hearing taking place, and 593 after a hearing and decision. In 286 cases a reference to a previous specification was inserted. Out of 13,995 patents sealed upon the applications made in the year 1901, 594, or 4·2 per cent., were maintained for the full period of 14 years. The total number of patents which expired in 1914 was 16,408, and the total number of new patents sealed 15,036. Thus, the number of patents in force was decreased during the year by 1,372. The number of applications made for the restoration of patents which had lapsed in consequence of the non-payment of renewal fees was 35, of which three were subsequently withdrawn, and three are still pending. In each of the remaining 29 cases the patent was restored. Under the provisions of sec. 26, which empowers the Comptroller to revoke a patent upon application made within two years from the date of the patent by any person who would have been entitled to oppose its grant, there were 14 applications. In two cases the patent was revoked (in one of these by consent), and in three orders were made requiring an amendment of the patentee's specification. Two applications were dismissed, two were withdrawn, and the remaining five are still pending. Under the provisions of sec. 26 (3), one offer to surrender a patent was received, and the patent was revoked. The number of applications made under sec. 27 for the revocation of patents worked exclusively or mainly outside the United Kingdom was 19. In four of these cases the patent was revoked (by consent), and in eight the applications for revocation were withdrawn. One application was dismissed, and the remaining six are still pending.

During the last 10 years the number of hearings upon oppositions to the grant of patents was 1,245, and the number of appeals to the Law Officer in these oppositions 245, of which 47 were withdrawn or abandoned and one is still outstanding, while in two cases the appliation for the patent was abandoned. The number of appeals heard by the Law Officer in these cases was therefore 195. In 132 of these appeals the decision of the Comptroller was supported, in 34 varied, and in 29 reversed. During the same period the number of hearings upon opposition to amendments in specifications was 85, and the number of appeals 35, of which 12 were withdrawn. In one case the application for amendment was subsequently abandoned, and one appeal is still outstanding. In the 21 appeals which were heard by the Law Officer, the decision of the Comptroller was supported in 15 cases, varied in four, and reversed in two. There were 1,407 hearings during the same decade under sec. 73 of the Act of 1907 and the corresponding provisions of the earlier Patent Acts, and 42 appeals, of which 10 were withdrawn. In 26 cases the decision of the Comptroller was supported, in three it was reversed, and in three cases were referred back to the Comptroller. One petition relating to a patent of the year 1900 was lodged during 1914, and was subsequently abandoned. There are now three patents in force which [illegible] the normal period of 14 years, dating from [illegible] respectively.

Progress has been made with the Fifty Years' Subject Index for the period 1861-1910 by the publication during the year of 64 sections, [illegible] 126 out of a total of 271. This [illegible] the whole range of patented arts, [illegible] any inventor to obtain readily, without the laborious search previously required, a complete list of [illegible] which have interested. The list can be continued up to date by referring to the subsequent annual, quarterly and monthly subject indexes, which are all prepared on the same plan. The sections already published contain 11,565 separate index divisions, an average of 92 per section.

A further addition has been made to the new series of classified abridgments in 271 volumes for the period 1909-1915 by the publication of 626 sheets (10,016 pages), making, with those previously issued, 2,196 sheets, an average of eight per class. However, owing to the war, the acceptance of complete specifications by "alien enemies" has been suspended, and consequently the figures for the year 1913 are incomplete, and will probably need revision. The effect of this suspension is particularly prominent in such a class as 2 (iii.) Dyes, &c., in which a large number of the inventions come from Germany; in 1912 there was an increase of about 23 per cent., but in 1913 there was an even larger decrease, the total number in that year already accepted being about the same as in 1909.

Designs.—The number of applications to register designs received during the year was 34,354, including 913 sets, as compared with 40,429, including 1,405 sets, in 1913. A "set" is a number of articles of the same general character ordinarily on sale together, or intended to be used together, all bearing the same design, with or without modifications not sufficient to alter its character or not substantially affecting its identity. During the year, 1,715 applications for registration of designs were objected to by the Comptroller. The objections, other than those on account of similarity to designs already registered, were chiefly on account of want of subject matter or want of substantial novelty.

The applicants in 896 cases acquiesced in the objections raised by the Comptroller without applying for a hearing. In 597 cases the applications were allowed after correspondence to proceed. In 216 cases the applicants were accorded hearings, with the result that 22 applications were accepted without alteration; 88 were refused, 104 were accepted subject to modification; and two are still under consideration. In the remaining six cases, an extension of time in which to apply for a hearing has been allowed at the applicants' request. There were three appeals from the Comptroller's refusal. In one case the appeal was allowed, one was dismissed, and one is still under consideration. There were eight applications by registered proprietors to cancel their registrations under Designs Rule 53. The number of designs of which the copyright was extended for a second period of five years was 1,817, as compared with 1,627 in 1913, and the number of which the copyright was extended for a third period of five years was 268, as compared with 242 in 1913.

Trade Marks.—The number of applications made in 1914 for the registration of trade marks (including 88 applications made to the Cutlers' Company of Sheffield) was 8,317, as compared with 9,689 in 1913.

The receipts from various sources on account of trade marks amounted to £16,439. 7s. 8d., including a sum of £4,770. 4s. for renewal fees. By an arrangement sanctioned by the Treasury, the Cutlers' Company retain the whole of the fees received by them in any one year (ending June 30th) up to £400, together with one-half of the fees above that amount. For the year ending June 30, 1914, the fees received by the Cutlers' Company amounted to £344. 14s. During the year 4,815 trade marks were advertised and 4,408 registered. The notices of opposition to the registration of trade marks under sec. 14 of the Act numbered 157, and 44 cases were heard. There were five appeals to the Court. In one case the Comptroller's decision was upheld, and one appeal was withdrawn; in the other three cases (two of which have gone to the Court of Appeal) the Comptroller's decision was reversed. In the cases shown as not determined in my last report one appeal was withdrawn, and in the other the Comptroller's decision was reversed. The appeal to the Court of Appeal was withdrawn. There were two appeals to the Court and 20 to the Board of Trade from the decision of the Comptroller under sec. 12 of the Act. Of the appeals to the Court, the Comptroller's decision was reversed in one case, and the other has not yet been determined. Of those to the Board of Trade, 15 were heard, four being allowed and 11 dismissed, and five were referred to the Court. Of the five cases referred by the Board to the Court, three were subsequently withdrawn, in one the application was cancelled under sec. 18 of the Act, and the other has not yet been heard. There were 38 special applications made under sec. 9, sub-sec. 5 of the Act. Of these, 13 were reported to the Board, who authorised the advertisement of one application, and the remaining 12 are under consideration. Of the other 25 applications, eight were deemed to be withdrawn under Rule 38 owing to the failure of the applicants to state a case, four were withdrawn, three were altered to ordinary applications, and the remaining 10 are not yet ready for report to the Board. Two of these 38 applications were made to the Manchester office. There were 63 applications for special trade marks under sec. 62. Of these, 12 were reported to the Board of Trade who accepted two applications and refused one. Five applications were deemed to be withdrawn under Rule 44 owing to the failure of the applicants to state a case, and the other four are under consideration. Of the remaining 51 applications, one was withdrawn, and the other 50 are not yet ready for report to the Board.

General.—The Trade Marks Act, 1914, was passed to explain clause (c) of sub-sec. (10) of sec. 64 of the Trade Marks Act, 1905, so as to confirm the registration of word marks for cotton goods other than piece goods or cotton yarn. The Patents and Designs Act, 1914, provides for the extension of the rights conferred by sec. 91 of the Patents and Designs Act, 1907, on applicants for patents, designs and trade marks in foreign states to their legal representatives or assignees, and thus gives effect to the Convention made at Washington in 1911. The remaining acts and the rules were passed to meet the special circumstances arising from the war.

CHARACTERISTICS OF CONTACT RECTIFICATION WITH A SILICON CARBON CONTACT.*

BY RALPH C. HARRISON.

Summary.—The author has investigated certain characteristics of contact rectification. Experiments were made to find the most suitable contact and the best construction and method of connection for the same. The preparation of the surface of the contact is discussed, and various results and the conclusions deduced therefrom are given.

During the last 35 years much experimental evidence has been brought to bear upon the phenomenon that a large current will pass in one direction and small current, if any at all, in the opposite direction, through contacts of certain dissimilar solids.† Though the greater part of these investigations have been valuable, there are many unsettled and disputed problems connected with the phenomenon of contact rectification. Some investigators have had much difficulty with the uncertainty of the rectifying properties of the contacts used. Among these uncertainties three are very much in evidence: (1) The direction of flow of rectified current was different with various voltages; (2) at various places on the materials used there would be lacking a rectifying property, and often different places on the same specimen would rectify in opposite directions; (3) the rectifying property would be lost by increasing the voltage a very slight amount.

After careful consideration of all former experiments on the phenomenon of contact rectification, it seemed that to make any sunsequent and real additions to previous investigations a more perfect pair of contacts would have to be found. It seemed from the standpoint of convenience and accuracy that, if a rectifying contact could be found which would stand up against from 5 to 10 volts and give 0·5 to 1·0 ampere rectified current, we should then be in a better position to study its characteristics. Also a very important feature for this proposed contact would be durability of its surfaces

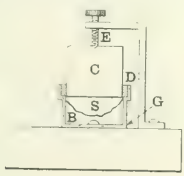


FIG. 1.

as well as permanency of the adjustment of contact of its surfaces. Durability here calls for absence of any change, physical or chemical, which would alter its rectifying action. By the durability or permanency of adjustment of the contact is meant that a certain pressure would remain the most efficient in the rectifying action under given conditions.

A systematic search was begun with the above conditions in mind. With all the better contacts used by former experimenters and a long list of metals and non-metals, a selective and sorting arrangement was devised. About 100 different metals, alloys and non-metals were included in this process, which was essentially as follows: All which apparently allowed more current to pass from than to the substance were put in class A and the opposite in class B. Those which were uncertain in their action were placed in another series. After these three series had been carefully worked over, a cross-testing process was carried on involving the use of both alternating and direct current in each of about 1,000 pairs of contacts tested. It was found that a silicon carbon contact most nearly fulfilled the proposed ideal conditions for a contact as outlined above. Further experiments were then made, and a grade of silicon and carbon found which had the desired properties.

In Fig. 1 is given a sectional view of the arrangement of the contact. S is the silicon mounted in molten type metal and allowed to cool. C is arc carbon, insulated and held in place away from the brass cup container *g*, by a hard rubber ring D. E is a pressure adjusting screw. To connect the rectifier so as to obtain a total effect of the alternating current as direct current. Two methods of connection were experimented with. In Fig. 2 is essentially the aluminium valve rectifier connection. This arrangement requires no auxiliary devices, and is not bothersome from that standpoint.

* Abstract of an article in the "Physical Review."

† Ferdinand Braun, "Pogg. Ann.," 153, p. 556, 1874; 157, p. 350, 1878. F. Streintz, "Akad. Wiss. Wein. Sitz. Ber.," 111—2a, p. 345, 1902. P. G. Nutting, "Phys. Rev.," 19, p. 1, 1904. L. W. Austin, "Bull." Bur. Standards, 5, 1, p. 133, 1908. G. W. Pierce, "Phys. Rev.," 28, p. 153, 1909, 29, p. 478, 1909. A. E. Flowers, "Phys. Rev.," 3, p. 25, 1914. R. H. Goddard, "Phys. Rev.," 34, p. 423, 1912.

However, to get the most efficient effect, all contacts should be adjusted to work the same under like conditions. In Fig. 3 is shown rectifier connected after the manner of a mercury arc rectifier. Altogether the writer had better satisfaction from this connection than from the previous one in Fig. 2.

A slight unsteadiness was noticed when the temperature was about 300°C., but apart from this, temperature seemed to have no effect whatsoever. There is reason to believe that the unsteadiness observed was due to expansion in the metals and thereby a change in pressure. No effect was noticed when the contact was placed in a vacuum of 1 mm. pressure. It apparently worked as well as when in the normal air pressure.

The surfacing and finishing as well as a suitable mounting of the silicon received not a little attention. The grinding was done on a carborundum wheel, but the finishing, a most important part, was accomplished on a thick plate glass, using alcohol and carborundum powder to bring it to as perfect a plane surface as could be obtained. It was found best not to put a high polish on this silicon surface. The surfacing of the carbon was essentially the same as that of the silicon. All surfaces were made chemically clean and dried thoroughly. It is very hard to make even a good estimate of the amount of surface in contact after using the best of care in preparation and manipulation. However, two points applied gave approximately twice the magnitude of rectified current that one point gave. Also, two pairs of surface areas, surfaced exactly the same way, one area being only a little over twice that of the other, gave very approximately twice the rectified current. We are led to conclude that the magnitude of the rectified current is approximately proportional to the area of contact.

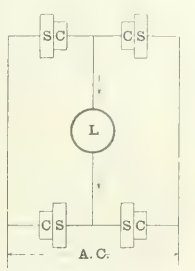


FIG. 2.

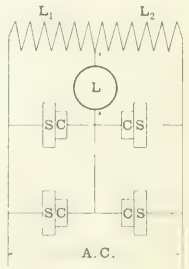


FIG. 3.

The character of the surface of both the silicon and the carbon is so closely allied with efficient rectification that a very thorough study of these surfaces was carried on. Many degrees of fineness of grinding compounds was experimented with to ascertain if possible to what extent the smoothness of surface affected the rectifying property.

After looking into the results of the different grades of surfacing, and after carefully studying the photographs of surfaces, we are led to think that the contact rectification takes place through the action of small points. There is no doubt in the writer's mind that the "forming effect," mentioned above, is a bringing of more points on the surface into activity. The writer's theory is that in the "forming processes" there are points which are very close yet not active as rectifiers, and an increase in voltage causes an arc across these points bringing them into contact. This theory is compatible with the fact that two surfaces which have been "formed," when separated have to be "re-formed" again the same as the first time. This shows that there is no chemical formation, and that this forming is evidently a point phenomenon. A surface once "formed" will hold constant as a rectifier as long as it is undisturbed. With the carbon surfaces the same conclusions are drawn.

In part of the experimental work an effect was noticed which started a long search for a time element in the rectifying action. This effect was the fact that a rectifier which would give complete rectification with an alternating E.M.F., would allow, with equivalent value of direct E.M.F., as much as 15 to 20 per cent. of the current to pass in the high resisting direction. Fig. 4 shows current E.M.F. curved with the direct current. The contact used gave complete rectification with alternating E.M.F. at 5·0 volts. The upper curve gives the current when the voltage was applied from silicon to carbon, the lower curve, the corresponding current when the voltage was applied in the reverse direction. These results could be repeated time after time.

That pressure is closely related to the rectifying property has been pointed out by almost every experimenter, but I believe not one has shown the exact relation. The following readings are characteristic of many taken. They show the effect of pressure, not only upon rectification but also upon the potential drop.

Conditions.—(1) Same voltage throughout experiment (5·0 volts alternating current applied); (2) same contact area (3·44 cm.²).

Volts P.D. contact.	Estim. rectification ratio.	Forces in grams.
4·25	200 : 1	25
3·85	500 : 1	50
3·70	400 : 1	100
3·65	400 : 1	150
3·60	375 : 1	200
3·55	350 : 1	250
3·50	325 : 1	300
3·40	300 : 1	400
3·15	250 : 1	800
3·00	200 : 1	1,200
2·80	100 : 1	1,600
2·25	50 : 1	2,000

Of the many investigators who have used the oscillograph in studying the peculiarities of contact rectification we believe none have reported the fact before mentioned—that a rectifier giving complete rectification will allow, with direct E.M.F., some current to pass in the high resisting direction. It was thought that by the sudden application of direct E.M.F. in the high-resisting direction a building up process, if present, would be detected by a lag in the current curve, but experiment failed to reveal this. Alternating current was now resorted to as offering an explanation of the time element in the rectifying action. Oscillographs were taken of a 60-cycle current beginning with the instant of application to the rectifier. Within the 12 in. of film which revolved on the drum at a speed of 600 revs. per min., a reducing of the current curve in the high-resisting direction was noticeable. Other curves clearly show a building-up effect which almost completely cuts off current in one direction. To get a complete record of this process as well as the time element would require a record 6 ft to 10 ft. long, perhaps more,

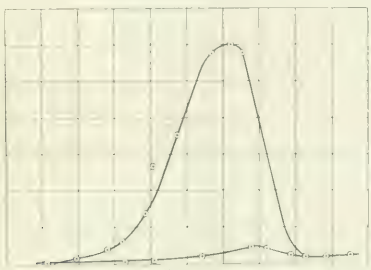


Fig. 4.

travelling at a speed of 600 ft. per minute, which was not available. Lower frequencies were investigated as to the effect they might have on this action.

Conclusions.—The most popular explanation of contact rectification is that electrons are given up more easily by some solids than others, and that the rectification ratio is of the same order as the ratio of emission of electrons at the contact of dissimilar solids. If the "forming theory," given in this Paper, is correct, the theory of the passage of electrons is still intact. It seems that, if the frequency should be increased many times we might get a larger amount of current in the high-resisting direction, for the first few cycles. The writer intends to try this at a later date. Also the "forming action" will require not a little study in its details to understand more accurately what happens.

THE COST AND EFFICIENCY OF TRANSFORMERS.

BY W. E. BURNAND.

Abstract.—The author deals first with the cost of obtaining the highest efficiency when the size of a transformer is varied. Curves are given to facilitate [illegible]. The author then describes an efficiency calculator by which [illegible] can be drawn mechanically for given iron and copper losses.

The Dependence of Efficiency on Cost.

As is well known, a single-phase transformer is a unit consisting of an interlinked magnetic and electric conducting circuit. It is [illegible] to place two or more of these units in parallel, [illegible] parts of the magnetic circuit may be common to more than one phase. Much has been written as to the efficiency and otherwise of various arrangements, but the essentials may be summed up by saying "The highest efficiency is obtained by the arrangement that gives the maximum product of magnetic circuit cross-section by electric circuit cross-section, with minimum length," as the output for a given density is proportional to the product of the two cross-sections, whilst the losses are proportional to this multiplied by the length of the respective circuits.

It is generally stated that this maximum efficiency is given by the plain Faraday ring with circular cross-section of the iron ring, the electric circuit being uniformly wound round this and filling the ring; but this is not quite correct geometrically, and, in fact, a still more efficient arrangement is a ring of approximately semicircular cross-section with well rounded corners, and the other circuit completely filling this circuit and dividing uniformly round the outside of the ring, the finished appearance closely resembling an apple sunk in more than usual at the two ends and being rather large in diameter in proportion to the length.

Neither, of course, is a commercial arrangement, being difficult to wind and insulate and wasteful of materials, so that a more rectangular arrangement is adopted, which, whilst less efficient for a given amount of used material, may still give a higher efficiency for a given cost.

The wasted energy has also to be got rid of, causing further modifications, and labour has to be minimised, and designs kept to shapes that the readily available insulating material can be efficiently used on, so that the final design may be greatly modified by these factors from that which might be evolved as a matter of geometry only.

Whilst the geometrical efficient distribution of metal appears to have been neglected in a number of designs, the tendency is still in that direction, even though this results simply from trial and error; it simply means that the final result is attained by a slow and expensive process which might be very much shortened by a study of the geometry of the matter. The evolution may be traced in the more squat proportions that are obtained in modern designs as compared with many of the old designs, which were often unduly elongated in either the magnetic or electrical circuits constituting the elemets of the transformer. As a result of the present state of transformer design, whether arrived at from first principles or by more or less haphazard evolution, it is quite certain that no new design would stand much chance without being designed at first on fairly geometrical lines put into mechanical and commercial form.

Whatever form may be evolved as the result of these considerations, there still remain certain relations connecting rating, efficiency and cost which hold for a line of transformers of any one form.

Taking, say, a 5 kw. transformer and doubling the voltage and also the current passed through the coils, the output now will be quadrupled, the copper losses also quadrupled (the same percentage as before) and the iron losses rather under four times their former value.

On the above lines of reasoning it has often been stated that to make, say, a 5 kw. of equal efficiency to, say, a 50 kw. of normal rating would cost as much and require the same weight of material as the 50 kw. transformer. This, however, is on the assumption that the space factor remains constant, that the iron loss is proportional to the square of the density, the copper losses also varying as the square of the density. The last is, of course, correct, and it is equally well known that the two latter are only approximate; but I do not think it is realised how far actual departure from the assumptions affect the results obtained.

Curve A, Fig. 1, shows the total loss in stalloy iron with, for comparison, curve B showing the loss if this varied directly as the density, and curve C the assumed square law. It will be seen that the actual loss curve is not very far from being half way between the two comparison curves, being rather nearer the [illegible] the total losses varying in fact about as the 1·7th power of the induction. The extent to which the actual loss curve departs from the midway position between the direct and [illegible] rate is easily made up by the poorer space

factor that would obviously obtain with the 5 kw. made to the 50 kw. dimensions—*i.e.*, for the assumed copper loss—owing to the lower space factor with the lower rating of the transformer. The required increase in the number of turns could not be accommodated, so that the induction could not be reduced at the assumed rate. The result is that as the density is simultaneously reduced in the iron and copper, the iron loss is decreased at not very much more than half the assumed rate, and thus the total losses, if the reduction in space-factor is taken into account, is certainly not over three-fourths that assumed with originally equal iron and copper losses.

The net result from this is that, instead of a 5 kw. transformer made up as large as a normal 50 kw. being equal to that

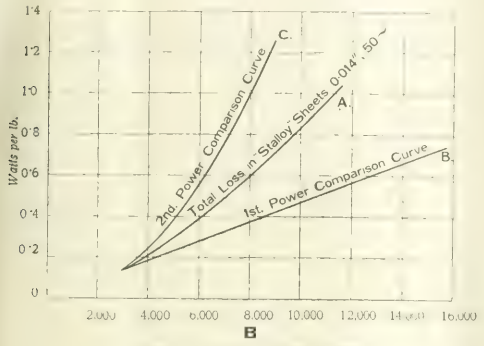


Fig. 1.—Comparative Curves.

50 kw. in efficiency, it would be lower to such a degree that even if made as large as a 100 kw. it would still be of lower efficiency than the normal 50 kw. If, therefore, a price list were arranged for a line of transformers on the basis of one given efficiency, the prices (neglecting irregularities due to cooling arrangements) would rise regularly and rapidly as the rating decreased. On the other hand, with a list based on a given temperature rise, the working density would be increased as the size became smaller, and decreased as the size became larger, the result being a very low efficiency in the small sizes, and a price list, through quite a wide range, at substantially a fixed price per kilowatt.

Without following blindly, therefore, the old fashioned method of basing a list on a given magnetic and current density, this still remains the most rational starting point, provided the

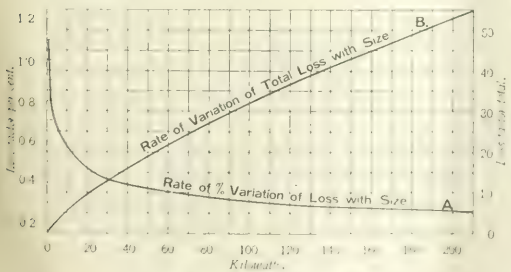


Fig. 2. Loss Coefficients.

requisite variations are made for different voltages, cooling arrangements, &c. This gives an intermediate value, the cost rising as the size is increased at a lower rate than the rated capacity, and the efficiency decreasing slowly with the decreasing capacity.

Limitations are met on the low side by low efficiency and bad regulation, and on the large sizes by heating, involving additional cooling arrangements that upset the even curve connecting cost with size. This follows as the capacity on this basis varies as the fourth power of the linear dimensions, whilst the cooling surface varies as the square. The weight of active material and therefore the loss (and also closely the cost) varies as the cube. Thus the losses in a given line of transformers on this basis increase at a lower rate than the capacity—as the cube of the fourth root. Dividing this by the capacity gives the loss per kilowatt with the various sizes, and a figure proportional to this rate of loss may be called the loss coefficient. This is shown in Fig. 2. The figures on the left, of course, require to be multiplied by a constant dependent on the particular design of transformer to which it is applied. An approximate average figure would be about 5 for the curve A, and 50 for the total watt loss curve B, for 50 ~.

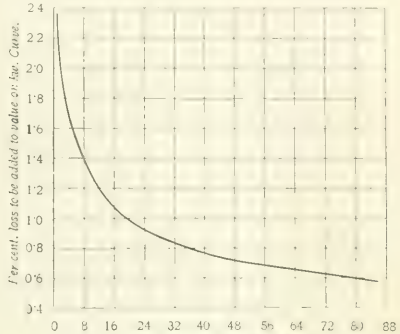


Fig. 3.—Cost Curve 50 ~.

As, of course, other efficiencies are required than those based on one line corresponding to a given density, and, as before shown, it is far from correct to assume that a given size and weight of material will give the same efficiency on any rating within the limits of heating and magnetic saturation, the writer constructed for a firm the curves reproduced in Figs. 3 and 4, as a ready and more nearly correct means of connecting cost with efficiency; they are called the "cost curve" and "kilowatt curve" respectively.

An example will probably best illustrate the use of these curves. Supposing a 30 kw. is required of, say, 97·83 per cent.

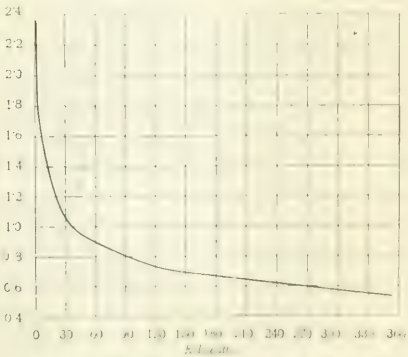


Fig. 4. Kw. Loss Curve (to be added to Cost Curve) 50 ~.

efficiency at point of highest efficiency. This gives a loss of 2·17, which is to be made up of the sum of the losses on the kilowatt curve plus the loss on the cost curve. On the kilowatt curve we see corresponding to 30 kw. is 1·05, leaving a balance of 1·12, and locating this value on the "cost curve" gives £13. 10s. as the cost of metal for the required efficiency.

If only £10 could be afforded, on the cost curve it will be seen that the loss is 1·3, the kilowatt loss remaining constant; therefore, reducing the cost by £3. 10s. increases the loss by 0·18 per cent. If, on the other hand, £20 could be afforded,

the loss by curve 3 is 0·99 per cent.; thus, £6. 10s. extra increases the efficiency by 0·13 per cent.

The figures on the curves represent about fair average present day values. They will, of course, vary through a small range with different types of transformers, but the relative values remain the same, so that a simple coefficient gives the correction required for different types. The originals were got out over 11 years ago, before the commercial advent of silicon steel sheets, and the "loss" values for the particular type of transformer with which they were used were 25 per cent. higher than those now shown, and the "cost" figures (Fig. 3) also 25 per cent. higher.

A fairly common requirement in transformer specifications is to ask for the efficiency to be stated at unity power factor, and at say, 0·75 power factor, but, as in ordinary commercial work the copper losses remain substantially constant with a given current whatever the power factor, the iron losses likewise being constant with constant voltage, this seems superfluous, as the losses stated as a percentage of the watt input simply vary as the power factor and are the unity power factor values divided by the power factor—*i.e.*, the watt loss at 0·5 power factor is a trifle larger, or for 0·5 power factor would be double. A transformer of course does not necessarily transform watts, but volts and amperes, these varying in [illegible] The volt-ampere ratio is really [illegible] the transformer being substantially [illegible] ordinary commercial work for a given load (in amperes) for any usual power factor. This might leave a very slight error if there was a considerable inductive drop in the transformer, but too small to be apparent under ordinary conditions.

Another point to which somewhat undue importance is sometimes attached is the power factor on no-load. As the important point is to keep down the no-load amperes to a reasonable value it would be much better to state that the no-load current must not exceed a given value. I have known cases where on account of the no-load power factor being specified to be a high figure it has been necessary to replace some of the high-grade transformer iron by a few stampings with high hysteresis loss, which has increased the no-load amperes, but increased the losses at a greater rate, so getting the required power factor, and giving corresponding satisfaction, though being in every way a worse transformer.

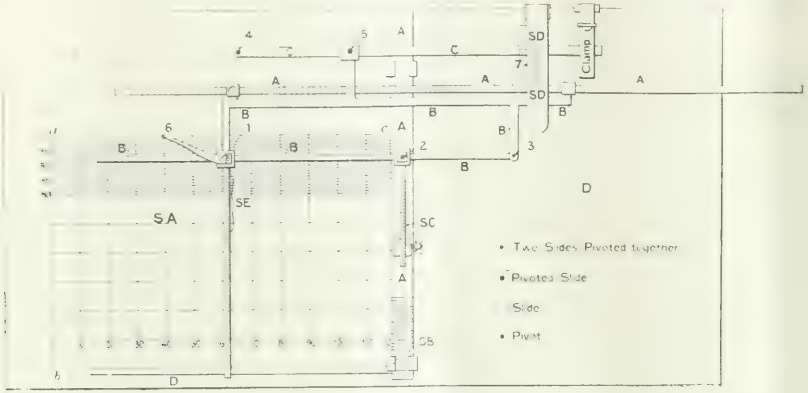


Fig. 5.—Diagram of Efficiency Calculator.

An Efficiency Calculator.

Having occasion some years ago frequently to work out sets of transformer efficiencies, the writer set about to design an apparatus to do this work automatically, except for the setting of two scales corresponding to the iron and copper losses respectively, with the result that the following mechanism was evolved. This shows all efficiencies as a frame is moved along, and, if desired, it draws the efficiency curve on suitably divided paper. The use of the device is not confined to transformer or electrical work.

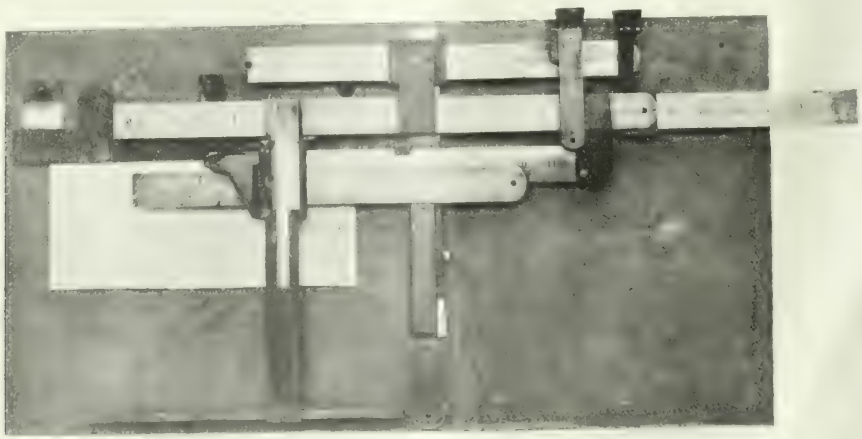


Fig. 6.—Efficiency Calculator.

On comparing a number of curves of transformer efficiencies it will be noticed that these all have a certain likeness, this being strongly suggestive of a family of hyperbolas. Drawing a rectangular hyperbola along any one of these, however, it will be found that the efficiency curve drops below the hyperbola at the higher loads, but does not correspond to a merely inclined hyperbola, being nearly co-incident on the lower values, falling away on the higher part of the curve. Separating out the respective copper and iron losses on the efficiency curve it will be found that the iron loss gives a true hyperbola, whilst the copper loss is an inclined straight line. The addition of the two curves gives the inclined and unsymmetrical shape of the full efficiency curve. On these lines, therefore, a mechanism was possible if it

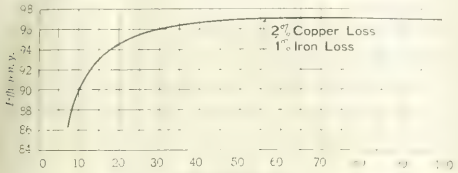


Fig. 7.—Efficiency Curve drawn by Machine.

could be arranged to give a resultant motion to a point combining this hyperbola and inclined straight line, the value of each being readily adjustable.

To design the straight line part of the arrangement presented no difficulty, but considerable study was needed to get an arrangement to move through a true hyperbola and then superimpose on this the incline corresponding to the copper loss.

The diagram (Fig. 5) will help to make clear the arrangement finally devised. The part A is a plain T-frame free to move vertically, but not sideways. Part B is a simple system of linkages as shown; and part C is connected to B for the purpose of controlling the vertical movement. The rough model constructed by the writer is shown in Fig. 6 (note that most of the regular markings on the steel rules of which this is chiefly constructed have no significance). The chief points in the construction of the device relates to part B, the essentials being that parts 1 to 3 should correspond to the distance allotted for no-load to full-load. Further,

2 must coincide with 1 at full-load.
2 .. .. .. 3 at no-load.
4 .. .. .. 5 .. ..

4 to 7 should also correspond to the distance allotted from no-load to full-load. Part A must be truly right-angled and free

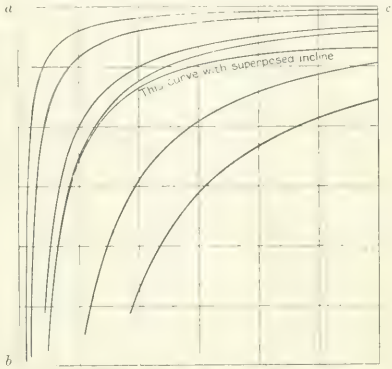


Fig. 8.—Hyperbolic Curves drawn by Machine illustrated in Fig. 6.

to move vertically without looseness. The whole being assembled, the manipulation is as follows: (*a*) Set and clamp index on scale SD at per cent. of full-load copper loss. (*b*) Set scale SC to per cent. of no-load loss (*i.e.*, the iron loss expressed as a percentage of full load).

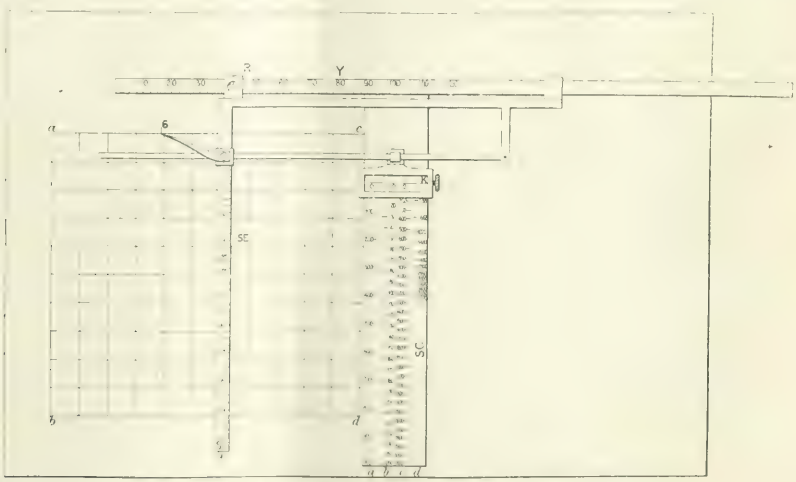


Fig. 9.—Calculator for Steam Calculations.

system of linkages, B, gives the desired hyperbolic motion to the pointer 6, as the frame is moved sideways; part C gives the vertical movement corresponding [illegible] Part A keeps frame B truly parallel, whilst permitting [illegible] vertical and horizontal combined movement. [illegible] mounted on a frame or board, D, with a suitably divided scale as shown at SA, and it is on this [illegible] combined results are shown, the separated results being shown on the separate scales described below. The whole assembled in a

Then 6 indicates efficiency at any load as frame B is moved along to any load. The pointer 6 being in the form of a pen, will draw the efficiency curve on suitably marked paper held by clip E. Also, as frame B is moved, in each position scale SE shows iron loss at each load, as per cent. of the load; scale SB shows the corresponding copper loss. The following relations also hold:—

Knowing the efficiency at any load and the no-load loss as a percentage of full-load, set scale SC to that figure and the

pointer to the efficiency. SD will then show the full-load copper loss.

Knowing the efficiency and copper loss, set pointer SD to these values. Scale C then shows the iron loss.

It will be noted that scales SC and SD always indicate the full-load values, only one of which, and the efficiency, need be known at any load.

The accuracy obtained is dependent on the mechanical accuracy of the mechanism and the degree of closeness with which the pointers are set. The model made by the writer is only rough, made chiefly of common steel rules, which were used as the most readily obtained straight edges, the workmanship being not up to ordinary instrument work, but the results on this are reliable to, say, one-fourth of 1 per cent. which is near enough for commercial work. Fig. 7 shows an efficiency curve drawn by the machine.

The fact that the pointer 6 describes a true hyperbola renders this device useful for a number of purposes besides transformer calculations. Some of these are described below.

The standard comparison curve for the steam engine indicator diagram is the hyperbola which involves considerable work to construct on the diagram. If, however, the indicator diagram is placed on the scale SA, so that the line of zero pressure is coincident with the line $a-b$, the clearance line being on $a-c$, and the pointer 6 brought to any part of the expansion curve, the clamp 7 on SC then being tightened, the pointer will describe the required hyperbolic curve as the frame B is moved about. This applies without correction, whatever scale the diagram may have. This curve is a most valuable gauge to compare with the actual diagram curve, the variations giving much information as to leakage of steam, condensation, effectiveness of steam jacket, &c. Where the conditions are known to be such that hyperbolic expansion is assured and the clearance is not known, this can be found by placing a series of curves as drawn by this machine on transparent paper (Fig. 8) on the diagram (keeping the line $a-b$ over the zero line of the diagram), moving this transparent paper till the nearerst hyperbola is parallel with the expansion curve ; this line $a-c$ then shows clearance line. Where, as in some jacketed engines, the expansion curve falls below the hyperbola, the part of machine C gives a most convenient means of giving a definite obliqueness to the hyperbola, enabling one readily to reproduce indefinitely almost any possible expansion curve.

The system of linkages B forms a compound slide rule, and connects together the components of a simple proportion ($a \times b = x$), the three scales all having equal divisions. With a logarithmic scale, on scale SC, this links together the elements in the form $(a \times b)^2 = x$. The latter are, of course, readily obtained by the ordinary slide rule, which for general calculations is more convenient than the one now described. For special calculations, however, this device may be the more convenient in a number of cases, the advantages being that for multiplication or division the scales are entirely separate and also evenly divided, leading to a much reduced liability of error ; also the scales may be marked in different units. The scales being in equal divisions instead of the logarithmic divisions of the ordinary slide rule suggests its use for various mechanical computations, but this is outside the scope of this article (the device is not patented or manufactured commercially, so can be used by anyone desirous of so doing).

As an example Fig. 9 shows the arrangement for a steam engineer. It will be noticed that scale SC has four sets of divisions ; a, may be the simple product of scale SE (or x) $\times$ scale y (for proportion, multiplication or division) ; b is the same lb. per square inch, for centrifugal force. With this arrangement curves for expansion diagrams.

As a calculator, with suitably marked scales, it could be moved to any other speed P shows the pulley required for this.

Also with this arrangement, index P being set to diameter and index R to revolutions, index K shows on b, the feet per minute peripheral speed if SE (scale for P) is in inches, or on c the peripheral speed if SE is in feet, and on d the tension per square inch due to centrifugal force. The scales at SC being arranged in this manner also serve as a convenient table, the diameter of any pulley or flywheel on a, being opposite its circumference on b and the centrifugal tension corresponding to any speed in feet per minute on c being shown on d.

TELEPHONE ENGINEERING ECONOMICS.*

BY HARVEY A. SMITH.

Summary.—The author considers the problems involved in the lay-out of a telephone area. The methods employed in taking into account the future development of the area, of determining the most economical situation of the exchange, of the provision of new exchanges, extension or rebuilding of old ones, of the alteration of the boundaries of an exchange area, are all clearly explained with the aid of diagrams illustrating an assumed area.

The maintenance of an existing telephone system offers considerable scope for the practical application of economic principles. The natural growth in subscribers involves the provision of new exchanges, new cable plant and new telephonic equipment. If it were practicable to instal each year the precise amount of plant necessary for the growth of subscribers in that particular year the problems proposed to be discussed in the following notes would become very much amplified. We know, however, that the principle of providing telephonic plant to meet the requirements several years ahead is a well-established one. Site and building capacity is usually provided on a 20 year basis, ducts and pipes on a 15 year basis, and cables on an eight year basis. Bearing in mind the fact that duct and cable plant alone may represent as much as 70 per cent. of the entire capital expenditure of a telephone system, it is obviously of importance that this plant should be provided in an economical manner. The greater the number of exchanges in a given area the shorter will be the length of subscribers' line. The shorter the line the lower the cost of the cable plant, and the problem of determining the economical permissible ratio between line plant cost and the whole cost of the system is one which must be faced if the system is to be maintained in an economical manner.

Fig. 1 illustrates a typical telephone area comprising eight exchanges. Assuming there is spare accommodation in the existing exchange buildings, it is, of course, possible to continue such a system for a considerable period by merely providing additional line and exchange equipment. The following points have to be considered : Will the existing exchanges meet telephonic development for a period of 15–20 years ? Are the exchange buildings in their most economical position having regard to the areas served by them ? And is there any portion of the present exchange areas of such a nature as to justify the opening of a separate exchange to serve it ? It is obvious that proper consideration of these points cannot be given without having definite knowledge of the telephonic development in the area concerned. A development study of the area, if not already made, must first be undertaken. The importance of this study cannot be overrated. It forms the basis of the entire design of the telephone system. The method of carrying out the development survey at present adopted by the Department provides for the figures for the periods concerned being given for the various road frontages divided into suitable blocks or distributing areas. This, while being the most suitable method in connection with the provision of cable plant, does not lend itself conveniently to the study of exchange area lay-outs, and it is necessary to summarise the [illegible] for the various blocks of territory into a more easily handled [illegible]. A very convenient way is illustrated in Fig. 2. A map of the territory proposed to be studied is divided into small squares, [illegible] depending upon the telephonic density, [illegible] square miles will be found a suitable size. A skeleton plan of existing lines is then prepared showing these squares together with the existing [illegible] and their areas. The summarised development figures [illegible] filled in for each square in the manner shown, existing lines in the top left hand corner, the eight years' [illegible] in the bottom [illegible] corner, and the 15 year or ultimate [illegible] forecast in the [illegible]. This figure can be [illegible] on the fundamental plan.

* A paper read before the Institution of Post Office Electrical Engineers.

for on it can be superimposed skeleton tracings representing all the various alternatives for rearranging the existing exchange areas.

The development study can then be considered in relation to the present lay-out of exchange areas. Fig. 3 shows a convenient way of doing this. This takes the form of a skeleton tracing which fits over the fundamental plan. Against each exchange is shown the maximum number of subscribers' lines the exchange building or site can accommodate, while the total lines for the present eight and 15 year periods are shown in the centre of each exchange area. The

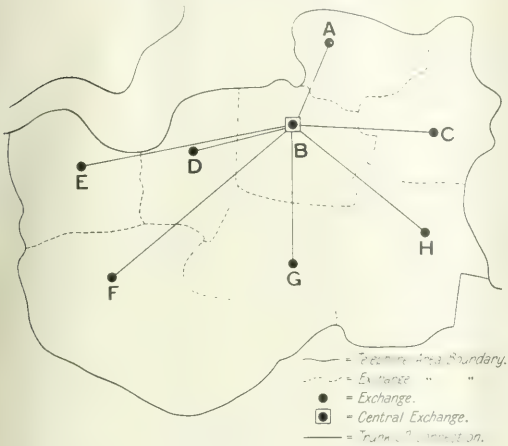


FIG. 1.—A TYPICAL LAY-OUT OF EXCHANGE AREAS.

telephonic centre of each exchange area (the method of calculating which will be described presently) is marked on the plan by means of a cross.

It will be seen, therefore, that a general idea cannot be formed of the suitability of the present lay-out, more especially with regard to the question of exchange accommodation and economical location of exchanges. In the particular example illustrated it will be noticed that there is considerable need for further investigation. Exchange A, although providing adequate accommodation, is a good distance from the telephone centre of its area, and the economy of retaining the exchange in its present position is open to question. This point will be dealt with later. Exchanges B, C, D and E are satisfactory as regards accommodation and location. Exchange F is badly out of centre and deficient in accommodation. There are two alternatives to consider in this case—viz., to replace the present exchange by a new one of greater capacity, or, in view of the extent of the exchange area, to divide the area and provide a separate exchange. This point will also be dealt with when discussing new exchange economic calculations. Exchanges G and H are both out of centre, but the remedy here is obviously to alter the exchange area boundary, thus transferring territory from H to G. The effect of this will tend to bring the telephone centres towards the respective exchanges. Moreover, an examination of the accommodation figure for G and H exchanges shows that such an alteration of boundaries is desirable from that point of view alone. In dealing with alterations of boundaries, there are other considerations, however, which will be discussed at length in due course.

Telephone Centres.—Before leaving Fig. 3 it will be desirable to discuss the meaning of the term "telephone centre" and its effect on line plant economies. To enable the cost to be at the lowest possible it is necessary that the telephone exchange should be located at a point where all lines can converge with the smallest aggregate mileage of wire. This point is known as the telephone centre, and the method of determining its position can, perhaps, best be illustrated by taking one of the exchanges on Fig. 3 and going step by step through the process of finding its centre. First, it is necessary to calculate the "theoretical" centre—that is, the telephone centre of the area assuming all lines connected *radially* to the exchange, and ignoring the actual routes the circuits must take from a practical point of view. Fig. 4 shows how this theoretical centre is calculated, and is self-explanatory. The next step is to place a sheet of tracing paper over a map of the area and mark in the various main thoroughfares. The development figures are then marked on to each section, these thoroughfares and the totals obtained, gradually working to a point in the near vicinity of the theoretical centre. Consideration must be given to the junction circuits. Usually the bulk of these circuits leaves the exchange in one direction, and are, weight for weight, equal to at least twice the equivalent number of subscribers' circuits. The true centre may be determined from these totals, taking into account the junction circuits. It will be gathered, therefore, that the true telephone centre may differ very considerably from the theoretical one, and that some importance must be attached to the routes the various subscribers lines will take.

New Exchange Investigations.—Returning once more to Fig. 3, it will be interesting to show the method of dealing with the problem of the most economical serving of exchange area F. Here it will be remembered the existing exchange is inadequate as regards accommodation and is also considerably out of centre. A new exchange capable of accommodating, say, 3,000 lines can be provided in the vicinity of the telephone centre, or, as an alternative, the present exchange can be relieved by cutting off a portion of the area and serving this by a separate new exchange. No safe rule can be laid down for the most economical size of exchange areas. A certain amount of detailed calculation is inevitable in connection with each case. The chief factors bearing on the problem are the telephonic density and superficial extent of territory concerned and its distance from the centre of the telephone system. The telephonic density and extent of area will determine more or less the cost of connecting up subscribers' lines, while the distance from the centre of the telephone system will determine the cost of the junction circuits. It is possible to express this problem mathematically, but it will be more convenient, for the purpose of these notes, to deal with it in the ordinary way.

The opening of an *additional* exchange in the area F will allow a smaller site and building to be provided for the new exchange than would be the case if a single new exchange to serve the entire area were installed. It will also avoid the scrapping and rearrangement that would be necessary in abandoning the present exchange premises; and, finally, will reduce the average length and cost of subscribers' line. It would appear, therefore, on first examination, that the installing of the additional exchange will be an economical step

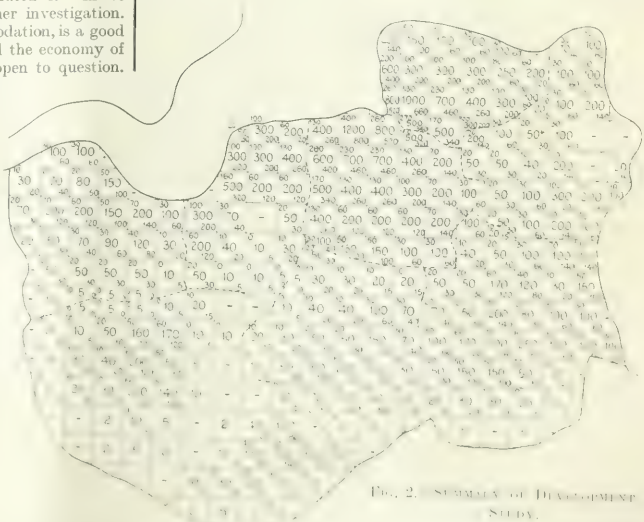


FIG. 2. SUMMARY OF DEVELOPMENT STUDY.

to take; but there is another side to the question. The cost of maintaining and operating two exchanges will be considerably more than one. There will be additional line cost in providing local junctions between the two exchanges, and there will also be a general increase in junction circuits due to the increased number of groups of junctions. This last point is one of some importance. If all the junctions from Exchange F ran to a central exchange in a single group, the maximum efficiency would be obtained—that is, the highest possible amount of traffic would be accommodated on

any one time. This is because the entire range of the group is available to the operator and in natural accordance with the law of probabilities, the chance of a junction being already in use when required is reduced to a minimum. If, however, this group of junctions is split into two it will be found that more circuits are necessary, although the same amount of junction traffic is handled at the exchange.

Much time will be saved in connection with new exchange investigations if fundamental data is obtained and recorded in a handy form for reference. In the majority of investigations it is necessary to calculate the cost of exchange premises, exchange equipment, exchange operating, and subscribers' and junction external plant for the various alternative proposals, and it would be an extremely tedious operation to estimate these in detail. It is also necessary to remember that when dealing with *comparative* costs approximations are permissible of a nature which would not be attempted in the ordinary way, and, in addition, items of cost which are practically common to the various alternative schemes need not be estimated at all.

The chief point to be borne in mind is that alternative methods of serving an exchange area cannot easily be compared on a capital cost basis, more especially when, as in the case under discussion, the question of abandoning existing exchange premises is involved. It is necessary to consider the matter from an annual cost point of view. The method of expressing the capital costs of any particular class of plant as an annual charge in accordance with its theoretical "life" and cost of maintenance is, perhaps, so well known that it



Fig. 3.—Development Study applied to Present Lay-out.

not be dealt with here. It will be as well, however, to say just a few words with regard to "deferred" costs. In the case of exchange area F the alternative of abandoning the present exchange in favour of a new one of greater capacity involves an initial financial loss due to the scrapping of the plant. This loss has to be expressed in such a way that it can be added to the annual charges incurred in serving the area for a period of 15 years under the new conditions. These annual charges, in turn, are not constant throughout the 15 year period. Switchboard equipment, for example, is provided by degrees as required, usually at four or five yearly intervals; operating charges, although incurred regularly each year, increase in amount [illegible] to the increase in the load. It is necessary, [illegible] to consider [illegible] annually and periodically.

To anyone acquainted with elementary accounting principles it [illegible] that an initial expenditure is, pound for pound, more [illegible] deferred for a number of years. It would not be therefore, to add the initial, annual and periodical costs of [illegible] would probably be more correct [illegible] by [illegible] to [illegible] be done with the [illegible] The [illegible] charges [illegible] and [illegible] the [illegible]

which requires to be undertaken if satisfactory conclusions are to be arrived at. It would be almost a hopeless matter, for example, to attempt the preparation of estimates for the various alternatives on the lines of the usual departmental methods, that is, pricing out the details of exchange apparatus, pipework and cabling. As a general rule, if the differences in the total cost of the various alternatives are small in comparison to the totals, a final choice of the alternative to be adopted should be made by weighing up those advantages and disadvantages which cannot be easily expressed in monetary terms. In other words, the question of policy should be the deciding factor rather than that of cost. If, on the other hand, the difference in cost is so considerable that the choice is governed entirely by it, it is fairly obvious that any slight errors likely to be occasioned in using approximate methods of calculating the costs will not materially affect the result. There is, therefore, quite a considerable scope, in exchange area economic problems, for the use of average or standard costs in connection with the main items requiring to be priced.

With regard to sites and premises costs, as these vary so much in accordance with their geographical situation, it is usual to estimate them separately for each alternative. The cable plant costs are nearly always the determining factor. There are two approximate methods of obtaining these costs. The first, which is the more accurate, is for use when dealing with a comparatively small extent of territory, such as in the case of a single exchange area being divided into two or more areas. This method consists of a detailed estimate of the requirements for each section of route concerned, due allowance being made for any duct and cable plant that may be existing. The cost of each item is obtained by means of standard costs of line plant. The alternative method of obtaining the approximate line plant costs is to calculate the aggregate circuit mileage of line and ascertain its cost by applying a unit cost per circuit mile.

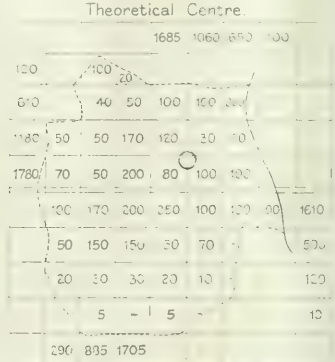


Fig. 4.—Method of Calculating Location of Telephone Centre.

If, for example, this method is used in connection with the problem of exchange area F, the total mileage of subscribers' circuit at the 15th year can be calculated from Fig. 2 by scaling the distance from the centre of each square to the telephone centre and multiplying each distance by the number of lines in that square. The resulting figure for each square represents the total radial mileage and must be converted to route mileage before the cost is calculated. The author gives graphs illustrating the relation between radial and route lengths, from which it is a simple matter to convert any radial length to its route length. This method of calculating line costs is only justified when the first method described is too lengthy a process, such as when dealing with territory comprising several exchange areas, the solving of all of which require simultaneous consideration.

In Table I. is illustrated a convenient method of summarising the comparative costs of the two alternative methods of serving the area F. The figures given on the summary schedule are merely assumed ones for the purpose of illustration. They are, however, fairly representative of the figures likely to be obtained in a comparison typical of that under consideration, and are interesting, therefore, in showing what items have most bearing on the result of the com- [illegible] and also that certain items, from a difference in cost po- [illegible] can be treated as practically negligible, thus saving the trouble of calculating them.

[illegible] leaving the question of exchange [illegible] economies it will be [illegible] to examine the case A in Fig. 3 and to deal as the other [illegible] being so much out of centre, this [illegible] seems to be [illegible] these [illegible] objection [illegible] the exchange

Table I.—*Comparative Costs. F Exchange Area.*

Comparison of Cost of { "A."—Abandoning present Exchange in favour of new 3,000 line Exchange. "B."—Retaining present Exchange and installing an additional 1,400-line Exchange.

Development Data.	Alternative A. Direct Exchange lines.				Alternative B. Direct Exchange lines.				Remarks.
	Existing.	8 years.	15 years.	20 years.	Existing.	8 years.	15 years.	20 years.	
F Exchange area	780	1,590	2,520	3,200	F^1 Exchange area	445	885	1,441	1,900
					F^2 Exchange area	335	705	1,079	1,400

Traffic Data.	Exchange.	Calling rate		% O.J.C.		Ratio.	Day B.hour	Equating factor.	
		Now.	Ult.	Now.	Ult.	Now.	Ult.	Now.	Ult.
	F	3·2	4·0	70	70	7	7	1·6 / 0·8	1·6 / 0·8
	F^1	3·0	3·7	75	75	7	7	1·8 / 0·8	1·6 / 0·8
	F^2	3·5	4·4	78	78	7	7	1·8 / 0·8	1·6 / 0·8

Top figure in equating factor column = O.J.C. valve. Bottom figure = I.J.C. valve.

Comparison of Costs over 15-year Period.

	Alternative A. Date.	Capital cost.	Annual cost.	P.V. of total annual cost over 15 years.	Alternative B. Date.	Capital cost.	Annual cost.	P.V. of total annual cost over 15 years.	P.V. difference. In favour of A.	P.V. difference. In favour of B.
		£	£	£		£	£	£	£	£
Exchange site	Now	4,000	200	2,300	Now	3,000	150	1,730	...	570
Exchange building	Now	1,500	75	870	Now	900	45	520	...	350
Exchange equipment	Now	4,200	398	6,160	Now	2,270	204	4,390	...	1,770
	3rd year	1,100	153		5th year	2,100	189			
	10th year	2,400	216		10th year	2,900	225			
Pipework (additional)	Now	10,000	500	5,760	Now	6,000	300	3,450	...	2,310
Cabling	Now	15,000	900	11,800	Now	5,800	350	5,000	...	6,800
	8th year	5,000	300		8th year	3,300	200			
Additional junctions	...	...	...	...	Now	...	50	1,320	1,320	...
					yearly	...	Av. inc. £8 p.a.			
Day operating	Now	...	350	8,700	Now	...	390	11,400	2,700	...
	yearly	...	Av. inc. £50 p.a.		yearly	...	Av. inc. £74 p.a.			
Night "	Now	...	70	1,740	Now	...	140	2,600	860	...
	yearly	...	Av. inc. £16 p.a.		yearly	...	Av. inc. £10 p.a.			
Exchange maintenance	Now	...	60	1,530	Now	...	70	2,200	670	...
	yearly	...	Av. inc. £9 p.a.		yearly	...	Av. inc. £15 p.a.			
Exchange lighting, heating, cleaning, &c.	Now	...	75	1,350	Now	...	90	1,700	350	...
	yearly	...	Av. inc. £5 p.a.		yearly	...	Av. inc. £7 p.a.			
Wastage due to abandoning existing Exchange premises and site	Now	...	...	...	...	...	...	...	...	...
Wastage due to recovering existing Exchange equipment	Now	...	...	700	...	...	...	...	...	700
Transferring subscribers	Now	...	...	800	Now	...	...	400	...	400
Rearranging existing cable plant	Now	...	...	200	Now	...	...	100	...	100
					Total Difference	...	...	...	£5,900	£13,000

in favour of a new one more centrally situated, that is to say, its equipment we will assume is in good condition, and, as will be seen from the diagram, its accommodation is adequate for the ultimate requirements of the area. The first step to be taken in such a case is to examine the conditions at the adjacent exchanges in order to ascertain if an alteration can be made to the exchange area boundary which will have the effect of improving the location of exchange F with regard to the telephone centre. It will be seen, however, that the conditions are such that nothing material can be done in this direction. Eliminating, as an uneconomical and inadvisable an alternative, the establishing of an additional exchange between exchanges A and B, there remains, only, the question of replacing exchange A by a new one at the telephone centre or retaining it in its present position at the cost of an expensive cabling system.

Bearing in mind that exchange plant [illegible] relatively small relation to that of line plant, it will be appreciated that the question of abandoning the existing exchange [illegible] of serious consideration. If the exchange is removed to the telephone centre the average length of line terminating at the exchange will be considerably decreased and a corresponding [illegible] in the provision of the cabling plant. Against this there is the wastage due to abandoning the present exchange and the cost of installing the new exchange in lieu. The wastage involved in recovering existing exchange equipment depends, of course, on its age and period of remaining effective life. The author gives a graph from which the wastage can be calculated.

New Exchange Sites.—Considerable importance must be attached to the location of an exchange with regard to the area it serves. In seeking a site for a new exchange, therefore, every effort should be made to secure one as close to the telephone centre as possible. It should be borne in mind that as the distance between the proposed site and the telephone centre increases the permissible purchase price of the site decreases, and that, consequently, a cheap site may not necessarily be an economical one. An instance is given in which a site costing £9,000 at the telephone centre is more economical than one costing £6,500 only 100 yds. away.

Exchange Area Boundaries.—There is considerable scope for economy in the defining of boundaries for exchange areas. Although alterations to existing boundaries may involve a re-arrangement of circuits with its attendant temporary inconvenience to the subscribers concerned, they may, on the other hand, offer such obvious economic advantages that the inconvenience to the subscribers must give place to the interests of the department. Boundary alterations are generally necessary for two reasons: (1) To avoid expense in providing additional exchange equipment. Effected by reducing the area of the exchange concerned, thus providing immediate relief to the exchange by the transfer of existing subscribers, and subsequent relief due to decreased development. (2) To avoid expense in providing additional line plant. An important and interesting point in connection with exchange area boundary economics is the fact that an apparent [illegible] between two adjacent exchange areas is not normally the most economical.

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ELECTRIC WELDING.

Electric welding is a subject in which, in these days, we do not expect many novelties, for the general principles on which it is based have been known for many years and it has become a recognised branch of the electrical industry. Several methods are available, depending upon the class of work to be undertaken. For much of the work that is carried on, the resistance method is, no doubt, most generally applicable, the required heat being produced simply by the passage of a heavy current through the resistance of the joint. On the other hand, the electric arc affords another means of obtaining localised heat, and is very convenient under other conditions. Apart from these two general methods, there are others of more or less limited application.

So far, electric welding has been applied chiefly to the welding of iron and steel, but the welding of aluminium has also been effected. This, however, is a much more difficult problem. A familiar lecture experiment is the heating of an aluminium wire by means of an electric current until the metal is fused, but, notwithstanding the state of fusion, the wire continues to hold together on account of the skin of oxide with which it is covered. This ready, though minute, oxidation is the cause of the trouble that is experienced when attempting to solder or weld aluminium, and for this reason, although aluminium welds can be made satisfactorily when the metal is above a certain size, it is a difficult matter in the case of wires.

Elsewhere we give an interesting description of a new process of welding which was developed originally in connection with the welding of aluminium wires. It was [illegible] accidentally that the discharge of a condenser caused welding to take place under certain laboratory [illegible]. Taking this fact as a basis for further investi- [illegible]. Messrs. C. E. SKINNER and L. W. CHUBB have

worked out a process which appears to give most satisfactory results for work of this kind. Essentially, the method depends on discharging a capacity of suitable size through an inductive circuit which is closed by the two pieces of metal to be welded together. The mechanical part of the process consists in bringing the two pieces of metal suddenly together, somewhat on the lines of a pile driver. When contact is made, there is a sudden rush of current, the metal is fused at the point of contact and a weld is obtained. Obviously, considerable capacity is necessary in this case, and therefore an electrolytic condenser is used.

One of the interesting points about the process is the extremely small amount of energy that is used. No doubt the power at the moment of fusion is considerable, and is placed by the author at 23 kw. in a certain case, but the time taken for the flow of current is extremely small. The current is akin to a flash of lightning, which provides an enormous flow, but for an infinitesimal time. Consequently, the author estimates that the cost, with energy at 5d. per kilowatt-hour, is only 24 millionths of a penny per weld.

One of the important features of the process is, of course, that the heating is extremely localised. In fact, it is no doubt on this account that the welding of aluminium is thereby rendered possible. The method is not, however, limited to the welding of aluminium, but is destined to be useful for many other purposes; in fact, for those conditions in which any extensive heating is out of the question.

REVIEWS.

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Factory Administration and Works Accounts. By E. T. ELBOURNE. (London: Longmans, Green & Co.) Pp. xv. + 238. 2s. net.

The aim of this work is, in the words of the author, "to present an analytical study of the problems pertaining to factory administration and accounts as a whole." Apparently the term "administration" has been selected to embrace a number of problems of higher stewardship which might not have been included in the more popular term of "management," although all the questions discussed in the various sections are such as are inseparable from responsible managership.

The book is divided into three parts, each by a different author. In the first, Mr. A. Home-Morton discusses the general problem of industrial works design, beginning with the conditions to be considered in selecting a site, passing on to the general lay-out, choice and generation of motive power, structural design of shops, and closing with considerations as to plant and equipment. From the fact that the whole of this section is dealt with in 26 pages only, one can see that the chapters are very concise; nevertheless, they are pregnant with thought and excellent advice, and are a most interesting introduction to the rest of the book.

The second part, by Mr. Elbourne, covers about four-fifths of the volume, and is the part from which the book takes its title. In the first section are discussed the conditions of general administration, such as, in limited liability companies, are dealt with by the general manager. These are mainly of the commercial order, and are divided under the following headings: Staff and Routine Organisation, Correspondence, Publicity and Sales Promotion, Estimates, Output Considerations, Official Orders. The particulars of each [illegible] explained very carefully and minutely, and a large amount of useful information regarding the practice of different tradesi s offered. The examples of works regulations and the extracts from Acts of Parliament affecting works management are particularly welcome. The impression, however, which one gets from the picture of the duties of the administrator is rather narrow; one would have preferred a broader view of the field of activity of the general manager, and a discussion of the considerations affecting the issue of any given policy, and the means of organising efficient production by watching statistics, costs and results. In pure commercial routine we are afraid that the value of statistics is not fully brought forward, seeing that only a few pages are devoted to it at the end of the book. This is all the more surprising as statistics are amongst the characteristic features of modern works organisation, and can be set up without any great expense or special staff of accountants.

No mention is made of the means of providing suitable officials to fulfil important duties, or of the way to promote loyalty amongst employés. On the other hand, one finds the strange proposal to display a notice to remind the purchasing staff of the penalties under the Prevention of Corruption Act. Another point which we think should have been discussed is the position of an employé versus the company in respect of inventions, patents, &c., or the validity of agreements binding an employé for a period subsequent to his leaving the company.

The next section describes the various branches of works administration, and consists of chapters on shop regulations, labour, drawings, specifications and patterns, materials, production, efficiency and despatch. In the description of this organisation we miss several very important factors—*e.g.*, the effect of overtime on production and cost, proposals for the establishment of a production department on modern lines, and, above all, a method of checking and inspecting the production and the products at all stages. The two chapters on Inspection and Supervision attempt to solve this most important problem of works management in only four pages. Some proposals for promoting the goodwill of the workers would also have been in place (mess rooms, clubs, sports, &c.). The impression one gains in reading through this section is that the author has carefully collected particulars from a number of works and given an average picture of their organisation, without attempting any constructive criticism of old-fashioned systems. The position of the engineering element in such systems appears necessarily very indistinct; neither is there any information as to where the engineers are drawn from, although a number of recommendations are made in connection with "trade" apprentices.

The largest section is devoted to Works Accounts, and here again current practice is represented with great minuteness, and the amount of detail is such that it is hard to find one's way through it all. This difficulty is again due to the fact that there is no explanation of the general principles of each system. This section is of necessity one for the accountant and the book-keeper, but the managing engineer will find plenty of food for discussion in the pages dealing with such items as shop charges, apportionment of works expenses to departments and application of shop charge rates. The point of view the engineer will take in reading this part of the book will most probably be in opposition to that of the author, this because the engineer uses his "costs" as essentially auxiliary and approximate calculations only, whereas the author insists that they should be in entire agreement with the financial accounts, and therefore kept with book-keeping accuracy. Whilst the several items of expenditure can certainly be ascertained to the smallest amounts, the apportioning of the "general" expenses to the various products can only be a matter of arrangement, and the accuracy of the "cost" obtained largely depends upon the degree of employment of the department in question. The author himself, at the end, agrees to an approximation of "normal" charges—viz., charges referring to periods of normal activity in the particular department.

A useful comparison is given of the methods of charging expenses to time versus charging them to total wages, and a

good discussion follows, showing the effect of the two methods on cost of production when employing labour of different grades. The old recognised principle that the most expensive service is the cheapest in the end is brought out very forcibly. At the end of this section there is a large chapter giving a good collection of routine forms for all commercial books of a factory.

The last portion of the volume is represented by a section on financial accounts by Mr. J. Maughfling, which, however, should be of more interest to secretaries than to engineers.

A good index facilitates the use of the book for purposes of reference. R. Orsettich.

Molecular Physics. By J. A. Crowther, M.A. Pp. viii. + 167. (London: J. & A. Churchill, 1914.) 3s. 6d. net.

This is a reprint of articles contributed to the "Chemical World." Their object is to give an account of the constitution and properties of the atom and molecule in the light of the fundamental discoveries of recent years as to the properties and activities of the electron.

It is well for the student at times to leave the systematic study of his subject in detail, and to seek a broad view of it as a whole, of its main features and its probable lines of future development. There is, further, something more than mere results to chronicle. New chapters in science may come, and have come, as the result of struggles as heroic as any recorded in the field of human activity. The achievements of Thomson, Rutherford and Wilson might well form the subject of an epic of science.

The present volume will be heartily welcomed by students of chemistry and physics. It is impossible to rise from its perusal without a grateful sense of its stimulating influence.

After an introductory chapter in which various conceptions and magnitudes are defined, there follows a chapter on "The Physics of the Electron." We learn, for instance, how the single atom or molecule may leave its visible impress. Chapter III., on "The Positive Particle," is the prelude to one on "The New Method of Analysis" by positive rays. Such questions as the existence of H_3 are discussed. The advantages and disadvantages of the method are fairly stated.

Chapter VI., on "The Chemistry of the Model Atom," contains much that is highly suggestive. We see how much light physical lines of inquiry can throw on the subject of valency. This chapter merits the careful attention of every chemical student. Chapter VII. deals with spectra, showing the significance of the Zeeman effect, and ending with a reference to the remarkable calculations of Bøhr. Chapter IX., on "The Atom in Dissolution," is not the least fascinating in the book.

A short mathematical appendix, and a list of the most important literature of the subject, complete the volume, which is also illustrated by many diagrams and some photographs made in the Cavendish Laboratory. D. O.

RECENT RESEARCHES ON ATOMS AND IONS.

(Concluded from page 778, Vol. LXXIV.)

In the last of the course of six lectures on "Recent Researches on [illegible] delivered by Sir J. J. Thomson on Saturday, March 27, we give a [illegible] of the last three lectures.

Referring in the [illegible] lecture to ionisation by heat, Sir Joseph [illegible] the case of salts, the electricity might be liberated from [illegible] metal plate in contact, and the two pieces should be [illegible] of opposite electrical [illegible] experiment, however, [illegible] [illegible] but which [illegible] [illegible] [illegible]

difference in the electric conditions which became apparent when the heat applied furnished the energy necessary to separate the charges.

Prof. Thomson then passed to an electrification of obscure origin, the small conductivity always observed in atmospheric air. Practically air might indeed be regarded as an insulator, but when air was sucked through an earthed pipe, about ¾ in. wide, passing an axial wire joined to an ordinary electroscope, a continuous though faint electric leakage was seen (demonstrated). Part of that conductivity (about half) was due to radio-active emanation in the earth and air. When the air was confined in a box with lead walls, thick enough to exclude all radio-active effects from outside, or when measurements were taken on the ice of Lake Ontario (McLennan), or far out at sea the ionisation value dropped to about half of the value in the open land atmosphere, and that was so all over the world apparently; observations made during the Antarctic expeditions confirmed this. The residual conductivity amounted to about 4 ions per cubic centimetre of air per second. That was a very small amount; it corresponded to a birth rate of less than one in a million. Yet it would be of absorbing interest to account for this persistent small conductivity. One might ascribe it to molecular collisions of some air molecules of abnormal energy; if that were so, the conductivity should increase with rise of temperature, but experiments made between 0°C. and 100°C. showed no difference. Special radiations from the walls of the boxes were not concerned either; for in that case the rate should be greater in small boxes, of comparatively large surface, than in big boxes; the rate was independent of the size of the box, however. The ionisation might possibly be due also to some proper radiation of the air, something of the Röntgen-ray type, ionising at low temperatures already, and it would be interesting to experiment with other gases than air.

In air charged with dust (towns) the ions were caught by the dust particles. The lecturer tried to demonstrate this capture by artificial dust particles. A closed glass vessel contained two metal plates, about 1 in. apart, charged to a potential of 200 volts; the vessel communicated with a bulb containing liquid ammonia, and a little hydrochloric acid was allowed to trickle down a glass tube terminating between the plates. A stream of condensed ammonium chloride vapour was seen to pass down between the two plates. At the bottom of the vessel was a small piece of aluminium foil, and when a radium tube was approached to this foil, the air inside the vessel was ionised, and the stream was attracted by one of the plates; in the experiment the effect was not distinct. According to Langevin the dust in the air of Paris caught 10 times as many ions as remained free, and Langevin devised some ingenious experiments to show what type of dust ions were formed. The small ions of the air moved at the rate of 1 cm. per second under a potential gradient of 1 volt/cm., big ions only at 0·001 mm. per second; the carriers of the small ions were air molecules, those of the big ions dust particles proper. It was mentioned in the first abstract that the water bubbles form an intermediate type of ions, but the two speeds given there were wrong, "faster" having erroneously been put for "slower." Langevin now passed Paris air through a tube across which an electric field was maintained. A certain field strength would arrest the ions down to a certain depth, *i.e.*, distance from the wall of the tube; when the field was increased, the depth would be increased, and finally no ions would escape from the tube at all; when the number of ions was plotted as ordinate against the field intensity, therefore, the curve would first rise and then show a kink, becoming parallel to the abscissa. This would hold if there were only ions of one speed present. Ions of another speed would themselves have given a similar curve, a kink occurring at an earlier or later stage. When, therefore, several types (speeds) of ions were present simultaneously, the combined curve should show as many kinks as there were types of ions. Langevin now observed two kinks, proving that the air as a rule contains only ions of two speeds, as above stated.

The residual conductivity of the air was further discussed in the fifth lecture. It fluctuated a good deal. J. Satterly had observed it at Cambridge almost every day for nearly a year, and had found that the extra ionisation (due to radioactivity) varied between less than one and more than 10 ions per cu. cm. per second. A close connection with meteorological features was not apparent; the weather seemed to have little influence, and that was to be expected. For the emanation remained active for over a week, and a connection was more likely with the source of the gas than with the place or weather. Tracing the course of the air back with the aid of meteorological charts, from which the wind direction and force could be derived, Satterly found that air, having travelled over land, was richer in emanation than air having travelled over sea. The air pressure also had some influence; with a falling barometer some emanation would be able to escape from the soil. [illegible] air up from the soil at different depths; that air was a good conductor of electricity, 2,000 times better than [illegible] gas from muddy ditches also conducted well, because the emanation collecting in the mud was liberated together with the gas bubbles. From his observations Satterly concluded that the radioactive emanation of the earth was equivalent to the production, in a year, of 3×10^{-17} cu. cm. of helium per cu. cm. of air. The amount of helium actually present in our atmosphere was 5×10^{-6} c.c. per cu. cm; but Sir Joseph did not wish to divide the one figure by the other in order to arrive at a new estimate of the age of the earth.

Passing to solids and liquids, the lecturer remarked that they also became conductors when exposed to Röntgen rays, though the effect was smaller than with gases. A mixture of vascline and bromine was an insulator, but turned a conductor under Röntgen rays. The hydrocarbon hexane behaved similarly, and was, according to Yaffé, in fact, more amenable to a determination of its ions (number and speed) than a gas. Polonium radiation also made liquid air, itself an insulator (J. Dewar), a conductor (McLennan). As the demonstration of this phenomenon was very difficult, because the condensing aqueous vapour spoiled all insulation. Sir Joseph showed that polonium made paraffined paper conducting. A small sheet of paraffined paper was put on a copper plate, and another copper plate, coated with polonium on one surface, placed over the paper. There was no leakage as long as the uncoated side touched the paper; but the electroscope oscillated rapidly when the plate was turned so that the polonium came in contact with the paraffin.

The similar behaviour of a selenium cell, the lecturer continued, might not be a simple ionisation effect. The selenium was coated on mica; both the edges of the mica foil were serrated, and two wires were so wound round the foil that wire one rested in notches 1, 3 . . , and wire two in notches 2, 4 . . . The wires formed the terminal of the cell; the notches were 1 mm. in width and were obtained by preparing two foils and turning them, suitably mounted, on a lathe. The cell was placed in a wooden box (to shut out the light) and exposed to the rays from the Röntgen bulb above it, the terminals being joined to a galvanic cell and a galvanometer; the resistance decreased to about one-third its value when the bulb was turned on. The diminution was less rapid, however, than that produced by holding a lighted match over the, now open, cell box in the dark room; so that the light effect was stronger than the Röntgen-ray effect.

Sir Joseph then explained that it should be easier to separate the two charges in a solid or liquid than in the individual molecules of a gas, from the following point of view. Let it be assumed that the electrons within the molecules exercised a certain pressure, characteristic for the substance one pressure for iron, another for copper, *e.g.* When those metals were brought in contact with each other, that P.D. should make electricity flow from the one metal to the other, so that the one became positively charged, the other negatively, like a condenser or Leiden jar. Now the resistance to be overcome, the work required for charging a jar, was the smaller, the greater the capacity; therefore the work required would be diminished if the capacity of the system were increased, and the separation of the charges should hence likewise need less energy in the case of the large aggregates of molecules of solids and liquids (corresponding to a large jar) than in the case of the individual molecules of gases.

An experiment of Quincke was shown in this connection. When small solid particles were suspended in a liquid and an electric field applied, the particles travelled with or against the direction of the force, the direction of this movement depending on the natures of the particles and the liquid. In the demonstration sulphur was suspended in turpentine within a horizontal glass tube, into the ends of which the terminals of a Wimshurst machine were introduced. When the machine was turned very slowly, the particles were all violently agitated, but collected near the one terminal, which they left again on reversing the machine. The explanation of the phenomenon was due to Helmholtz. If the particle had a negative charge on its outside, the liquid (water generally) in contact with it would assume a positive charge. The force of the external electric field would pull as much on the one charge as it would push against the other; therefore the charges of the double layer should remain connected, and there should be no effect, no separation and no relative movement. There was movement in most instances, however, and the case was somewhat like that of a man who was being pulled one way by his legs and the other way by his sleeves; there would be no movement if it were not that he could slip his coat. Similarly, there was slipping between the two layers, a new charge being induced on the fresh water molecules brought into play. If that were the correct explanation there should be some limiting condition, and Sir Joseph suggested that there would be no movement when the P.D. exceeded a maximum value, as there would be none when the difference of potential was zero. The speed of the movement had been measured; it was proportional to the P.D., and did not depend upon the size of the particles, and the values observed were all of the order of 0·03 volt, the maximum he had found (for metal in contact with water) being 0·05 volt, whilst the P.D. between metals was about 1 volt, of course. Now, that poten-

tial of 0·03 volt was of the order of the thermal energy possessed by a molecule of gas at room temperature. Sir Joseph hence suggested that the energy which effected the separation of the two coatings was really the thermal or kinetic energy, and when the P.D. exceeded the available thermal energy there would be no separation. The problem required further elucidation, however. The velocities involved in these movements of small particles were difficult to measure, since the movements took place in all directions, and not in straight lines. H. A. McTaggart had hence made measurements in a centrifugal apparatus, in which the electrified light gas bubbles (charged with various gases) travelled in the water towards the axis. He found that bubbles of hydrogen, oxygen and air travelled towards the positive pole (as Quincke had stated), all with about the same speed. This was rather surprising; but it was difficult to get rid of the oxygen in the water by boiling it, and the hydrogen bubbles might have contained oxygen.

Referring in the sixth lecture again to the fact that polonium radiation turned paraffin paper into a conductor, Sir Joseph said that the Nernst filament was another case of an insulator becoming a conductor, this time by heat. The filament was coated with a mixture of oxides of alkaline earths; cold it was an insulator, but when heated by a special coil it conducted, and then the current itself raised the temperature further, until the light burst out suddenly. Experimenting with the oxides of Ca, Ba, Sr, Horton (Cavendish Laboratory) had found that the increase in light brilliancy went parallel with the emission of negative particles and with the conductivity of the mixture. The emission of particles was conveniently demonstrated simply by coating a platinum wire with common sealing wax; the cheapest wax was the best, because it was adulterated with barium salts to make it heavy, as it was sold by weight. The peculiar point about this phenomenon was that the oxides emitted many thousand times more particles than their metals, and the radiation from the oxides was likewise much stronger; the presence of a second substance, oxygen, evidently exerted a strong influence. According to Kirchhoff's law the sum of the light given out by a body and of the light reflected depended merely upon the temperature of the body, not upon its nature. Both these radiations together made up the "black body" radiations. When the surface was dull little light was reflected, but much light radiated; when the surface was polished more light was reflected. This law failed, however, in what was called "thermical luminescence," when light was emitted at low temperatures. The best-known case was that of phosphorus; hydrogen peroxide also seemed to become luminescent when in contact with other bodies, and the source of the additional energy which came into play was probably chemical. It was noteworthy that barium was known to form several oxides at different temperatures; locally the temperature might become very much higher at a few points than the average temperature. Oxygen generally seemed to be concerned in this luminescence; the sparks emitted by broken pieces of flint were also ascribed to an oxidation of the freshly-exposed surface. The character of the radiation changed with the temperatures, the hotter the body, the more blue the light, so to say. That could be shown even when dealing with the luminosity of particles in discharge phenomena. When an exhausted bulb was made the secondary of an induction coil by placing a coil for oscillating currents over the bulb, the bulb became luminous, and an outer bluish ring could be distinguished from a reddish inner ring; in the outer ring near the circumference the speed of the particles was greater than further inside.

Passing to another point, Prof. Thomson said that the mechanism of the way in which a charged particle gave up its charge to a metal was by no means simple. It might be said that a positive particle (*i.e.*, one which had lost a negative charge) became neutralised when touching a metal by putting out a negative particle from the metal to which it stuck. But that need not be easily done. Experimenting with a high vacuum bulb containing an earthed pool of mercury years ago, he had noticed that the gas inside the bulb retained a charge after hours of working the bulb. According to Franck and Hertz, different substances possessed different powers of absorbing electrification; some molecules, in fact, appeared incapable of retaining any negative particles which would stick to them, whilst others had a strong affinity for negative particles. Franck and Hertz used a large glass bulb and placed inside it an appliance for

[illegible]

extent also in any other gas) were sometimes simply reflected from

of the collisions; but there was no communication of energy. That was due to the enormous difference in size between the particles and molecules; when the colliding bodies were equal in size, energy was communicated, but when the one body was a thousand times smaller than the other there was little energy transferred. The case of oxygen was different, and the energy which was lost in oxygen was apparently chemical. These considerations explained why an inert gas like neon showed certain effects at ordinary pressure which other gases exhibited only at low pressure. A constricted neon tube containing some mercury showed the reddish neon glow when shaken and thus electrified by friction. When a P.D. was established between two plates inserted in a gas, *e.g.*, helium, the helium atoms might be turned back on their way from the one plate to the other by collisions with other particles of the same gas; but they would only lose little energy, and arrive at the other plate with almost their original energy. When the gas was oxygen the particle would lose energy on its zig-zag path, and if we wanted to diminish this loss of energy we had to reduce the oxygen pressure. As now oxygen was an impurity of all gases, difficult to get rid of, other gases behaved more like oxygen than they might otherwise do.

For such reasons it was also difficult to get the charge out from a gas and into a metal. The metal became covered with a double layer, and some particles stuck to the surface, not making room for others to take up a charge. That was also so when a gas was to be electrified by being passed through a gauze screen joined to a battery, double layers being formed round each wire. The potentials involved in these double layers did not run up high, fortunately, not above 12 or 15 volts, but they caused trouble in experimenting at small potentials and were responsible for the creeping of some electrometers, for instance. Another interesting question was this: What happened when a gas was ionised? A negative particle was taken out: but what was left behind, a molecule or an atom? Were the molecules altogether split up into atoms? There was energy available for splitting the molecules up. In his positive ray analysis he (Sir Joseph) had found that the carriers of the positive charges were mostly atoms; but there were also some molecules. Were the mechanisms of the formation of atoms and of molecules different? Did big particles perhaps split up the molecule altogether, whilst small negative particles only detached something? In order to investigate this problem he had conducted experiments with a Coolidge bulb in which the number of kathode particles produced was small, as long as the spiral kathode was cold, and very much increased as the kathode was made hotter and hotter. The numerical proportion of atoms to molecules (revealed by positive ray analysis) had hardly been affected by the temperature change, however, so that it looked as if small negative particles could effect the splitting up of molecules without the help of big positive particles. Similar arguments might explain why there was always an excess of hydrogen (over oxygen), *i.e.*, more than the double volume of hydrogen in the gas mixture (H_2O), which was collected when water was decomposed by radium radiations. In recent experiments Duane, in fact, had found hydrogen only, and H_2O_2 (hydrogen peroxide) in the resididual water, so that the oxygen had apparently been utilised in effecting peroxidation. Such phenomena suggested that in the collisions between particles and molecules something was knocked off in peculiar ways, not necessarily in accord with ordinary chemical reactions. As a rule only one particle was knocked off. But there were cases of the simultaneous (not successive) knocking off of several particles, by collisions of very high intensity. Sir Joseph showed one of his positive ray photographs, in which seven traces spread out above one another in fan fashion on the positive side, suggesting that atoms of mercury had been deprived of 1, 2, 3 . . . 7 negative particles.

ELECTRIC COOKING, MAINLY FROM THE CONSUMER'S POINT OF VIEW.

We give below an account of the discussion which took place [illegible] the Manchester Section of the Institution of Electrical Engineers on Mr W. R. Cooper's Paper on this subject. An abstract of this Paper appeared on p. 765 of our issue of March 12.

[illegible]

the wall, and if the supply was from a 3-wire alternating-current system a double-pole switch should always be used in order to isolate the apparatus entirely. The pilot lamp was a very useful accessory. It was gratifying to note that the author had taken up the earthing question so strongly. In the speaker's opinion, not only cooking apparatus, but every power circuit such as radiators, &c., should be so arranged that the appliance itself could be earthed. If the Council of the Institution decided to follow the author's recommendations and take action regarding earthing, the speaker suggested that the Home Office Mining Rules might be remodelled to suit domestic conditions. The speaker had used flexibles of various types domestically for about 8 years, and after having experienced all the troubles, he had discarded rubber-insulated flexibles entirely, and adopted flexibles insulated with asbestos bound with thread. These asbestos flexibles were entirely satisfactory after 18 months use, and withstood heat and ill-usage much better than rubber flexibles. Regarding comparative costs, accurate accounts of the heat bill for a family of 8 were kept for 2 years, which showed a total difference of 25s. between the electric cooking year and the coal year. Electrical energy was supplied at 1d. per unit flat rate with 2½ per cent. discount, and coal cost 17s. 6d. per ton average. The apparatus installed by the author appeared much larger than actually required by the household, and would probably accommodate 50 per cent. more persons. The speaker's apparatus had a maximum demand of 4 kw., whereas the author's maximum demand was apparently about 7½ kw. In confirmation of the view that the apparatus was too large, the speaker had perused figures in connection with a factory using an electric oven which would cook many more meals than at present demanded. The cost per meal served under such conditions was heavy, owing to the apparatus being larger than was immediately required. The author might have made out a stronger case for electric cooking by stating that the electric oven or cooking apparatus was always available ; also a complete absence of risk of explosion or fire. Reliability was important; even one breakdown in the first year did not tend to promote the desired confidence of the domestic user. Regarding rates and charges, the consumer on the flat-rate system never knew what his bill was to be at the end of the quarter, and in the speaker's opinion the time was near at hand when domestic consumers would be charged on the contract basis involving maximum demand. Suitable meters for such a system were not at present on the market, but investigations were in progress to produce such an apparatus shortly.

Mr. W. Cramp referred to the heating of domestic water supply, and cited a special form of heater suitable for attachment to water taps, which had been widely advertised some time ago. Extraordinary efficiencies were claimed for this appliance, and it would be interesting to know if it was successful. Regarding the coke water-heating stove suitable for holding a kettle on the top, the speaker suggested that the stove might well be designed with a hollow top to contain water, thus making it more efficient. The initial outlay on apparatus prevented the adoption of electricity, and it would be interesting to learn why the Corporation authorities could not supply electric cooking apparatus on similar terms with gas appliances. The speaker could not understand why electric ovens should not be mounted at a reasonable height. Gas ovens were placed on a stone slab on the floor to avoid the risk of fire. This was not at all necessary with electric ovens, and further, there was no flue to contend with. The plan of putting a thermometer on the oven door seemed not only ill-advised but useless ; the proper place was inside, so that the actual temperature of the oven could be taken. In the comparison of cooking costs the author had not given the temperature of the coal oven. If the temperature was too high, an average loss of 25 per cent. was not a great deal more than the 23½ per cent. loss given in the case of the electric oven, when the temperature was too high. Everyone using domestic electrical apparatus had no doubt experienced the trouble caused by the flexible breaking where it left the wire support. An appliance which would insulate and also prevent the sharp bend was required to replace the present wire spring. The subject of flexibles had been dealt with previously in a Paper by Prof. Schwartz in 1907, and although the method of test differed somewhat from that of the author, the results showed an extraordinary difference. The author seemed very optimistic regarding the question of earthing, when he stated that possibly in those towns where the supply undertaking had a wiring department this part of the work received proper attention. The speaker's experience showed that it did receive proper attention by the wiring department if it was contractor's wiring ; but if the municipal wiring department carried out the work, anything would do. A case was recently discovered where a circuit carrying 500 amperes was earthed by Corporation workmen. For this purpose a No. 18 wire was twisted round a screw on one of the switches and the other end round a lead water pipe which was hanging loose from a roof. Three contractors were engaged on this installation beside the Corporation, and the former put in enclosed fuses, the latter installed bare wire.

Mr. Alderman Walker thought the electric cooking load was one to be sought after. The diversity factor was good, and whilst the individual load was small the cumulative effect on a large system like Manchester would be beneficial to the department. Accordingly, they had adopted a new tariff in order to attract the cooking load—12½ per cent. on the rateable value, plus ½d. per unit metered. It was also stipulated that houses under £30 should not have more than 2 kw., and over £60 4 kw. The response to the [illegible] was considerable investigation as to the cause the only conclusion arrived at was the inadequate wiring of the houses originally. A prospective user of cooking plant would not entertain the idea of rewiring his house, involving destruction of plaster and fittings. A note had been prepared by the Department for circulation amongst architects, builders and house owners, requesting steps to be taken to ensure sufficient copper being put into new premises to admit of radiator and cooking loads. The capital cost given by the author for the family mentioned seemed excessive. It remained with the manufacturer to dispose of the failures mentioned in the Paper, and even during the past few months advances had been made in both radiators and ovens to make them fool-proof. The necessity of putting all switches and even the oven in an accessible position was obvious, and a pilot lamp on each circuit was very desirable. The author was right regarding the use of a thermometer ; the indications, even if they were not actual degrees, would guide a cook to work the oven at the greatest efficiency. The question of tariff was still one for revision. Assessable value was perhaps the easiest method, but if the basis was to be on plant installed, or on maximum demand, or on the number of points, great difficulty would arise in regard to the expense incurred. After all, a person living in a highly-assessed house was accustomed to pay on the standard of his house being worth £50 or £60 a year, and he accepted that as the value which he ought to pay for anything installed by the municipality.

Prof. E. W. Marchant said the best cooks were the most stupid, and he did not believe thermometers to be of any service to such persons. Regarding small electrical appliances the weak spot was certainly the flexible, although, contrary to Mr. Cramp's opinion, he thought the wire springs seemed quite satisfactory. The author's suggestion of an inspector attached to the Corporation department, readily available to carry out small repairs, was good and obviated the intrusion of the local contractor whose dealings often convinced the consumer that the apparatus was not a success. The time taken for repairs was usually much too long, and easily replaceable elements were to be advocated. The speaker entirely agreed with the author on the question of charges. The primary charge and the secondary charge should be kept down, but if any choice had to be made, the secondary charge should be kept down in order to induce consumers to use energy. It seemed grossly unfair that the primary charge should have any bearing upon the amount of garden attached to a house ; a charge based upon the cubical contents or floor space of the house would surely be more reasonable. Regarding diversity factor, the development of electric cooking would involve an enormous number of people of a different type to those the author had mentioned. The engineer of a large gas company had stated that the maximum load was at 11 o'clock on Sunday morning when people started to cook a hot Sunday dinner. The demand for other purposes at this particular time was very small, and therefore the cooking consumer was evidently a very desirable one for the electrical engineer. Why, in the case cited by the author, was the consumption so heavy between 9 and 10 o'clock at night ?

Mr. E. M. Hollingsworth said that at St. Helens, with a rateable value system and a secondary rate of ¾d. per unit, they had been fairly successful. The initial outlay on apparatus and wiring was the chief drawback, together with the competition of gas cookers, with gas at 2s. per 1,000 cubic ft. There would be no difficulty in meeting the gas competition successfully were it not for the cost of installing and unreliability of large cookers. A large works employed electricity for cooking for 18 months with every success, excepting the question of reliability. Experiments employing thermometers had been made at a cookery school, and in the hands of experienced cooks the results were far more satisfactory with thermometers than without. The author did not say too much about the necessity of earthing cooking apparatus. The three pin plug was a very satisfactory device, and it was hardly possible for a negligent wireman to earth improperly apparatus fitted with such plugs. Speaking of tariffs, the author had said that at Norwich the charge was 12 per cent. as it was six years ago. With few exceptions the rateable value system had been introduced to meet cooking and heating loads and not lighting only ; therefore if the consumer derived the advantage of more efficient lighting, why should the supply authority give him a further advantage by reducing the primary charge ? The speaker advised engineers who had not yet adopted a rateable value or double-charge system to do so, as the half-watt lamp would doubtless arrive and place them in a worse position than when the metallic filament lamp was introduced. A comparison of figures referring to the question of high assessment had shown that the average cost of energy for a large house was a little less per unit than in the case of a small house not paying a fixed charge. Energetic station engineers had appreciated the value of cooking load for a long time but they also realised the keen competition represented by the free, installation of gas appliances and gas at 2s. per 1,000 cubic ft.

Mr. W. Eccles gave details of equipment and costs in the case of his own house, assessed at £30 and usually accommodating three adults. The equipment was as follows :—

Electrical.—Lighting on a generous scale throughout. Cooking by means of a cooker comprising oven, grill, hot closet and 4 boiling plates ; also a number of self-contained utensils. Heating by means of portable radiators. Power for washing, vacuum cleaning, fans, &c.

Gas.—For washing, boiler and hot water for house supply when kitchen fire was unavailable.

Coal.—During winter only for kitchen and one room fire.

Electricity cost ½d. per unit plus 12½ per cent. of rateable value.

Gas, 2s. per 1,000 cubic ft.

Coal, 1s. 0½d. per cwt. approximately.

The accounts were :—

	1914	1914 March, 1915.
Quarterly [illegible]	£ s. d.	£ s. d.
Electricity	2 16 7	2 12 1
Gas	0 15 8	0 6 2½
Coal	0 1 9	1 1 9
	3 14 0	4 0 0½
		3 9 0

which represented about £17. 12s. per annum. There had been a saving in laundry, carpet cleaning, baking, and charwomen of about £13 per annum. The advantages derived were: (1) Less of the drudgery of housework and increased cleanliness: (2) comparative independence of maids: (3) comforts and luxuries otherwise unattainable at any price. The author's case, whilst being devoid of the aforesaid advantages, except perhaps a little extra cleanliness in cooking, showed a loss of £8. 18s. 9d. This loss was reduced to £1. 12s. 6d., if the cost of electricity was adjusted to the speaker's rate. Further, coal at £13. 10s. per annum for eight or nine persons was very economical and probably much below the average. On the whole, the author's apparent results were likely to be discouraging to prospective consumers, as the average layman would not trouble about explanations. Regarding electrical cooking appliances, there was still much to be desired in the matter of cost and design. It appeared that the maker of electrical ovens followed gas oven practice by constructing tall narrow ovens which were quite undesirable. The fact that the lower 6 in. or 8 in. of gas oven was utilised for distributing the heat from the burners seemed to be quite overlooked. An electrical oven should never be less than 16 in. by 16 in. plan area, with a height varying from 12 in. upwards, according to the capacity required. The electric grill was practically perfect. The speaker thought the loss due to roasting should be the same whether the oven was electric or coal heated, provided that in each case the oven was well made and air tight. In the case of a gas oven the constant stream of hot air and burnt gas caused the excessive loss. Regarding the wiring of furnished houses, the local authority could do much to assist the prospective consumer by evolving a more satisfactory combination of wiring and fittings, and giving the benefit of their experience instead of leaving the applicant to the mercy of an unknown contractor, and a book of regulations. In the speaker's opinion a fair basis for tariff would be a "primary" fixed charge to cover the capital outlay in providing the supply, which, of course, would depend on the situation of the house and maximum demand; also a "secondary" charge covering the cost of production during the time supply was required. The application of such a basis of charging was a question for the supply authorities to settle.

Mr. H. A. Ratcliff thought electric cooking would have to stand or fall on its merits quite apart from questions of cost. Gas cookers were in use about 20 years before they became really popular. The carbon filament lamp did not compare favourably with incandescent gas in the matter of cost, but there was a big demand because its advantages were recognised and appreciated. The same would apply to electric cooking sooner or later. One of the strongest arguments in favour of electric cooking, as compared with gas cooking, was that the average gas cooker was not a model of hygenic conditions. There was one outstanding feature in gas cookers, as compared with electric cookers, namely, their undoubted robustness and general mechanical construction. The occasional renewal of grill plates was the only point for attention. Referring to the subject of water heating, the author did not regard it as financially impracticable provided the tariffs were suitably adjusted. If by this was meant the necessary reduction in cost of electricity the speaker agreed, but not otherwise. Electric water heating was an expensive luxury at ½d. per unit, and only became worthy of consideration on the score of convenience and cleanliness; at ½d. per unit it was a reasonable financial proposition. The most efficient heaters were undoubtedly of the [illegible] type in which water [illegible] through the heater as required. Their efficiency was high, but there were serious objections, one of which was the enormous kilowatt demand for a few minutes, which would not permit of a reasonable tariff. A further disadvantage was the necessity of reducing seriously the rate of flow in order to obtain high temperatures. Tests carried out on a model heater of this type showed a water inlet temperature of 60°F., outlet temperature 110°F., flow 7⅞ galls. per minute, efficiency 98·1 per cent. The load on the meter was 7 kw. The efficiency fell as the temperature was increased, and eventually when a temperature of 200°F. was reached, the flow became very unstable and slow, about ¼ gallon per minute, and the efficiency dropped to 94 per cent. The solution of the problem was undoubtedly the thermal storage system, the efficiency of which was very problematical. It compared very well with coal heating, but the fact was not to be overlooked that coal heating systems were very inefficient, and if the refinements usually applied to electric thermal storage were applied to coal heating systems the results might be surprising; in fact, the electric system would be out of the question. The principal defect with the thermal storage system was the limited supply of water at high temperatures, and in order to prevent the serious losses occurring in pipes it was almost necessary to [illegible] electric cookers there was not much likelihood of progress so long as the [illegible]

Mr. Alcock considered it a very difficult matter to interest the ordinary [illegible] the design of cookers hot plates, &c., the efficiency of the [illegible] was largely dependent upon the intimacy of contact between [illegible] ground in an attempt to obtain the desired intimate [illegible]

aluminium were liable to warp after a time. Whilst the Manchester Corporation demanded the installation of a certain number of kilowatts for a particular house, it would be interesting to know if they insisted upon this being used. Regarding rateable value, the speaker found the most equitable charge to be 12½ per cent. on £15; 15 per cent. from £15 to £30, and 20 per cent. for anything over £30.

Mr. Cooper, in reply, said that the lateness of the hour would prevent him from dealing in any great detail with the numerous points that had been raised. He did not agree with Mr. Welbourn that the apparatus he had used was too large. It was necessary to have a certain elasticity about arrangements so as to provide for more than the actual normal family from time to time, and it was also necessary to remember that the ordinary coal range provided a large surface for cooking operations, and in many cases two ovens. These had to be replaced by a single oven, and by a much smaller top-plate. In reply to Mr. Cramb, all coke boilers had an aperture at the top for feeding in the coke. It was difficult to water-jacket this part of the boiler, and on that account it seemed to him better to have it so made that it could be used for keeping things hot. As to the position of the thermometer it would probably be better to have this fitted to the top of the oven rather than to the oven door, though he did not feel that the latter position presented any very great objection. A proper thermometer rapidly took up its temperature again when the oven door was closed. He had not experienced any difficulty (in the case of three domestics) in getting the thermometer used. A portable thermometer might, of course, be used inside the oven itself, but this had the great disadvantage that it could not be easily inspected without altering the temperature, and if it happened to be on a porcelain base, the lag was very great. He thought the idea mentioned by Mr. Alderman Walker of giving notice to builders to put in sufficiently large conductors in the wiring, so as to permit of radiators and other plant without re-wiring, was an excellent move in the right direction. As to tariffs, Prof. Marchant had suggested floor area as a basis, and he (the speaker) believed that this basis had actually been used in America. In regard to the remarks of Mr. Hollingsworth, he quite agreed that the cost of installing apparatus required serious attention on the part of supply authorities. In his own case the work had been carried out by the supply undertaking, and presumably, therefore, it had been carried out cheaply. Mr. Eccles had suggested that other advantages of electric cooking might have been mentioned, and he (the speaker) would certainly have mentioned many other advantages if the Paper had been one for popular consumption, instead of for discussion by engineers. As to the question of efficiency in thermal storage, this depended partly on the proper proportioning of the apparatus to the demand, and under suitable conditions it might reach a reasonably high figure.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from The Electrician Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. And 10 per cent for abroad or for foreign books.]

"First Principles of Production." By J. Taylor Peddie, F.S.S. (London: Longmans, Green & Co.) Pp. 231. 5s. net.

"Proceedings" of the South Wales Institute of Engineers. (Cardiff: The Institute.) Vol. XXI. No. 1. Pp. lxxvi.+135. 5s.

"Science Abstracts." By the Physical Society of London. (London: E. & F. N. Spon.) Vol. XVIII. No. 207. Part 3, Section A—Physics. Pp. iv.+55. Section B—Electrical Engineering. Pp. iv.+31. 1s. 6d.

"Art de L'Ingénieur et Métallurgie Resistance des Matériaux et Données Numériques Diverses." By S. L. Archbutt, G. Fieck, Prof. W. Hinrichsen, E. Nusbaumer, A Portevin. Preface by M. A. Mesnager. Extract from Vol. III., 1912. Pp. ix.+90. (Paris: Gauthier-Villars et Cie.) 10 fr.

"Transactions" of the Institution of Engineers and Shipbuilders in Scotland. Vol. LVIII., Part V. Pp. xii.+48. (Glasgow: The Institution.)

"Annuaire Français de l'Electricité." (Paris: La Lumiere Electriqué.) Pp. XLI. 446. 4 fr.

"Journal" of the Washington Academy of Sciences. (Baltimore: Waverly Press.) Vol. V., Nos. 5 and 6. Pp. 43. $.25.

"Proceedings" of the Koninklijke Akademie Van Wetenschappen Te Amsterdam. (Amsterdam: Drukkerij De Standaard.) Vol. XVII. Pp. 128.

"Motor Cycles." Edited by Bernard E. Jones. (London: Cassell & Co.) Pp. viii.+152. 1s. net.

"Proceedings" of the American Institute of Electrical Engineers. (New York: American Institute of Electrical Engineers.) Vol. XXXIV. No. 3. Section 1—Institute Affairs. Pp. 23. Section 2—Papers, dis- [illegible] &c. Pp. 146. $1.00.

"Annual Report of the Director of the Department of Terrestrial Magnetism." (Washington: Carnegie Institute of Washington.) Pp. 34.

[illegible] Regulation of Electroplating Solutions." [illegible] the Department of [illegible] (Washington: Government Printing Office.) Pp. 13.

"Electric Wire and Cable Terminology." By the Department of [illegible] (Washington: Government Printing Office.) Pp. 13.

REORGANISATION OF THE BOARD OF TRADE AND BRITISH CONSULAR SERVICE.*

BY CHARLES H. LUKE.

One or two serious considerations specially obtrude themselves in connection with British trade and commerce just at present, one being the silent pressure of the British Fleet, which has (*a*) practically driven German trade off the seas, (*b*) allowed our Mercantile Marine almost normal scope, (*c*) practically cut off the whole supply of raw material required to keep many of the works and factories of Germany employed. Another factor is the competition for German trade which naturally arises from our friendly rivals in the United States. This great country being neutral, American manufacturers are free to devote themselves to this work, and to secure quietly full benefit of their enterprise in building the Panama Canal. Further, we must not forget that, crush Germany as you may, you will have sooner or later to reckon with the genius of the nation in the competition for the world's trade, and, bearing in mind the phenomenal rise of Teutonic industry since 1870, this may well come sooner rather than later, though probably on healthier and less aggressive lines. Bearing all these facts in mind, let us consider how we are equipped for the industrial fight. I desire this evening to draw attention particularly to the national or Government aspect of this question, as I consider that it is on this side of the question that we must to a great extent look for the reason of our failure to fully benefit by our undoubted opportunities in the past. The Government is represented by the Board of Trade at home, and by Commercial Attachés (whose work is seldom heard of) and Consuls abroad, all controlled by the Foreign Office. The Board of Trade is divided up into numerous departments, among these being the Railway Department, which examines plans for railways, inspects them, inquires into causes of accidents, and controls tramways, gas, water and electric light companies; a Marine Department; and a Finance Department (established about 1900), which has to collect information on various matters connected with conditions of employment, details of labour disputes, and more recently has, under the able guidance of Sir George R. Askwith, had a great deal to do with the settlement of strikes. The Patent Office and the Bankruptcy Board are also under the Board, and recently an Exhibition Branch has been established to take charge of British interests in foreign international exhibitions in cases where the Government has been officially asked to participate. Lastly, there is the Commercial Intelligence Department, which can be considered to be the only reasonably business-like department in the Board of Trade, though all who know the attitude assumed by Civil servants must have a good deal of pity for those unfortunate business men who are in charge of this particular department.

When one considers the list of duties with which these departments are required to deal, and the fact that it is reasonable to suppose that the sympathetic fostering of British trade, and export trade in particular, is one of the first duties of the Board of Trade, one cannot help but think that this Board, as at present constituted, is not properly equipped to do justice to the work entrusted to it, which in all other great countries is in the hands of several Ministries. The export trade of this country has steadily grown from a value of £244,080,577 in 1870 to £525,245,289 in 1913, but German export trade has grown from a value of £114,000,000 in 1872 to £496,482,000 in 1913, thus, while British trade has considerably more than *doubled* in value, German export trade has more than *quadrupled*, and would probably, had there been no war, have equalled or passed the British total by the end of 1914.

Taking into consideration the vast mass of trade and its great importance to the country, is it reasonable to expect that the constitution of the Board of Trade, which was originally intended to deal with a trade of £70,000,000, is calculated to deal satisfactorily with the present vast turnover? Since 1864 the President of the Board of Trade has been a Cabinet Minister, a somewhat tardy recognition of the importance of trade to a "Nation of shopkeepers." The principal officers are secretaries, all taken from the ranks of the Civil Service, and all more or less tainted with that contempt of trade so characteristic of the Government official. Such is the Government Department to which is mainly entrusted the official regulation of our commerce, our Mercantile Marine, with its 20,000,000 tons of shipping, and our railways.

The concentration of so many functions under one official head has for a long time been considered by business men to be a basic mistake in our Government Trade Department. The magnitude of the interests involved would seem to point to a proper division of the duties of the Board of Trade into three Ministries—a Ministry of Commerce, a Ministry of Marine and Railways, and a Ministry of Labour, or, if it is objected that as we have an Admiralty Department a Ministry of Marine is unnecessary, the division might be—a Minister of Commerce (controlling all ordinary trade and Mercantile Marine matters), a Minister of Railways and a Minister of Labour, this latter a most important and greatly needed reform. All these Ministers to be responsible to Parliament, which is most important.

By such a division it might be possible to gradually permeate the Commercial Departments with a greater realisation of what the nation expects, and ultimately, perhaps, to get rid of the official attitude that the Government has no interest in *trade qua trade*, except to tax industry to the limits of its capacity, and frame regulations defining the conditions which must exist on ships, on railways, in works, collieries and factories, such regulations being frequently characterised by ridiculous want of knowledge of what is required. There have been attempts in recent years to graft some more up-to-date methods on to the constitution of the Board of Trade, and two departments have been added, the Commercial Intelligence Department (which incorporates the old statistical department) and the Exhibition Branch, both of which are doing valuable work. It may be urged against the suggested reorganisation of the Board of Trade that the present is not an opportune time at which to undertake such work, owing to the serious difficulties which have to be faced from day to day. In this connection I would only cite the action of the Government in appointing as War Minister the greatest organiser in the British Army, *after* the outbreak of war, and in spite of the fact that his service had been available for a number of years, and for political reasons the nation had been deprived of the benefit of his universally acknowledged genius. In the same way the question of altering the constitution of the Board of Trade has been brought before successive Governments by business deputations and through the Press for many years, and nothing has been done, and now in trade, as in war, we are at the parting of the ways, and are as prepared for a trade campaign as we were for a world war on August 4, 1914.

What will happen after the war? Dumping of a character such as has never been experienced in the whole history of this country, for a considerable number of German manufacturers are making for stock, and they will require to convert the stock into money as quickly as possible, and will probably offer the goods at any price to the only country that is likely to have the necessary cash for same. This is a very serious question. I cannot help believing that the majority of business men in this country are agreed that the best will not be made of the present situation unless the Government attitude towards trade is altered, and the department in question thoroughly reorganised. The Ministers selected should be selected by merit, and not because of party allegiance, on the same principle, for instance, as the Sea Lords of the Admiralty are chosen.

The work of the Board of Trade in safeguarding life at sea, travelling on railways and the hundred and one other details to which attention is given, is excellent; but this is departmental work, and should be entirely subordinate to what should be the main objective of such a department, the *sympathetic* fostering of the commercial interests of the nation. We have recently had before us two remarkable examples of the want of business instinct in Government circles. A short time ago the Government decided, very wisely, to establish an Industrial Council, but, much to the surprise of the ordinary man, not a single labour leader was appointed as a member of this Council. One of the main reasons for the appointment of the Council was to deal with questions between employers and employé, with a view to preventing strikes, and generally helping things forward in an amicable way during this time of national stress. It was only after an outcry from various directions that a labour representative was appointed. The other glaring case is shown in the scheme for holding a London fair on the lines of the Leipzig Fair, which the Board of Trade are promoting directly. No one will dispute that it would be exceedingly important for British trade if a fair on the lines of the Leipzig Fair were held in Great Britain every year, but I do not think that the way in which the Government are handling this matter will tend to assist British manufacturers to any extent, as, as far as we can learn, it is to be a very small fair in the Agricultural Hall, whereas a proper fair on the lines of the Leipzig Fair would require about 10 or 12 times the accommodation, and, further, it is well known that the Board of Trade have no exhibition experts on their staff, and therefore they run a very grave risk of upsetting the manufacturers who exhibit by not knowing the ABC of the business.

The author makes a comparison with other countries, and it is shown that, in France, for instance, there are three Ministries to deal with the work of our Board of Trade. Similar conditions prevail in Germany, where there is a special Industrial Council, formed of men of eminence in commerce and also Government officials, which has practically autocratic power in the direction of fostering German trade.

The Foreign Office and Trade. The work of this department is extremely important to British commerce, for it is this office which

* Abstract of a Paper read before the Circle of Commercial Technical and Commercial Journalists.

[illegible] the appointment of Commercial Attachés and Consuls. There are no doubt quite a number of good business men among Attachés and the Consuls, but how few business men there are who, travelling abroad, get any good whatever from our Consuls. How different are the men we send out to those who represent Germany and the United States. All American Consuls must be American citizens, while German Consuls are generally men academically trained in the science of national economics, and are versed in every detail connected with the commercial life of the nation to which they are accredited. Out of about 1,200 of our Consul-Generals, Consuls and Vice-Consuls about 25 per cent. or more are foreigners, among them some foreigners occupying the position of Consul-General. Again, showing how slowly we have progressed in this matter, in spite of warning, and how endless awakening is needed, see leads in the "Manchester Guardian" of October 14, 1914, a communication from a gentleman who travels a good deal on the Continent, in which he says: "The Government would do well to establish Trade Consuls with sound practical business knowledge, working longer hours and receiving salaries calculated to make such positions worth striving for. We should have only British subjects as Consuls on the Continent."

But what can we expect? The Foreign Office is one of the Government Departments the one most permeated with the spirit of red tape. Surely a department such as this, where trade and commerce are looked upon as "vulgar," and the high craft of diplomacy is the ruling deity, is not the one to be entrusted with the important task of selecting the consular representatives of a great industrial nation, when one of the most important duties of these Consuls is to report on the commercial position of the district to which they are accredited. The diplomatic service of this country costs about £300,000 per annum for 160 members, nearly £1,700 each per annum, the Consular Service with about 1,200 members costs about £100,000 per annum, and after deducting fees received by Consuls leaves a net cost of about £20 per Consul per annum to this great industrial nation!

The inefficiency of our Consular Service has been indisputably demonstrated in the earlier stages of the great war by the fact that many of the British Consuls in the parts of the world where German raiders were carrying on their operations were natives of these countries, and therefore very little information was sent to the British Admiralty with regard to suspicious colliers, &c., who were arranging to coal these raiders. Had there been an efficient British Consular service in these countries the raiders might have been caught more quickly, and a great loss to the Merchant Marine saved.

This is not an attack on the personnel of the Board of Trade or on any Government Department, but on the prevailing system, and on that environment in Government circles, perhaps best described as a contempt for trade which seems to stultify all efforts at reform. One cannot help suggesting that it should be possible to implant the best elements of the German methods on our commerce, particularly their co-operative organisation, which, if grafted on our individualism, would forge an irresistible weapon for the nation. All the kindly feelings engendered by the stern struggle side by side against the common foe, as well as the bitter hatred of that enemy, will work for us if we are wise in seizing the opportunity. Britain has shown that she stands by "scraps of paper," and recognises international obligations, and is standing alongside her Allies, strong for liberty and justice and the rights of small nations. Now is the time for the Government, as well as the banking interests and the people, to help where Britain also stands in trade and commerce.

CORRESPONDENCE.

THE EXTENSION OF THE OPERATOR "j" TO THE MEASUREMENT OF ANGLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The operator j is ordinarily used to turn a vector through a right angle, but it would appear that the symbol could be employed to turn a vector through any angle at all. Writing $j = 1^{\angle 90}$, then multiplying by j will turn a vector through 90 deg. Multiplying by $(-1)^{\angle 0}$ will turn it through 180 deg. Similarly $(-1)^{\angle 0}$ will turn it through 0 deg., $(-1)^{\angle 90}$ through 90 deg., $(-1)^{\angle 180}$ through 180 deg., $(-1)^{\angle 270}$ through 270 deg., and $(-1)^{\angle 360}$ through 360 deg. Similarly $(-1)^{\angle 45}$ will turn it through 45 deg., $(-1)^{\angle 135}$ through 135 deg., $(-1)^{\angle 225}$ through 225 deg., $(-1)^{\angle 315}$ through 315 deg., and so on. Generally $(-1)^{\angle \theta}$ will turn it through θ deg.

Obviously the notation would mean that the value of the small increment of the operator θ to which the vector has been subjected, is the conversion that an index of [illegible] equal to [illegible]. The method therefore gives a simple and direct method of representing the value of an angle, which may be of interest to mathematicians.

Possibly it may already be well known, but I have not seen it mentioned anywhere.—I am, &c.,

North Shields, April 1. C. TURNBULL.

POLYPHASE COMMUTATOR MACHINES AND THEIR APPLICATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice that Dr. Wall has taken the opportunity to revert to the above in your columns, his reason for doing so being that I appear to have failed to recognise the main points of his remarks on the shunt type commutator motor. My reply as given in the "Journal" may seem strange to anyone who studies it attentively, and it is now necessarily incumbent on me to give an explanation.

His contribution to the discussion was sent to me for comment, and it clearly confirmed the verbal remarks he made at the time the Paper was given. It contained erroneous statements and an erroneous conclusion with regard to the operation of the motor in question, and these I corrected in my reply as printed in the "Journal." These statements were contrary to those he now makes; they were afterwards eradicated and his conclusion was corrected without my knowledge and before his remarks appeared in print.

The point he wishes to bring out is in connection with over-synchronous running; if, however, he will re-read my reply he will perhaps appreciate its significance.—I am, &c.,

Rugby, April 6. N. SHUTTLEWORTH.

ELECTRIC WATER HEATING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Evidently a wrong impression has got abroad with reference to my remarks on Mr. Cooper's Paper on "Electric Cooking," read before the I.E.E. on the 11th inst. Will you, therefore, be good enough to publish the letter which I have found it necessary to write to the editor of the "Gas Journal"? I enclose herewith copy of the letter.—I am, &c.,

Harrogate, March 31. GEO. WILKINSON.

The following is the letter to which Mr. Wilkinson refers:—

"Beech Mount," Harrogate, March 31, 1915.

The Editor,
"Journal of Gas Lighting and Water Supply," 11, Bolt-court, Fleet-street, London.

DEAR SIR: In perusing your "Electricity Supply Memoranda" in your issue of the 30th, I find that the writer grossly misrepresents my statement as to water heating made during the discussion on Mr. Cooper's Paper at the Institution of Electrical Engineers.

Moreover, your writer casts aspersions upon the cleanliness of myself and members of my family, which appear to me to be in very bad taste.

What I actually said was that the electric heater has a cubical capacity equal to 12 gallons, but it is equal to an output of over 60 gallons of water per day at 100° F., which I think you will agree is a fair supply for a small household; it is found sufficient for two or three baths per day in addition to the ordinary kitchen requirements.

I have facilities for the production of 10 times this amount of hot water if necessary, but the output of the electric heater is found ample for ordinary every day demands.

I hope you will do me the justice to have this matter put right in your next issue.

Yours faithfully,

GEO. WILKINSON.

THE "ELECTRICAL ENGINEER'S DIARY."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of April 2nd you publish a review of the Electrical Engineer's Diary" for 1915. The volume was issued in December last, and a copy was sent you then. Your review seems to be somewhat belated.

Your question as to the copyright of the matter appearing in the "Electrical Engineer's Diary" is best answered by referring you to your own report of the action brought by the publisher against an electrical firm who had reprinted in their [illegible] certain matter from the "Electrical Engineer's

Diary." The copyright was admitted by the defendants, who undertook to pay damages, the costs of the action, and to give a perpetual undertaking that the infringement would not be repeated.

Your reference to the table on p. 168 and the Standard Specification on p. 147 is, I think, too petty to call for comment.

Regarding your reference to the "Index to Manufactures," I find it is a fact that two obvious printer's errors have crept in. They are, of course, regretted, and will be corrected in future editions. These two unfortunate errors seem to have got on your nerves, seeing that this is the second time you have publicly denounced them in your paper. Incidentally, I note that you refer to this list as the "Index to Manufacturers." Permit me to call your attention to the fact that your printers have made an error. The correct title, as you can easily see by reference to your copy of the Diary, is the "Index to Manufactures." —I am, &c.,

THE EDITOR.

London, April 6. THE "ELECTRICAL ENGINEER'S DIARY."

LEGAL INTELLIGENCE.

Hood v. Walthamstow Urban District Council.

Last week the Court of Appeal (Lord Chief Justice Lord Justice Swinfen Eady and Mr. Justice Bray) ordered a new trial of this action. Plaintiff had been awarded damages for personal injuries received owing to defendant's alleged negligence in the management of owned their tramcars, the question being whether the accident occurred through inattention to the electric wire and its supports. The Court held that the verdict of the jury was ambiguous, and could not support a judgment for the plaintiff.

Prize Court Case.

In the Prize Court last week the President (Sir Samuel Evans) had before him a suit by the Crown asking for the condemnation as enemy property of five cases of electric fans, seized on board the P. & O. steamship "Poona," in London on Oct. 17 last. The goods were claimed by Isaria (Ltd.), a company duly incorporated in England.

Mr. J. B. ASPINALL (for the Crown) said that the fans were sent to Germany at some time before the outbreak of war by the Isaria Zohlerwerke, of Munich. The outer wooden case in which the goods were packed bore labels printed in Germany, and also had the words "Made in Germany" stencilled upon them, and each of the fans was wrapped in paper bearing printed German labels. They were forwarded to Australia by the s.s. "Rheinland," but were afterwards sent back to this country on the s.s. "Poona" to Isaria (Ltd.). The goods reached Australia before the outbreak of war; they were consigned by Messrs. Lascelles, Parrington & Brasche, of Melbourne, "to order," London. The goods were handed over to the firm in Melbourne by one Brandl, who was alleged to be the Australian traveller of the English company, but who the President was asked to say was the Australian traveller of the German company. He submitted that the goods were so tinged with German interest that they ought to be condemned. The contention on the other side is that the goods were the property of the English company. After referring to the constitution and directorate of the company, Mr. Aspinall said that looking at the reality of the transaction, his case was that the goods were probably the property of the German company. But even if they were not, but were the property of the English company, then he contended for the purpose of prize, that that company was so German that if the goods belonged to them they ought still to be condemned. He asked his Lordship to follow up what he said in the [illegible] and look at the "realities of the thing."

Mr. ELKIN (for the claimants) said his submission was that where the goods were shipped and seized in a British ship trading between two British ports, the onus was on the Crown to prove that the goods were of an enemy character.

The PRESIDENT: No.

Mr. ELKIN said that then he submitted that the [illegible] were clearly the property of the English company, and as such were [illegible]. The transaction was a simple one. The goods were [illegible] the Munich company by the British company, and were sent direct to Brandl, the British company's Australian traveller, and he handed them over to the British company's Australian agents (Messrs. Lascelles, Parrington & Brasche) on sale or return terms. The goods [illegible] suitable for the Australian market, and the agents shipped them to London. At the time of the seizure they were the property of the English company.

FRANK MORTON, the English company's manager since Aug. 3, gave evidence to the effect that the goods were bought outright by the English company from the German company, and had been [illegible] trading account.

The hearing was adjourned till the 13th inst. [illegible]

Dundee Tramway Arbitration.

The Board of Trade arbitrator (Mr. W. A. Carter, C.E.) recently commenced to hear evidence in the arbitration between the Dundee, Broughty Ferry & District Tramway Co. and Dundee Town Council to determine the price to be paid by the Council for the portion of the tramway line between the eastern boundary of Dundee and the western boundary of Broughty Ferry as they existed in 1904. This portion is less than a mile in extent and the Council have power to purchase it under sec. 45 (7) of the provisional order of 1904.

The company was represented by the Solicitor-General and the Council by Mr. Macmillan, K.C.

The company claimed £14,500, allocated as follows: Permanent way on main road and on Craigie estate, and formation of road for tramway through Craigie estate, £9,970; servitude and formation of street referred to in the agreement with Mr. Guthrie, of Craigie, £3,120; overhead equipment, fences, &c., £1,410.

Mr. STEPHEN SELLON, tramway engineer, who gave evidence as to the value of the various items of the claim, put the total value at £17,000. In his evidence he gave particulars of the cost of construction, Parliamentary expenses, the cost of floating the undertaking, and engineering expenses. He also dealt with the question of the life of the track in order to arrive at depreciation.

Mr. GEORGE BALFOUR, managing director of the company, also gave evidence as to the various items of the claim. The price for the overhead equipment was adjusted without proof. The company claimed £985 for that item, but they accepted £640. Mr. Balfour said the original claim was for £15,486, made up of £12,636 for constructing the tramway, £1,100 Parliamentary expenses, £1,500 raising capital and £250 for interest during construction. In cross-examination, he said that after making all allowances for depreciation in value, he put in a figure which he regarded as absolutely incontestable. For Parliamentary powers the figure of £1,100 referred specifically to the portion of the line now being arbitrated on. His view was that it was necessary, in order to construct the line, to promote a bill in Parliament for its construction. He did not believe the Council could get such an order for less than £1,600. His contention was that the cost of any bit of that line was the cost of the promotion of the order without reference to that being only one-sixth of the total line. The minimum cost of the order, as a separate order, would not be less than £1,600. It cost him from 10 to 15 per cent. to raise the capital, and to that had to be added some other charges. He did not believe the money could be got on better conditions.

J. J. MACLAREN, surveyor, gave evidence on the claims for excavations and the making of the roads over which the tramway was laid. The various items charged for had been put in, and the charges made were fair.

The proceedings were adjourned.

PARLIAMENTARY INTELLIGENCE.

EDINBURGH CORPORATION TRAMWAYS ORDER.

The consideration of the application of Edinburgh Corporation for a provisional order authorising the construction of tramways was concluded by the Parliamentary Commissioners (Lord Wemyss, Lord Torphichen and Messrs. G. B. Esslemont and G. W. Currie) was concluded last week. The Colinton Tramways Co. opposed, and after hearing evidence, including that of Major-Gen. Sir Charles Hadden (who submitted a communication setting out the conditions of the War Office), the chairman and the Commissioners found the preamble proved so far as regarded the proposed tramway to Corstorphine. They were prepared to find the preamble proved in regard to the other tramways provided the Corporation acquired the Colinton tramways at £9,000, with interest at 5 per cent. from the confirmation of this Order till payment, and they also accepted the conditions of the War Office, and carried out certain widenings. If the Corporation used the Tramway Company's track, the connection with Firrhill to be made by a curve to the north of the Oriel Cottage feu.

Mr. COOPER then stated that the Corporation proposed to abandon the Colinton extension unless the Commissioners would grant the tramways from Comiston terminus to the barracks without any conditions.

The Commissioners agreed to this, and the result was that the Corporation declined to take over the Colinton Company's undertaking, and under the preamble of the Order they have power to lay down the Corstorphine tramway and the line from the Braid Hills terminus across country to Firrhill.

DUNFERMLINE TRAMWAY ORDER.

Last week the Commissioners under the Private Legislation Procedure Act considered the application for a provisional order by the Dunfermline & District Tramways Co. for an extension of their tramways to Rosyth by way of Queensferry-road. Lord Elgin opposed on the ground that it had already been agreed that a tramway should be laid down Grange-road before any other route was constructed.

After hearing evidence the Commissioners found the preamble proved. The company is to construct within 18 months (but subject to such considerations as may be imposed by any road trustee) the tramway from the dock yard gates to the new Inland [illegible] along Queensferry road to High street, Dunfermline.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Payor, Chartered Patent Agents, 70 and 72, Chancery Lane, London, W.C.

Whenever no date appears it differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

[illegible]

An electric switch or circuit-breaker having a movable bridging contact member comprising side plates and two contacts or groups of contacts of the brush or leaf type secured in an oblique or inclined position between said side plates, each contact or group of contacts co-operating with a single fixed contact.

6,162 Western Electric Co. (Woodward, acting for Western Electric Co.) Electric switches.

An electric switch having a plurality of switch operating cams mounted on a rotatable shaft which are engaged at or near their peripheries by a positioning member, which positioning member is located relative to the shaft by means of a plurality of members forming spring couples which engage the shaft and positioning member.

6,180 Electric & Ordnance Accessories Co. & Etchells. Electric switch apparatus for use in connection with the electric lighting and heating equipments of railway and other vehicles.

6,209 Betulander Automatic Telephone Co. & Aitken. Electrical impulse transmitters and the like.

6,460 Boot & Spencer-Phillips. Method of heating liquor and the like in breweries and similar works.

8,052 Withers. (Sander.) Recording mechanism for use with electric measuring instruments.

8,286 Wauchope & Stothert & Pitt. Safety devices for electrical winding mechanism.

10,895 Giles. Electrical condensers and the manufacture thereof. (29,5/13.)

12,964 D. Bell. [illegible]

12,976 Cox. Electrical switches.

14,192 Cote & Pierron. Process and electric furnace permitting the extraction in a state of purity of zinc from its ores.

16,318 Mahoney. Electric circuit interrupters. (8/11/13.)

A circuit interrupting device having main and auxiliary circuit-breaking contacts with reactance coils surrounding the ends of the terminals of the fixed contacts, and with two operating mechanisms, one to operate the main and the other to operate the auxiliary movable contacts, the operating mechanism for the auxiliary contacts being arranged to be actuated a definite time after the other during the opening movement and vice versa during the closing movement.

22,133 Olsson & Pedersen. Self-induction coils for use in duplex or multiplex telephone systems. (7/11/13.)

22,732 Allmanna Svenska Elektriska Aktiebolaget. Means for regulating the speed of electric motors. (5/1/14.)

Speed regulating means for controlling the number of revolutions of a shaft driven by an electric motor to which is mechanically coupled a continuous-current generator exciting the coil of an automatic regulator controlling the driving motor, the continuous-current generator being built with series excitation.

1915 Specifications.

2,060 Taylor. Means for and methods of changing the frequency of alternating-electric currents. (Divided application on 15,729/13. 9,2/14.)

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

March 1, 1915.

3,241 Grocott. Ceiling roses and the like electrical accessories.
3,244 Schaschke. Electric lampholders and similar couplings.
3,261 Maurice & Cash. Electric light fittings.
3,277 Tugwood. (Radium Therapy Corpn., U.S.) Porous radio-active bodies and process of producing same.*
3,283, 3,284 Igranic Electric Co. (Cutler-Hammer Mfg. Co., U.S.) Electric controllers.*

March 2, 1915.

3,300 Hitch. Electric conductors or cables.
3,302 Sampson. Electric dry cells.
3,303 Dunkerley. Electrical alarum switch.
3,321 [illegible]
of attacking Zeppelins or other aircraft.
3,326 Naylor. Secondary electric batteries or accumulators.
3,329 Jenkins. Sanitary telephone mouthpiece.*
3,364 Richards. Manufacture of electric insulating materials and the like.
3,366 International Electric Co., Le Noir & Funccius. Telephone exchanges.
3,369 Ginori. Electric insulators. (5/3/14, Italy.)*

March 3, 1915.

3,377 [illegible]

3,393 Scott & Wheatley. Mine-shaft signalling apparatus.
3,406 Vangel. Manufacture of illuminated signs.
3,409 B.T.-H. Co. & Whitaker. Dynamo-electric machines.
3,410 B.T.-H. Co. (G.E. Co., U.S.) Exhausting machines.
3,411 Myers & Baker. Connecting electrical conduits to their fittings.
3,419 Stern. Signalling systems.*
3,433 Torchio. Reactance coils. (Addition to 11,116/14.)*

March 4, 1915.

[illegible]

3,460 Whiteley. Automatic controls or control boxes.
3,490 Waller. Electric switch gear.*

[illegible]

March 5, 1915.

3,527 [illegible]

March 8, 1915.

3,657 Anderson. Electric switches. (7,3/14, U.S.)
3,660 Wilson. Electric condensers.
3,668 Collis. Protecting apparatus on alternating-current systems.
3,688 Hele-Shaw & Martineau. Control apparatus for searchlights and the like.
[illegible]

3,710 Patterson. Frames or racks for use in charging secondary electric batteries.

March 9, 1915.

3,715 Raden. Sparking plugs for internal-combustion engines.
3,720 Parez. Instructional means for signalling by Morse or other codes.
3,723 Cowper-Coles. Process for the electro-deposition of lead.
3,724 Cowper-Coles. Coating or plating metal sheets with other metals by electro-deposition.
3,728 Loukes & Hunter. Renewing the wearing parts of trolly wheels of electric tramcars, omnibuses and the like.
3,733 Wynne. Electrical switches.
3,748 Hailwood. Miners' safety lamps. (Addition to 18,694/13.)
3,760 Canton. Incandescent electric lamps.
3,762 Edman. Connections for electrical conduit fittings.
3,763 Tucker & Crabtree. Electrical fuse boards or the like.*
3,774 Walker. Electric signalling apparatus.

March 10, 1915.

3,796 Poole. Collector gear for overhead trolleys.
3,804 Paton. Signalling apparatus for use in mines.
3,837 Igranic Electric Co. (Cutler-Hammer Mfg. Co., U.S.) Electromagnetic switches.*
3,855 Landis & Gyr Akt.-Ges. Electric heating and cooking apparatus. (18,3/14, Germany.)*
3,856 Landis & Gyr Akt.-Ges. Measuring electric current. (10,3/14, Germany.)*

March 11, 1915.

3,860 Hislop. Electric firealarm contacts.
3,882 Lister, Watson & M-L Magneto Synd. Magnetos.
3,891 Ward. Electric apparatus for therapeutic and like purposes.
3,910 Compagnie de Fives-Lille. Magnetic [illegible] of the like. (1,3/14, France.)*
3,912 Hookham. Incandescent electric lamps and the like.

March 12, 1915.

3,918 Miles & Lawrence. Electrical high-tension fuse boxes.
3,927 Booth & Booth. Incandescent electric lamps.
3,928 Broadbent. Bonding devices for electrical conduit systems.
3,932 Schöngut. Winding the armatures of electric machines. (13/3/14, Hungary.)*
3,949 Harrison. Incandescent electric lamps.
3,950 Lee de Forest & Logwood. Wireless receiving systems. (12,3/14, U.S.)*
3,953 Scott & Howles. Electric furnaces.
3,954 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maats chappij. Wireless telegraphy or telephony. (5,2/15, Germany.)*

March 13, 1915.

3,975 Royce & Matterson. Manufacture of dynamos and electric motors.
3,985 Rainey. Synchronising system for multiplex telegraphy. (26,3/14, U.S.)*
3,987 Dixon. Printing telegraph receivers. (19/3/14, U.S.)*
3,993 Cowper-Coles. Process for coating metallic surfaces with lead.
3,995 Fried. Krupp Akt.-Ges. Distant controlling apparatus. (13/3/14, Germany.)*
3,997 Wilkinson. Electrically-driven radial-arm drilling and the like revoluble-head machines.
4,006 Vargas. Attachments or fittings for telephone mouthpieces and earpieces.
4,007 Binyon. Submarine signalling.
4,012 Bozzetti. Apparatus for cut-out switches of the push or pull type. (14,3/14, Italy.)*
4,017 Axel Uno Sarnmark. Devices for wireless telegraphy and telephony. (13/3/14, Sweden.)*
4,026 [illegible]

NEW BOOKS AND NEW EDITIONS.

[Copies of the new books mentioned below can be obtained *post free* from The Electrician Offices on payment of the prices indicated in parentheses. Where an asterisk is added to the number 20 days will elapse before books are supplied. It is only necessary to specify the number when sending remittance.]

473. "Notes on Practical Physics for Junior Students." By Barkla and Carse. 3s. 6d. net (3s. 9d.).

474. "Treatise on Statics." By G. M. Minchin. Vol. II. Rev. by Gerrans. 10s. 6d. net.

475. "Practical Chemistry." By A. Findlay. Third edition. 4s. 6d. net (4s. 9d.).

476. "Marine Oil Engines: Including Verbal Questions and Answers." By W. D. Martin. 2s. 6d. net (2s. 9d.).

477. "Practical Mathematics: Second Year." By A. E. Young. 2s. net (2s. 3d.).

478. "Radiography, X-Ray Therapeutics and Radium Therapy." By R. Knox. 25s. net.

479. "Text Book of Radiology." By E. R. Morton. 7s. 6d. (7s. 9d.).

480. "Practical Science and Mathematics for 2nd Year Preliminary Technical or Industrial Course." By Edwards & Tickle. 1s. 6d. net (1s. 9d.).

481. "Electricity of To-day." By C. R. Gibson. 5s. net (5s. 3d.).

482. "Overhead Transmission Lines." By F. Capper. 16s. net.

483. "Single Phase Electric Railways." By E. Austin. 21s. net.

484. "Telegraph Engineering." By E. Hausmann. 10s. 6s. net 10s. 10d.)

485. "Mechanical Technology." By Prof. C. F. Charnock. 7s. 6d. net (7s. 10d.).

486. "Structural Steel Drafting and Elementary Design." By C. D. Considine. 10s. 6d. net (10s. 10d.)

487. "The New Income Tax in Relation to the War and Business." By E. Burrows. 1s. net (1s. 2d.)

488. "Modern Illuminants and Illuminating Engineering." By Gaster & Dow. 12s. 6d. net.

489. "Treatise on Theory of Alternating Currents." By A. Russell. 2nd edition. Vol. I. 15s. net.

490. "Electrical Engineering." By T. C. Baillie. Vol. I. 5s. net (5s. 4d.)

491. "Lathes: Their Construction and Operation." By G. W. [illegible] 3s. 6d. net (3s. 10d.)

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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IMPROVED CONSULAR SERVICE.

During eight months of the great European War opportunities have presented themselves of indulging in some analyses of the attitude of the Government towards the industrial and commercial interests of the country and its overseas Empire. For years past the inherent slackness of the average Englishman in carrying on his affairs on an organised basis has been known and criticised. It was regarded more as a complaint than a disease, and has been treated as such in consequence. Latterly, the keener business men in the country have examined this national failing, and can advise nothing short of surgical methods to remove the accretions, which threaten such life as the Government is able to show in industrial and commercial affairs. Among these surgeons we may place Mr. C. H. Luke, who has recently made public his views upon the reorganisation of the Board of Trade and British Consular Service. On another page of this issue we give in abstract the results of some of Mr. Luke's observations on this important subject, as given before the Technical and Commercial Circle of the Institute of Journalists. The records of these departments point to an increasing interest in later years on the part of the Board of Trade in the organising of International Exhibitions, and in the supply of information, of a kind, through its intelligence department. Evidence is not yet forthcoming that the heads of this department are business men, having ripened experience and sound judgment upon the subjects with which they are dealing. As Mr. Luke intimates, the British equivalent of the Leipzig Fair, which the Exhibitions Department had in hand, was hardly to be planned by business men, when the Agricultural Hall in fixed upon as a suitable venue for it in London. This and similar instances are cited as clear proof of the crying need for the appointment of men of experience for the handling of such matters. In his references to the Foreign Office and the Consular Service Mr. Luke reiterates a number of facts which we feel should be constantly dinned into the minds of business men. There seems to exist among the officials of the Foreign Office a feeling that the Government has no real interest in British trade, and can only regard it as an avenue to taxation, or an organisation which must be hedged about with regulations and restrictions, thus placing it at a disadvantage. Obviously a department which is chiefly concerned with the science and practice of international diplomacy cannot stoop to consider the claims of matters so derogatory as trade and business. The anomaly to which Mr. Luke draws attention is the appointment by this very department of our commercial attachés and consuls! In the early stages of the war the action of many of these gentlemen in various parts of the world afforded proof of their German partiality, though this fact need not occasion surprise, seeing that they themselves, though British consuls, were of German nationality. Mr. Luke and others, of broad business experience, are doing good work in constantly driving in the facts as they stand concerning the inadequate nature of the business side of the Government at a time, when all the ability which the nation possesses should be displayed in the common cause of dominating Germany in the markets of the world. Although the war has proceeded for eight dreary months, that time has not stifled the power of the German to spring again into the commercial arena, strong and resourceful, to get and hold more than his share. The preparations of Lord Kitchener for a three years' conflict may prove exaggerated, but they ought to be regarded as the maximum of time in which British industries can be allowed to adjust themselves to the new state of things brought about by the war.

Electro-Galvanising. Electro or cold galvanising is now an industry of considerable importance in the engineering and shipbuilding districts throughout the world, having an electro-galvanising plant for coating various parts. All boiler tubes for the Admiralty are coated with zinc by electro-galvanising before being assembled. The process is also largely used for coating iron and steel when it is important that the tensile strength should not be affected, also for machined and finished work which has threads or screws cut upon it or accurately fitting parts, as these are not filled up. Mr. Cowper Coles has recently made an apparatus for the coating of small articles, such as bolts, nuts and tubes.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week March 29, 1915, to April 3, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE.—*France:* Elec. glow lamps, 5s/kgs.; telephone instruments, 5 pkgs.; carbons, 5 pkgs.

LONDON.—*Switzerland:* Elec. machinery, £426; unenumerated, £47. *U.S.A.:* Carbon candles, £60; elec. machinery, £1,523; wire and cable, £18; unenumerated, £1,068. *Holland:* Elec. lamps, £94—392 pkgs.; machinery, £97. *Sweden:* Elec. machinery, £219; telephone material, 102 pkgs. *France:* Carbon candles, £75; unenumerated, £44. *Italy:* Wire and cable, £1,005. *Canada:* Unenumerated, £40. Wireless telegraph instruments, 14 pkgs.

LIVERPOOL.—*U.S.A.:* Unenumerated, 922 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Machinery, £35; unenumerated, £43. *Melbourne:* Elec. machinery, £1,063; unenumerated, £281. *Sydney:* Machinery, £409; unenumerated, £266. *Wellington:* Wire and cable, £124; unenumerated, £10. *Lyttelton:* Unenumerated, £74. *Adelaide:* Elec. machinery, £61; unenumerated, £63. *Brisbane:* Unenumerated, £40. *Freemantle:* Elec. machinery, £20; unenumerated, £83. *Hobart:* Unenumerated, £10. *Dunedin:* Elec. machinery, £201. *Napier:* Wire and cable, £18; unenumerated, £322.

AFRICA.—*Durban:* Elec. wire and cable, £115; unenumerated, £94. *Port Elizabeth:* Unenumerated, £153. *Cape Town:* Machinery, £17; unenumerated, £316. *Alexandria:* Wire and cable, £160. *Zanzibar:* Unenumerated, £14.

MALTA.—Elec. machinery, £16; unenumerated, £30.

CYPRUS.—Elec. machinery, £300.

GIBRALTAR.—Unenumerated, £44.

CHINA.—*Hong Kong:* Unenumerated, £140.

INDIA, CEYLON AND INDO-CHINA.—*Bombay:* Elec. machinery, £28; unenumerated, £651. *Calcutta:* Elec. machinery, £51; unenumerated, £1,327. *Madras:* unenumerated, £169. *Penang:* Wire and cable, £189; unenumerated £106. *Singapore:* Elec. machinery, £34; unenumerated, £565. *Karachi:* Unenumerated, £36. *Shanghai:* Elec. machinery, £34; unenumerated, £60.

JAVA.—*Sourabaya:* Elec. machinery, £50.

CANADA.—*Halifax:* Telegraph material, £33.

FRANCE.—*Bordeaux:* Unenumerated, £20. *Rouen:* Unenumerated, £56. *Havre:* Elec. machinery, £570.

SOUTH AMERICA.—*Buenos Ayres:* Elec. machinery, £130; unenumerated, £51. *Arica:* Telegraph material, £27. *Aniofagasta:* Elec. light apparatus, £267.

MEXICO.—*Talcahuano:* Elec. cable, £1,020; unenumerated, £62.

SPAIN.—*Bilbao:* Unenumerated, £22. *Malaga:* Elec. machinery, £17.

HOLLAND.—*Rotterdam:* Unenumerated, £350.

U.S.A.—*New York:* Unenumerated, £132.

JAPAN.—*Yokohama:* Unenumerated, £467. *Kobe:* Unenumerated, £239.

DENMARK.—*Copenhagen:* Wire and cable, £158.

WEST INDIES.—*Trinidad:* Unenumerated, £36.

FOREIGN GOODS DUTY (paid and free).

Calcutta: Unenumerated, £14. *Bombay:* Unenumerated, £63. *Calais:* Unenumerated, £94. *Karachi:* Unenumerated, £34. *Nagpier:* Unenumerated, £30. *Port Elizabeth:* Unenumerated, £92. *Sydney:* Unenumerated, £15. *Cape Town:* Unenumerated, £215.

IN TRANSIT.

Sydney: Elec. lamps, £1,755. *Adelaide:* Elec. lamps, £800. *Christchurch:* Elec. lamps, £210. *Lyttelton:* Unenumerated, £176. *Melbourne:* Elec. lamps, etc., £2760. *Perth:* Elec. lamps, £330. *Brisbane:* Elec. lamps, £240.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Increase in Prices. The British Thomson Houston Co. notify that from April 7 there will be a 10 per cent. advance in the price of electrical fittings.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Spanish National Submarine Telegraph Co. (Ltd.) is being wound up voluntarily and Mr. James Jeffery has been appointed liquidator. A meeting of creditors will be held at 106, Cannon Street, London, E.C., on April 12.

The Otis Elevator Co. (Ltd.) is being wound up voluntarily and Mr. R. P. Sellon has been appointed liquidator. A meeting of creditors will be held at 4, Queen Victoria-street, London, E.C., on April 14. (The business of the company has been acquired by Waygood-Otis, Ltd.)

A dividend is to be paid to creditors of Herbert Jas. Godfrey, electrical engineer, 188, Balham High-road, London, S.W., and claims are to be sent by April 16 to the Hon. W. J. H. Boyle, 132, York-road, London, S.E.

ELECTRICITY SUPPLY.

EXTENSIONS.

Blackburn. The Council have applied to the Board of Trade for their consent to the construction of a new generating station at Whitebirk.

Leyton. Application is to be made to the L.G. Board for sanction to borrow £1,000 for mains.

The Electric Lighting Sub-committee has considered a report of the electrical engineer (Mr. F. Harman Lewis) on the necessity of providing additional plant at the generating station, and also an offer of Hackney Borough Council to give a bulk supply. The cost of the engineer's proposals is estimated at £17,158. The sub-committee recommends that the Hackney offer be not entertained, but that the increased means of supply be provided by the installation of additional plant, as recommended by the engineer. The Electricity Committee is of opinion that the additional plant should be installed with as little delay as possible, and recommends that application be made for sanction to a loan to cover the cost of carrying out the work.

The recommendations were adopted at a meeting of the Council last week.

London County Council.—At the last meeting the Finance Committee reported that the Treasury had raised no more objection to the granting of a loan of £5,000 to Battersea Council for electric mains; and of £10,000 to the Hammersmith Council for the electricity undertaking. The Council also agreed to sanction a loan of £4,000 to the Stoke Newington Council for electricity supply purposes.

Electric Light Charges. Mr. W. C. Johnson asked if the Electricity Supply Committee would consider the question of the electric supply companies charging increased rates to customers in order to maintain dividends. Mr. Hume replied that the companies supplied electric light under provisional orders in which maximum prices were fixed. The companies charged well under the maximum price. He promised to consider whether the present regulations afforded sufficient protection to the public.

Woolwich Sub-station. A capital estimate of £14,000 was passed by the building department for an extension of the Woolwich sub-station.

Manchester.—At the recent monthly meeting of the Central Executive Committee of the Employers' Association the following resolution was unanimously adopted:—

That this meeting is of opinion that permission should be accorded to Manchester Corporation and to other corporations similarly situated, by His Majesty's Treasury to raise fresh loans for the purpose of the extension of any electricity undertakings, as any refusal to secure permission would hamper to a very considerable extent those firms engaged on Government contracts who are dependent upon the Corporation for their supplies of motive power, and this committee is emphatically of opinion that where it can be shown by any corporation that the extension of electricity plant is necessary for an adequate supply of motive power, on account of the additional requirements of firms engaged on Government contract work, on application by the corporation concerned, permission to undertake such extensions ought to be granted with all possible expedition.

A petition has been presented to the Treasury to allow the Corporation to proceed with their scheme for the erection of a new power station at Barton and to permit the borrowing of the necessary capital. It is pointed out that never in the history of the electricity undertaking has there been such an enormous demand for power. Every month sees the demand becoming greater, and at present the generating plant is so severely taxed as to necessitate the erection of a new generating station. The effect of the demands by many of the larger engineering works has been to draw still further on the existing reserves of the various electricity generating stations. In addition, the Corporation are supplying a very large amount of electricity to a number of textile mills, many of whom are concerned in Government contracts. The proposed expenditure would not entail any increase in the rates, and the yearly allocation to relief of rates would continue.

Nuneaton. Electric supply mains are to be laid in three streets, at a cost of £400.

Salford.—The Electricity Committee has decided that no extensions of mains are to be carried out during the war except where, in the opinion of the Borough Electrical Engineer, they are absolutely necessary, and in these cases the cost is to be met out of the existing unexpended loan balance for mains and services.

Sheffield.—An inquiry was held last week into the application of the Corporation for sanction to borrow £164,373 for extensions of the electric generating plant and mains.

In regard to the loan for electric supply extensions, the town clerk (Mr. H. E. Hart) said that they were pressed to carry out the work, not for the ordinary expansion of the business, but largely in order that they might supply a much needed assistance to the large armament works that were fully engaged on Government orders. That was their principal object in pressing forward the work at present. The sum asked for would be spent as follows: £86,813 for additional plant, £30,000 for substations and equipment and £27,560 for buildings at Neepsend. It was no use spending money for plant to put into the building unless they got the money for the buildings. All the applications hung together, and if they could not have one they might as well be denied the whole.

Councillor T. G. EVANS (chairman of the Electricity Supply Committee) stated that numerous applications for power were being made, chiefly from the large armament works, some of which had discarded their own plant because the Corporation could supply them more satisfactorily and cheaply. Also application had been made for current for six new melting furnaces, which would require 6,000 kw. Eight such furnaces (taking 4,400 kw.) were already in use. One firm could not carry on at the speed required without extra supply, and the Government had recognised the desirability of the Corporation's electricity works being fully manned, and so had given them permission to prevent their men from recruiting.

Stoke-on-Trent.—The Town Clerk has had an interview with a representative of the Treasury on the question of capital expenditure on electricity supply extensions.

It was stated that it was the desire of the Treasury that works should not be proceeded with except and unless they had been commenced and had been partially executed or were urgent for other reasons, or were for the purpose of assisting the War Office in the manufacture of munitions of war, or were required to enable English manufacturers to capture German trade.

The Electricity Supply Committee have decided to extend the mains from Stoke works to new premises on the Fenton side in course of erection by Messrs. Keeling & Walker, for the introduction of a colour industry which has been carried on successfully in Prussia, and which it is urged) might be made equally successful in the district.

There is a clause in their agreements by which the committee can give notice to consumers to terminate the arrangement as to the price charged in the event of coal going up and other circumstances by which it was found that electrical energy was being supplied at a loss to the Corporation, and so cease to supply electrical energy except at a revised rate agreed to between the Corporation and the consumer.

Swansea. Last week there was a public inspection of the additional plant recently installed at the electricity works.

The new plant includes two water-tube boilers, two 3,000 H.P. Curtis turbines, a three-phase alternator generating current at 6,600 volts, switchgear, &c. A new sub-station has been erected at the Uplands, to which current at extra high pressure is transmitted from the generating station. The chairman of the Electricity Committee (Ald. Sinclair) and the electrical engineer (Mr. J. W. Burr) received the visitors and supplied particulars of the new plant.

GENERAL.

Aylesbury. A supply of electric current will be available by the end of this month.

At the last meeting of the Council the contract for the supply of electrical energy to Messrs. Hazell, Watson & Viney was ordered to be sealed. The firm agree to make an annual payment of not less than £200. The contract is terminable at three months' notice at the end of three years.

Application has been made for sanction to a loan of £400 for street lighting, and of £250 to cover the cost of wiring and fitting the Town Hall, &c.

Belfast. At the meeting of the Corporation last week the minutes of the Tramway and Electricity Committee caused considerable discussion.

The committee reported that in accordance with the Council's instructions as to the reorganisation of the electric supply department, they had directed the city electrical engineer (Mr. T. W. Bloxam) to submit a scheme for giving effect to that decision. Mr. Bloxam submitted his scheme on Feb. 22, and the committee, having considered that report, came to the conclusion that it did not comply with their instructions. They regretted to have to advise the Council that they were not prepared to submit a scheme for the reorganisation of the undertaking. At a subsequent meeting of the committee a resolution was passed to receive and enter on the minutes the report of the Electrical Engineer, "and that it be a recommendation to the Council that, as a first step in the reorganisation of the department, the present chief assistant be relieved of his duties as such and assigned other duties in lieu thereof at appropriate remuneration, and that the committee be authorised to proceed to appoint a person to hold the position of chief assistant engineer, to be mainly responsible for the superintendence of all electrical and mechanical repairs, and to have practical experience of large turbo-generators and three-phase power supply. The salary for that office to be £450 per annum."

At the meeting of the Corporation the chairman of the committee (Ald. TYRRELL), in moving the minutes, said that though it was his duty to move the minutes, it was also his duty to declare his dissent from the decision arrived at. The Corporation would remember the resolution dealing with reorganisation sent on to the committee at the end of last year. The committee agreed that reorganisation was desirable, and decided with practical unanimity to ask the Chief Engineer to submit a reorganisation scheme. He thought Mr. Bloxam was treated by the committee with the utmost fairness as head of the electric department. He did not wish to discuss the merits of his scheme. Suffice it to say that that scheme did not commend itself to any member of the Electrical Committee. The minority of the committee (of which he was one) believed that the process of reorganisation ought to begin at the top, but the majority felt that the second in command ought to be dealt with first. There, however, they found themselves in conflict with the chief engineer. Recognising the full measure of his responsibility as chairman, what he deemed the best thing to be done was that all reference to the reorganisation of the department should be deleted from the minutes and that a special meeting of the Council should be called in committee to deal with the whole question. The whole question would have to be dealt with thoroughly and at an early date, and each member of the Corporation should have an opportunity of participating in the decision to be arrived at.

Ald. Dr. KING KERR said he thought the [illegible] and he said it with very great regret, when the Council must appoint a special committee to reorganise the electricity department. He [illegible] action of the chairman and of the committee. They [illegible] Electrical Engineer to submit himself for the purpose [illegible]. They must either have thought that he was competent for that purpose or that he must be included in the scheme. They were now told by the chairman that no scheme would be satisfactory unless the Chief Electrical Engineer was included, but he thought there was something very inconsistent about the procedure adopted.

Councillor JAMES JOHNSTON thought it would meet the wishes of the Council if they adopted the suggestion of the chairman. The Council in committee could decide what to do, and he did not think they should say anything at that meeting that would prejudice Mr. Bloxam's case. He moved that all matters referring to the reorganisation of the electricity department be deleted from the minutes and referred to a special meeting of the Council in committee to be called at an early date.

Councillor RIDDELL who seconded, said he thought the majority of the committee were wrong in their attitude towards the question.

Ald. DORAN appealed for fair treatment for Mr. Bloxam, and not to put a rope round his neck without charging him with some offence. He said that Mr. Bloxam was not the right man, but he was not going to condemn him on the evidence which was then produced, and which to his mind was a very "shilly-shally" business altogether.

The amendment was ultimately carried.

Colne. A report by the borough electrical engineer (Mr. A. G. Cooper), recommending the adoption of an optional system of charging for electricity on a ratable value basis plus ¾d. per unit for current consumed, has been referred to a sub-committee.

Croydon.—Last week the Corporation were recommended to increase the charge for current for private lighting from 3½d. to 4d. a unit owing to the increased cost of coal.

The charge for public lighting is to be increased in corresponding proportion to the increase in cost of gas lighting, and the question of an advance in the charge for current for traction was referred to sub-committees of the Lighting and Electricity and Tramway Committees. A further report on the matter is to be presented by the Lighting and Electricity Committee.

Easebourne.—As the Midhurst & District Electric Supply Co. hopes to be able to give a supply of electric current by October, the Parish Council have passed a resolution in favour of public electric lighting for the parish.

Heston and Isleworth.—The Electricity Committee has decided to charge for current supplied to rifle ranges on the same basis as that fixed for power supply.

Heywood (Lancs.). The L.G. Board have sanctioned a loan of £6,140 for the electricity supply department.

At the recent inquiry the Council asked for borrowing powers for £12,460, but Mr. H. Ross Hooper, chief inspector of the Board, intimated that the Board (in conjunction with the Treasury) had decided not to grant any borrowing powers during the war except for works which were absolutely necessary and for war purposes. As a number of local firms are engaged on war contracts it was necessary to carry out certain extensions at the electricity works. An amended application in respect of work absolutely necessary was, therefore, submitted and approved.

Kirton (Lincs.). Messrs. J. E. & H. Thompson are preparing a scheme for the erection of electricity works for supplying electric current in Kirton, Frampton, Wyberton, Sutterton, Fosdyke, &c. It is probable that a local company will be formed if sufficient support be forthcoming.

London Electricity Supply.—The London County Council propose to call an early conference of representatives of the municipal electricity undertakers and supply companies in order to consider the present position of electricity supply in the London area.

The Parliamentary Committee of Surrey County Council recently reported upon the fate of the two bills of the 1915 session which dealt with electricity supply in London and the suburban areas.

In their report the committee state that "a demand may exist among consumers in the County of Surrey for facilities for a cheaper and more efficient supply of electrical energy, and that there may be some grounds for the contention that, within certain limits, concentration and standardisation over a considerable area is the best method of attaining this result. It will, therefore, be necessary for the Council to adopt some constructive policy on this question, so far as it affects the Administrative County, and with a view to their determining what such policy shall be your committee propose to consult with the electrical undertakers in the county, both municipal and private, for the purposes of ascertaining what the requirements of the county are in this respect and how they can best be met within the county, and will report to the Council at some future date."

Maidstone.—Owing to the increased cost of coal the Electricity Committee has decided to increase the price of electric current to consumers by ¼ d. per unit for lighting and heating from April 1, and for power by ⅛d. as from Jan. 1 last.

Rugby.—The Council have authorised the electrical engineer to purchase two dozen slot meters for use when required.

Torpoint.—The formal inauguration of the electric supply undertaking took place on the 31st ult., when Lady Beatrice Pole-Carew switched on the current for public lighting.

The electricity works, which are owned by the Torpoint Electric

Supply Co., were designed by and erected under the supervision of Messrs. J. & W. Purves, while Messrs. Brooking & Co., of Exeter, erected the plant and laid the mains. Mr. H. Hill is resident engineer and manager of the company, which has secured a contract for the street lighting. The plant comprises two gas engines and also dynamos with D.P. storage battery.

Wells. The Rural Council have decided to petition the Board of Trade that they cannot object to the application of the Mid Somerset Electric Lighting Co. for a provisional order, but only to the proposed maximum charges, viz., 7d. per unit for lighting and 3d. for power.

Wembley. A supply of electric current is now available in the district, and over 500 customers have already been connected. The North Metropolitan Electric Power Supply Co., which is supplying current to the district, is extending the mains to Wealdstone.

LIGHTING, POWER & HEATING NOTES.

Electric Pumping at Waterworks. At a recent meeting of Windsor Council it was decided to accept the offer of the Windsor Electrical Installation Co. to instal duplex pumps and electric motors at the waterworks, at £1,100.

The pump to be of the Ross Rotarbo pattern, with a capacity of 600,000 gallons per hour at 200 ft. head. The company is to allow £100 for the existing pump, which is to be taken away.

Frant.—At a recent parish meeting it was decided to adopt the Wadhurst Lighting Act for the whole of the parish.

Arrangements are to be made by Tunbridge Wells Corporation for supplying electric current for public lighting and for the maintenance of lamps.

Grangemouth. The Council have declined to allow the Scottish Central Electric Power Co. to instal a temporary system of electric light in the Town Hall for the use of the military authorities.

Hydro-Electric Works.—It is reported that an ambitious scheme is being prepared for the erection of hydro-electric works at Belfast, and at Limerick, to utilise the water power of the Shannon in generating electric energy.

A private company has been formed for promoting the scheme, and among its members are Messrs. Walter Hume and J. M'Andrew, of Dublin; and B. L. Winslow, solicitor, Enniskillen. It is believed that much water power is available at Belfast, where the company proposes to generate electricity for light and power for factories in Belfast and the northern half of Ireland. It is also proposed to erect water turbines at Castleconnell, Limerick, from which electricity will be supplied to Dublin and the southern half of Ireland. The name of the company will be the Hydro Electric Co.

Portaferry (Ireland). Downpatrick Rural Council have been informed by the L.G. Board that the application of the Council to be empowered by the necessary order to carry out the proposed electric lighting scheme has been granted.

The area embraces the three townlands of Ballymurphy, Ballyphilip and Tullyboard, within which the town of Portaferry is situate.

Ripon. The question of taking a supply of electrical energy for public and private lighting from the military generating station is [illegible] Committee, and Mr. Geo. Wilkinson, [illegible] has been communicated with in order to obtain a report on the matter.

TRACTION NOTES.

Bolton. The Tramways Committee have authorised the [illegible] to commence negotiations for the purchase of the [illegible] Co., with the view to [illegible] the [illegible] of the Corporation.

Glasgow. The [illegible] of the Corporation Tramways [illegible] have been [illegible] to the Council. The total [illegible] £[illegible], which [illegible] £[illegible] has been [illegible] the Renewals Fund, and £[illegible] has been [illegible] to the Reserve Fund.

Light Railways.—In the House of Lords Light Railways Order (No. 1) Confirmation Bill was read a second time. Orders have been made to the Board of Trade by April 17.

Newcastle-on-Tyne. To assist the Tramways Committee in dealing with an application for increased pay for the employés of the tramways department, the following particulars of the working of the [illegible]

[illegible]

rates £18,000, additional cost of fuel £5,000, and reduced interest on investments £1,000), so that there is an estimated deficit of £2,436 on the year ended March, 1916, to which is added £18,000 to be expended out of reserve and renewals fund to keep the undertaking in working condition. The total estimated deficit is, therefore, £20,436. This will reduce the reserve fund to £54,577. The Committee recommend the reduction of contributions to rates in future years until the reserve fund is increased to £100,000. They also recommend that the additional allowance to dependants and the war bonus to employés be deducted from the £18,000 proposed to be paid towards relief of rates.

The Committee has been asked to grant increases of not less than 3s. per week per man.

Trailer Tramcars.—The Board of Trade have authorised the London County Council to run trailer cars on the Woolwich tramways.

Tramway Transfer.—The Urban Council of Cheadle and Gatley give notice of intention to grant a lease to Stockport Corporation of a tramway from Stockport-road to a point near the junction of Church-road and Gatley-road.

The term of the lease will be as from March 4, 1904, to March 3, 1925. The rental for the unexpired part of the term will be £1,043. 12s. 8d. per annum. The lessees agree to maintain and repair the tramway, and the lease contains provisions for the electrical equipment of the line.

EMPIRE NOTES.

Australasia. In a recent issue of the "Auckland Weekly News" particulars were given of the New Zealand Portland Cement Co.'s scheme for harnessing the Wairua Falls for the generation of electric power and the erection of a modern cement mill at Tikorangi, on the south shore of Whangarei Harbour. The whole project involves an expenditure of about £200,000.

The company's engineer (Mr. S. Irwin Crookes) says the large canal from the river is almost completed, and it will take water from the river just above the falls, leading it to steel pipes (5 ft. in diameter), which will conduct it to the turbines in the power station. The erection of the pipe line and the turbines on the site will be carried out by Messrs. Geo. Fraser & Sons. Two sets of 1,125 kw. each are to be installed to start with, but the station is being planned for four such units. The electrical equipment is to be carried out by the National Electrical Engineering Co., whose Auckland branch is acting for the General Electric Co. of America. The generators and accessories, switchboard, lightning arresters and transformers will cost about £14,000. The transmission line to the Dominion Cement Co.'s works at Tikorangi was completed before Christmas, and is of aluminium on steel poles. The transmission voltage will be 22,000. The erection of a branch line from the works to Whangarei has also been started.

The "Australian Mining Standard" says Sydney (N.S.W.) Council have adopted recommendations of the Electric Lighting Committee that tenders be invited for the supply of 12,000 kw. turbo-alternators in accordance with amended specification submitted by the engineer, in which the general conditions of the contract have been modified. In consequence of the Australian Metal Co. not being able to supply the motors (for hiring out) under their contract, due to the motors tendered for by them being manufactured in an enemy country, the tender of Gardner, Waern & Co. (the next lowest satisfactory tender), at £87. 5s. for one motor of each size, has been accepted. In consequence of its not being possible, owing to the war, to obtain further quantities of carbons for the Beck type arc lamps, and as the "Nitro" incandescent lamps, which were recommended to replace the arc lamps, will not be available as early as they were promised, authority has been given for temporarily reducing the number of hours' use of Beck type lamps, and various Beck street lamps are to be replaced by lamps of another type; while an order has been placed with the Tudor Accumulator Co. for filling the cells of the secondary battery with plates in order to increase its original capacity of 1,287 ampere-hours to 1,344 ampere-hours, at an estimated cost of £700.

The Sydney City Solicitor has reported on the question of the supply of underground cables by Messrs. Siemens Bros. & Co. Both Siemens Bros. & Co. and Siemens Dynamo Works were companies registered as English companies, and a proportion of the shares in each was held by Germans, but these facts alone did not entitle the Council to cancel a contract made with either company before the outbreak of war. The City Electrical Engineer's report correctly indicated the legal position—[illegible] placing an order for this class of cable during the 12 months' period must be placed with the company whose tender was accepted.

The Electric Lighting Committee recommended that tenders be invited (in accordance with the specifications of the City Electrical Engineer) for 500-750-watt 45-volt nitrogen filled lamps for public lighting and conduits for feeder cables at Phillip-street sub-station; and also for the supply and erection of two steel towers required for spanning the Parramatta River at Five Dock, Drummoyne, in connection with the 33,000-volt transmission lines to supply electric current to the North Shore municipalities.

In connection with the contract with Messrs. Lawrence & Hanson for public lighting fittings, as the shades for those fittings were to have been made in an enemy country, 500 public lighting fittings without shades

are to be ordered from Messrs. Lawrence & Hanson at 2s. 10½ each, and the shades are to be obtained locally.

Some months ago Melbourne Council resolved that in advertising for tenders for plant German and Austrian firms should be disqualified from tendering, and it was decided that a tender received from Siemens Bros. Dynamo Works for a 5,000 kw. set should not be entertained. At a recent meeting of the Council a letter was read from Mr. A. S. Herbert, the company's general manager in Australasia, pointing out that if such action as contemplated by the Council were universally adopted it would cause the company to shut down, entailing great hardship upon a large number of British people, including the dependants of over 700 employés of the company who have been called up on active service. The British Admiralty, War Office and other Government departments were placing orders and contracts with the company, and it had received very clear indications of the desire of the British Government that it should continue its operations, and thus keep in employment its large number of officials and workmen. The two Siemens companies had about 7,000 employés in Great Britain and the oversea dominions (including 60 in Australia); both companies had arranged to pay full time wages to every married man and half wages to every single man on military service. Siemens Bros. Dynamo Works had never paid a dividend since its foundation in 1906, while the largest dividend earned by the parent company (Siemens Bros. & Co., Ltd.) for the last 12 years was 5 per cent. in 1913. In those circumstances it was expected that the amount being paid to the men on active service and their dependants would, during the war, more than absorb any dividends which might have been possible under ordinary conditions. Mr. Herbert also pointed out that Lord Kitchener (in a letter to the company) had stated that he "should like all engaged by your company to know that it is fully recognised that they, in carrying out the great work of supplying munitions of war, are doing their duty for their King and country equally with those who have joined the army for active service in the field."

Ald. CABENA, chairman of the Electric Supply Committee, said he had understood that 60 per cent. of the firm's capital was German. That firm had been more generous to those of its employés who had enlisted than any other firm he knew of, and its generosity and patriotism were costing it £35,000 a year. As the firm was contracting for the British Government, the Council, perhaps, would not object to the tender from the firm being considered with the others. There should be some consideration shown to such a firm. Let Siemens Bros. be allowed to tender as usual, and the Council could decide between the tenders on their merits. He moved that the letter be received, which would have the effect of debarring the firm from tendering for that particular 5,000 kw. plant, but would leave them free to tender in future.

The motion was adopted by the Council.

In reference to the tender of the British Westinghouse Co. (which Melbourne Council recently decided to accept) for the supply of a 5,000 kw. turbo-alternator, at £15,111 (with £1,015 additional for spare parts), the Electric Supply Committee asked the company to give a guarantee that no part of the plant would be of German or Austrian manufacture, and that there was no German or Austrian capital in the company. The manager of the company in Australia has made an affidavit to the effect that out of 2,432 shareholders, representing a capital of £1,150,000, there were only five persons whose names appeared to be German or Austrian. Those persons held shares amounting to a little over £2,000, or less than one-third per cent. of the capital of the company. He thought it would be practically impossible to get any large concern that was nearer to being an all-British company.

The Electrical Traders' and Contractors' Association of Victoria are determined not to accept as final the decision of Melbourne Council with respect to the supply of metal filament lamps to the public. At a recent meeting of the Council a letter was read from the Association's solicitor which stated that the Association was advised that the proposals were not warranted by any powers possessed by the Council and the Association would be compelled to appeal to the Court to restrain the Council if it entered on the proposed new field of business.

Ald. CABENA said it had been decided to order 62,500 filament lamps and sell them to customers, but he learned that the Council had no legal authority to do so.

The letter was referred to the Legislative Council.

The "Commonwealth Engineer" says Melbourne Corporation recently installed in the Queen Alexandra gardens 30 reinforced concrete lamp standards, each surmounted by an opal globe enclosing a 100-c.p. metal filament lamp. These are the first lamp standards of their kind used in Melbourne.

The Donald (Victoria) electric supply undertaking has been taken over from the Donald Electric Supply Co. by the Shire Council, and the plant is to be remodelled. Messrs. Lancaster, Mackenzie & Dennis are the consulting engineers.

Maldon (Victoria) Council has decided to [illegible] tenders for lighting the town with electricity or gas. [illegible] Council from £200 a year for street lighting by gas, and the [illegible] 10s. per 1,000 ft. and 7s. 6d. for cooking and [illegible]

North Illawarra (N.S.W.) Council has [illegible] municipality electrically.

Cooma (N.S.W.) Council has decided to [illegible] to report upon an electric lighting scheme.

Lismore (N.S.W.) Council has declined to purchase the plant of the local electric lighting company for the [illegible]

The electric lighting of the streets of [illegible] N.S.W. was inaugurated on Dec. 31. The public lamps number [illegible] arc and 104 metallic-filament, varying from 50 c.p. to 1,000 c.p. [illegible] include the lighting of Parramatta road, which [illegible] under a joint contract with the Councils of Leichardt, Annandale and Petersham by June 30. 18 lamps, varying from 300 c.p. to 2,000 c.p., will be required. The lamps erected in Petersham were supplied by the General Electric Co. (U.S.A.). Current is supplied by the Electric Light & Power Supply Corpn. of Balmain.

The Albury (N.S.W.) electric lighting plant will be operated in conjunction with the water supply and sewerage system. During his visit to England and the Continent in 1912 the chief electrical engineer of the N.S.W. Public Works Department (Mr. Wm. Corin) arranged for the plant. Tenders were called for in England and contracts placed. The plant will consist of two 150 kw. Howden-Brush three-phase sets (3,300 volts, 50 cycles), and electrically-driven centrifugal pumps. The transmission mains will be of aluminium, and at the sub-station at Albury Town Hall the pressure will be reduced to 415 volts between phases, 240 volts between each phase and neutral, distribution being on the three-phase four-wire system.

Recently Hamilton (Queensland) Council decided to apply for an Order in Council to instal a municipal electric lighting plant, and to invite the co-operation of the Toombul and Windsor Shire Councils.

Mr. Ashton-Bremner has prepared a report on the lighting of Oaklands (Tasmania) electrically.

A proposal has been made that Launceston (Tasmania) Council ask the State Government to submit terms upon which they will supply electric energy from the Great Lake hydraulic works.

Yarrawonga (Victoria) Shire Council has confirmed a resolution previously passed in favour of extending its electric lighting plant.

"Tenders" (Melbourne and Sydney) says Thebarton (South Australia) Council have decided to negotiate with the Adelaide Tramway Trust with a view to the Council's procuring electric current in bulk for private and street lighting.

Dalby (Queensland) Council has been granted an order authorising the electric lighting of the district.

The Aspendale, Chelsea & Carrum Electric Lighting Co. has been formed in Melbourne.

The Frankston (Victoria) Gas Co. has appointed Mr. V. J. Crowley to furnish the company with a report on an electric supply scheme for the district. There is considerable demand for lighting outside the area served by the company's gas mains, and it is considered the position can best be met by the installation of electric generating plant.

Romsey (Victoria) Shire Council is to undertake an electric lighting installation in Lancefield. The charges for current are to be not more than 20s. per quarter for up to 20 units and 1s. per unit thereafter.

The Mt. Pleasant Colliery, Wollongong (N.S.W.), is having new electrical plant installed at a cost of £35,000. The refuse of the mine will be used as fuel. The electrical plant will consist of three 440 k.v.a. 6,500 volt alternators, direct coupled to three 530 B.H.P. steam engines. The alternators were supplied by the Lancashire Dynamo & Motor Co. At night there will be a surplus of 700 H.P., which would be available for supplying current outside.

The Sydney City Electrical Engineer has submitted to the Electric Lighting Committee a rough estimate of probable expenditure required during the next three years beyond what has been already approved. This includes £200,000 for the power house, £90,000 for new sub-station and show-room in Castlereagh-street, £300,000 for mains and a.c. sub-stations, and £25,000 for new building for stores and test rooms, or a total of £615,000.

North Sydney Council have decided to enter into an agreement to take electrical energy from Sydney Council for lighting in North Sydney.

Mr. V. J. Crowley has been requested by the Yarram Butter Factory to report upon its plant, and especially as to the desirability of converting it to the three-wire system.

A conference of representatives of local authorities in connection with the establishment of the proposed electric power station for Ipswich (Queensland) and district was held recently. Representatives from Ipswich, Brassall and Punga attended, and the Town Clerk was authorised to communicate with Messrs. Holmes & Church to ask them to prepare drafts of the proposed order in council and articles of association of the company for submission to a future conference.

Canada. The Ontario Hydro-Electric Commission is supplying current in bulk to three townships, 102 municipalities, and over 800 rural industrial enterprises.

At present over 100,000 H.P. is distributed, and the chairman of the Commission (Sir Adam Beck) recently stated that, apart from the benefit of cheap power to industries, the Province of Ontario would soon have 1,000 miles of publicly-owned electric railroads. Already, in some districts, electric power was being applied to farm work. Farmers were cutting their ensilage and filling their silos by electricity, and were commencing to use electrically-driven threshing machines. The farmhouses, barns and stable were also lit by electricity, and power was used for domestic purposes, such as washing and ironing.

Mr. C. Hamilton Wickes, H.M. Trade Commissioner in Canada, who has arrived in London, will spend some time at the Commercial Intelligence branch of the Board of Trade (73, Basinghall-street, London, E.C.), in order to give British firms an opportunity to consult him as to trade conditions in the Dominion.

India. The Commissioner in Sind, Mr. R. E. Barrow, I.C.S., opened the central generating station of the Karachi Electric Supply Corpn. on Feb. 1.

Mr. M. de P. Webb, C.I.E. (chairman of the company), said many of the hall had come on moderate duty, or to work on train port, but the remainder had worked tremendously to frame the electric supply scheme to

completion, especially Mr. Raven (of Crompton & Co.), Mr. Fraser Nash (the Karachi Electric Supply Corpn's chief engineer), Mr. Cuthbert (the erector of the Diesel engines) and Mr. Arnold. The plant consists of two 240 H.P. and one 100 H.P. Mirrlees-Diesel engines coupled to Crompton dynamos. There is also a Tudor battery of 276 cells. Current is supplied on the three-wire system at 220 and 440 volts through bare overhead mains.

Electric lighting and power are to be adopted in the Mint at Bombay. It is also stated that the subject of electric railways formed the subject of a question in the Indian Imperial Council recently.

Mr. Clark pointed out that, while no proposal for the general introduction of electric traction on Indian railways is under the consideration of Government, reports have been prepared regarding the introduction of electric traction on suburban lines in the neighbourhood of Calcutta and Bombay, but no decision has been arrived at yet.

FOREIGN NOTES.

Argentina. The "Review of the River Plate" says the Chamber of Deputies of the province of Mendoza has approved the project of law and the ad referendum contract between the Government and Anastasio Lopez & Cia. for the installation of an electric or steam tramway service connecting the station of the Western Railway at General Alvear with that of the Pacific Company at San Rafael, with the right to construct branch lines.

The passengers carried on the Rosario electric tramways in 1914 were 27,014,436 (compared with 27,181,607 in 1913), and the receipts were $2,701,443 (m.n.) (against $2,718,156). During the year the length of lines open increased from 80⅔ to 99½ miles.

The Ministry of Marine has appointed a committee to prepare the plans for the electrical installation at Puerto Militar.

The contract for the supply of electrical energy to the Administracion de Contribucion Territorial, Patentes y Sellos, at calle San Martin, Buenos Ayres, has been awarded to the Cia Italo-Argentina de Electricidad. This service has hitherto been supplied by the Cia. Alemana Transatlantica de Electricidad.

A concession for a telephone service in Puerto Deseado (territory of Santa Cruz) has been granted to Sr. H. Lavatelli.

The working of a telephonic service by the Argentine estates of Bovril (Ltd.), connecting their establishment at Santa Elena (province of Entre Rios) with the Saladero of M. Cabal (province of Santa Fé), has been authorised by the Government.

The National Government has authorised Sr. A. Demaria to transfer to Messrs. J. Casales and A. Doddi the telephonic concessions in Viedma (Rio Negro) and Carmen de Patagones (province of Buenos Ayres) accorded to him in April and July, 1914.

Sr. J. G. Wright has been authorised to register in the Federal Capital the telephone concession in San Julian (territory of Santa Cruz) granted to him on March 16, 1914.

Chili. The "Review of the River Plate" says the difficulty existing between the municipality of Santiago and the tramway company have not yet been arranged. It is affirmed that, legally, the Chilian Electric Tramway Co. does not exist, and article 34 of the contract provides that unless the company has duly authorised representatives in Santiago the municipality has to take over the fiscalisation of the company and name an interventor. It is believed that the municipality will adopt this course.

Siam.—A consular report for the year ended March 31, 1914, states that £28,700 was provided for work on the Government electric power station at Bangkok, and that this sum is likely to be exceeded.

The fuel to be consumed is paddy husk and the plant has been tested at full-load and found to be satisfactory.

Imports of electrical goods and apparatus in 1913-14 were valued at £86,189 (from Germany £44,084 and from the United Kingdom £22,768) compared with £47,415 in the previous year. The increase is partly due to the requirements for the new power station referred to above.

Uruguay. The "Review of the River Plate" says the contract for the electrification of the Tramway del Norte has been signed by the Government.

The electrification will probably extend to the railway line between Montevideo and the neighbourhood of Santa Lucia.

MISCELLANEOUS NOTES.

Coal Prices.—The Committee recently appointed by the Board of Trade to inquire into the causes of the present rise in the retail price of coal have issued their report, and their recommendations are :—

Exports to neutral countries should be restricted.

Steps should at once be taken to consider, in consultation with the public bodies concerned, the question of the accumulation by such bodies of reserves of coal in or near London, for the use of small consumers during next winter.

The rates of freight on the interned steamers should be further reduced.

Suitable enemy ships condemned by the Prize Court should be taken over by the Government and used for coal transport.

If prices do not shortly return to a reasonable level the Government should consider a scheme for assuming control of the output of collieries during the continuance of the war.

Inquest.—An inquest was held at Birmingham on Saturday on Alex. Mitchley.

Evidence was given that deceased, who was attendant-in-charge at the Corporation power station in Alma-road, entered a steel cubicle containing h.t. switchgear on the 28th ult., and was seriously burnt. Deceased had no duty whatever to take him into that cubicle, and he was not supposed to enter it for any purpose. There were no definite instructions telling him not to enter that cubicle, but to a skilled electrician, such as deceased was, the danger would be obvious.

A fellow workman said they were engaged in dusting the switches, and he imagined that deceased thought he had switched off the current (which was at 5,000 volts) from the cubicle. Witness had only been at the station a week and did not know the third cubicle was not supposed to be entered. He described how deceased opened the door of the cubicle and the explosion that followed. Deceased's clothing was burning and with assistance he brought him out of the cubicle and took him to hospital.

Medical evidence was to the effect that deceased was suffering from extensive burns, and that death was due to shock.

A verdict of accidental death was returned.

Russian Equivalent Tables.—We have received from the Central Translations Institute (Ltd.), 265, Strand, London, W.C., a useful card of tables of Russian weights and measures with English equivalents. The card is published at 1s.

TENDERS INVITED.

Tramway Construction.—

EXETER Corporation want tenders by noon April 14 for Doubling Track in Blackboy-road and Reconstruction of Track in Pinhoe-road, Exeter. Specification can be seen at the office of the City Engineer.

Electrical and Tramway Stores, Fittings, &c.

WALTHAM Corporation want tenders by April 22 for 12 months' supply of Meters, Cable and Junction Boxes, Span and Guard Wire, Switches and Cutouts, &c., for the Electricity Department. Forms of tender, &c., from the Engineer.

[illegible] Corporation require tenders by first post April 17 for the supply of Tramcar Trucks, Motors, Controllers, &c. [illegible], &c., may be obtained at the Tramway Office.

[illegible] Corporation require tenders by noon April 14 for 12 months' supply of Incandescent Electric Lamps, Rubber Goods, etc. Forms of tender from the Engineer.

[illegible] Corporation require tenders by 10 a.m. April [illegible] for 12 months' supply of Electric Wiring Materials, [illegible] and Insulating Material for Electric Cables, Iron Tubes, [illegible]. Particulars from the Electrical Engineer.

Wiring and Fitting.

RHONDDA Urban Council require tenders by noon April 17 for an Electrical Installation at the Council offices, Pentre, Rhondda (83 points). Specification from Electrical Engineer.

Steel Constructional Work.

ST. PANCRAS (London) Council require tenders by noon May 11 for Steel Constructional Work of extension to power house. Drawings may be seen at 57, Pratt-street, Camden Town N.W.

Generators.

The NEW ZEALAND PUBLIC WORKS Dept. require tenders by noon April 30 for the supply of a Three-unit Exciter Set and a 1,500 kw. Generator in connection with the Lake Coleridge power scheme. Particulars from the Public Works Offices, Auckland, Wellington, Christchurch and Dunedin.

Testing Instruments.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. May 5 for the supply of one Double-range Ammeter, one Search Fuse, two double-pole Two-way Switches, two Single-pole Six-way Voltmeter Switches, Graphic Ammeter and Graphic Voltmeter. Specification from the Commissioners' Offices, Spencer-street, Melbourne.

Diesel Generating Set, Balancer and Cables.

Basingstoke Corporation invites tenders for supply and erection of a Diesel Engine Generating Set, a Motor-generator Balancer and Cables. Tenders to the Electrical Engineer by noon April 19.

Water Tube Boilers, Fuel Economisers, Feed Pumps, Condenser, &c.

Tenders are invited for the supply, delivery and erection in Melbourne of Four Mechanically-fired Water-tube Boilers, Two Fuel Economisers, One Turbine-driven Boiler Feed Pump, 18 Machines of the Stationary Type for the automatic weighing of coal, and Two Circulating Water Pumping Sets for the City of Melbourne. Tender forms, &c., from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Propy. (Ltd.), Billiter-square-buildings, London, E.C. Tenders to the chairman, Electric Supply Committee, Town Hall, Melbourne, by June 15.

Brighton Corporation invite tenders for the supply, delivery and erection at their Southwick power house of one Surface Condenser, capable of dealing with 52,500 lb. of steam per hour. Specifications, &c., from the office of the town clerk, Mr. Hugo Talbot, Town Hall, Brighton, where tenders must be delivered by noon April 12. Further information may be obtained from the electrical engineer and manager Mr. J. Christie.

Edinburgh Corporation invite tenders (by April 12) for supply and erection of Water-tube Boilers. Specifications, &c., from the Engineer, Dewar-place, Edinburgh.

Dundee Corporation invites tenders (by April 28) for supply and erection of Centrifugal Circulating Pumps and about 750 ft. of 42 in. and 30 in. c.i. Pipes.

Overhead Traveller and Economiser.

Darlington Corporation want a 25-ton Travelling Crane and an Economiser. Tenders to Town Clerk by 20th inst.

Track Transformers, Signals, Wheels and Axles, &c.

The Victorian Railway Commissioners require tenders by 11 a.m. May 19 for 120 s.p. Track Transformers and 300 Electric Signals and Spare Parts; and by 11 a.m. June 2 for 300 Electric Train Stops (and in each case such further supplies of similar goods as may be required during five years); and by 11 a.m. June 2 for Bogie Trucks, Wheels and Axles for 10 Electric Street Railway Cars. Specifications from the Railway Offices, Spencer-street, Melbourne.

Cables, Meters, Carbons, C.I. Boxes, &c.

The Council of the Metropolitan Borough of Southwark invite tenders for the supply during the next 12 months of Paper-insulated Electric Cables and Electricity Meters. Tenders to the Town Hall, Walworth-road, S.E., by noon April 14. Further particulars from the electrical engineer, Mr. D. M. Kinghorn, electricity works, Penrose-street, Walworth, S.E.

Glascow Corporation invite tenders for 12 months' supply of Cables, Meters, Arc Lamp Carbons, C.I. Boxes, Section Pillars, &c. Specifications from the engineer (Mr. W. W. Lackie), 75, Waterloo-street, and tenders to the town clerk (Mr. J. Lindsay), by 10 a.m. April 16.

Tenders are invited for supply of 1,027,900 Arc Lamp Carbons for the City of Melbourne. Tender form, specification, &c., from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Propy. (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon, April 21.

Mountain Ash Urban Council require tenders (by noon April 26) for Sub-station Building Underground Cables, l.t. Overhead Lines and Public Lighting, e.h.t. and l.t. Switchgear and Transformers.

Telegraph and Telephone Material.

The Public Service Stores Tender Board, Wellington (N.Z.) will receive tenders until 4 p.m. April 21 for the supply of 74 miles 552 yds. of Lead-covered Cable, 35,000 yds. of Wire, 5 tons of Bronze Wire, Sinclair Bolts and Cups, Extension Bells and Lead Seals. Particulars from the Controller of Stores, Post and Telegraph Department, Wellington.

The Deputy Postmaster-General, Perth, Western Australia, will receive tenders until 3 p.m. May 5 for the supply to the Australian Commonwealth Postmaster-General's Department of Dry Cells, Syringes, Zincs, Connectors and Sal Ammoniac for batteries. Specification, &c., from the Deputy Postmaster-General, Perth, W.A.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. May 4 for the supply of 5,000 Porcelain Insulators, and by 3 p.m. April 27 for 200 Telephone Transformers. Specification, &c., from the Deputy Postmaster-General, Melbourne.

Railway Carriage Lighting, &c. (Extension of Time).

The time for the receipt of tenders by the Victorian Railway Commissioners for the supply of Material for Railway Car Lighting and Electric Lighting Material for Car Repair Shops is extended to June 2. Specifications from the Commissioners' Offices, Spencer-street, Melbourne.

Insulated and Bare Copper Cables.

Tenders are invited for the supply of quantities of Single Conductor Lead-covered Cable to Melbourne City Council. Specifications, &c., from the Agents for the Council (Messrs. McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon April 19.

Tenders are also invited for the supply of quantities of Bare Hard Drawn Copper Cables to Melbourne City Council. Specifications, &c., from the Agents for the Council (Messrs. McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon April 19.

Telephone Systems, Apparatus and Accessories.

The Greek Ministry of Communications (Posts, Telegraphs and Telephones Department), Athens, require tenders by April 28 for the supply and installation of a Central Exchange and Telephone System at Salonica, and a Central Exchange at Athens, and the supply of Telephone Apparatus and Accessores. The Greek "Government Gazette" containing the specification, &c. (in French), can be seen at 73, Basinghall-st., London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Liverpool.—The Electricity Committee has accepted the following tenders:

Babcock & Wilcox, three water-tube boilers, coal and ash-handling plant, &c., for Lisfer-drive station; E. Green & Son, three economisers and accessories.

The following tenders have been accepted for annual supplies to the electricity supply and tramways department: Vacuum Oil Co. and Matthew Wells & Co., lubricating oils and greases; Sykes & Sugden, British Insulated & Helsby Cables, British Electric Calibrated Fuse Co., and Simplex Conduits (Ltd.), for electrical fittings and sundries; Staveley Coal & Iron Co., c.i. circulating water pipes.

Salford.—Siemens Brothers Dynamo Works have again secured the contract for the annual supply of Wotan, Tantalum and carbon filament lamps to the Corporation tramways department.

The following tenders have been accepted for annual supplies to the tramways department:

Siemens Bros. Dynamo Works, electric lamps, approximate value of contract £353. 9s. 8d.; British Oxygen Co., oxygen, 36s. 6d. per 1,000 cubic ft; Hall & Pickles, steel sheets, £92. 2s. 9d.; British Petroleum Co., petroleum, £81. 5s.; Anglo-American Oil Co., Pratt's motor spirit, £314.

The following tenders have also been accepted: Pendleton Ironworks Co., steel work for car depot extension, £1,480; Hadfield's (Ltd.), axles, wheel tyres and wheel centres, £1,188.

Hammersmith (London).—The following tenders have been accepted for annual supplies for the electric supply department:—

James Gibb & Co., stores, tools and implements, ironmongery (hardware) amd metals; Pryke & Palmer, steam tubes and fittings, bolts and nuts; Middleton Bros., oilmen's goods, steam packing and jointing materials; Johnson & Phillips, box frames, covers, boxes, &c.; A. B Bosher & Co., files; General Electric Co., electrical goods (accessories) and insulated wires; Ferranti Ltd., prepayment meters.

Watford.—The Electrical Apparatus Co. have withdrawn their previous tender for 200 meters and the electrical engineer (Mr. A. W. Barham) has been authorised to purchase the same number from the company at schedule prices, to be taken when required during two years. The tender of the British Westinghouse Co. has also been accepted for the supply of 350 larger size meters at schedule prices.

St. Anne's-on-the-Sea.—The Council have accepted the tender of Hick, Hargreaves & Co. for the supply of a multi-jet condenser with a capacity of 18,000 lb. of steam per hour. Six other tenders were received.

Woolwich.—The Electricity Committee has accepted the offer of Babcock & Wilcox to supply the additional shafts and uptakes for two additional steam units for £990 and that of G. & J. Weir for a feed pump at £200.

Walthamstow.—The Council have renewed their contract for the next 12 months for s.p. and d.p. 5 and 10 ampere tumbler switches with Messrs. J. H. Tucker & Co., of Birmingham.

St. Albans.—The tender of Giffen Bros. has been accepted by the Guardians for wiring the infirmary and the board room block.

Ilford.—The Urban Council have placed an order with the British Thomson-Houston Co. for twelve months' supply of electricity meters.

BIRKENHEAD.—The Corporation have accepted the tenders of the British Insulated and Helsby Cables for the supply of 100 and 200-ampere fuse boxes, and that of Sykes & Snyder for 15, 25 and 50-ampere fuse boxes.

L.C.C.—The Education Committee has accepted the tender of the Lancashire Dynamo & Motor Co. (at £36. 10s.) for the supply of a 5 H.P. electric motor for driving the various machines at the Shoreditch Technical Institute.

CROYDON.—The tender of Callender's Cable & Construction Co. for 12 months' supply of cables has been accepted at a price based upon the market price of copper.

GRIMSBY.—The Public Lighting Committee has accepted the tender of Johnson & Phillips (at £296. 10s.) for supply of cables.

Meter Contracts.—Amongst the contracts recently obtained by Messrs. Ferranti Ltd. are the following:

[illegible] Corporation, current year's supply of [illegible] Corporation, year's supply of 6d. and 1s. prepayment meters. Horsforth (Leeds) Urban District Council, annual supply of prepayment meters. Ilford Urban District Council, Londonderry and Whitehaven Corporations, contracts for the year ending March 31, 1916. and 12 months' Corporation, sole supply of 1-phase meters.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments:—

Postmaster-General's Dept., Sydney.—British Insulated & Helsby Cables, wire £968. 2s. 6d.; cable, £15,316; Siemens Bros. Dynamo Works, telegraph cable £634. 10s., resistances £1. 0s. 10d., shunt, standard of self induction, secohmmeter and voltmeters, condensers £18. 12s., pole hangers £220. 15s. 10d., rheostats £110. 5s., relays £37. 18s.; Lawrence & Hanson, cable, £4,020; Noyes Bros., cable £2,068 and testing sets as per schedule; W. T. Henley's Telegraph Works Co., cable £1,341, cable boxes £164. 15s., submarine cable £700. 19s.; W. G. Watson & Co., insulators £51. 10s.; Western Electric Co., keys £118. 15s., lamps £115. 18s. 9d., plates £41. 5s., plugs £36. 9s. 2d., registers £3. 10s., relays £95, resistances £2. 14s. 2d., telephone sets £250; Australian General Electric Co., carbon filament lamps £28. 15s., metal filament lamps £498. 6s. 8d.; Ramsay Sharp & Co., portable telephones, £90; Jas. Paton & Co., micro-telephones £190. 12s. 6d., mouthpieces £34. 7s.6d., switches £328. 14s. 10d., telephones £4,303. 10s.; India Rubber, Gutta Percha and Telegraph Works Co., galvanometers £51. 19s. 6d., and two ditto as per schedule; British General Electric Co., detectors, £570; Ramsay Sharp & Co., megger £34. 8s.; Falkiner Electric Co., motor generator, power board, &c., £427; F. S. Lee, insulators £1,193. 15s.; J. Schark, Morse keys £118. 2s. 6d.; F. Kanemaku, insulators, £286. 17s. 6d.

Postmaster-General's Dept., Adelaide.—Western Electric Co., desiccating plant £156. 2s. 6d., ebonite sleeves £21. 13s. 4d.; Siemens Bros. Dynamo Works, cable terminals £84. 10s., corks for Meidinger cells £3. 5s., glass tubes £1. 12s. 6d.; British Insulated & Helsby Cables, telegraph condensers £30. 15s., relays £31. 5s., rheostats £27. 15s. 6d., sounders £5. 15s.; India Rubber, Gutta Percha & Telegraph Works Co., zincs £251. 5s.; G. D. Guthrie & Co., insulators £68. 15s.

Postmaster-General's Dept., Brisbane.—W. T. Henley's Telegraph Works Co., cable £1,302. 15s.; British Insulated & Helsby Cables, wire £818. 8s., cable boxes £260. 11s. 6d., solder £64. 3s. 4d.; Siemens Bros. Dynamo Works, insulators as per schedule; Western Electric Co., cable £447, jointing sleeves £95. 5s.; Lawrence & Hanson Co., h.d. copper wire, £2,429. 5s.; India Rubber, Gutta Percha & Telegraph Works Co., copper binders £16. 5s., copper tapes £13. 16s. 0½d.

Postmaster-General's Dept., Melbourne.—Lawrence & Hanson Co., cords £77. 10s., ear pieces £11. 5s., mouth pieces £5. 12s. 6d.

Metropolitan Board of Water Supply and Sewerage, Sydney.—Clerk & Mulholland, electric driving gear for 42 in. valve, £91. 7s.; Australian General Electric Co., three motors £177.

Victorian Railways.—Wm. Adams & Co.

Public Works Dept., N.S.W.—Haes & Eggers, electrically-driven centrifugal pumps, Homebush Abattoirs, £763.

Department of External Affairs, Melbourne.—Siemens Bros. Dynamo Works, electrical equipment for Maranhoy Tinfield, £421. 16s.

New Zealand Government Contracts.—The N.Z. Public Service Stores Tender Board have accepted the following tenders:

B. L. Danne, table telephones £2,483. 6s. 8d.; P. R. Baillie & Co., dry cells £582. 1s. 8d., and wire.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Halifax. [illegible] year ended March 31 [illegible] £112,792 [illegible] £109,640 in previous year. The [illegible] £17,592 [illegible] £7,647. Profit carried [illegible] £9,707,971

Ilford. The accounts of the electricity department for the year ended March 31, 1914, show total capital expenditure £194,760 (increase £2,905), of which £123,025 is outstanding.

[illegible] £13,342 [illegible] profit £14,993 (£13,731) and net surplus £1,452 (£521). Units generated were 4,797,412 (4,137,975) and sold 3,906,807 (3,512,927). Average [illegible] were 1.024 [illegible] 2.204 [illegible] 1.958 [illegible] 20.21 [illegible]

Leicester. The Council recently adopted the report of the Tram [illegible] £170,275 [illegible] £6,718.

The working [illegible] £118,607 [illegible] £8,492, [illegible] £11,028 or £6,288 [illegible] £1,668 interest on [illegible] £5,748 [illegible] £5,748 [illegible] £11,221. Passengers carried were 37,914,774 (increase 841,026). Ald. Flint, in [illegible] service with His Majesty's forces amounted to £42 066. The net balance [illegible]

[illegible] £1,193 [illegible] £1,193 [illegible] £1,193 [

COMPANIES' MEETINGS AND REPORTS.

ALDERSHOT GAS, WATER & DISTRICT LIGHTING CO.—At the recent meeting the chairman (Mr. W. T. Robertson) said that their electric lighting plant at Farnborough was opened in December and about 50 large consumers had been connected up.

ARBROATH ELECTRIC LIGHT & POWER CO. (LTD.)—At the recent meeting it was stated that the profit for the past year was £1,499, and, after taking into account amount brought forward, paying interest and the preference dividend, a balance of £1,037 was carried forward.

BARTON-ON-HUMBER ELECTRIC SUPPLY CO. (LTD.)—The chairman (Mr. F. Hopper) presided at the recent meeting and said the number of consumers had increased by over 60 per cent. during the year, and there was every prospect of a continuance of such increase during the present year. There was an unabated demand both for light and power.

BRAUNTON ELECTRIC LIGHT & POWER CO. (LTD.)—At the recent meeting, the chairman (Mr. T. Yeo) said that steady progress had been made. The net revenue for the year 1914 was £238 against £136, and the directors recommended payment of a dividend of 5 per cent. on the cumulative preference shareholders and a dividend of 2½ per cent. on the ordinary shares, and after writing off 5 per cent. for depreciation of machinery, plant and accumulators, and 2 per cent. off mains, cables and services the balance (£22) was carried forward.

BRIXHAM GAS CO.—At the recent meeting the chairman (Mr. W. A. Schultz) said that the past year's profit on the gas department was £1,997, and on the electricity side of the undertaking £56. The action brought against them by Mr. S. C. Edwards, for an alleged nuisance in respect of vibration, was settled by the company agreeing to remove the causes of vibration. The total costs (£2,297) had been charged against the profits of the company, leaving £61 to credit of profit and loss. In the electricity department they had a plant capable of turning out 10 times the current actually demanded, and the increase in sales was only £17 over 1913.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—During 1914 the connections increased from 3,850 kw. to 4,089 kw. but the effect of the war (especially during the last quarter) has been to seriously reduce the current sold. The result of the year's trading (including £1,805 brought forward) is a profit of £13,884, and after payment of debenture interest and trustees' fees, &c. (£3,013), the balance is £10,871. An interim dividend at rate of 4 per cent, per annum was paid for the half-year in October, and the directors recommend payment of a further dividend for the second half-year at rate of 10 per cent. per annum, making 7 per cent. for the year, that £4,000 be placed to general reserve, leaving £1,621 to be carried forward.

BURNHAM & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The first annual report states that the balance of £62 on revenue account has been swallowed up by bank interest (£97). There are 53 consumers, and the Council's contract to use electricity for the town lamps for three years, has two years to run. A greatly increased demand for electricity for pumping at the new sewerage system has involved an increase of capital.

CLEVELAND & DURHAM ELECTRIC POWER (LTD.)—At the annual meeting last week the chairman (Mr. Jas. Falconer, M.P.) said that the gross profit for the past year was £36,838. The business had been adversely affected by the war owing to economies effected by their consumers and to increases in coal and other costs. It was almost impossible to eliminate all the different causes arising from the war and say what the condition would have been if work had been going on as in normal times, but, under the circumstances, he thought the gross profit was not unsatisfactory. Net profit, after paying debenture interest, was £16,826, and, adding the carry forward (£8,798) the available balance was £25,624. It was proposed to pay a dividend of 4 per cent. on the preference shares (£13,348) and to carry forward £8,276. They had connected up a large supply to Horden Colliery, and the plant was a complete success, demonstrating that electrical working could be established satisfactorily on a large scale in all departments of colliery working. They had contracted for further connections of 9,000 H.P., including contracts with Middlesbrough and Stockton Corporations. In reply to Mr. Gemmell who criticised the accounts and said the system adopted did not admit of the figures being thoroughly checked, the chairman said the directors did not think it was the practice of companies like theirs to give figures that would show the price at which they were supplying current to different consumers, or even the average price. His own view was that the time had arrived when it was desirable, and he thought they were fairly entitled to charge a somewhat higher price for current than in the past. The report and accounts were then adopted.

CLYDE VALLEY ELECTRICAL POWER CO.—Mr. F. C. Gardiner, who presided at the meeting last week, said the net profit for the half-year showed an increase of £9,297 over the corresponding half of 1913. Contracts for supply of current showed an increase of 2,104 H.P. and since the commencement of the current half-year further contracts amounting to over 1,000 H.P. had been signed. While the increased consumption in the price of coal was being felt, that was being compensated for to a certain extent by new and increased supplies of current. A large proportion of their output was being used for the manufacture of munitions of war.

CORK ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.—The revenue for 1914 was £61,601 1s. 9d. and the expenditure £47,903 3s. 3d. With £1,302 brought forward and deducting debenture interest, £1,000 to sinking fund, the balance was £20,598 3s. 9d. Of this amount £8,125 18s. 3d. was paid for the half-yearly dividends on the 5 per cent. cumulative preference shares, £6,500 was added to reserve for depreciation and renewals, £1,804 written off, and the directors recommend payment of 3 per cent. dividend on the ordinary shares (£3,450), leaving £2,480. 10s. 7d. to carry forward. The lighting and power business again shows satisfactory progress, agreements for 161 connections having been concluded during the year, representing a total gain of 467 kw. against 212 kw. in 1913. The revenue increased by £1,469, but the lighting and power revenue was £1,509 in excess of the previous year and the traction revenue £140 less, the decrease being mainly due to the war. There was a reduction of £1,315 in traction and lighting expenses, mainly due to lower maintenance charges for permanent way and cables. Power expenses were increased by £1,700 partly due to increased output and partly to heavier maintenance charges for plant. The year's capital expenditure was £2,500, mainly for house services and additional plant for the power station. To meet the increasing demand for lighting and power the directors have ordered a 1,000 kw. direct-current geared Curtis turbine. In view of the substantial increase in cost of coal and other materials and also wages, the directors may have to consider the question of increasing the charges for electricity.

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—The gross receipts during 1914 were £7,367, or £40. 7s. 9d. less than in 1913. The expenditure decreased by £12. 10s. 11d. After providing for debenture interest the available balance was £362. 9s. 6d., which was carried forward. The chairman (Mr. J. W. Hill) stated at the recent meeting that they carried 462,331 passengers against 459,887 in 1913.

GALASHIELS & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—At the first annual meeting last week the chairman (Mr. Geo. Balfour) said that the generating station was ready to supply current on Oct. 1, 1914. Two mills had been taking a partial supply since that date, and were now taking all the power required for driving their works, while a third was being fitted with the necessary equipment, and in addition a number of miscellaneous consumers both for power and light had been connected up. The sale of current to the end of the year amounted to £382. 14s. 7d., and after adding bank interest and paying all expenses a balance remained of £87. 14s. 2d., which had been carried forward.

WM. GRIFFITHS & CO. (LTD.)—At the recent meeting the chairman (Mr. R. H. Burdett) stated that the powers for the Preston, Chorley and Horwich tramways expired in August last, and though they used every endeavour to dispose of the Acts they were unable to do so, and had no alternative but to write off the whole amount of the expenditure. He said their balance sheet was the best for many years, and the business had been well maintained in every department. A dividend of 2 per cent. was declared on the ordinary shares.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—The result of the trading for 1914 (including £3,428. 5s. 4d. brought forward) is a profit of £16,374. 4s. 3d. After providing for interest and sinking fund on debentures (£5,500) and 5 per cent. dividend on preference shares (£2,500) there remains £8,374. 4s. 3d. The directors propose that a dividend at rate of 2½ per cent. per annum be paid on the ordinary shares, which will absorb £2,500, and that £3,500 be placed to renewal fund account, leaving £2,374. 4s. 3d. to be carried forward. The equivalent of 145,818 33-watt lamps is connected, against 133,809 in 1913 and 125,455 in 1912.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—The report for 1914 states that, after providing for interest and charging full depreciation, the profit is £12,426. With £1,812 brought forward the disposable balance is £14,238. It is proposed to pay a dividend on the ordinary shares of 10 per cent. per annum (making 8 per cent. for the year), pay £700 in directors' fees, add to reserve £2,000, and carry forward £1,118. Many employees have joined his Majesty's forces and thus reduced output, while the higher cost of materials and wages continues to grow. In view of these circumstances the results of the year's working are considered satisfactory. Since the close of the year the company has undertaken a large contract for war material, and for this purpose has rented, and is at present engaged in altering, additional premises.

LISTOWEL ELECTRIC LIGHT CO. (LTD.)—At the recent meeting a dividend of 7 per cent. for the past year was declared. It was stated that there were about 200 consumers, an increase of 12½ per cent., but the average income from consumers had decreased owing to economies in consumption.

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—The chairman (Mr. Chas. M'Laren) stated at the recent meeting that they had sold 31,279 more units than in 1913, and the profits had increased by £744. The directors did not anticipate any serious capital expenditure during the year, extensions of cables being the only necessary item. By agreement with the Hightown Gas & Electricity Co., they were supplying that company in bulk for distribution and sale in Huyton, and in that way they were supplying a large military camp at Sniggery Woods and also the battery at Hightown. They were also supplying by arrangement electricity to another camp in Thornton, about 200 yds. beyond their boundary. These would make up for the economies practised by their existing consumers, but he was afraid they could not look forward to any substantial increase of business during 1915. Their engineer was preparing a report and plans for suitable coal storage bunkers, and if it was in any way possible to arrange for a reasonable price they intended to make themselves independent of the coal trade.

NORTHERN GENERAL TRANSPORT CO. (LTD.)—The report states that considerable progress was made in the development of the company, but owing to the war [illegible] in 1914. The dividend on the Company's shares in the Gateshead, Tynemouth and Jarrow Tramways

undertakings amounted to £22,443. 15s. 1d. The gross profit for the year was £38,197. 18s. After deducting management expenses, &c. (including £4,450. 8s. for loan and debenture interest, and £5,412. 10s. 6d. for renewals) there remains £24,379. 11s. 6d., out of which the directors recommend a dividend of 6 per cent. for the year on the preference and ordinary shares, carrying forward £4,230. 3s. 10d.

SALT UNION (LTD.)—At the recent meeting the chairman (Mr. G. H. Cox) said their subsidiary companies, including the Mersey Power Co., were making material progress. The youngest of those companies was the Mersey Power Co., which dealt with the public supply and marketing of the electricity produced at their vacuum plant installation at Weston Point, and in that company they possessed a valuable asset.

SHAWINIGAN WATER & POWER CO. LTD.—The revenue from all sources during 1914 was $1,805,217, while the net income, after making provision for operating expenses and interest, was $1,081,347. A dividend at rate of 6 per cent. for the year has been paid, £200,000 transferred to reserve and sinking fund, $100,000 to depreciation reserve, $20,000 to contingent fund, leaving surplus of $39,472.

SLOUGH & DATCHET ELECTRIC SUPPLY CO. (LTD.)—The annual meeting was held last week when the directors' reported that the capital expenditure at Dec. 31 last was £67,073, an increase of £2,727, mainly due to the provision of a new feeder cable from the works to Slough, in order to meet the growing demand for electricity. The equivalent of 1,227 additional 8 c.p. lamps was connected last year, making the total connections 8,956 8 c.p. The total available was £4,830. 8s. 5d., out of which £1,350 was allocated to depreciation and reserve, and a dividend of 5 per cent. per annum was recommended, leaving £427 to be carried forward.

In moving the adoption of the report the chairman (Mr. H. L. Prior) stated that the lighting revenue had been affected by the war, and they had sold only 831,803 units, against 842,389 in 1913. The directors had made arrangements to supply current to Farnham district, when they had notice from the Board of Trade that opposition had been suddenly made by Eton Rural Council, and whilst the subject was under discussion war broke out, and it did not seem advisable to risk capital. Since then they had had a memorial to go on, but as the people sending it only offered to take about 300 lights, it would not pay interest on the capital, and although they had not abandoned the idea they had had to defer it until better times. The Diesel plant had done, and was doing its work very well. They had a favourable oil contract to the end of the year. Sometimes they ran the Diesel engines, at other times the steam turbine, and occasionally both. Each source of power had proved satisfactory.

STEWARTS & LLOYDS (LTD.)—At the recent meeting it was reported that, after setting aside £100,000 for depreciation, the net profit for 1914 was £233,419 (against £246,034 in 1913), and with balance brought forward the total was £328,790. The directors proposed to place to reserve fund £50,000, to employés' benefit fund £10,000; and they also recommended payment of a dividend of 2s. per share on the deferred shares, leaving £97,666 to be carried forward. The chairman (Mr. J. G. Stewart) said that, as regards 1915, they could not expect to maintain the profits. Their output would be less, owing largely to the fact that a great number of their men and staff had volunteered for service, no fewer than 1,850 having done so. The directors had encouraged their going.

WESTERN UNION TELEGRAPH CO.—The gross revenue for 1914 was $47,287,388, from which must be deducted operating expenses (including rent for leased plant, taxes, &c.), $40,578,750, leaving a net income of $6,708,638. Interest on bonds absorbed $1,337,243, leaving $5,371,395.

WINNIPEG ELECTRIC RAILWAY CO.—The net earnings for 1914 were $1,685,093, and after providing for fixed charges and four quarterly dividends of 3 per cent. each, the credit to profit and loss of $901,697 brought forward was reduced to $816,309. A dividend of 2½ per cent has been declared for the quarter ended March 31.

WOKING ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the report stated that the revenue for 1914 was £19,291. 11s. 4d., and after deducting costs of generation and management (£10,415. 7s. 10d.) the balance was £8,876. 3s. 6d. Adding amount brought forward (£622. 8s. 7d.) and income tax accumulations (£132. 9s. 8d.) the total was £9,631. 1s. 9d. After paying interest on debenture stock (£2,471. 5s. 1d.) and on temporary loans (£369. 2s. 4d.) and paying the dividend on the 6 per cent. cumulative preference shares (£2,845. 18s. 2d.), leaving £3,944. 16s. 2d., the directors recommended that £1,500 be placed to depreciation and renewals fund, and after placing £500 to reserve and writing down certain items they recommended a dividend of 5 per cent on the ordinary shares (£1,056. 7s. 3d.), leaving to be carried forward £652. 15s. 2d. Since 1908 the number of consumers had increased from 1,225 to 2,021, the connected load from 1,070 to 2,803 8 c.p., and the revenue from £14,453 to £18,878. The capital expenditure to Dec 31 was £138,964 19s. 5d.

In moving the adoption of the report the chairman (Mr. John Ashby) said he thought it very satisfactory, the revenue touching a higher figure than ever before. The whole of the 6 per cent. preference shares had been taken up and recent applications had had to be refused. But debenture stock and ordinary shares were still being issued. Units sold during 1914 totalled 950,700, an increase of 8,684. The cost per unit generated was ⅛d. less than in 1913, while the cost per unit sold was just over ⅞d. less. Referring to the supply to Chobham, he said the Ascot Electric Light Co. (who held the provisional order) had now decided to supply their consumers. They would, therefore, take over from the Woking Company the cable which the latter had laid at Mayford under licence of the Board of Trade, together with whatever cost had been incurred in connection with the work.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

CARK & DISTRICT ELECTRIC SUPPLY CO. (LTD.) (139,728.)—Reg. March 23, capital £2,000 in £1 shares (1,500 6 per cent. cumulative preference) to carry on at Cark, Flookburgh, Allithwaite and adjoining district the business of an electric light supply company. Private company.

DRYCELLS (LTD.) (139,605).—Reg. March 11, capital £100 in 10s. shares, to carry on the business of manufacturers of electric refill batteries for pocket and other lamps. Private company. First directors are R. W. Gale and W. H. R. Hargrave. Reg. office: 24, John-street, Bedford-row, W.C.

ELBRON METALLISING CO. (1915) (LTD.) (139,823).—Reg. March 30, capital £100 in £1 shares, to take over the business carried on by L. G. Lewis as the Elbron Metallising Co., and to carry on the business effecting the electrolytic deposit of metals on non-metallic substances, engineers, machinists, metallurgists, &c. Private company. First directors are L. G. Lewis (permanent director and chairman) and M. Dodds. Reg. Office: 42, Berners-street, W.

MANLEY & SANDY (1915) (LTD.) (139,678.)—Reg. March 17, capita £1,000 in £1 shares, to take over the assets of Manley & Sandy (Ltd.) (in liquidation), to carry on the business of electrical and mechanical engineers and contractors, manufacturers of and dealers in machinery, electric and other apparatus, &c. Private company. First directors are G. B. Dobb, J. W. Manley and R. B. Dobb.

MID-SOMERSET ELECTRIC SUPPLY CO. (LTD.) (139,699).—Reg. March 19, capital £7,000 in £1 shares, to adopt agreements with Christy Bros. & Co. for construction of plant, and with C. & J. Clark for supply of electricity in bulk, to take a transfer of a provisional order acquired in the name of Christy Bros. & Co., and to carry on the business indicated by the title. First directors are F. Christy, H. B. Clark, J. B. Clark, J. C. Morland, J. Pursey, F. W. Voake and J. E. Ward.

NEWCASTLE WEST & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.) (4,227). Reg. in Dublin on March 30, capital £3,000 in £1 shares (2,000 preference), to carry on the business of electricians, mechanical engineers, manufacturers and contractors, &c. First directors are W. Phelan, W. A. Phelan and Mrs. B. Phelan. Reg. office: South Quay, Newcastle West, Co. Limerick.

NEWTON BROTHERS (DERBY) (LTD.) (139,711.)—Reg. March 20, capital £31,000 in £1 shares (1,000 employe's), to take over the business carried on as Newton Brothers, to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in electric lighting and power plants, dynamos, motors, cranes, pumps, motor vehicles, telegraphs, telephones, accumulators, lamps and other apparatus, metal workers, tool makers, &c. Private company. First directors are C. A. Newton, R. Newton and H. Newton (all permanent). Secretary: E. A. Swindall. Reg. Office: 21, Market-place, Derby.

RADIO ELECTRIC LAMP CO. (LTD.) (139,784) –Reg. March 26, capital £200 in £1 shares, to carry on the business of manufacturers of and dealers in electric lamps and all kinds of devices for lighting or heating by electricity, electricians, electrical contractors, &c. Private company. Reg. office: 27, Kingly-street, Regent-street, W.

ROTO ENGINEERING CO. (BRADFORD) (LTD.) (139,737.)—Reg. March 23, capital £1,000 in £1 shares, to carry on the business of electrical, mechanical and ventilating engineers, merchants, manufacturers of rotary pumps, oil cabinets, steam, pneumatic or other engines, &c. Private company. Reg. office, Borough Mills, Bradford.

SEEAR, SCOTT & CO. (LTD.) (139,663.)—Reg. March 16, capital £1,000 in £1 shares (750 7 per cent. preference), to carry on the business of railway, motor, mechanical, electrical, experimental and general engineers and manufacturers, &c. Private company. First directors are E. C. Seear and J. Scott (provisional directors).

SUNLIGHT MFG. CO. (LTD.) (139,636)—Reg. March 13, capital £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in electric batteries for pocket lamps and torches, general electrical goods and accumulators, magnetos, &c. Private company. First directors are J. Abrahams and P. Abrahams (both permanent). Reg. office: 1 & 3, Paxton road, Tottenham, N

TUNGSTEN (LTD.) (139,665).—Reg. March 16, capital £30,000 in £1 shares, to carry on the business of extractors, producers, refiners and manufacturers of tungston, dealers in wolfram and tungsten and their products, metal workers, electrical engineers, electric lamp makers, &c., and to adopt an agreement with the National Industrial Synd. (Ltd.), F. W. Warburton and others. Private company. First directors are P. Richardson, S. Clarke and F. W. Warburton.

STATUTORY RETURNS.

ADELAIDE ELECTRICITY SUPPLY CO. (LTD.)—According to return to Jan. 5, capital is £500,000 in 50,000 preference and 50,000 ordinary shares of £5 each. 43,805 preference and 50,000 ordinary shares taken up. £5 per share called up on 43,805 preference and 24,000 ordinary. £339,025 paid. £130,000 considered as paid on 26,000 ordinary. Mortgages and charges, £219,572 5 per cent. debenture stock. (A further 959 preference shares were allotted, payable in cash, to Feb. 3, 1915.)

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—Capital in return to Nov. 5, 1914, is £600,000 in £1 shares (150,000 preference). All shares taken up. £1 per share called up. £585,100 paid, and £14,900 considered as paid. Mortgages and charges : £408,327.

BURMAH ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—In return to Dec. 31, 1914, capital is £200,000 in 20,000 ordinary and 20,000 preference shares of £5 each. All shares taken up. £100,000 paid on the preference, £100,000 considered as paid on the ordinary. Mortgages and charges nil.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—In return to March 10 capital is £100,000 in £10 shares. 9,909 shares taken up. £9 per share called up, and £89,181 paid. Mortgages and charges, £41,000 (£30,000 debentures and £11,000 loan from bankers).

FLATHER & CO. (LTD.)—Capital in return to Dec. 18, 1914, is £3,000 in £1 shares. 1,910 shares taken up. £1 per share called up and paid on 410 shares. £1,500 considered as paid on the remainder. Mortgages and charges : £1,000.

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—The return to Jan. 5 gives capital as £812,000 in 50,000 ordinary, 25,000 preference and 6,200 unissued shares of £10 each. 50,000 ordinary and 25,000 preference shares taken up. £750,000 paid. Mortgages and charges : £400,000.

RAIL-LESS ELECTRIC TRACTION CO. (LTD.)—According to return to Jan. 14, capital is £5,000 in 4,750 ordinary shares of £1 each and 5,000 deferred shares of 1s. each. 2,571 ordinary and 5,000 deferred shares taken up. £1 per share called up on 2,056 ordinary shares, £1,916 paid, leaving £140 in arrears. £765 considered as paid, being £1 per share on 515 ordinary and 1s. on 5,000 deferred shares. Mortgages and charges : nil.

ROBERT W. BLACKWELL & CO. (LTD.)—Return to Jan. 14 gives capital as £250,000 in £1 shares. All shares taken up. £1 per share called up on 75,007 and 10s. per share on 25,000. £87,507 paid. £149,993 considered as paid on 149,993 shares. Mortgages and charges nil.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—According to return to March 2, capital is £300,000 in 20,000 preference and 40,000 ordinary shares of £5 each. All shares taken up. £5 per share called up on 20,006 preference and 39,650 ordinary. £298,250 paid. £1,750 considered as paid on 350 shares. Mortgages and charges : £150,000 3½ per cent. debenture stock and £236,729 4 per cent. guaranteed debenture stock of the Central Electric Supply Co. being half of total loan capital.

SUN ELECTRICAL CO. (LTD.)—Capital in return to Dec. 29, 1914, is £45,400 in £1 shares (20,000 preference). 17,141 preference and 5,400 ordinary shares taken up. £22,541 paid. Mortgages and charges at date of return : £3,325, sincere gistered, satisfaction to extent of £275 on Feb. 9, 1915, of debenture stock dated March 31, 1911, originally securing £7,000.

SUPPLIERS CONSTRUCTION CO. (LTD.) –According to return to Dec. 31. capital is £350,000 in £5 shares. All shares taken up and £350,0000 paid. Mortgages and charges : nil.

UNITED ELECTRIC CAR CO. (LTD.)—Capital in return to Sept. 30, 1914, is £300,000 in £1 shares (150,000 preference). 150,000 ordinary and 100,000 preference shares taken up. £250,000 paid. Mortgages and charges : nil.

WALSALL ELECTRICAL CO. (LTD.)—Return to Dec. 25, 1914, gives capital as £20,620 in £1 shares. 12,000 shares taken up and £10,000 paid. £2,000 considered as paid. Mortgages and charges : £3,000.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD)—According to return to March 10 capital is £2,000,000 in £5 shares (200,000 ordinary and 200,000 4½ per cent. cumulative preference). 110,000 ordinary and 110,000 preference shares taken up. £5 per share called up, and £1,100,000 paid. Mortgages and charges : £250,000.

MORTGAGES AND CHARGES.

BRILLIANT ARC LAMP & ENGINEERING CO. (LTD.)—Issue on Feb. 27, 1915, of £50 debentures, part of series of which particulars have been filed.

CORONA LAMP WORKS (LTD.)—Issue on Feb. 27, 1915, of £1,350 debentures, part of series of which particulars have already been filed.

CREED, BILLE & CO. (LTD.)—Two mortgages (one as collateral security), dated Feb. 4, 1915, to secure £1,500, charged on land in Cherry Orchard-road, Croydon, with buildings thereon, &c. Holder, W. T. Bolland, 22, Colston-road, Croydon.

DERBY LAMP WORKS (LTD.)—Debenture dated March 24, 1915, to secure £6,000, charged on company's undertaking and property, including uncalled and unpaid capital. Holders : F. W. Greaves and J. Rae.

ELECTRIC REDUCTION CO. (LTD.)—Memorandum of satisfaction in full on Feb. 9, 1915, of debentures dated June 25, 1903, securing £2,000, has been filed.

NAYLORGRAPH (LTD.)—Two debentures dated March 13, 1915, to secure £576 and £100 respectively, charged on company's undertaking and property, including uncalled capital (if any), subject to prior debentures. Holders : J. M. Hunt and J. P. Naylor.

PLAYER & MITCHELL (LTD.)—Particulars of £1,200 debentures, created March 17, 1915, have been filed; which amount being now issued. Property charged, company's undertaking and property, present and future. No trustees.

G. H. TURNER & CO (LTD.)—Particulars of £500 2nd debentures, created 17th March, 1915, have been filed, amount at present time being £250. Property charged : Company's undertaking and property, including uncalled capital, subject to £350 1st debentures. No trustees.

RECEIVERSHIPS.

ATLAS ELECTRICAL CO. (LTD.)—Notice of appointment of W. H. Clegg, 58, High-street, Charing Cross, W.C., as receiver on March 17, 1915, under powers contained in debentures dated Nov. 5, 1913, has been filed.

FARDON & CARPENTER (LTD.)—C. A. Carpenter, 87, Capri-road, Addiscombe, Surrey, ceased to act as receiver or manager on March 27, 1915.

LONDON ELECTRIC WORKS CO. (LTD.)—Notice of appointment of Arthur Taylor, Thames House, Queen-street, E.C., as receiver, on March 24, 1915, under powers contained in debentures, dated Oct. 1 and Oct. 30, 1914, has been filed.

CITY NOTES.

MEMORANDA (April 7).—**Bank rate 5 per cent. (since Aug. 8, 1914.)** Consols 66⅞. Consols Pay Days May 5 and June 1. Stocks and Shares Ticket Days April 13 and 28. Pay Days April 14 and 29. **Price of silver,** 23¾d.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—The directors have declared the usual dividend for the quarter ending March 31 of 1¾ per cent. on the common stock and the half-yearly dividend of 3½ per cent. on the preference stock.

COMPANIES STRUCK OFF THE REGISTER.—The following companies were struck off the Register of Joint Stock Companies on March 26 :

British Tungsten Metals Synd., Electrical Regulators & Economisers, Frank Suter & Co., Haskin Wood Vulcanising Co., Illuminated Advertising Screens Co., Indestructible Accumulators, International Electric Transport & Enterprise Co. of Alsace-Lorraine, Leeds & Bradford District Electric Railways, Telephone Disinfecting Co.

CONSOLIDATED SIGNAL CO. (LTD.)—An interim dividend of 6 per cent. per annum has been declared on the preference shares, but the question of a distribution on the ordinary shares has been deferred until the end of the year.

HENDON ELECTRIC SUPPLY CO. (LTD.)—The directors propose to pay a final dividend of 5 per cent. and a bonus of 3 per cent. on the ordinary shares.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The directors recommend, subject to final audit, payment of the following dividends : At rate of 6 per cent. per annum on the preference shares for the half-year ended Dec. 31 last (less tax) ; a final dividend of 6 per cent. on the ordinary shares (tax free), making a total of 10 per cent. for the year.

SUBMARINE CABLES TRUST.—The coupon due on the 13th inst. will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C., between 10 a.m. and 2 p.m. on that day.

TELEPHONE CO. OF EGYPT (LTD.)—After providing for debenture interest, &c., the profit for 1914 was £198,281, inclusive of £134,646 brought forward. The directors recommend a further dividend of 6 per cent. on the preferred and deferred shares, making the usual distribution of 10 per cent. for the year, carrying forward £171,550.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, April 7. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

of £	LAST DIVIDEND	NAME.	Price, Wed., April 7.	RATE PER CENT YIELDED.	DIVIDEND DUE.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	10½†	6 18 3	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9⅞	4 13 11	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	10⅛	5 19 3	Feb, Aug
5	10%	Brompton & Kensington Ord.	8½	5 16 0	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs...	91	4 7 11	Jan, July
5	2/3	Do. 4½% Pref.	4⅞	5 7 6	..
10	9%	City of London Elec. Lt. Ord.	14½	6 4 2	Feb, Aug.
10	6.6	Do. 6% Pref.	12½	4 14 1	Mar, Sept
St.	5%	Do. 5% Deb. St.	110	4 10 10	Jun, Dec
10	6%	County of London 6% Pref.	111	5 15 0	Feb, Aug
St.	4½%	Do. 2nd Deb.	98	4 11 10	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs...	79½	5 13 2	July
5	9%	Kensington and Knightsbridge Ord.	7¼	6 4 2	Feb, Aug
5	3/0	London Elec. Supp. 6% Pref.	4½	6 13 6	..
St.	4%	Do. 4% Mort. Deb.	86½	4 12 3	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	3⅞	5 9 10	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	93	4 13 3	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs ..	96½	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S.5%2dMt.Db.St.	77	6 1 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1	5 10 4	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs. ..	85	5 5 3	Jan, July.
St.	4½%	Urban Elec. Supp 4½% Db. St.	94½	5 6 10	Apl, Oct
..	9%	Westminster E.S. Corp. Ord.	2½	6 0 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4⅛	4 14 1	Jan, July.
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	8.	5 19 1	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	71	8 9 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord. ..	7⅝	5 4 3	..
St.	4%	Do. do. Assented Def. Ord. ..	75½	5 5 1	..
10	8½%	Lancashire Tramways	9½	5 17 11	Feb, Aug

†Ex dividend or interest

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	NAME.	Price, Wed., April 7.	Rate per cent. Yield £. s. d.	Dividend Due.
		Electric Railways and Tramways.			
10					Jan, July
5			6½		Mar. Sept.
5					
10		Metropolitan Ry. Con. Ord.			Feb, Aug
5			77		
5			74½		Feb, Aug
5			83		
5			83		Jan, July
		Metropolitan Dist. Ry. Ord.			
5	4%	Do. 4% Prior Lien			Feb, Aug
5	4½	Do. 4½% First Pref.			Jan, July
5	6%				Jan, July
5	4%				Jan, July
5	4%	Do. 4% Debs. (1903-5)			Mar, Sept
1		Underground E. Rys. of London Shares			
		Do. 6% Inc. Debs.			Mar. Sept
5		Do. 6% Inc. Bds., with coup. 15			Mar, Sept
		Electric Manufacturing, &c.			
1					Apl, Oct
1		Brit. Aluminium Ord.			Jan, July
1					Jan, July.
					Jan, July
					Aug. Feb
5		Do. 6% Cum. Pref.			Jan, July
5		British L.M.Ericsson Mfg. Cm.6% Pref.			Mar. Sep
		Brit. Westinghouse Pref.			Jan, July
5		Callender's Cable, &c., Co. Ord.			Feb, Aug
					May, Nov
1					Sept
		Edison & Swan U.Elec.Lt.A. £3 pd.			
1		Elec. Construction Ord.			May
5	4%	Do. 4% Debs.			Jan, July
1		General Electric 6% Pref.			Jun, Dec
5		W. T. Henley's Teleph. Wks. Co. Ord.			Feb, Aug
5	2/3				
					Jun, Dec
10		India Rubber, G. P. &c., Ord.			Feb, Aug
					Apl, Oct
1					Apl, Oct
12	36/0	Telegh. Con. & Main. Co. xd & bonus			Mar, July
1					
1					May, Aug
					Jun, Dec
5					Jun, Dec
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.			Fb,My,Aug,N
St.	30/0	Do. Def. Ord.			Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.			Ja,Ap,Jly,O
10	10/0	Cuba Submarine 10% Pref.			
					Ja,Ap,Jly,O
St.	25/0	Eastern Tel. Co. Ord.			Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.			Ja,My,Jly,O
St.	4%	Do. 4% Pref.			May, Nov
St.	4%	Eastern Extension Tel. Co. 4% Debs.			Feb, Aug
10	2/6	Do. Ord.			Ja. Ap. Jly.O
10	5/0	Gt. Northern Tel. Co. with Coup. 6			Ja. My. Jly
1	2/0	Marconi's Wireless Tel. Co.			April
1	2/0				July
10	1/3	West India & Panama Ord.			May, Nov
10	6%	Do. 1st Pref.			May, Nov
1		Western Teleph. Co.			Mr. Jly.O.Dec
St.	4%	Do. 4% Deb. St.			
		Telephones.			
		American Telephn. & Telgh. $100 Cap.			Ja,Ap,Jn.O
		Cuban Telephn. Co. 5% Bds.			Jan, Jly
1		Monte Video Telephn. Ord			Nov.
		New York Telephone 4½% Bds.			May, Nov
1		Oriental Telephone Ord.			Apl, Oct
		Do. Db. St.			Jan, July
St.		Telephn. Co. of Egypt Db. St			Jan, July
	3/0	United River Plate Ord.			Apl, Oct
		Financial and Investment.			
10					Sp,Dc,Mr,Jn
10	3/0				Sp,Dc,Mr,Jn
					Ja, Apl, Jly,O
					Ja,Ap,Jly,C
100		Submarine Cable Trust Certs.			Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.		5% Debs.			Jun, Dec
St.		% Debs.			Jan, July
					Jan, July
		1st Pref.			Jan, July
		2nd Pref.			
					Ja,Ap,Jly,O
					May, Nov
		Ord.			Mar, Sep
		Bds.			Feb, Aug
		6% Cum. Pref.			
1					Jan, July
St.		11% Debs. (1922)			Feb, Aug
					Jun, Dec
		Colonial and Foreign Electric Supply, &c.			
					Mar, Sept
					Jun, Dec
					Apl, Oct
					June, Dec
					Apl, Oct
					May, Nov
					Jan, July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date April 7, the following as the present basis prices of:

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	10½d.	Antimony	£30 0 0
Solid Drawn Copper Tubes	11½d.	English Lead	£23 10 0
Brazed Copper Tubes	11½d.		
Brazed Brass Tubes	12½d.	**Old Metals.**	**per ton**
Brass Wire	10d.	Clean Scrap Copper	£65 0 0
Copper Wire	11½d.	Brazlery Copper Scrap	£63 0 0
Rolled Brass	9½d.	Clean Scrap Brass	£48 0 0
Brass Sheets	10½d.	Old Lead	£21 0 0
		Old Zinc	£31 0 0
	per ton.	Hollow Pewter	£115 0 0
Copper Sheets	£70 0 0	Black Pewter	£85 0 0
Spelter	£42 0 0	Gun Metal	£59 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date April 7, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£60 0 0	Lead (less usual Draft)	£20 10 0
Clean Mixed Brass	£48 0 0	Tea Lead	£19 0 0
Clean Copper	£64 0 0	Old Zinc	£32 0 0
Brazlery Copper	£60 0 0	Hollow Pewter	£115 0 0
Gun Metal	£60 0 0	Stamped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	Aggregates. No. of weeks.	Aggregates. Amount.	Aggregates. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	March 31	1,508	+	44	72,122	+ 2,240
Anglo-Argentine	April 1	51,093	+ 4	44	1,961	— 74,260
Ashton-under-Lyne	,, 3	447		1	447	14
Ayr Corporation	,, 31			46	15,318	1,196
Bath Electric Trams, Ltd						
Birkenhead Corporation						
† Birmingham Corporation	March 27	13,222		51	632,192	+ 10,370
Blackburn Corporation	,, 31	1,117		1	1,117	+ 1
Bolton Corporation						
† Bournemouth Corporation	,, 31	1,755		52	102,815	— 1,534
Bradford Corporation	,, 27	5,810		52	316,659	+ 14,042
Brighton Corporation	April 4	992		1	992	+ 86
† Bristol Trams & Carriage	,, 2	8,584	+ 444	13	109,792	+ 11,284
Burmah E. Trams & Ltg.	,, 3	R3,625	+ 494	13		— R37,351
Burnley Corporation	,, 3	1,699	+ 74	1	1,699	+ 74
Burton Corporation						
Bury Corporation	March 31	431		52	68,830	— 1,022
Calcutta Tramways Co.	April 3	R60,528	— R 226	13	R781,953	— R60,771
Camborne-Redruth	March 27	123		12	1,454	
Cardiff Corporation	,, 27	1,554	+ 153	51	137,468	— 3,166
Central London Railway						
Cork Electric Trams Co.	April 1	429	+ 54	13	5,653	— 217
Croydon Corporation	March 26	1,676		12	86,703	+ 2,739
*Derby Corporation	April 1	966	— 18	52	51,659	+ 691
Dover Corporation	March 27	244	+ 31	52	13,137	+ 324
Dublin & Lucan Railway	April 2	184	+ 24	13	1,555	+ 35
Dublin United	,, 2	5,652	+ 732	13	72,598	+ 3,414
Dundee Corporation	March 31	1,212	+ 46	52	58,165	— 1,241
East Ham Council	April 3	1,259	+ 203	52	61,917	+ 141
Erith Urban Council						
Exeter Corporation						
Glasgow Corporation	,, 3	20,438	+ 1,111	464	888,691	— 7,745
Glossop Trams	,, 3	110	+ 4	14	1,510	— 150
Gloucester Corpn.	March 31	275	— 4	52	16,693	— 136
† Halifax Corporation						
Hastings Elec. Trams Co.	April 1	746	— 30	13	9,296	+ 43
Hong Kong						
Huddersfield Corpn.	,, 3	2,334	+ 81			
Hull Corporation	,, 3	3,034	+ 347	1	3,034	+ 137
Ilford District Council	,, 3	585			29,881	+ 3,340
Ilkeston Corporation	March 31	119	+ 13	52	6,529	+ 403
Ipswich Corporation	April 3	423	+ 51	52	22,811	— 397
Isle of Thanet Co.	,, 3	324	+ 31	24	7,612	+ 1,406
Kilmarnock	,, 3	156	+ 14	46	7,322	— 715
Lanarkshire Trams Co.	March 25	1,711	+ 164	12	20,911	+ 1,181
Lancashire United	,, 31	1,440	+ 98	13	19,550	+ 214
Leeds Corporation						
Leicester Corporation	April 3	2,883	+ 67	14	37,[illegible]	— 508
Leith Corporation	,, 3	661	+ 31	40	32,[illegible]	— 138
Lincoln Corporation	,,	129				+ 5
Liverpool Corporation	March 27	13,539	— 1	12	1,[illegible]	— 3,183
Liverpool Overhead Rly.						
Llandudno&ColwynBayR	April 2	290	+ 102	12	3,[illegible]	+ 243
London County Council	March 24	47,162	+ 4,466	51	2,[illegible]	+ 126,[illegible]
London Elec. Ry. Co.						
London United						
Lowestoft Corporation	April 3	167		14	2,[illegible]	— 344
Maidstone Corporation						
Manchester Corporation	,, 3	16,182	— 1,119			— 22,451
Metro. Railway						
Nelson Corporation						
Newcastle-on-Tyne Corpn	,, 3	5,888	+ 534		[illegible]	+ 3,[illegible]
Newport (Mon.) Corpn.	,, 3	392	+ 18			
Northampton Corporation	,, 3	652		52	31,650	+ 1,[illegible]
Oldham Corporation	,, 4	2,157			[illegible]	— 364
Perth (N.B.) Corporation						
Perth (W.A.) Elec. Trams						
Portsmouth Corporation						
Preston Corporation						
Rotherham Corporation	March 31	924		52	[illegible]	+ 231
Salford Corporation	April 5	[illegible]			1,[illegible]	108
Scarborough						
† Sheffield Corporation	,, 4	8,117	+ 105	1	11,[illegible]	— 113
Singapore Trams						
Southampton Corpn.	March 31	1,175	+ 4	52	[illegible]	+ 369
Southend Corporation	,, 31	[illegible]			45,[illegible]	+ 1,130
St'lyb'dge, Hyde, &c., Jt. B	April 3	765			[illegible]	
Sunderland Corporation	,, 4		132	1	[illegible]	132
Sunderland District	March 31	[illegible]		22	11,[illegible]	+ 1,[illegible]
Swindon Corporation						
Tynemouth Corpn.		513	42	† 12	[illegible]	+ 280
Wallasey Corporation	April 3	1,057		1	1,[illegible]	104
Walsall Corporation						
Warrington Corporation						
West Ham Corporation	,, 1	2,926		52¶	148,013	+ 3,[illegible]
Wolverhampton Corpn.	March 31			26	26,195	643
[illegible] Trams	April 4	[illegible]		14	19,914	118

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Including motor buses, &c. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 3 days.
†† Plus 2 days.

THE ELECTRICIAN:

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NOTES.

Electrification of the Butte, Anaconda Railway.

ENGINEERS have awaited with interest the results of the conversion from steam to electric traction on this line, and will, therefore, welcome the comprehensive description that we are now able to publish. The railway in question is used almost exclusively for mineral traffic, and the present conversion adds one more to the growing number of such lines where the electric locomotive has solved the problem of heavy traction service. The present case gains much of its interest from the fact that it is the first application of the 2,400-volt continuous-current system on American railways; consequently the description of the technical details will attract as much attention as the statement of the excellent financial results. Novelties in the electrical equipment begin at the converting machinery in the sub-stations. Here 1,450 k.v.a. synchronous motors running at 720 revs. per min. are directly coupled to two 500 kw. 1,200-volt generators joined in series to provide the track pressure of 2,400 volts. The compound generators have both interpole and compensating windings, and the series-winding is connected to the earthed pole, whilst the shunt winding is excited off a 125 volt supply. Thus, every precaution has been taken to safeguard the supply.

THE locomotives are provided with a four-motor equipment, connected all in series or in series-parallel. Consequently the motors work on 600 or 1,200 volts, but are insulated for the line pressure. The motors have interpoles and are rated at 300 H.P., though, of course, they are not subjected to the same space limitations as motors mounted under the floor of a coach. Multiple-unit control is used, so that double-unit locomotives, as required for freight service, offer no difficulties. The current is collected from the overhead conductor by means of roller pantographs, care being taken to connect the pantographs of the two locomotives in parallel to reduce sparking. The normal current collected by each is about 400 amperes on gradients, but the author expresses the opinion that there should be no difficulty in collecting 600 amperes per roller when connected in this way. From this it will be seen that it should be possible to build single 2,400-volt electric locomotives for 2,000 H.P., and it would seem that we are now able to combine the advantages of the continuous-current system with the overhead conductor for heavy traction over long distances. Experience alone can show how far this will affect the single-phase system.

Efficiency of the Electric Arc.

A PERUSAL of the "Elektrotechnische Zeitschrift," which, since the outbreak of war, has not been available until recently, shows two developments tending to increase the efficiency of the electric arc. One of these is due to Dr. W. WEDDING, who heats the ends of the carbons by means of a flat non-luminous flame, though it appears that the actual function of the flame is to cool that part of the carbons to which it is applied. From the information that is given the arrangement is not altogether clear. It is obvious that if the efficiency of an arc is to be increased, the current density in the luminous part of the electrode must be increased so as to obtain a higher temperature. Evidently this desideratum has been achieved by Dr. WEDDING, as the candle power in a certain direction is raised from 30,000 up to about 100,000 Hefner candles, although the temperature of the carbons in certain parts has been reduced. Some other figures of the results obtained will be found in the short account which we publish in another column. The idea of cooling has also been attempted in the United States, and

we gave some details of this method, in which vapour-cooled electrodes were used, in our issue of September 18th of last year. In the projector then described alcohol vapour was the cooling medium. When one attempts to increase the candle power merely by increasing the current density, the difficulty is experienced that the crater becomes larger and the carbons tend to burn; there is no great increase of current density within the crater, and consequently a higher intrinsic brilliancy is not gained. Largely increased candle-power was obtained by means of this vapour cooling, to much about the same extent as was found by Dr. Wedding. Some interesting results also seem to have been obtained by Prof. Lummer, by means of working under high atmospheric pressures. From the practical point of view, however, increase of pressure does not seem to be a very promising direction in which to work.

Municipal Employés and the War.

The readiness of men in electricity departments and other spheres of municipal work to respond to the call to arms has been so marked that in some towns there is no little difficulty in carrying on the work of electricity supply, more particularly as the increased demand for electrical energy has been very considerable by factories turning out war material. Nevertheless, owing to the further call for men to manufacture munitions of war, municipalities are looking into the matter to see whether still more of their employés cannot be spared. Thus, in Birmingham there are already 2,500 municipal employés serving with the Colours, but the Corporation is prepared to spare another 1,062 men for manufacturing purposes. We do not doubt that there will be a similar response in other large cities, and in all probability those who must remain at their work will feel that they are suffering some hardship. In this connection the idea seems to have gained ground that badges indicating that the wearer is engaged on war service can be obtained for all men who have signified their willingness to join the Colours, but whose employers are unable to allow them to do so. This does not seem to be the case, and we understand that the War Office is only issuing badges to men who are definitely engaged upon making war material. That being so, we think that the municipalities themselves might consider the question of issuing a badge to those of their employés who must be retained in their present positions, and who are really serving their country in maintaining public services that are essential. Some such step is in contemplation at Ealing.

Canberra (Australia's new capital).—The formation and construction of this city is making good progress, and will soon assume definite shape. The electricity supply building is already erected and the power plant, costing about £60,000, is approaching completion.

Standard Specification for Portland Cement.—The Engineering Standards Committee have just issued a new edition of the British Standard specification for Portland cement, one of the most widely adopted of the reports issued by the committee. The original report first appeared in 1901, and has been revised from time to time. The further modifications, which are included in the new edition, deal with the fineness of grinding of the cement, the preparation of briquettes and other matters. Copies of the report can be obtained from the secretary, 28, Victoria-street, London, S.W., for 5s. net.

Arc Lamps Burning Under High Gas Pressures.—It is stated in the "Elektrotechnische Zeitschrift" that Prof. Lummer, of Breslau, has run arc lamps under pressures of 20 atmospheres absolute, and obtained intrinsic brilliancies 18 times higher than those obtained at ordinary atmospheric pressure, the calculated temperature rising from approximately 4,200°C. to about 7,500°C. The experiments are to be continued.

Transmission of Electric Waves Over the Surface of the Earth.—A Paper on this subject was read recently before the Royal Society by Prof. A. E. H. Love, F.R.S., in which an analytical solution of the general equations of electrodynamics was obtained for the case of waves generated by a vibrating doublet in presence of a conducting sphere, and was adapted to obtain the known solution for perfect conduction, and the correction for moderate resistance, such as that of sea-water. The known solution was expressed by the sum of a series involving zonal harmonics, and the correction by a similar series. Different results had been obtained by different writers who had investigated the numerical value of the former sum. In the Paper a new method of summing the series was explained, and worked out in detail for the wave-length 5 km. In the case of perfect conduction the result confirmed that found by H. M. Macdonald, "Proc. Roy. Soc., Ser. A.," Vol. XC., 1914, p. 50. The effect of resistance was found to be a slight increase of the strength of the signals at considerable distances, counteracting to some small extent the enfeebling effect of the curvature of the surface. A comparison was instituted between the results of the theory and those of recorded experiments. From these it had previously been inferred that the diffraction theory failed to account for the facts; but, after a discussion of the experimental evidence, it appeared that the observations might admit of a different interpretation, according to which the results of the diffraction theory would be in good agreement with those of daylight observations at great distances.

Chemicals Produced by the Aid of Electricity.—According to the thirteenth census of the United States, there were 34 establishments making chemical and metallurgical products by the aid of electricity. It is stated by "Metallurgical and Chemical Engineering" that of the total value of products, New York claimed £2,680,376, or 72·6 per cent.; Michigan, £302,640, or 8·2 per cent.; Pennsylvania, £180,639, or 4·9 per cent.; and all other states, £526,638, or 14·3 per cent. The accompanying table shows the products and their value. The class "metals and alloys" includes aluminium, silicon, ferro-vanadium, ferrosilicon, ferrotitanium, cupro-vanadium, and other metals and alloys. Elements and compounds, produced by the aid of electricity specifically reported and included under the heading of "all other," are phosphorus, sodium, lead oxides, liquid chlorine, carbon disulphide, sodium carbonate, potash and potassium bromide.

	No. of establishments reporting.	Quantity, tons.	Value.
Calcium carbide	4	60,973	£596,800
Caustic soda	5	19,428	206,529
Chlorates	5	5,785	180,910
Hypochlorites	5	45,976	301,366
Metals and alloys	9	...	1,530,797
Abrasives and electrodes	4	...	283,160
All other	11	...	590,730
Total	34	...	£3,690,292

Exhaust Steam Turbine Installation at the Silksworth Colliery.—An interesting electrification scheme has recently been put into service by the Londonderry Collieries (Ltd.) at their Silksworth Colliery, near Sunderland, which utilises the large amount of available exhaust steam at the colliery by means of mixed-pressure turbo-generators. According to the "Iron and Coal Trades Review," the exhaust is taken from Nos. 1, 2 and 3 winding engines, and from the compressor and screens engines, the total quantity being 62,000 lb. per hour. Two 760 kw. mixed-pressure turbo-generators, of the Willans-General Electric type, have been installed in a power house

arranged to take a third set if and when required. The turbines are of the disc drum construction and the generators of the three-phase type, 0·8 power factor, 2,750 volts, 2,400 revs. per min., 40 frequency. The exhaust steam from the winding engines, &c., is led by steel pipes to three receivers consisting of shells of old Lancashire boilers. They are automatically drained, and relief valves are provided so that should the pressure of steam rise by more than 2 lb. above the atmosphere the valves come into operation. An oil separator of the Princeps type is placed in the main exhaust-steam range near the receivers, so that the oil may be taken out of the steam before it enters the receivers or the turbines. The power furnished by these units is used for haulage underground, for driving the fan motors, repair workshops, &c., all of which have been converted for electric driving. After ample provision for interest and depreciation on the power-station machinery, it is estimated that, assuming the main ventilating fan is continuously operated by exhaust steam, the cost of current will not exceed 0·15d. per unit. Previously the consumption of coal underground was 6,654 tons per annum, and the wages paid to underground stokers about £1,500 per annum, so that it will be seen there is considerable scope for economy, as the whole of the underground boilers and the stokers are now dispensed with.

"Telegraph and Telephone Journal."—In the April number of this journal, just published, there are a number of articles of considerable interest to Post Office telegraph and telephone men. The leading articles deal with matters which have a more general interest. We would particularly mention a Paper read before the Telegraph and Telephone Society in London in January by Mr. D. H. Kennedy, entitled "Special Services in the Metropolis." This shows how manifold are the duties which the telegraph and telephone perform in the commercial and social life of London and Greater London. Amongst the personal paragraphs there are nine resignations in the telephone section occasioned by marriage!

It will be remembered that we took the occasion of the issue of the March number to call attention to the ultra-official character of the envelope (O.H.M.S.) in which the "Journal" reached us, to the legend "G. R." with Crown &c., that forms a prominent feature of the front cover design, to the Postmaster-General's very special and official patronage, and to a conspicuous advertisement (repeated in the April number) calling attention to the merits of the "Journal" as an advertising medium because of its official character. We considered that, in view of this official character of the publication, there is a distinct danger that the King's name and also that of the Postmaster-General might, in the hands of zealous advertising canvassers, be improperly utilised in touting for advertisements.

The April issue contains a note in reply to our strictures, informing us that the "Journal" is not an official publication, is not the property of the Government, and that no harm can follow the use of the letters G.R. and the Royal Crown. We must hold to our view that the use of these letters and Crown, of the O.H.M.S., and of the distinct intimation of the Postmaster-General's close association with this production, is most liable to mislead, and is a use of official symbols to be regretted. With regard to the distribution O.H.M.S., whether wholly or in part, we regard the practice as one distinctly calculated to give the "Journal" an official status, notwithstanding the editorial disclaimer. The matter is one, we consider, for the Newspaper Society to deal with, but it seems to us as a bad example of subsidised official competition with private enterprise at a time when such competition is gravely improper.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. R. D. Gifford contributes the first part of an article on the "Direct Measurement of Power Factor" (p. 47).

We publish a short article on "The Formula Coil to give Maximum Self-Inductance for a given Length and Thickness of Wire," by Messrs. R. E. Shaweross and R. I. Wells (p. 64).

We abstract a Paper on the "Electrical Operation of the Butte, Anaconda and Pacific Railway," by Mr. J. B. Cox (p. 45).

An account of the discussion which took place at Birmingham on Mr. W. C. Acfield's Paper on the "Development of Main Line Signalling on Railways" is given (p. 50).

We reproduce an abstract of a Paper on the Power Supply of the Central Mining-Rand Mines Group," read last night before the Institution of Electrical Engineers, by Mr. J. H. Parker (p. 53).

We describe the extensions at the Carlisle Corporation electricity works (p. 51).

We give an account of a discourse before the Royal Institution on "Experiments in Slow Cathode Rays," by Prof. Sir J. J. Thomson, O.M., F.R.S. (p. 60).

We give an account of a discussion which took place before the Bristol Section of the Institution of Electrical Engineers on Electric Cooking and Heating (p. 57). Our Leading Article deals with certain aspects of this question (p. 58).

An abstract of a Paper on "Electric Heating and Cooking Apparatus," by Mr. S. M. Hills, and the discussion thereon, is given on p. 64.

Companies' Meetings and Reports.—Meetings of the Cork Electric Tramways & Lighting Co., Edison Accumulators, Guildford Electricity Supply Co., are reported, and the report of the directors of the Indian Electric Supply & Traction Co. is abstracted (p. 73).

OBITUARY.

Prof. W. Grylls Adams, M.A., D.Sc., F.R.S., F.G.S.—The death occurred on Saturday last of Prof. W. G. Adams, aged 79. As far back as 1855 Prof. Adams entered St. John's College, Cambridge, and was subsequently elected a Fellow. He was appointed Examiner in Physics for 1877, 1878 and 1879, and for 10 years subsequently was Examiner in Experimental Physics to the University of London, of which university he was a Member of the Board. He assisted Clerk-Maxwell in his famous experiments at King's College to determine the value of the ohm, and succeeded Maxwell as Professor of Natural Philosophy at King's College. He was on the jury of the Crystal Palace Electrical Exhibition in 1882, engineered by the late Major Flood Page, and was a member of the International Congress of Electricians at Paris in 1881. He was a Past President of the Society of Telegraph Engineers and Electricians (now the Institution of Electrical Engineers), and also of the Physical Society of London. He delivered a course of Cantor Lectures in 1881, entitled "The Scientific Principles involved in Electric Lighting." He was a Cornishman, and had estates in that county. He contributed many Papers to the Royal Society and the British Association on electrical engineering and allied subjects.

David Smith.—A wide field of business and social friends will learn with regret of the death, at his residence at Ealing, of Mr. David Smith, who was intimately associated with the commercial side of the electrical industry over a period of 20 years. Mr. Smith was a Scotsman, born in 1865. On first coming to the City of London he entered the service of the Electric Construction Co., and became assistant secretary. From there he went to the Electrical Power Storage Co. as secretary, until November, 1904, when he left to join the United River Plate Telephone Co. as secretary, and after faithful service was elected a director and appointed managing director of the company, which position he held at the time of his death. Mr. Smith was also a director of the Constantinople Telephone Co., and at the opening of the war found himself at Vienna on his way to Constantinople, and had to leave somewhat hurriedly, eventually reaching the latter city after a long and arduous journey. The difficulties and anxieties of getting home and the strain of the situation seriously affected his health, and he passed away on the 10th inst., as stated, after a somewhat lengthy illness. Mr. Smith was a very active and able man, was greatly respected, and his death at the early age of 50 will come as a shock to many who knew him well. He leaves a widow and two young children.

Major S. Flood Page.—The death occurred on Wednesday, the 7th inst., of Major S. Flood Page, who was actively connected with the development of the electric lighting industry. Major Page was born in 1833 in the Isle of Man and was gazetted ensign in the Second Madras European Light Infantry in 1855. On his retirement from military work in 1873 he was appointed secretary of the Crystal Palace, becoming manager in 1877. He organised, and successfully carried through, the first electrical exhibition held in the United Kingdom in 1881-82. In 1882 he became general manager of Edison's Indian & Colonial Electric Co., and in that capacity introduced incandescent electric lighting into Victoria, New South Wales, Queensland and New Zealand. He was appointed secretary and manager to the Edison & Swan United Electric Co. (Ltd.) on its foundation in 1883, which position he held till 1892, when he became a director. He took an active share in patent litigation in England and on the Continent, and was connected with the formation of the Compagnie Générale des Lampes in Paris. In the later years of his life he became interested in wireless telegraphy and was appointed managing

director of the Marconi Wireless Telegraph & Signal Co. in 1899. He was also a director of several of the subsidiary Marconi companies. He was a member of the Institution of Electrical Engineers. He took a very prominent part in the early Stock Exchange business connected with the chief Marconi companies.

PERSONAL.

Mr. James Kent, manager for many years of the Canadian Pacific Railway Co.'s extensive telegraph system, has recently retired. Mr. Kent had been with the company for nearly 30 years. He was born at Montreal in 1854, and he joined the Montreal Telegraph Co. as a messenger boy. Mr. Kent has held every post up to that of manager in a service which operates over 100,000 miles of landlines.

The new manager is Mr. John McMillan, who was born in Liverpool on Nov. 2, 1866. He joined the Canadian Pacific service as a telegraph operator at Winnipeg, was appointed assistant-superintendent in 1906, and general superintendent of the Western lines in 1912.

APPOINTMENTS VACANT AND FILLED.

The Governing Body of Battersea Polytechnic invite applications for the position of principal of the Polytechnic. Commencing salary £800, increasing to £1,000 by £20 per annum. Particulars from the Clerk to the Governing Body, Battersea Polytechnic, London, S.W. *See advertisement.*

A chief of the mains department is required for the Gemeente-Electriciteitswerken, Amsterdam. Applications by 28th inst. to the Directie der Gemeente-Electriciteitswerken, Hoogte Hadijk 200, Amsterdam. *See advertisement.*

A number of sub-station attendants are required with experience in the operation of rotary converters and h.t. three-phase systems. Applications by April 19. *See advertisement.*

A shift engineer is required with good training in electrical and mechanical engineering. Salary, £175 to £200 per annum. Applications by April 19. *See advertisement.*

A chief switchboard operator is wanted for a large 11,000-volt three-phase power station. *See advertisement.*

Instrument testers are required by the British Westinghouse Co., Trafford Park, Manchester. *See an advertisement.*

A switchboard attendant is wanted at the Canterbury Electricity Works. *See advertisement.*

An advertiser requires an electrical engineer to take charge of electrically-driven machinery, &c., in important works in Wales.

Bolton Tramways Committee require a car shed superintendent. Commencing salary £200 per annum. Applications to the Town Clerk by April 19.

Mr. H. J. Quick has been appointed first assistant electrical engineer at Chatham Dockyard.

Redditch Urban Council have appointed Mr. V. F. Bush, A.M.Inst.E.E., formerly assistant mains engineer at West Ham, assistant engineer at a salary of £170 per annum.

In September last Mr. H. C. Ashton was temporarily appointed meter assistant at Hammersmith (London) electricity works to fill the vacancy caused by Mr. H. R. Watts having been called up for service with H.M. forces. Mr. Ashton has been appointed permanently to the position of meter assistant at £175 a year, and when Mr. Watts returns he will obtain another position.

Mr. J. Ellison has been appointed chief tramway inspector by Darwen Corporation, and becomes deputy manager of the department.

INSTITUTIONS AND SOCIETIES.

Royal Society of Arts.—At a meeting of the Council on Monday last Sir Alfred Yarrow presented the Society's Albert Medal to Senator Guglielmo Marconi, G.C.V.O., LL.D., D.Sc., for his services in the development and practical application of wireless telegraphy. The medal, which was instituted in 1863 to commemorate the Prince Consort, president of the Society, is awarded annually as a reward for meritorious action in promoting arts, manufactures and commerce.

Institute of Chemistry.—The Council has published a short report of the work of the Glass Research Committee, appointed in October last to conduct investigations with a view to arriving at suitable formulæ to be freely available to manufacturers willing to assist in maintaining the continued supply of laboratory glassware. The Committee consisted of Prof. R. Meldola, Mr. B. Blount, Mr. O. Hehner, Prof. H. Jackson, Mr. W. C. Hancock and Mr. T. R. Merton. Research has been carried on, principally by Prof. Jackson and Mr. Merton at King's College, the chief aims being (1) to produce working formulæ for all glasses used in laboratory work and (2) to ascertain the influence of various ingredients on the physical and chemical properties of glass. The work was extended to include glasses for miner's lamps and for ampoules. In the reports 11 formulæ for glasses for various purposes are given. Copies of the report can be obtained from the Secretary, 30, Russell-square, London, W.C.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, April 16th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Meeting at Storey's-gate, St. James's Park, London, S.W. Presidential Address by Dr. W. C. Unwin, F.R.S.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at 39, Victoria-street, London, S.W. Paper on "Diesel Engines," by Mr. W. A. Tookey.

SATURDAY, April 17th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. Meeting at the Swan Hotel, New-street, Birmingham. Paper on "Telephones," by Mr. E. J. Jarrett.

MONDAY, April 19th.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

5 p.m. Annual general meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C.

NEWCASTLE SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting at the Mining Institute, Newcastle-on-Tyne. Lecture on "Illumination," by Mr. V. H. Mackinney.

TUESDAY, April 20th.

WIRELESS SOCIETY OF LONDON.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C. Lecture on "Methods of Measurement of the Strength of Wireless Signals," by Prof. E. W. Marchant.

RÖNTGEN SOCIETY.

8:15 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C. Papers on "Late Radium and X-Ray Burns," by Dr. N. S. Finzi; and "A New Alpha Ray Effect," by Mr. F. H. Glew.

WEDNESDAY, April 21st.

WEST OF SCOTLAND BRANCH OF THE ASSOCIATION OF MINING ELECTRICAL ENGINEERS.

6:30 p.m. Meeting at the Royal Technical College, Glasgow. Paper on "Bearings of Electrical Machinery," by Mr. A. Gibson.

FRIDAY, April 23rd.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington, London, S.W. Agenda: Papers on "The Theories of Voigt and Everett Regarding the Origin of Combination Tones," by Prof. W. B. Morton, M.A., and Miss Mary Darragh; "Experiments on Condensation Nuclei Produced in Gases by Ultra-Violet Light," by Miss Maud Saltmarsh; and "On the Self-induction of Solenoids of Appreciable Winding Depth," by Mr. S. Butterworth.

THE NATIONAL RELIEF FUND.

(Treasurer H.R.H. The Prince of Wales.)

This great National Fund, for the relief of those amongst the needier classes who are widowed, orphaned and otherwise affected by the fighting in which our troops and ships are now taking part, urgently seeks contributions however small. These can be sent with the following note, which can be cut out, filled in, put in an envelope and sent *unstamped*, addressed H.R.H. The Prince of Wales, Buckingham Palace, London.

Date.....

I enclose £ *s. d. toward the Prince of Wales*

NATIONAL RELIEF FUND.

Name .....

Address.....

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THE ELECTRICAL OPERATION OF THE BUTTE, ANACONDA & PACIFIC RAILWAY.*

BY J. B. COX.

Summary.—The author describes the electrification of the Butte, Anaconda & Pacific Railway, giving particulars of the locomotives, their performances and operating records. The operating records are compared with the records for steam operations, full details of the savings effected by electric working being given.

The Butte, Anaconda & Pacific Railway was built in 1892 principally for the purpose of conveying the ore from the mines at Butte to the Washoe smelter which had been located at Anaconda, 26 miles west of Butte, where an abundant supply of water, so necessary in the reduction of the ore, was obtainable. The tracks connecting Butte and Anaconda constitute the main line, which is approximately 25·7 miles in length. From the Butte Hill yards spur tracks radiate about Butte Hill to the shafts of the various mines and other points where supplies are to be delivered. Bins for receiving ore as it is hoisted from the mines are located near each shaft and from these bins the ore is loaded into hopper-bottom steel ore cars of 50 tons capacity each, these loaded cars being delivered to the Butte Hill yards, where they are made up into trains and taken down to the Rocker yards, where they are made up into still larger trains and taken over the main line to East Anaconda yards. Here the trains are broken up to be transported in smaller units up Smelter Hill to the concentrator yards, which are 340 ft. above the main line level. Thus practically all ore cars are handled by five different engine crews between the ore bins at the mines and the receiving bins at the concentrator.

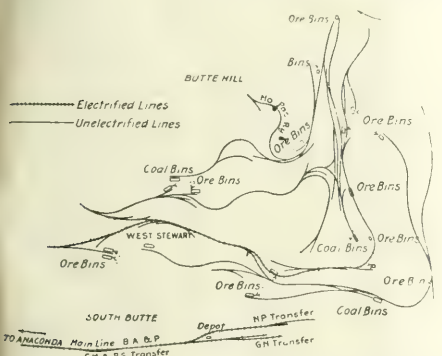


FIG. 1.—LINES AROUND BUTTE HILL FOR COLLECTING THE ORE.

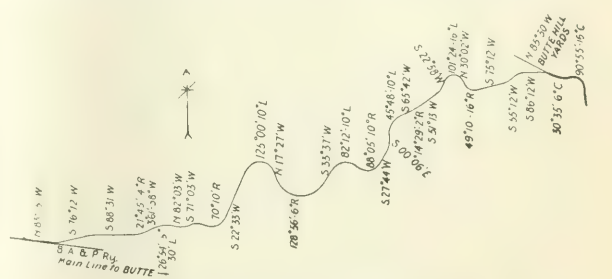


FIG. 2.—MAP OF LINE TO BUTTE HILL YARDS.

A total of 27 steam locomotives was owned by the railway company, the coal for which had to be transported approximately 395 miles for delivery to the bins of the railway company, at which point its average cost was approximately 17s. per ton. The machinery at the mines and the smelter had mostly been electrified, and the results had been so satisfactory that the railway company had a study of their conditions made for the purpose of investigating the advantages that might be expected from the electrification of their lines, the result of which was the placing of a contract in December, 1911, for the electrical equipment of the main portion of its line, consisting of the main line, spurs and yards between Butte and Anaconda, the Missoula Gulch line between Rocker and Butte Hill yards and the Smelter Hill lines. Owing to local conditions on the spur tracks leading to the various mines from Butte Hill yards, it was thought advisable not to electrify these until a later date. It is fair to assume that a vital consideration leading to the electrification of this railway was the rapid development and physical consolidation of a network of hydroelectric power plants in the territory tributary to the railway.

A contract for the power for the operation of the road was made with the Great Falls Power Co., which, operating under the same management and in physical connection with the system of the Montana Power Co., was enabled to guarantee an ample supply of power at all times with exceptional freedom from interruptions to service, and at a reasonably low price.

The tracks recommended to be electrified totalled approximately 90·5 miles, all of which are supplied with power from two sub-stations, one being located in the Missouri River Power Co.'s sub-station on Butte Hill and the other in the sub-station building on Smelter Hill, from which electrical power for operating the machinery there is distributed. At each of these sub-stations there was vacant space for the location of the extra apparatus required for the operation of the railway, and the transformer capacity already installed at each place was sufficient to meet the extra demand required for the operation of the railway. The Anaconda sub-station is connected with the Butte sub-station by three high-tension trunk lines. The Butte sub-station receives power over five separate transmission lines from six hydroelectric stations of total rated capacity of 57,500 kw., while another station of 60,000 kw. is under construction. The available storage capacity of these stations is alone equivalent to 100,000 H.P. for a period of 100 days. With all these systems available, the cost of the delivered power is less than it would have been from an independent development, because the power company is enabled to operate large generating stations at relatively high load factor (about 75 per cent.), whereas an independent plant purely for the operation of the railway would have to operate in this case at about 30 per cent. load factor, with correspondingly high fixed and operating charges per kilowatt-hour actually used.

The original equipment of each sub-station was practically the same, consisting of two 1,000 kw., three-unit motor-generator sets with the necessary starting and operating devices. Each motor-generator set consists of a 1,450 k.v.a. three-phase 60-cycle 720 revs. per min. synchronous motor coupled direct to two 500 kw. 1,200-volt direct-current generators, one at either end, the two generators operating in series and supplying 2,400-volt direct current to the trolley lines. The generators are compound wound, and have compensating pole face windings as well as commutating poles. The series fields are connected on the earthed side of the armature while the main fields are separately excited from a 125-volt circuit. The motor-generator sets are capable of carrying overloads up to three times normal load momentarily, and 50 per cent. overload for two hours. The value of this characteristic will be appreciated when it is noted that each electric locomotive unit has a continuous rating of approximately 900 kw., almost equal that of a single motor-generator set, and frequently 16 of the 17 units are in service simultaneously, 11 of which are concentrated at the Anaconda end at intervals. Seventeen 80-ton electric locomotive units were purchased originally, 15 of which are being operated in freight service and two in the passenger service. These units are practically interchangeable with the exception of the gearing, the passenger locomotive being geared to operate normally at 40 or 50 miles per hour, while the freight locomotives are geared to operate at from 15 to 25 miles per hour, the maximum free running speed being approximately 35 miles per hour. The continuous tractive effort of the freight units is 25,000 lb., at 15 miles per hour, but they are capable of exerting a maximum tractive effort of 48,000 lb. for five minute intervals, based on a coefficient of adhesion of 30 per cent. All locomotive units are of the articulated, double-truck type with twin gears mounted on projections provided on the wheel centres for the purpose. Each unit is equipped with four commutating pole motors wound to operate at 1,200 volts each, but insulated for 2,400 volts, so that two are connected permanently in series and the four arranged in pairs, thus securing the usual two running points, with the difference that on the series position all four motors are in series, and in multiple the two pairs are connected in series parallel. The standard rating of each motor is approximately 300 H.P., making the hourly rating of each locomotive unit about 1,200 H.P. The control equipment is of the multiple-unit type, and provides a total of 19 steps, 10 of which are in series, and nine in series parallel. The 2,400-volt contactors, switches, fuses, &c., are located in enclosed compartments where they

* Abstract of a Paper read before the American Institute of Electrical Engineers.

can be reached only by deliberate effort. The current for the operation of the control equipment, the air compressor and the lights on the locomotive as well as the lights on the passenger coaches, is supplied by a 2,400/600-volt dynamotor located in the main compartment of each locomotive unit.

A blower is direct-connected to the armature shaft of this dynamotor which provides artificial ventilation for the main motors and the rheostats.

Work on the electrification began in the spring of 1912, and the first electric locomotive was run in Anaconda on May 14, 1913, about a year later. On May 27 two ore trains were hauled up Smelter Hill on trial trips with electric locomotives, and on the following day a double-unit electric locomotive took over the regular day service of hauling the ore from East Anaconda yards to the concentrator yards, the distance between which is approximately seven miles, the ruling gradient being 1·1 per cent. compensated, and the grade fairly uniform through the entire distance. The steam locomotive used in this service made ordinarily six round trips per shift, hauling 16 loaded ore cars per trip, equalling 96 cars per shift. The double-unit electric locomotive began taking only 16 cars per trip, but made eight trips per shift, delivering 128 cars per shift. The average time for the up-hill trip with the electric locomotive was about 22 minutes or approximately half the time required by the steam locomotive for the same number of cars. Empty cars were taken to East Anaconda on the return trip which, being all down grade, gave the electric locomotive no decided advantage, as the speed in either case was limited to about 25 miles per hour for safety, on account of the curves in the line. The load per trip was gradually increased from 16 cars to 25 cars, which is to be the standard for the present. The

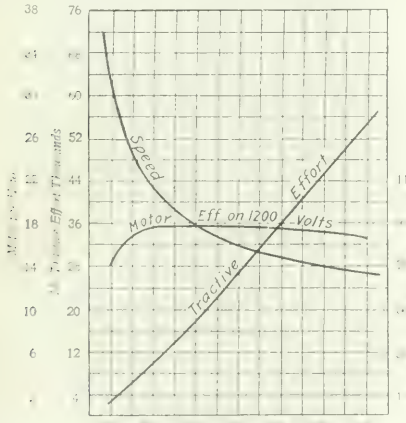


Fig. 3.—Characteristic Curves of Freight Locomotives.

average time for the up-hill trip with 25 cars is about 26 minutes, so that eight trips per shift is easily made, making a delivery of 200 cars possible or an increase of slightly more than 108 per cent. over what had been possible for the same crew with steam locomotives. These loaded ore cars average from 70 to 72 tons each, making the trailing load for a 25-car train from 1,750 to 1,800 tons.

On arrival at the concentrator yards the ore trains are taken by a switching engine called the "spotter," which places one car at a time over the weighing scales, after which they are re-arranged for placement over the concentrator bins from which the ore is fed by gravity to the crushers. When the electric engines were put on the night [illegible] all the handling of ore between East Anaconda and the concentrators was done electrically, and the hauling capacity per [illegible] was so much greater that it was no longer necessary to have a [illegible] crew on the night shift, so that this crew was [illegible] the night crew hauling the ore up Smelter Hill did their own [illegible] at the concentrator yards, it being no longer [illegible] the regular number of trips. On October 1st [illegible] between Butte and Anaconda was [illegible] operation. The distance between the [illegible] Anaconda to Butte—is 25·7 miles, the schedule time for the trip, one [illegible] has been made in this time though a [illegible] with the electric locomotives [illegible] The standard passenger train consists of one mail [illegible] passenger coaches, but as many as [illegible] passenger coaches are handled by a single electric unit on special occasions, such as excursions and on holidays. The baggage coaches average approximately 40 tons in weight and the passenger coaches 45 tons, each making the gross weight of the three-car electric train approximately 210 tons, whereas that of a similar steam train was 262 tons, showing a reduction of 19 per cent. in favour of the electric locomotives, with approximately 33 per cent. more weight on its drivers. As had been done in the freight service, the steam enginemen in the passenger service were transferred from the steam to the electric locomotives with but little previous instructions, and after the first day or so were left mostly to themselves. It may be of interest to note here that on the day shift, averaging four trips per day, during the first five months the passenger train did not come in late a single time on account of engine trouble. The total delays during June, 1913, with steam operation was 20 hours 46 minutes, while with electric traction during June, 1914, the total delays amounted to only 5 hours 10 minutes. The number of trains were: Steam, 272; electric, 280.

On October 10th a double-unit electric locomotive was put in the day freight service on the main line between East Anaconda and Rocker, a distance of 20·1 miles. The steam locomotive replaced in this instance weighed 103 tons, 77 tons of which was on drivers, the tender loaded weighing 55 tons. The standard train hauled on the trip west was 50 to 55 loaded ore cars weighing approximately 3,500 to 4,000 tons gross and the average running time of such trains where no stops were made was about 1½ hours, corresponding to an average speed of approximately 13·4 miles per hour. In the beginning the electric locomotive took only the standard train, but made the trip without stop in about one hour, corresponding to an average speed of 20 miles per hour. The weight of the trains hauled by the electric locomotives on this run has been gradually increased up to 65 loaded ore cars averaging about 71 tons each, making the gross weight trailing about 4,620 tons. Adding 160 tons for the weight of the double-unit electric locomotives and 20 tons for the caboose makes a gross train weight of approximately 4,800 tons. The remainder of this main line freight service was gradually taken on during the months of October and November, thus completing the electrification of the main line service. As many as 76 ordinary freight cars loaded with coal, coke and general merchandise have been taken in a single train on the west-bound trip and 85 empties are frequently taken from East Anaconda to Rocker east-bound, the ruling grade being 1 per cent. Comparative results of the month of June, 1913, steam operation versus the same month, 1914, electrical operation of this main line service, shows that with a slight increase in the total tons of ore hauled the average tons per train was increased from 1,761 to 2,378 or 35 per cent., thus decreasing the average number of trains per day from 12·5 to 9·3, or 25·6 per cent. A comparison of the time per trip for these trains shows a gain in this direction which has to be added to the decrease in the number of trains. The average time per trip during steam operation was approximately two hours and 25 minutes, while with the electric locomotive it was approximately one hour and 45 minutes, showing a decrease of 40 minutes, or 27·5 per cent. The result of these improvements is indicated in tables in the Paper, which show that the overtime in this particular service has been decreased 73·5 per cent. and the total time 42 per cent., resulting not only in greater economy to the railway company but in shorter and easier hours for the crews.

The service on the Missoula Gulch line running between Rocker and Butte Hill yards was taken over for electrical operation on October 20th. This line is 4·5 miles in length, and the ruling gradient 2·5 per cent. Two complete crews had been required to handle this service during steam operation, averaging six trips per day each. A single crew with a double-unit electric locomotive has been doing this work successfully. Thirty-five to 45 loaded ore cars are taken down from Butte Hill yard to Rocker, and about an equal number of empties taken up. In addition to the empties, large quantities of timber and supplies for the mines are delivered over this line.

On November 25th the last of the electric locomotive units went into service, thus completing the electrification originally intended. The full electrical service has, therefore, now been in operation more than nine months and that on Smelter Hill more than 15 months, so that the total locomotive miles operated would be approximately close to an average year's performance.

This was the first installation of 2,400-volt direct-current apparatus for the operation of a railway in this country, 1,500 volts being the highest heretofore installed for such a purpose. The results have been more satisfactory than had been anticipated, and the development charges due to such imperfections as usually appear during the first year of operation have been perhaps smaller than is customary with an undertaking of like magnitude, even where standard apparatus is used. Difficulties especially attributable to the higher potential have been negligible, and while there have been

occasional instances of arcing and flashing or short circuits due to ordinary causes, the resultant damages have been really smaller than might be expected from a like occurrence on a 600-volt installation of equal capacity. The original brushes supplied in the motors chipped badly, and before all these had been replaced it was often found when the units were brought in for regular inspection that some of the brushes were broken entirely into pieces, and while there was evidence that a flash-over might have occurred at some time, no harm had resulted other than the blowing of the motor fuse, on the replacement of which the engine was continued in service until its regular time for inspection, when the cause of the fuse blowing would first be discovered. The locomotives have made from 25,000 to 50,000 miles each and without exception the motors are in excellent condition. The wear on the commutators is imperceptible, and the general performance of the entire equipment is quite as satisfactory and promising as that of any railway equipment with which we have had experience in similar service.

The overhead construction has been quite satisfactory and a recent examination of the trolley wire shows no indication of unusual wear. The roller pantographs are operating quite successfully, the average life of these being from 10,000 to 12,000 miles per roller. Where a double-unit locomotive is operated, the two pantographs are connected electrically by a main bus line, and the average current collected by each, when ascending the grades with standard loads, is from 350 to 400 amperes. Two pantographs operating in multiple thus will collect more than double the current that can be successfully collected by a single pantograph for the reason that sparking is usually due to the momentary breaking of contact between the trolley wire and the roller caused by hard spots in the line. When two pantographs are operated in multiple both do not encounter these hard spots at the same instant, hence one of the two is more apt always to be making good contact, so that the flow of current is not so frequently interrupted, and consequently the sparking is greatly reduced. The double units operating on Smelter Hill were run experimentally for several days with only a single roller making contact with the wire, the operation being quite successful with the single roller collecting an average of 650 to 750 amperes while running at 16 to 17 miles per hour and 800 to 1,000 amperes during the accelerating period in multiple. The sparking was not serious except at hard points in the line, and with two rollers in multiple there should be no difficulty in collecting 500 to 600 amperes per roller, which at 2,400 volts should be equal to the requirements of any ordinary locomotive unit.

Some trouble was experienced with the bearings for the rollers, owing to the lubricating oil being thrown out along the spindle. Roller bearings lubricated with grease are now being tried, and so far no trouble has been experienced.

Small change in the personnel of the maintenance or operating departments of the railway has been made on account of the electrification, nor has there been any reduction in salaries or wages. An extra man with electrical experience was placed in the shops to supervise the electrical repairs to the locomotives and three linemen were retained for the maintenance of the trolley system.

The three steam switching locomotives used for concentrating the ore at and distributing supplies from Butte Hill yards are continued in this work. Another steam locomotive is used on the Georgetown branch, and a fifth one operates at intervals over unelectrified tracks at the Anaconda end. Approximately 20 per cent. of the total locomotive-miles now being operated is by these five steam locomotives, the cost of which is upwards of 40 per cent. of the total cost of all locomotive performance. The electrification of the remaining tracks on Butte Hill has been recommended and no doubt will be commenced at an early date. The analysis made up from the regular monthly locomotive performance sheets of the railway company, of which a summary, placed on a yearly basis, appears below. The saving from the partial substitution of electric power for coal is the chief item, being at the rate of £49,145·41 per year, which is remarkable when it is considered that more than 39 per cent. of the total combined costs for fuel and power for the period considered was for coal and charged against electrical operation. In this instance the saving on this item alone would undoubtedly justify the expenditure covering the entire cost of electrification. It is to be noted that with a single exception, that for depreciation of equipment, every item of expenditure in the locomotive performance sheet shows a substantial percentage of decrease in favour of electrical operation.

The total saving from locomotive performance amounts at the rate of £47,516·36 per year, to which should be added the item of coal handling, an increase of 8·77 per cent. more traffic, [illegible] locomotive performances should be added the [illegible] wages, which is at the rate of £6,223·25 per year, making the total saving from these two items £53,745·61 per year. [illegible]

be deducted £2,167·82 for maintenance of the distribution system, leaving £51,578 as the net operating saving per year due to electrical operation.

The roadmaster states that it is quite evident that the electric locomotives are much easier on the track at curves but that there is no noticeable difference on tangent track, and that while sufficient time has not yet elapsed to form definite conclusions, present indications lead him to expect that any difference relative to his work will be favourable to the electric locomotives.

Item of operating expenses.	Steam, 1913.	Electric, 1914.	Decrease, 1914.	Per cent. decrease.
Fuel and power	£63,047·15	£32,901·74	£30,145·41	47·81
Repairs	24,957·58	18,455·62	6,501·96	26·05
Enginemen's wages.....	20,892·24	14,245·18	6,647·06	31·81
Engine house exp.....	5,981·56	3,727·68	2,253·88	37·68
Water	990·73	238·74	751·99	75·90
Lubricants	1,950·29	988·46	961·83	49·30
Other supplies	1,164·70	910·47	254·23	21·83
Total locomotive performance	£118,984·25	£71,467·89	£47,516·36	39·93
Trainmen's wages	29,526·46	23,297·20	6,229·26	21·10
Grand total	£148,510·71	£94,765·09	£53,745·62	36·19
Ton-miles hauled.....	158,917,720	172,855,856	13,938,136*	8·77*

* Increase.

The total cost of the electrification, including a change of signal system on Smelter Hill, the extra motor-generator set recently installed at Anaconda, interest during construction and all incidentals due in any way to the electrification, was in round numbers £240,200. This does not include the step-down transformers, which are the property of the power company, but, on the other hand, no deduction has been made for the salvage due to the elimination of 20 steam locomotives.

The item of £2,167·82 for maintenance includes depreciation from the time the locomotives were taken over by the company. As some of these had been running some months before this a correction is needed, and if this is made the total saving per year from locomotive performance would be reduced to £44,398·39, making the total net saving £48,459·82, which is equivalent to 20·02 per cent. on the entire cost of the electrification, to say nothing of the increased capacity of the lines, the improvement in the service and more regular working hours for the crews. The estimate on which the decision to proceed with the electrification of the road was made, placed the annual net saving expected at 17·5 per cent. of the cost, so that the results financially have been quite as satisfactory as the general performance of the equipment.

ON THE DIRECT MEASUREMENT OF POWER FACTOR.

BY R. D. GIFFORD, M.SC.

Summary.—The author deals with the subject under the following headings: I. Description of the Dynamometer and Moving Iron Types of Power-Factor Indicator. II. Description of the Induction-Dynamometer Power-Factor Indicator. III. The Meaning of the Power-Factor of a Three-Phase Unbalanced Circuit. IV. The Theory of the Six Unit Power-Factor Meter. V. Results of Tests Substantiating Theory. VI. The Four Unit Power-Factor Meter on Three-Phase Unbalanced Circuits. VII. Frequency Tests on the Induction-Dynamometer Power-Factor Meter. VIII. Power-Factor Meters with Artificial Scales. IX. The Induction-Dynamometer Synchroscope.

I. Description of the Dynamometer and Moving Iron Types of Power-Factor Indicator.

Considerable attention has been paid by engineers to the measurement of the power-factor of alternating-current circuits, with the result that numerous instruments have been devised for this purpose. Some of these have not been direct-reading instruments, whilst others have been superseded by later developments.

It is the intention of the author to describe a power-factor meter in which a new combination of principles is employed, and also to investigate the operation of these instruments, particularly on three-phase unbalanced load circuits. Before doing so, however, for purposes of comparison, two other types of power-factor meter differing in their underlying principles

will be briefly described, viz., (1) the dynamometer type, and (2) the moving iron type.

1. In the dynamometer power-factor meter due to Punga,* as constructed for use on three-phase balanced load circuits, the moving pressure system, to which the pointer is attached, consists of a former on which is placed a three-phase winding of fine wire. The inner ends of these windings are starred, and the outer ends are connected through suitable resistances to the three lines, the currents being taken into the coils by means of fine ligaments. The current system consists of a short solenoid rigidly attached to the base of the instrument in such a position that the centre of the moving coils coincides with the centre of the solenoid. The current in one of the three lines traverses the fixed coil producing an oscillating flux, which, in the usual way, may be regarded as the resultant of two fields rotating in opposite directions. That one which rotates in a direction opposite to that of the field produced by the moving coils has no average effect upon the latter, whilst the other rotating field produces a torque on the moving system proportional to the product of the field strengths and the sine of the angle between their instantaneous positions. The moving system, therefore, rotates until this torque becomes zero—that is, until the rotating field vectors coincide in direction.

If the power-factor of the circuit changes, the vectors will no longer be in line until the moving system has taken up a new position fulfilling this condition. The scale of the instrument can, therefore, be calibrated to indicate the power-factor of the balanced circuit.

It will be observed that it is necessary to use the current of only one line. If the instrument be calibrated for use with phase one current, it would still be accurate with phase two or phase three current provided the pointer were advanced or retarded 120 deg. with respect to the moving coils.

The instrument as described would not, however, read accurately on an unbalanced circuit, as the reading would obviously depend upon which line is connected to the fixed coil, apart from the setting of the pointer, for the reason that the angles between the currents are no longer 120 deg. As will be shown later, if readings are to be obtained which accord with the power-factor of the unbalanced circuit, it is essential to take into account the currents in all three lines—that is to say, the meter must have six variables—viz., three pressure and three current coils. This we shall term a six-unit meter.

Therefore, when constructed for use on unbalanced circuits, the dynamometer power-factor meter has three fixed current coils disposed at 120 deg. to each other with their common centre coinciding with the centre of the moving coils. They are connected one in each line, and so that the field produced rotates in the same direction as that of the moving system. The pointer then takes up a position under the action of the [illegible]

2. The moving iron type of phase-meter consists essentially of three fixed current coils as in the dynamometer type just described, but the moving system takes the form of a soft iron shaft which passes through the centre of a flat pressure coil fixed within the space enclosed by the three current coils and with its axis normal to the axes of these coils.

Attached to opposite ends of the iron spindle are two semi-circular plates of soft sheet-iron. These plates are diametrically opposed to each other, and their planes being normal to [illegible]

Under the influence of the current in the pressure coil, the iron plates become alternating magnetic poles, and, therefore, react with the rotating field from the fixed coils, taking up stable positions according to the power-factor of the circuit. This is a four-unit meter, and does not lend itself to a construction involving six units, as in the dynamometer type for [illegible]

It will be noted that in this instrument no conductive [illegible] necessary, as there are no current flowing in the moving system (other than eddy currents). This is a great advantage, as it permits of a complete circular scale divided into four quadrants covering the whole cycle of possible phase angles—viz., 0 deg. to 90 deg. lead, 0 deg. to 90 deg. lag. and similar scales for reversed current.

The great advantage of the dynamometer type is, as indicated above, its flexibility of construction—*i.e.*, it can readily be adapted for use on single-phase, two-phase or three-phase balanced or unbalanced circuits. The necessary use of conducting ligaments, however, is a disadvantage, for not only do these exert some control on the moving system, although this is unimportant except perhaps at low loads, but they also necessitate a restricted scale, stops having to be provided to prevent free rotation of the pointer, which would result in damaging or breaking the ligaments. This disadvantage is greater than would appear at first sight, for in the unbalanced load meters there are usually nine terminals, six for the three current coils and three for the moving coils, and, therefore, when connecting the meter into the circuit it is a very easy matter to make a mistake, especially as the meters are usually operated through the medium of current and potential transformers, the polarity of whose windings may be doubtful.

In trying to take up its reading the pointer may come into contact with one or other of the stops, in which case, as it is unknown at what part of the scale the pointer should come to rest, the doubt as to the correctness of the connections cannot at once be dispelled.

II. The Induction-Dynamometer Type of Power-factor Indicator.

A power-factor meter, which may be termed the induction-dynamometer type, has recently been developed by the author

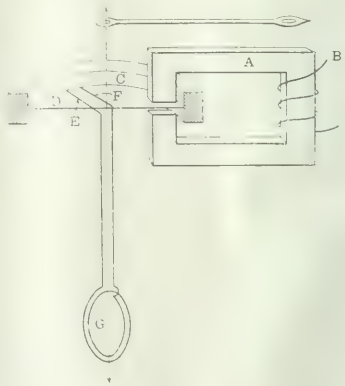


Fig. 1.

with the object of combining the advantages of complete freedom of the moving system, as in the moving-iron type, with the adaptability of the dynamometer type for use on unbalanced circuits.

This is achieved by the use of fixed coils in combination with a wound rotor as in the dynamometer type, but with this difference—that instead of leading the currents into the moving system by means of ligaments, they are taken in by induction.

The principle is clearly shown in Fig. 1, in which A is a small core of laminated iron having a primary winding, B, connected to the external circuit. Attached to the spindle is a circular coil, C, shown in section, supported by a disc of mica, D. The coil C constitutes the secondary of the transformer, a narrow air-gap in the core permitting of the free rotational movement of the secondary coil within the magnetic circuit. The ends of the secondary winding are brought out at E and F to a central hub, and are connected to the moving coil G, which also is rigidly attached to the spindle.

It will be seen that owing to the symmetry of the secondary [illegible] there is no tendency for it to rotate under the action of the [illegible] flux from the primary—that is to say, there are no extraneous controlling forces on the moving system.

Other advantages arise incidentally from this system of construction. Reverting to the moving-iron type, it has already been said that three fixed current coils surround the fixed pressure coil. It is not permissible to use the three external coils as pressure coils, and to provide the inner coil with a current winding. The reason for this is that the rotating field

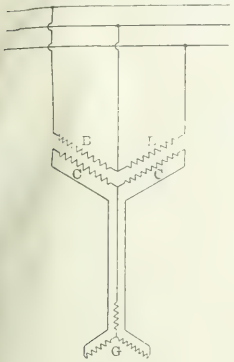


FIG. 2A.

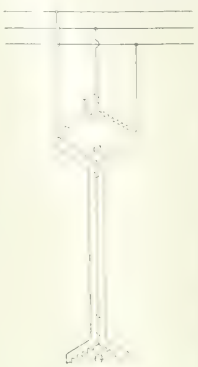


FIG. 2B.

creates a considerable drag upon the moving iron, tending to cause rotation of the moving system. In addition to this there is the directive torque produced by the alternating magnetisation of the iron, reacting with the rotating field, which causes the pointer to take up a definite position on the scale. Assuming the usual construction, that is to say, the rotating field being produced by the line currents, we may denote the drag torque by $T_1 = f(I)$,

and the directive torque by

$$T_2 = f(I) \times f(V).$$

The instrument is designed so that T_2 is greatly in excess of T_1,

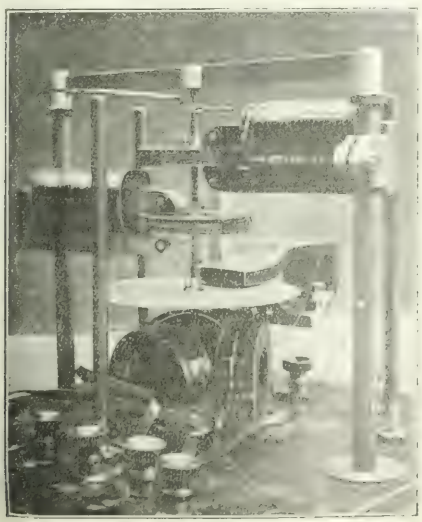


FIG. 3.

and since both torques vary with $f(I)$, the readings of the meter are independent of the load.

If, however, the order of things be reversed, the moving iron being magnetised by a current coil and the rotating field produced by three pressure coils, then

$$T_1 = f(V) \text{ and } T = f(V) \times f(I).$$

That is to say, as the current falls the drag torque remains constant, but the directive torque becomes weak, with the result that the pointer deflects more and more in the direction of field rotation, and at some critical value of the current the drag torque preponderates, causing a continuous rotation of the pointer.

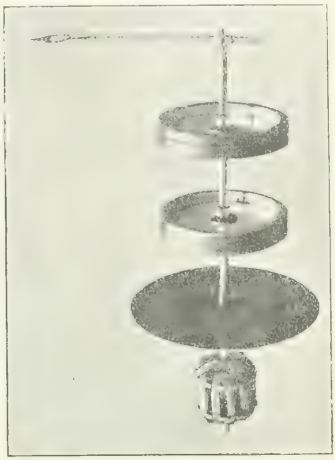


FIG. 4.

For this reason then, it is essential that the rotating field of this type of phase meter should be produced by the line currents. The only disadvantage entailed by this is that in a heavy current balanced circuit, although only one current transformer is necessary for the other measuring instruments, such as ammeters and watt-hour meters, yet three, or at least two, current transformers are required to supply the three current coils of the moving iron phase meter. On the other hand, in the induction-dynamometer type, the primary winding B may be equally well a current or a pressure winding, and in the particular case just cited B would be in the secondary of a single current transformer, the three fixed coils having fine pressure windings. By this means, therefore, the expense of one current transformer may be avoided.

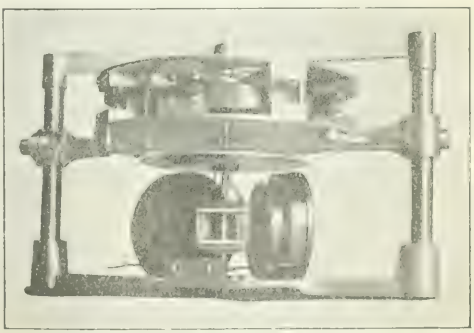


FIG.

In connection also with the dynamometer type, the resistance of the small moving coils being relatively low, even on low voltage circuits a three-phase external resistance box for series connection with the moving coils becomes essential, and for medium pressure circuits up to about 600 volts (the usual limit for instruments connected directly to the circuit),

this resistance becomes considerable both in dimensions and in power consumption.

The primary windings of the induction-dynamometer meter, however, may be wound to suit any circuit pressure without external resistance and with a constant volt-ampere consumption, the only limit being either the difficulty of insulation or the impossibility of obtaining wire sufficiently fine to give the requisite number of turns in the coils.

It should be mentioned, for the sake of completeness, that in both the dynamometer and induction-dynamometer meters,

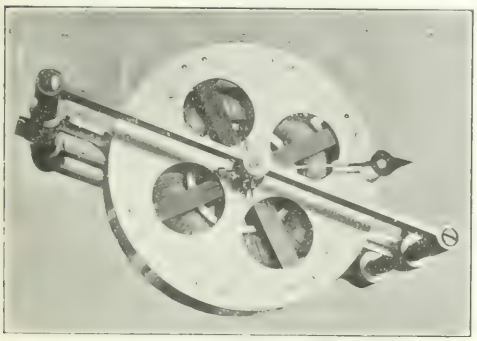


Fig. 6

the drag torque mentioned above does actually exist, but as the moving systems of these types consist of coils of very fine wire, in place of plates of iron, the drag forces are so minute as to be comparable with those of pivot friction, and therefore do not affect the readings of these meters.

In the induction-dynamometer phase-meter for three-phase unbalanced load circuits, the moving coil is wound with three phases, and is fed from either two or three secondary coils, as shown in Figs. 2A and 2B. Fig. 3 is from a photograph of the first experimental meter of this type, and is here shown (with scale plate removed), because it demonstrates the principle of action with greater clearness than the more compact and effi-



Fig. 7.

cient later development. The moving system is shown separately in Fig. 4, and is well damped by means of the magnet and [illegible]. It would be supposed that the presence of the magnet would introduce an error, not, of course, due to any reaction between the alternating fields and the permanent magnetic field, but due to the proximity of a magnetic material to any part of the coils, which might have a distorting effect upon those fluxes. As a matter of fact, the reading of the meter is entirely unaffected by the presence of the magnet.

The readings obtained with this first instrument showed [illegible] discrepancies of the most unintelligible kind, which, by the aid of an exploring coil, were ultimately traced to a small leakage flux between the two cores. Magnetic shields of copper placed around the poles failed to eliminate entirely the effect. An obvious remedy was to increase the distance between the cores, at the expense of increasing the height of the instrument. This trouble has, however been entirely overcome by the multipolar arrangement shown in Figs. 5 and 6, which are photographs of the essential parts (with one current coil removed) of a meter for balanced circuits.

In these figures the transformer cores are clearly seen, the upper and lower halves of each set of iron stampings being attached to the circular plates. In place of a primary winding on each pole, the complete set of poles is energised by a single annular coil. By this method of construction there is a great economy of space over that shown in Fig. 3. A view of the complete circular scale obtained on these instruments is shown in Fig. 7.

The induction-dynamometer power-factor meter has also been developed for single-phase circuits. As it is necessary to have a rotating field, this is produced in the usual way by means of a phase splitting device. The fixed system consists essentially of two pressure coils at right angles to each other, one being in series with a non-inductive resistance, and the other with a choking coil or condenser. The fluxes in the coils being nearly in quadrature, a rotating field is obtained. The moving coil is supplied from the moving secondary of the transformer, whose primary is excited from the line current.

Having dealt with the construction of the induction-dynamometer phase meter, we may now enter into an examination of its theory and its behaviour on actual circuits, especially those of an unbalanced nature. Before doing so, however, it will be well to see what is meant by the power-factor of an unbalanced three-phase circuit.

(To be continued.)

DEVELOPMENT OF MAIN LINE SIGNALLING ON RAILWAYS.

We give below an abstract of the discussion which took place before the Birmingham Section of the Institution of Electrical Engineers on Mr. W. C. Acfield's Paper on this subject. An abstract of this Paper appeared on p. 887 of our issue of April 2nd :—

Mr. A. Hurst (President of the Institution of Signal Engineers), in opening the discussion, explained a fundamental difficulty of designing signal apparatus, which was due to the necessity of making it comply with conflicting conditions. When high and low-speed traffic passed over the same rails the signalling had to be suited to the requirements of the high-speed traffic, and this was not always the most suitable for low-speed traffic. Ideally, two distinct systems of signalling were required to suit the two cases, but this was not practical, and in consequence the design of signal systems resolved itself into finding the best compromise. With regard to electrical apparatus, the engineer must not think that because his apparatus worked well in the laboratory, it would also work well on the road, because disturbing factors were often found in practice which were not suspected until failure was experienced under actual working conditions. As an instance of this kind of thing, the speaker mentioned that if the engineer in repairing a line put in a new length of rail the electric signalling apparatus ceased to operate until the skin on the rail has been removed.

Mr. A. F. Bound mentioned as a matter of interest to electrical engineers that in all-electric signalling one unit of power would operate from 500 to 600 signals.

Dr. Kapp demonstrated a model of the railophone method of signalling, and explained the operation of the Kapp-Kramer relay.

Mr. T. S. Lascelles (communicated) said that Mr. Acfield had pointed out the mistake that enthusiasts for power signalling schemes fell into, of supposing that men could be reduced to a negligible quantity and the speed of working vastly increased. The electro-mechanical system now being extensively adopted in U.S.A. enabled many of the advantages of power signalling to be obtained without the troubles of maintenance and operation attached to power-worked points.

Mr. W. J. Thompkinson (communicated) stated that the advantages of track circuits were obvious, and no doubt extensive use would be made of them in future. The weak spot as regard the use of track circuits [illegible] was the fact that there were a number of vehicle-fitted Mansell wheels —*i.e.*, wooden-block wheels. The resistance between the rim of one wheel to the rim of the other wheel of a pair is practically infinite as regard the track circuit. Hence, such wheels failed to shunt the current

from the relay, and thus failed to operate the track circuit apparatus. The difficulty could be overcome by bonding the hub to the rim. The use of sand by drivers should be discouraged, as the accumulation of sand on the rail was likely to introduce considerable resistance between the rail and rim of the wheel, and thus cause even a heavy engine to fail to operate a track circuit.

Mr. A. E. TATTERSALL (communicated) stated that in his opinion the alternating-current system would eventually supplant the direct current in track circuiting in this country, especially in large installations, for the following reasons: (1) It afforded an economical system of power transmission and the main could be utilised for other purposes than signalling such as power and lighting. (2) The question of track insulation did not enter to nearly such a large extent as in direct current systems. (3) Extraneous currents could be fully guarded against by using suitable frequency relays or employing some form of apparatus embodying this principle of resonance.

Mr. WHYSALL (communicated), referring to the author's statement as to a signalman being able to attend to more roads under power systems than under manual signals, mentioned the fact that during the rush hours on the District Railway 98 trains per hour were passed through Earl's Court Station. There were four roads through this station. All these trains were signalled by one man operating a power frame. A signalman doing the same work with a manual frame would be exhausted towards the end of his shift.

EXTENSIONS TO THE CARLISLE ELECTRICITY WORKS.

The official opening of the recent extensions at the Carlisle Corporation electricity works took place yesterday afternoon, when an interested company assembled at the invitation of the chairman of the Electricity Committee to inspect the new buildings and plant. The extensions comprise considerable alterations in the original works, and include the laying down of a 1,250 kw. turbo-alternator, with room for two other similar units.

The history of electricity supply in Carlisle has been rather an eventful one. In December, 1882, six companies announced their intention of applying for powers to supply electricity in the city, and on the recommendation of the Corporation Gas Committee these applications were opposed, and a provisional order was applied for and obtained by the Corporation in 1883. Despite this, however, no material progress towards the supply of electricity was made till 1897, when Prof. A. B. W. Kennedy drew up a scheme to meet the needs of the district, which scheme was completed in 1899. The original installation consisted of two 60 kw. steam balancers and two 125 kw. steam dynamos, these machines having Willans' engines and Siemens' generators. It is interesting to note that the cost of this installation of 370 kw. was approximately £30,000, or £81 per kilowatt, while with the completion of the present extensions the total capacity of plant installed will amount to 3,920 kw., at a cost of approximately £128,000, or £33 per kilowatt. When the full capacity of the present station is reached—that is to say, 6,420 kw.—the cost will be about £150,000, or £23½ per kilowatt.

Before the works had been opened three months it was decided to make an extension of the plant, and two 250 kw. steam dynamos were laid down. After this the progress of the department could not be considered satisfactory until a policy of selling energy for power at a low charge was adopted. Better progress was then made, but no further extension to the generating plant occurred until 1909, when a 300 kw. Willans-Siemens turbo-generator was laid down. This extension, however, did not long meet the needs of the rapid demand for power, and in 1910 it was decided to make further extensions at a cost of £14,000. These extensions included the laying down of two 500 kw. Browett-Lindley E.C.C. steam dynamos with the necessary plant. Applications for current from the adjoining districts were received about this time, and the Corporation applied for a provisional order to enable the supply to be given at any place within 2 miles of the centre of the city. This order was granted in 1911.

In May, 1911, a church next to the site of the works was acquired to permit of extensions, and in December of the same year this building was altered and made into offices and a showroom, while a new battery was located in the basement. In 1913 further extensions were required, and three 500 kw. Browett-Lindley E.C.C. dynamos were installed. All these extensions had been confined to the original direct-current system; but as applications had been received for a supply into outer districts it was felt undesirable to continue extending the direct-current mains for this purpose. On December 3, 1913, therefore, it was decided to apply to the Local Government Board for a sum of £23,940 for plant and £6,000 for mains in order that an alternating-current system could be started. The completion of this scheme was celebrated at the official opening yesterday.

The scheme included very considerable alterations to the old buildings to make room for three 1,250 kw. turbo-alternators, one of which was started up yesterday. To enable these alternators to be installed, the old battery room, which abutted on James-street, had to be shortened to permit of the erection of the requisite high-tension switchboard. The batteries displaced are accommodated on an additional floor, which allows sufficient room for any future battery extensions. The church buildings have been joined up to the original station buildings, and by this means the whole of the staff is accommodated in the one building. Considerable space has been saved thereby, which will be utilised for much needed stores accommodation. An extension has also been made to the boiler house, and a new water-tube boiler installed. The foundations for another water-tube boiler have been laid down, which when installed will fill up the present boiler house. An increased boiler capacity can, however, be obtained by installing water-tube boilers instead of the present Lancashire boilers in the old boiler house.

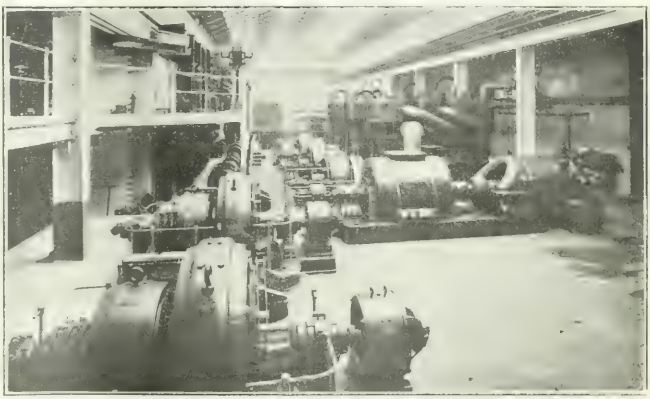


FIG. 1.—GENERAL VIEW OF ENGINE ROOM, SHOWING THE NEW ROTARY CONVERTORS AND TURBO-ALTERNATOR IN THE FOREGROUND.

A new basement 12 ft. deep has been dug out for the condensing and filtering plants. This necessitated extensive underpinning of the church building foundations. Above this on the main engine-room floor, foundations of steel and concrete, supported on concrete piers, have been constructed to carry the turbo-alternators and rotary converters. As the width of the original engine room was too narrow for the new plant, the walls carrying the crane rail and roof have been replaced by heavy steel stanchions, and in the space thus gained the rotary converters and transformers have been installed. In Fig. 1 the rotary converters and the turbo-alternator are seen in the foreground, and the vacant space

for the installation of two further sets in the future is also seen. Another view of the turbo-alternator is given in Fig. 2, in which the old switchboard is visible in the background.

To deal now with the details of the plant installed, the turbo-alternator was supplied by the Maschinenfabrik Oerlikon Co., the steam turbine being on the Rateau pure impulse principle, running at a speed of 3,000 revs. per min. Current is generated at a pressure of 3,000/3,300 volts at 50 frequency. An Oerlikon automatic voltage regulator is mounted on the switchboard to maintain a constant pressure of supply. The construction of the alternator follows the usual Oerlikon

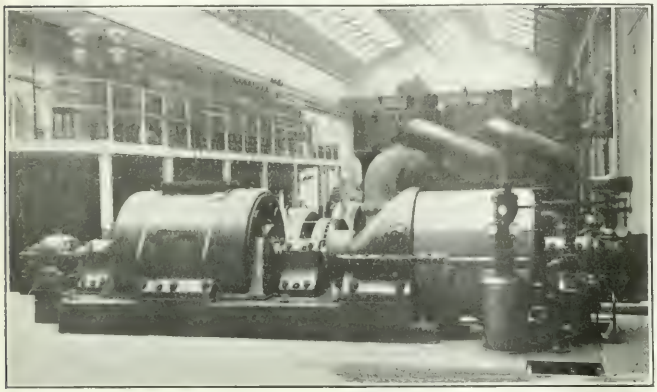


Fig. 2.—The 1,250 kw. Oerlikon Turbo-alternator.

standard. An oil-pressure pump for the lubrication of the bearings and for the operation of the governor is driven direct by the turbine shaft, the usual oil cooler, speed-limiting device, valves and pressure gauges being mounted on the machine. A steam-driven stand-by oil pump is provided for starting purposes. A separate exciter is provided coupled direct to the alternator shaft. The speed of the set is controlled electrically from the switchboard by an oil-controlled relay governor. A wet air filter of the Heenan-Froude type has been installed. The condenser, which has been supplied by the Worthington Pump Co., is of the standard rectangular design, mounted directly underneath the turbine, and having 2,100 sq. ft. of cooling surface. The circulating pump is capable of dealing with 1,450 gallons of water per minute, and is driven by an Oerlikon direct-current motor. The plant is capable of maintaining a vacuum of 28 in. with the turbine exhausting at full load when supplied with circulating water at a temperature not exceeding 65°F. The condensing plant motors are supplied from the lighting 'bus bars, and are automatically switched over to the batteries in the event of a failure of supply. Arrangements have been made for flooding the condenser to permit temporary exhausting to atmosphere.

The supply of condensing water is taken from the River Caldew through a 22 in. suction pipe, and discharged back again through an 18 in. pipe. These pipes will supply the requisite amount of water for the three turbine sets when they are all installed. Some doubt is expressed as to whether a sufficient supply will be available in a dry summer for the complete installation, but this is a matter which is being left for future consideration. The guaranteed consumption of the new turbine is 14¾ lb. steam per kilowatt, which compares favourably with the 17¾ lb. per kilowatt, which were the guaranteed figures for the 500 kw. reciprocating engines.

In order to provide connection between the alternating and direct-current systems, two 600 kw. Westinghouse six-phase rotary converters are installed, together with the necessary [illegible]. These converters run at a speed of 750 revs. per min. and are supplied supplying traction current at 500/550 volts, or lighting current at 460/550 volts with the middle wire taken back to the transformer, so that an out-of-balance current up to 25 per cent. can be dealt with. The converters are arranged for direct-current starting only. They are also capable of running inverted off either the lighting or traction supply, and so furnishing an alternating supply at 3,000/3,300 volts. Their overload capacity is 25 per cent. for two hours, 50 per cent. for 30 minutes and 100 per cent. momentarily.

With regard to the construction of the rotaries, these have yokes made of cast steel divided horizontally so as to facilitate the removal of the armature. The field poles are arranged so that they may be removed together with their respective coils without disturbing the field yokes on the armature. A special exciter is mounted on the shaft of each rotary so that when it is running from direct to alternating current any undue speeding up, due to the demagnetising effect of the wattless currents in the armature when an inductive load is suddenly thrown on, will be prevented. A further speed limiting device is fitted which takes the form of a centrifugal arrangement operating a switch which causes the no-volt tripping coil of the circuit-breaker to come into action at excessive speeds, thus bringing the rotary to a standstill. A synchronous booster has been provided with each machine in order to obtain proper voltage regulation. The transformers are of the British Westinghouse standard C.T.E. type. They have a capacity of 660 k.v.a. each, and are oil insulated and self cooled.

Fig. 3 illustrates the new switchgear, which has been supplied by the British Westinghouse Co. As indicated above, this is located on a new gallery forming an extension of the existing direct-current switchgear gallery; it is arranged so that the high-tension feeder cables are brought direct from the street into the cubicles without any intervening cable subway. Moulded stone cubicles containing the 'bus bars, oil switches, instrument transformers, and isolating links, are erected behind the operating board. The cubicles are designed so that all this apparatus is isolated, the cells being arranged on



Fig. 3.—New Alternating-current Switchboard.

the usual back-to-back system with a passage way round the whole structure and with the sheet-iron doors for each cell. The alternating current operating board includes panels for two rotary converters, two turbine sets, two feeder panels and spare panels for an additional rotary and turbine set. The Oerlikon automatic voltage regulator for the Oerlikon turbine set is also located on this board. The board on the extreme right of the illustration controls the direct-current side of the rotary con-

verters, and is fitted with the usual starting switch, circuit-breakers and instruments. The main machine switch is electrically interlocked with the change over switch fixed on the rotary to ensure that both switches are set for lighting or traction as required. The connection to the old direct-current board is made by bare copper strip suitably mounted on insulators.

We are indebted to Mr. F. W. Purse (the city electrical engineer) for the information given above of the extensions, and also to the British Westinghouse Electrical & Mfg. Co. for some further details and photographs.

THE POWER SUPPLY OF THE CENTRAL MINING-RAND MINES GROUP.*

BY J. H. RIDER.

Summary.—The author deals generally with the electrical energy used by the large Central Mining-Rand Mines group. Reference is made particularly to the question of metering the supply to electric winders and their control, overwinding devices, depth indicators, mill driving and the switchgear for supply of electrical energy to the mines. Lastly the author deals with the troubles that have been experienced.

Introductory.

This Paper deals with the power (electricity and compressed air) supply given by the Rand Mines Power Supply Co. (Ltd.) to those gold-mining companies of the Central Mining-Rand Mines group which have contracted with the power company for the whole of their power requirements, and treats the subject from the consumers' point of view. These companies crush at present about 8,500,000 tons of ore per annum and produce about 36 per cent. of the total gold output of the Transvaal, or about 14·5 per cent. of the total gold output of the world.

When it was decided, in 1908, that the whole of the power requirements of the above mines should be taken from an outside source, it was stipulated that a separate supply company, to be called the Rand Mines Power Supply Co. (Ltd.) should be formed for that purpose. The entire working and operation of the system of the Rand Mines Power Co. are under the technical control of the Victoria Falls Co.

Each of the mining companies in the Central Mining-Rand Mines group has its own separate contract with the Rand Mines Power Co., but all questions relating to the power supply are dealt with by Rand Mines (Ltd.) (one of the controlling companies) and not by the individual mines, an arrangement which greatly simplifies the work, and ensures uniformity of policy in all dealings with the power company.

The history of the first three years of the supply under the contract teaches one outstanding lesson, namely, that it is only courting failure to attempt to give a permanent and reliable supply without a proper reserve of generating and transforming plant. Since the full amount (25 per cent.) of reserve plant has been available the supplies have been quite reliable, and any troubles have been generally local and of no long duration.

At the end of March, 1911, the power company was notified by Rand Mines (Ltd.) that its companies would require a total of 70,000 k.v.a. of electricity supply, and 21,000 lb. per minute of compressed air supply at a gauge pressure of 100 lb., these demands being the aggregate of the demands of the individual mines as measured at the points of delivery. Experience has shown that the maximum individual demands of the mines for electricity supply have a diversity factor of about 1·14, while the power factor averages about 0·77, so that the above aggregate demand represents a maximum demand upon the electrical system of about 47,300 kw. The load factor of the electrical system is about 75 per cent., and the annual consumption at the rate of about 310,000,000 units. The maximum demand upon the compressed air system is about 15,800 lb. per minute, or 37,900 kw. The load factor is about 34 per cent., and, as an air unit represents 27·441 lb. at 100 lb. gauge pressure, the annual consumption is about 103,000,000 air units.

The contract allows a variation of 10 per cent. up and down from the mean pressures of 2,100 volts and 525 volts, or a total range of 20 per cent. before any damages become due from the power company. Such a range is much too great. Damages are only payable for pressure variations beyond the above limits which last for more than 10 consecutive minutes. If, however, the pressure variations cause a stoppage of any of the pumping, mining and metallurgical operations, the damages due for failure to supply are payable. The standard frequency of the electricity supply is 50 periods per second, but the contract allows a variation of 5 per cent. up and down from this, or a total range of 10 per cent., before any damages become due.

* Abstract of a Paper read before the Institution of Electrical Engineers.

Metering the Supplies.

The number of units of electricity supplied to the consumer is ascertained by three intergrating watt-hour meters placed in series and connected in circuit at each point of delivery on the low-tension side of the transformers. One complete set of meters is installed for each pressure of supply. The number of units of electricity paid for by the consumer is the number of units represented by the mean of the readings of the three meters at each pressure of supply, together with an allowance for the actual losses in the transformers installed by the power company at each point of supply, which allowance does not, however, exceed 2 per cent. of the number of units as represented by the readings of the meters. If the reading of each meter is within 3 per cent. of the mean of the reading of the three meters, each meter is considered correct for the purposes of the accounts.

The number of units of compressed air supplied to the consumer is ascertained by an air meter or meters of a type to be approved by the consumer, provided by and maintained at the expense of the power company and connected in the air-pipe line at the point of delivery. The pressure and temperature of the air supplied are measured by the power company's meter or meters at the outlet end. The consumer also has the right to have a meter. The air meter used by the power company is of the Venturi type, while that used by the consumer is of the swinging-gate type.

All electric and air meters are open for the inspection of each of the parties, or their authorised agents, and all questions regarding types of meters to be used are settled between the representatives of Rand Mines (Ltd.) and of the power company. Electric meters are tested *in situ* where necessary by means of portable secondary standard meters, the property of the power company, which have previously been tested against the primary standard instruments of the power company in its laboratory. In any instance where it is agreed between the parties that a test *in situ* will not be satisfactory, the meters are tested in the laboratory of the power company.

Electric Winders.

The number of motors installed (1914) is about 1,500. They vary in size from 2 H.P. to 2,000 H.P. (R.M.S. rating), and the total horse-power is about 142,300.

The most important service is that of winding, as not only is the output of the mines entirely dependent upon it, but also the safety of thousands of men (both white and coloured) who descend and ascend the shafts daily. There are at the present time 38 shafts in use on the mines of the group, many of which have underground winders for the lower depths, in addition to surface winders. For the purpose of winding, shafts may be divided into three classes, viz., (*a*) incline shafts, which approximately follow the dip of the reef; (*b*) vertical shafts, which strike the reef at its lower depths; and (*c*) compound shafts, which descend vertically until the reef is struck and then follow on the incline. A few of the compound shafts are still served by single-stage winders, the skip or cage first descending the vertical portion, then turning the corner, and finally descending the incline; but the majority now use a separate winder for the incline portion.

When the general electrification scheme was decided upon, it was resolved, for financial reasons, to use as many of the existing steam winders as possible, by removing the connecting rods and connecting up the motors to the drum shafts, either directly or through gearing. At the end of 1914 there were 69 electric winders in use or on order. Out of the total number of winding motors now in use 54 of the three-phase type and four of the Ward-Leonard type were ordered before the advent of the author on the Rand at the end of 1910. The policy which guided his predecessor in deciding to use three-phase motors in such large numbers for winding was that of saving fresh capital outlay. This saving is certainly worth having if there are no serious practical disadvantages from the operating point of view, and, generally speaking, it must be admitted that the three-phase winding motors on the Rand are working quite satisfactorily. Whether their use is justified, however, under all conditions, and whether Ward-Leonard sets would not have proved more economical in working in many cases, are debatable points.

A three-phase winding motor *per se* is a much simpler machine than a continuous-current winding motor, with its necessary adjunct on a three-phase system of supply, the motor-generator, but its control is not nearly so simple. The control apparatus, as usually supplied, will be familiar to most engineers, so it need not be described in great detail. It consists essentially of: (*a*) Stator reversing switches,

operated by the first motion in either direction of the driver's control lever: (*b*) a variable rotor resistance, controlled by the further motion in either direction of the lever.

The rotor resistance usually comprises a tank in which are suspended metallic electrodes connected to the three slip-rings. One side of the tank is closed by a moving weir or shutter, so that the level of the electrolyte, which is circulated by a small centrifugal pump, can be raised or lowered at will, which varies the resistance across the slip-rings accordingly. The rate of rising of the electrolyte, and, therefore, the acceleration of the winder, are independent of the driver, being determined only by the rate of delivery of the pump, which is adjustable. This is apparently, and actually, much simpler than the complicated resistances, switches, and connections required by the Ward-Leonard system. In practical operation, however, the Ward-Leonard winder is much the easier to control, and for the following reasons :—

(*a*) The manual energy required to operate the control lever is much less.

(*b*) In the Ward-Leonard system the winding motor can be converted into a generator for braking, by bringing the control lever back just sufficient to lower the voltage of the generator (of the motor-generator set) below the back E.M.F. of the motor. In the three-phase system the control lever has to be brought back beyond the neutral point, before braking (by reverse current) is obtained. That is (1) the weir and electrolyte have to be lowered, (2) the stator switches opened, (3) the stator switches closed again for the reverse direction, and (4) the weir and electrolyte raised.

(*c*) It is much easier to move the skip or cage of a Ward-Leonard winder for a few inches (as is frequently necessary when coming to the landing place or tip) than to do the same with a three-phase winder, for the reasons given in (*a*) and (*b*) above.

The above features are obvious to anyone who has ever handled both types of winders, and appeal strongly to the drivers. Attempts have been made to relieve the driver of the manual labour required to operate the control lever of a three-phase winder, by using electricity or compressed air for opening and closing the stator switches, and compressed air for raising and lowering the weir. So far as the stator switches are concerned, both agents are quite successful, although electricity is to be preferred from the author's experience, and is in common use on the Rand. For raising and lowering the weir, however, compressed air has proved a failure, because it was found impossible to predetermine the exact position to which the weir would come, owing to the elasticity of the operating medium. Its trial showed conclusively that the driver must have direct mechanical control of the weir to work his winder properly. There are other points which only affect the relative economy of working. In the Ward-Leonard winder electrical braking requires no electrical energy from the line, and will easily return energy by running the motor-generator slightly over synchronous speed. This is a material saving, as electrical braking with a three-phase winder can practically only be obtained by using either reverse current or an auxiliary braking machine, such as an eddy-current brake, both of which make a direct call for energy from the line.

The eddy-current brake, of which several made by the British Westinghouse Company are in use on three-phase winders at City Deep (Ltd.), and Village Deep (Ltd.), consists of a rotating field magnet system, exactly similar to that of a low-speed alternator, fixed on the winder drum shaft, and revolving within a hollow cast-iron stator ring, with a smooth circular face opposite to the field pole faces. Eddy currents are set up in the face of the ring when the magnet system is excited, which exert a very considerable and effective braking force without jerk or jar of any kind. Water is circulated through the hollow of the stator ring to carry off the heat which is generated. The energy for the magnet system is obtained from a motor-generator. As originally fixed it was intended that one motor-generator should serve the brakes on several winders, and, to this end, the regulating resistance was placed in the main circuit of the brake magnet system. The final breaking of the field circuit at each operation proved very destructive to the switch contacts, [illegible] and the arrangement has recently [illegible] to employ a separate motor-generator for each brake, [illegible] in the field of the generator, so that the main circuit [illegible]. This has proved very effective.

[illegible] current brake was guaranteed to lower a net [illegible] 7,200 lb. at a rope speed not exceeding 1,000 ft. per [illegible] half of normal running rope speed for the winder. [illegible] it has been found that the brake will [illegible] with an unbalanced load of 9,000 lb. [illegible] down to 500 ft. per minute, with [illegible] 45 kw. The application of the mechanical brakes will then stop the [illegible]. To obtain an equivalent result by applying reverse current to the winding motor, required an expenditure of energy at the rate of about 1,600 kw. The obstacle to the more general use of the eddy-current brake for three-phase winders is capital cost, which amounts (with the motor-generator, &c.) to nearly two-thirds of the cost of the winding motor, and, in the cases above mentioned, make the cost of the equipment practically the same as for the Ward-Leonard system. Until its use was proved successfully possible by the engineers of the Central Mining-Rand Mines group, braking three-phase winders by reverse current was not generally practised. Considerable difficulty was experienced in a number of cases, largely caused by want of knowledge and experience on the parts both of those who drew up the specifications and those who manufactured the plant, as to the precautions which must be taken with the motor and the control gear (particularly the latter) to make reverse-current braking safe.

While general motor troubles are dealt with later, the two principal ones peculiar to three-phase winding motors may be mentioned here. The first relates to the stiffness of the stator frame. Some makers do not pay nearly enough attention to this point, and have supplied three-phase winding motors of which the frames distort visibly when current is switched on to the stator, so much so that the radial air-gap has disappeared at certain points. In many cases the rotor core has had to be ground down, and radial stiffening arms made for the stator. Deep frames of box section, with heavy external or internal stiffening rings, are absolutely essential. The second trouble relates to the rotor slip-rings and the control gear. If a three-phase motor is running at full speed and reverse current at full pressure is applied to the stator, the induced open-circuit standstill rotor voltage is doubled. Manufacturers of three-phase motors do not always provide sufficient insulation between the rotor slip-rings, between the slip-rings and the shaft, and between the brush holders, even for the full open-circuit standstill rotor voltage, if kept on for any length of time. With three-phase winder motors this point is even more important, not only because such motors are started and reversed frequently for many hours together, but also because of the higher rotor voltage obtained when reverse current is applied.

The rotor resistance tanks which were originally supplied with the large majority of the three-phase winders gave considerable trouble, because they were too small for the required duty and the electrodes were arranged much too closely together, a spacing of about $\frac{3}{4}$ in. between phases being common. During straight winding operations no great difficulties were experienced, but flash-overs between the electrodes were frequent when reverse current was applied, and even when these did not occur the electrolyte soon reached too high a temperature, as the retarding losses were then added to the accelerating and winding losses. As soon as a flash-over takes place the automatic circuit-breaker opens and cuts the winding motor off the supply circuit, leaving only the mechanical brakes for stopping the winder.

Some experiments were then made to determine the safe minimum distance apart between phases, so as to avoid any chance of flashing over. The following were the results obtained, viz. :—

	Distance apart of electrodes.	Flash-over voltage.	Water temperature.
(1)	$\frac{1}{2}$ in. ...	750-800 ...	186°F.
(2)	$\frac{5}{8}$ „ ...	850-900 ...	188°F.
(3)	1 „ ...	680 ...	185°F.
(4)	$1\frac{1}{4}$ „ ...	1,300-1,400 ...	
(5)	2 „ ...	1,500 ...	200°F.
(6)	$2\frac{1}{2}$ „ ...	1,620 ...	200°F.
(7)	3 „ ...	No flash-over up to 1,800 volts. ...	200°F.

N.B.—Ordinary water, without added salts or acids, was used for the electrolyte, and the lower edges of the plates were just touching the surface, except in No. (3), when the plates were immersed $2\frac{1}{4}$ in.

It would be impracticable to arrange all the electrodes with no less distance than 3 in. between them, as the sizes of the electrodes and tanks would have to be very great in order to give a sufficiently low resistance at full load and speed, when the electrodes are fully immersed. But if the immersed portions of the electrodes are far enough apart and of such areas as will always keep the current density at a value not greater than the figure given, it will be found that they will be close together and of large area at full immersion when the rotor voltage is low and the current high; and at a safe distance apart, and of small area when the rotor voltage is high and the current low. A density not exceeding 1 ampere per square inch has been found to be a safe limit.

Various designs of flat-plate electrodes were tried with this object in view, but they all proved more or less impracticable. The experiment was then made of using a large number of rods (actually angle iron) of varying lengths, arranged in the tank so that their disposition could be easily changed to obtain the required result. This was

successful, as no flashing over was observed under working conditions, and the increases and decreases of areas and resistances were quite satisfactory.

It has been suggested that two resistance tanks could be used, one for winding and the other for reverse-current braking. While no doubt this would be successful it would be complicated. In 1913 a new type of control apparatus was suggested by the South African General Electrical Company (G.E. Co., of America); this system apparently possessed so many advantages that it was thought worth while to procure a sample equipment and to prove it under actual working conditions. The general arrangement of this apparatus consists of (1) Electrically-operated contactor switches for the stator circuits. (2) A rotor resistance of the metallic type, the various sections being operated by contactor switches. (3) Control by a small master controller, the rate of accelerating the speed of the motor being automatically controlled by a relay system in the rotor circuit, so that the control lever may be put right over at the start.

The advantages claimed for this method of control were: (*a*) No heavy work is imposed on the driver in operating the control lever. (*b*) No energy is wasted in continually pumping electrolyte. (*c*) The full speed of the motor is obtained, as, when the last rotor switch closes, the rotor is metallically short-circuited. (*d*) No energy is wasted in the rotor resistance during the period of full-speed running, but only during the periods of acceleration and retardation. (*e*) There is no possible risk of flashing over, however quickly the control lever is operated. (*f*) There is no cooling pipe system to be kept clean and in order.

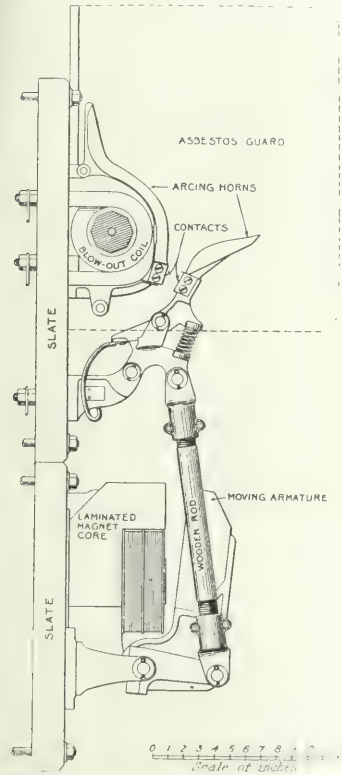


FIG. 1.—ELECTRICALLY-OPERATED CONTACTOR SWITCH.

After some defects had been eliminated this apparatus was found to be very satisfactory.

With a view to obtaining competitive arrangements, the author, in July, 1914, sent particulars of the contactor-relay system of control to a British firm which claims to be expert in this class of work. It took nearly five months for a reply, other than an acknowledgment, to be received, and then the information sent was entirely useless. Wake up, England! Electrically operated contactor switches for the stator circuits are used with great success on [illegible] three-phase winders of the group. The contacts are self-cleaning and are broken under a magnetic blow-out, and the maintenance is exceedingly small when compared with the ordinary pattern of oil switch. A contactor switch is shown in Fig. 1, from which its essential parts will be seen.

Manufacturers do not seem to realise the nature of the duties which winder oil-break switches have to perform, and they usually supply the ordinary switchboard type. While the latter is only called upon to open and close feeder or machine circuits occasionally, and generally with no load on at the time, switches for three-phase winders frequently have to make and break circuits from 500 to 1,000 times per day, and the breaking is usually done under full load. It requires a very substantial switch to stand up to this sort of work, and the arcing contacts and the oil have to be renewed at least once a week. This is a very "messy" and expensive job, and contactor switches are being insisted upon for all future three-phase winders. On a three-phase winder at Rose Deep, Ltd., these switches have made and broken the stator circuits over 388,000 times without any cost whatsoever for repairs or maintenance.

Experience has shown that most of the so-called overwinding accidents which have occurred on the Rand have been caused, not by any failure to stop the skip, but by starting the winder in the wrong direction when one skip is at the tipping point. In such cases the skip is pulled into the headgear sheaves before the winder drum has made half a turn. Over-winding devices which cut off the supply of energy when the skip has reached a pre-determined point are not of much use for avoiding such accidents, because the driver must retain full command of the winder, in whatever position the skip is, to be able to bring the skip to the exact tipping point. This operation frequently calls for slight movements of the winder after it has first been stopped.

In 1912 the author's attention was directed to an electrical device in use on certain winding engines at the Simmer and Jack East mine, near Johannesburg, the invention of Mr. W. Philip, the resident engineer, which, it was claimed, would give unmistakable warning to the driver if he attempted to start the winder in the wrong direction with the skip in the tip, without in any way taking away from him the full command of the winder. On investigation this claim was found to be fully justified, and since that date the whole of the winders on the mines of the group have been fitted with the Philips device. By means of this device, when a skip is within what may be called the "danger zone" the smallest movement of the operating lever in the direction to raise the skip will sound the hooter, which is placed close to the driver.

DEPTH INDICATORS.

Owing, however, to a recent (1914) requirement of the Transvaal Government Mines Department, that the tip of the pointer of the indicator should have a movement of not less than 1 in. for each complete revolution of the winding drum, dials must be large, and a dial 18 in. in diameter was found to be too small for most of the winders, as with an 8 ft. winding drum it would only indicate to a depth of about 1,000 ft. The vertical screw type is too unwieldy.

In order to reduce the size of dial the author decided to use a depth indicator of the dial pattern, of the type in which the pointer moves through a very wide angle, covering at least $1\frac{3}{4}$ turns, in a circular path of constantly and regularly increasing (or decreasing) radii. In this arrangement the dials are of only 27 in. diameter, and the end of each pointer can move through a total path of about 116 in. This, with only an 8 ft. diameter drum, will serve for a depth of 2,900 ft., on the basis of 1 in. of movement for each revolution of the drum.

PUMPING.

Next to winding, the most important duty of the electric motor on a mine is probably that of underground pumping. Motor-driven geared ram pumps for heads up to between 2,000 ft. and 3,000 ft. were the common practice until 1912, when, on the advice of the engineers of the group, it was decided to use high-speed, multi-stage centrifugal pumps, with direct-coupled motors, at the South Rand shaft of the Crown Mines, Ltd., and at No. 1 Shaft, Durban Roodepoort Deep, Ltd. The plant at both mines is identical, and each consists at present of two pumping units. Each unit comprises a high- and low-pressure eight-stage Sulzer pump, with the motor arranged between the two pumps, and lifts 375 gallons of water per minute to a height of 2,400 ft. The sets run at 1,470 revs. per min. and take about 500 B.H.P. A little trouble was experienced at first owing to the nature of the water, which was slightly acid, and contained a large amount of finely powdered rock in suspension. A scheme of settling sumps was then arranged, in which the acidity of the water is removed by lime treatment and the suspended matter is allowed to settle. Since these sumps have been provided the plant has worked with great success, and is now being extended at Crown Mines, Ltd., by units of twice the size. The reduction in working costs over the original ram pumps has been very marked, and is

sufficient to wipe off the whole of the new capital outlay in about two years. It is not that the centrifugal pump, by itself, has a higher efficiency than the ram pump, but the use of the former renders concentration of large, high-power, and high-speed pumping units possible in a minimum of space, with a minimum of attention and very low maintenance costs.

MILL DRIVING.

It consists of a circular steel weight, about 9 in. diameter, and 4 ft. long, fixed at the lower end of a steel rod called the "stem." The rod and its stamp are lifted by means of a cam, which, by rotating, engages on the underside of a tappet on the stem, lifts it for a distance of about 8 in., and then allows the whole to fall by gravity on to a steel block at the bottom. Double-armed cams are employed, and the stamps are generally set in blocks of five or ten, and worked from a common cam shaft, the cams being arranged so that the stamps fall, one after the other, in a regular sequence. The ore is fed with water under the stamps, which weigh from 1,200 lb. to 2,000 lb. each. The cam shafts of the different stamp groups are driven by belts—(*a*) in the older types of mills from a common line shaft to which the motor is belted, one large motor frequently driving from 80 to 100 stamps, and (*b*) in the newer mills from a separate motor to each group of 10 stamps. Each stamp requires 5 H.P. on the average.

If the shaft is run at too high a speed (found to be 98 drops per minute) there will be a danger of the uprising cam meeting the descending tappet before the latter has completed its fall, with the great risk of either breaking the cam or the cam shaft. While any increase in the speed above this value is dangerous, any decrease will reduce the output of the mill in the same proportion. A constant rate of speed for the driving motors thus becomes imperative. This, unfortunately, is in the control of the power company, and is determined solely by the frequency of the electrical supply, in which a variation of 10 per cent. is permitted. During the early period of the power supply considerable trouble was experienced from these causes, which affected all the mills at the same time.

In the earlier days the crushing of the ore was completed in the stamp mill by retaining it under the stamps until it was small enough to pass through a screen of very fine mesh. The modern practice is to crush to a moderate fineness only in the stamp mill and to complete the process in tube mills. By this means the output capacity of the plant is considerably increased and a much finer product is obtained. The tube mill is a cylindrical steel vessel, like a boiler shell, a common size being about 22 ft. long by 5 ft. 6 in. diameter. It takes a considerable amount of energy to start it rotating, as the whole of the weight of the material lies at the bottom. It is also very sensitive to overloading, and many tube mills motor have been burnt out from this cause. Motors of 100 H.P. have been generally used, but these are gradually being replaced by motors of 125 H.P. and 150 H.P. for this reason.

(To be concluded.)

ELECTRICAL UNITS AND FRENCH LEGISLATION.*

BY R. DE BAILLEHACHE.

On April 3rd of last year, the Chamber of Deputies passed a law on the subject of the units of measurement; the second article runs as follows: "The units of measurement include primary and secondary units. The primary ones are those of length, mass, time, electrical resistance, electric current, temperature-interval, and luminous intensity, as defined in the schedule annexed to the present law. The secondary units are enumerated and defined by the regulations of the public administration." The schedule in question contains the [illegible] Electrical Units, held in London, 1908. The standard for measurement of resistance is the international ohm, which is the resistance [illegible] The law, as originally proposed, only defined the international ohm, [illegible] communicated for examination to several competent bodies of [illegible] mental electric units, the ohm, the ampere and the volt; and (2) to reserve to the Public Administration the work of defining these practically by means of standards. It was determined, however, to maintain the definition of the ohm in the projected law. The word "international," as applied to the unit of resistance was, however, omitted, and it was determined to add a reference to the international ohm, approved at the general conference held at London in 1908.

On November 10, 1913, the Académie des Sciences unanimously approved M. Violle's report, in which it was said that "it would appear to be the wisest course to include the three fundamental electric units, in accordance with the unanimous agreement of electricians, among those which should be within the scope of the regulations of the Public Administration. On November 11th, the law, submitted to the Chamber of Deputies, made no mention of the definition of the ohm. The report of M. Perot was very explicit on this point. He said: "The electric units, mentioned in the report of M. Cellerier, should all appear in the regulations of the Public Administration. It seems well, in accordance with the proposals of the Société Internationale des Electriciens and the Société des Ingénieurs Civils to deduce the theoretical definition of each unit from the C.G.S. system by means of the electromagnetic system, and the standard corresponding to it, as fixed at the most recent conference, held at London, in 1908." He then refers to the facts stated above. It was, therefore, surprising to find the definitions of the ohm and the ampere in the proposed law, a modification introduced on February 16th. It was then reported to the Académie des Sciences that "the representation of the ampere ought to cause no difficulty in the future, even if a more convenient standard were unanimously accepted, which could replace the original one by means of administrative regulation." The author, however, thinks differently. It is not evident that the original proposal, which defined the ohm by means of a standard, is essentially necessary. Further, the silver voltameter is not of an industrial nature, and there was no reason for mentioning it in a law which was intended to facilitate commercial transactions. The silver voltameter is exclusively used in research laboratories; it has none of the qualities of a good standard, such as easy manipulation or cheapness, and it is not easy to reproduce. Its use gives directly a measurement of a quantity of electricity and not of the intensity of a current; it defines the coulomb, and not the ampere. It is beyond dispute that the definitions of the international ohm and the international ampere are of a purely scientific nature. M. Barthelot says: "When one reads a definition, stating that the ohm is represented by the resistance of a column of mercury of a mass of 14·4521 grammes and a length of 106·3 cm., it is plain that this is not an independent unit, but one which has reference to experiments conducted with the C.G.S. units." Finally, it is not easy to understand how the definition of the ampere could be adjusted if a more convenient method than that employing the silver voltameter were discovered. In such a case, it would be necessary to fall back on a definition resting on theoretical considerations. It would at any rate be impossible for the Public Administration to define any unit in a manner differing from that contained in the law.

The Committee on units, appointed by the Académie des Sciences, introduced into the law the definitions of the international ohm and the international ampere; this was done to comply with the decisions of the international conference of London, seeing that these decisions were ratified by the French delegates. It might be supposed that the fact of sanctioning the international agreements would facilitate the adoption of new legislation in France, having reference to units of measurement in all countries for international transactions. And the Conference of London declared that the adoption of the international ohm and the international volt were recommended as a system of units, representing the fundamental electric units sufficiently exactly for electrical measurements and serving as a basis for legislation. It further defined the ohm and the ampere as being, respectively, the first and the second primary units; it also said that "the international volt is the electric pressure which, being applied to a conductor, whose resistance is the international ohm, produces a current of an international ampere. But these resolutions date from 1908, and since then, certain figures, which were then uncertain, have been more exactly ascertained.

Ought one, therefore, at the present moment to consider the volt as being less definitely known than the ohm or the ampere? There ought to be no doubt on this point. The definition of the volt, considered as a function of the E.M.F. of a normal Weston cell, which is 1·0183 international volts, is so precise that it is correct to [illegible] places of decimals; very careful comparisons between standards, prepared in France and abroad, give slight differences in the fifth decimal place. The permanent Committee on electric units has, therefore, reported that it ought to be possible to proceed to the materialisation of the volt in the same way as in the case of the ohm [illegible] the ampere. If the matter is looked at from the practical point [illegible], it is certain that in industrial affairs the methods of the potentiometer are almost exclusively employed, which use only the

ohm and the volt. The author has, therefore, pointed out on several occasions that the normal Weston cell can be constructed in a manner which meets with general agreement, that its E.M.F. is known with an error of less than 1 in 10,000, that its temperature coefficient is very small, that it can be used without being obliged to allow long intervals of rest, as in the case of the Latimer-Clark cell, that it can be transported easily without any risk of alteration of the E.M.F. due to shocks, and finally it is not expensive. It would, therefore, have been more rational not to regard the volt as a derived unit, but to include it as a primary unit along with the ohm, if it was absolutely necessary to confine the definition to two units only. This view has received the support of the Board of Trade Electrical Standards Laboratory, and of many French electricians.

There has been a good deal of discussion as to whether the law should contain the theoretical definitions of the three fundamental electrical units. It may be urged, for the following reasons, that it is better to omit them: (1) Commercially speaking, it is the fixing of the standard which determines the unit, as M. Perot has pointed out; (2) the differences between the international units, fixed by the standards and the theoretical units are much less than the errors in commercial measurements, however exact they may be; (3) the fundamental units of the practical system are defined theoretically by means of a system which rests on very debateable conventions. On this point, it is possible to cite the authority of M. Blondel, who says: "It is necessary to reserve the possibility of replacing the electromagnetic C.G.S. system by a system of units, which is more rational from the electrical point of view. I am not one of those who admire unreservedly the co-existence of the electrostatic and electromagnetic C.G.S. systems, which seems an irrational absurdity." (4) It also seems foolish to state that the unit of electrical resistance is the ohm, which is, however, vastly greater than the electromagnetic C.G.S. unit. To understand such a statement it is necessary to have some sort of acquaintance with Maxwell's ideas.

The Committee of Commerce and Industry in the Chamber of Deputies attaches great importance to the question of teaching. They say that "It appears impossible to load the memories of small children with complicated definitions of units." If it was a question of conforming to the decisions of the Conference of London, the definition of the ohm and the ampere could be slightly modified so as to give them a less complicated form. Thus we might say that the standard for measurements of resistance is the ohm, which is the resistance offered to a constant electric current by a column of mercury at the temperature of melting ice, the column having a cross-section of 1 sq. mm. and a length of 1·063 metres. The addition of the fact that the mass of the mercury is 14·4521 grammes, correct to four places of decimals, is of interest only to laboratory workers. As for the ampere, we might say that the international ampere is the constant intensity of that electric current, which, passing through an aqueous solution of silver nitrate, under specified conditions, deposits regularly 4·025 grammes of silver in an hour. It is easy enough to weigh directly 5 milligrammes, though such a weight is a delicate thing to handle; but it is another thing to weigh directly thousandths of a milligramme. It is necessary to bear in mind that children and even the public generally are unable to understand systems of such extreme accuracy.

It seems unfortunate that in spite of expert opinion, it is proposed to separate the group which includes the ohm, the ampere, and the volt. The legislator has obviously nothing to do with the units employed in scientific work; his business is to deal with commercial disputes, and thus in this sphere it might have been logical to define electric units by material standards. However, the conference of London has left the international volt in a precarious condition by defining it as dependent on the international ohm and the international ampere. It is quite possible that this resolution may be modified at some later congress.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from [illegible] post free (unless otherwise stated), on receipt of [illegible] published under 2s. and 5 per cent. for books published at [illegible] for foreign books.)

"The Physical Review." By the American [illegible] Pennsylvania: The American Physical Society.) Vol. V. No. 2. Pp. 97. $0.60.

"Temperature Coefficient of Magnetic [illegible] within the Working Range." By Raymond L. Sanford. [illegible] (Washington: Government Printing Office.) Pp. 10. 5 cents.

"The Emissivity of Metals and Oxides." By Paul D. [illegible] (Washington: Government Printing Office.) Pp. 5. [illegible]

"Insulating Properties of Solid Dielectrics." By P. D. Curtis. (Washington: Government Printing Office.) Pp. 61. [illegible]

"A Vibration Electrometer." By Harvey L. Curtis. (Washington: Government Printing Office.) Pp. 17. 10 cents.

ELECTRIC HEATING AND COOKING.

Last Monday a discussion was held at a meeting of the Western Local Section of the Institution of Electrical Engineers at Bristol on this subject in connection with the recent Papers of Messrs. W. A. Gillott and W. R. Cooper. The chair was taken by Mr. D. E. Roberts, the Chairman of the Section, and Sir John Snell, the President of the Institution, was also present.

Mr. S. F. Walker, in opening the discussion, disagreed with the view of Mr. Gillott that a well-lagged oven, which retained its heat for a long time after switching off, would consume more energy during the heating-up stage. He was also inclined to think that electric cooking was in competition against gas rather than against coal. In any case difficulties were certain to be experienced, but they would be overcome in time, as in other branches of electrical work. In his opinion the importance of earthing electric cooking apparatus could not be exaggerated.

Mr. E. F. Tremain gave some interesting personal experiences of electric radiators in comparison with gas, showing that gas at 2s. was about equal to electricity at ½d. per unit. He thought that it was a mistake to put in such large radiators as was suggested by Mr. Gillott. As to water heating, he felt that the coke boiler was not the true solution, because it required attention.

Mr. A. T. Kinsey thought that visible signs to show when various circuits were switched on were most desirable.

Mr. C. Faraday Proctor agreed with both the opposing sides in regard to the electric heating of water. In his opinion electric heating was in some cases desirable and in other cases not desirable. He thought that the efficiency of electric ovens might be very materially improved if they were made with an entrance in the bottom instead of at the side, because so much heat escaped from the ordinary oven every time the oven door was opened. With this idea in view he suggested that electric ovens should be made in the form of large dish covers of various sizes having the heating element within them.

Prof. D. Robertson gave some calculations in regard to the amount of heat required to heat a room, expressed in watts per square foot of the walls, floors, windows, &c. For the case of a room 20 ft. by 15 ft. by 12 ft. these figures worked out at 3,300 watts, to which 1,200 watts should be added for ventilation, giving a total of 4,500 watts. He also gave figures of the British thermal units obtainable for 1d. from coal, gas and electricity, showing what electricity had to compete against, and how important a part efficiency must play.

Mr. F. W. Prosser stated that his experience of maintenance did not agree with the figures given by Mr. Gillott, and it was a curious fact that maintenance varied unaccountably with the same cookers in different parts of the country.

Mr. W. R. Cooper disagreed with Mr. Gillott's views as to the efficiency of the lagged oven. It was clear that if an oven could be provided with a vacuum jacket it would retain its heat almost indefinitely, and yet it would be the most efficient kind of oven we could have. He asked Mr. Gillott how the temperature had been measured in obtaining the curves showing the performances of the ovens, as there was some difficulty in obtaining really comparable results. He also asked for further figures in regard to the saving mentioned by Mr. Gillott by less shrinkage.

Mr. W. A. Chamen referred to the advantages of the bell-shaped oven which had been placed on the market, and which was used by raising and lowering, thus giving the advantages suggested by Mr. Faraday Proctor.

Mr. D. E. Roberts thought earthing was important, but it was better to take the further precaution of keeping electrical apparatus away from water taps, as well as adopting the precaution of earthing. From experience in steel works he thought the idea of a closed top for an oven would give good results.

Mr. W. A. Gillott, in reply, expressed his objection to thermometers and preferred to rely upon the work of lady demonstrators in educating the cooks. In Newcastle, competition was against coal, not against gas, because coal was so cheap. In a year's cooking by electricity he had found that the sum of £6. 10s. had been saved in the butcher's bill, the total of which was £17. 10s. The total number of units used for cooking was 2,129, and this at ¾d. amounted to £6. 13s. He agreed that the bell form of oven was excellent if only one kind of cooking was required, but otherwise it was undesirable because it was difficult to clean, and the food cooked therein was liable to taste of the previous dish in consequence. He gave details of a cafe in Newcastle which provided 1,100 meals per week at a consumption of 0·55 unit per person per day. Of this, the water accounted for 0·3 and the cooking for 0·25 unit. In another case three meals were provided for 70 persons per day at a consumption of 0·58 unit per person per day.

Mr. W. R. Cooper, in reply, reiterated his preference for working with a thermometer. By so doing, instructions were so simple that they could be transmitted to a fresh cook without difficulty and without the need of a further educational campaign by a lady demonstrator. There was no difficulty in seeing the thermometer without stooping if the former was placed on the oven door with proper illumination. In regard to electric water heating he quite agreed with the view that this should not be undertaken if the amount required was very large. A coke boiler, however, did not provide a complete solution of the difficulty. It needed attention, and there was a good possibility of being without hot water when it was most desired. The advantages provided by the automatic heating of water electrically might be worth paying something for.

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ELECTRIC COOKING.

The subject of electric cooking has recently been fully discussed in London and at four of the Local Sections of the Institution of Electrical Engineers, and it will, we think, be well if we emphasise a few of the points which have been brought to the front. One of the most important of these is, no doubt, the question of the hiring of electric cookers. The British public have become so well accustomed to the hiring of gas cookers that they look upon it almost as one of their rights to be able to hire any similar kind of apparatus on more or less similar conditions. Here we are faced with several difficulties. When it is a question of a new device coming into domestic use, obviously, from the point of view of the consumer, facilities for hiring at a comparatively low rental become even more important than when the apparatus is well known, for, to the would-be-consumer, it has yet to prove its merits, and so it may seem something of a risk except on hire terms. On the other hand, from the point of view of the supplier, hiring arrangements present some objections. It takes time for a new line of apparatus to settle down to a position in which its commercial value has been ascertained with practical certainty; and thus something in the nature of a deadlock is liable to arise, just at the very moment when everything should be plain sailing.

Further, there is the question of first cost to the manufacturer or the supplier. The criticism is sometimes made that the manufacturer of a new line of apparatus charges too high a price for his goods, and that he ought to reduce his prices considerably in order to create a demand in what is, more or less, a new field of operations for him. This, however, is largely a matter of the likely demand for his apparatus when its success has been demonstrated. If the output can be made sufficiently large, prices will fall as a matter of course,

but this is where the manufacturer's risk is involved. We do not think that the burden of reducing prices should be put entirely on the shoulders of the manufacturer, who has in all probability sunk a good deal of money in evolving suitable designs, and who has a right to expect to see his money back, with interest, in a reasonable time. Meanwhile, we think it will be agreed that the station engineer and the contractor for the installation of domestic appliances should both give every possible facility so as to help forward an increase in the demand and thus to bring about the lowering of first cost, which they both so much desire in the interest of their separate businesses.

Obviously, a very great impetus would be given to electric cooking were municipal electricity undertakings to be given the right of hiring out the apparatus, as gas apparatus is hired. So far, although the Incorporated Municipal Electrical Association has made several attempts to get a Bill through Parliament with this object in view, these attempts have failed owing to the antagonism of the electrical contractor. When it comes to the question of wiring, we feel there is a good deal to be said for this antagonistic attitude on the part of the contractor, but the same objections do not apply, or, at least, apply to only a very minor extent, in regard to hiring, and, therefore, we feel it to be most unfortunate, in the general interest, that so much opposition has arisen between these parties to a common interest. Possibly the Incorporated Municipal Electrical Association would have been well advised to have introduced a Bill dealing with hiring alone, which is not only less contentious, but really more important at this moment. Wiring for connecting up electric cookers could be kept sufficiently under supervision without a special Bill for the purpose, and the cost of such wiring, which is also an important matter from the consumer's point of view, as it must come back to him to meet the cost in one form or another, could be kept down materially if station engineers would consider the matter carefully, and decide what system should be adopted in order to reduce cost.

For the time being it is clear that we must take matters as we find them—that is, mainly without facilities for hiring. Even where such powers are available advantage is by no means always taken of them. We are, therefore, confronted in many cases with one of two methods, either purchase outright by the consumer or purchase on the instalment principle.

We next approach the important question of maintenance. Where the cooker is hired the charge for hire includes that of maintenance; but where the cooker is purchased the cost of maintenance is a separate proposition. There is no question in our mind that if electric cooking is to make the headway its merits deserve the question of maintenance of the appliances must be considered by the supply station engineer on the principle that the consumer pays an agreed sum per annum, and upon an understanding that any needed repairs are carried out with a minimum of delay. There are few things more annoying to an electricity consumer (and this is a strong point with the potential consumer) than any uncertainty as to maintenance, and especially the possibility of undue delay in setting right any little defects. Obviously, it is impossible for the maker to carry out replacements, from the points of view of either cost or time, in such a way that the consumer is certain to be satisfied. It is essentially a matter for co-operation between the manufacturer and the station engineer (and, possibly, contractor). Considering that the electricity undertaking benefits by the energy consumed, that undertaking should be prepared to effect replacements at practically cost price so far as labour is concerned, as we understand is the case with gas apparatus.

Lastly, we would emphasise the importance of earthing. A number of speakers in the discussions, to which we have referred, alluded to undesirable experiences through lack of proper earthing. Some engineers, no doubt, see that this is properly carried out. On the other hand, there is no question that in many cases proper precautions are not adopted. It is largely a question of ignorance on the part of wiremen, and the only way in which this can be overcome is for the engineers of electricity undertakings to see not merely that earthing is carried out, but that it is carried out effectively, so that any possibility of shock is entirely eliminated. As engineers, we shall fail in our duty if we allow conditions to prevail which we know are undesirable and which can only lead to cooking by electricity getting a bad name. So far there are no rules governing the subject by the Institution of Electrical Engineers, and, therefore, everyone is free to do as he likes. We suggest that this matter is essentially one upon which the Institution should take active steps, so that wiring in connection with electric cooking shall be beyond reproach from the point of view of shock.

REVIEWS.

Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

A Manual of the High-Speed Steam Engine. By H. KEAY PRATT. Pp. 267. (London: Constable & Co.) 7s. net.

The requirements of electrical generators led to the design and adoption of direct-coupled high-speed engines of the reciprocating type, and although the field of the latter has been limited by the more recent introduction of turbo-generators, we can welcome a book which deals exclusively with the design and running of the high-speed steam engine.

The first chapter deals with a brief history of this type of prime mover, together with a comparison of the single and double-acting engines. The author endeavours to show the advantage possessed by the single acting over its double acting competitor for small units. Generally speaking, however, the former type has been displaced by the double-acting forced lubrication engine with which this book is chiefly concerned.

Several chapters are devoted to the design and construction of engine details, including cylinders, pistons, valves, rods, shafts, flywheel, framing, &c.

These, on the whole, are well treated and the treatment justifies the statement of the author that he has paid considerable attention to the practical side of this work. The details do not lack variety, and are well described.

Clearance, of course, plays an important part in the design of cylinders with short piston strokes such as are used on quick revolution engines, and the author prefers to use a diagram factor which includes the effect of clearance. It may be pointed out that the usual hyperbolic formula on p. 20 is incorrect when taking into account clearance, even when the real ratio of expansion is used.

The thermodynamic theory of heat engines is, of course, beyond the scope of the book, but even in a book which deals more with the practical side of the work we should prefer to eliminate the confused notions respecting Boyle's Law and isothermal expansion of steam.

The Euler formula is given as being usual in the design of piston and connecting rods, and, probably owing to a misprint, is wrongly stated in one or two places. For long rods the formula may prove a useful check on stability, using an apparent factor of safety. In a book which deals exclusively with high-speed work we should like to see a more complete treatment of the straining actions due to inertia.

The work on speed regulation is good, and, as might be expected, special attention is given to crank shaft governors. A chapter is devoted to indicator cards and crank effort diagrams.

To those who have charge of high-speed engines the book should prove very valuable, as in addition to the work already mentioned, there are excellent practical hints on running, together with a chapter on testing.

The book concludes with good descriptions of various well-known high-speed engines, and the illustrations throughout are characterised by their clearness and good quality.

E. C. M.

La Téléphonie et les Autres Moyens d'Intercommunication dans l'Industrie, les Mines et les Chemins de Fer. By P. Maurer. (Paris: H. Dunod et E. Pinat, 1914.) Pp. vii.+232; 115 figures. Paper covers, 9 fr.; cardboard, 10 fr. 50c.

The subjects dealt with by Mr. Maurer include the use of telephones and electrical and mechanical telegraphs and other systems, as used for intercommunication purposes on a small scale. It is divided into three parts. Intercommunication systems as applied to industrial purposes generally (such as works, factories and offices), to which are devoted 128 pages; then mines occupy 27 pages and railways 73 pages. In his preface the author points out that to get the best results from manufacturing processes, and from the production of raw materials such as coal, &c., thoroughly practical and reliable means of intercommunication are essential. For railways speedy and easily worked transmission of signals is required for the quick and economical handling of goods and passengers, and for their safety in transit, for which in many cases special arrangements are necessary.

The first part of the book commences with a description of the well-known types of primary batteries, ordinary electric bells and indicators with diagrams of their connections; and then goes on to describe the elementary details of telephones and small switchboard exchanges and their installation. Automatic telephone systems, which the author evidently considers are the coming ones in the future, are well described at some length, and include the Strowger, Betulander and Lorrimer.

Mechanical telegraphs, hydraulic telegraphs and many electric systems of various kinds, such as voltmeters, electromagnetic, alternating current and time-lag systems are all more or less described and illustrated. An electrical one has been devised by the author, for which he claims many advantages; it can be used with or without the addition of a telephone and only necessitates two wires between stations; it can also be arranged to give a permanent record of the messages transmitted.

Part II. deals with mine installations and is divided into two headings, mechanical and electrical systems, the latter being, in the author's view, by far the best for all purposes; it must be remembered, however, that they require very careful installation and constant skilled supervision. Descriptions are given of all sorts of systems of mine telegraphs, including an automatic telephone system; but the few pages devoted to the subject only allow of a very superficial treatment.

Part III. deals with railways. Descriptions are given of the telegraph systems in use on the French railways, such as the Max and Breguet, with diagrams of connections; as also of duplex and quadruplex working. Various apparatus for communicating between several stations by means of one wire are described at some length, different types of relays being used. As regards telephone systems, the author states that they are fast replacing telegraph systems, notwithstanding their disadvantage in not being able to record the messages; mention is also made of superposed telegraph and telephone lines, communication between passengers, &c.

The author evidently started out with the idea of making his book thoroughly practical and a sort of elementary text-book, and in this he has succeeded. It deals principally with French practice, and so would be found of use by anyone interested in the subject and desirous of knowing what our neighbours are doing.

Die Elektrischen Metallfaden-glühlampen. By C. Heinrich Weber. Pp. vi.+453. (Leipsic: Dr. Max Jaenecke.) M16.

This book of 452 pages contains an immense amount of information, but is already out of date. We find no account of recent progress. Gade's vacuum pump, the preparation of ductile tungsten by Dayton's swaging machine, the half-watt lamp, to these there is no reference. As a record of work previous to those developments it should be valuable.

SLOW CATHODE RAYS.

The discourse on "Experiments in Slow Cathode Rays," which Sir J. J. Thomson delivered at the Royal Institution on Friday evening, March 26th, was an account of the continuation of his researches on the "Production of Very Soft Röntgen Radiations by the Impact of Positive and Slow Cathode Rays," which he described at the Cambridge meeting of the Physical Society last June.* Having explained that visible light, electric waves and Röntgen rays were now regarded as members of the same family, though the wave-length of electric waves might reach all across London, whilst the λ of Röntgen rays was of the length of the radius of an atom, he pointed out that there was no gap in the continuity of the radiations on the red side of the spectrum. Electric waves had been produced of a wave-length of a few millimetres, and that length might further be reduced to a fraction of a millimetre, which was the length ($\frac{1}{2}$ mm.) of the extreme infra-red light waves of Rubens. There was a gap, however, of about seven octaves on the other side of the spectrum between the extreme ultra-violet light (the Lyman rays of the Schumann region) and the longest Röntgen rays. All those rays ionised gases (which visible light did not), and had strong chemical and physiological effects, but they were, unfortunately, stopped by very thin layers of air already.

In the more recent experiments Sir Joseph had made use of a Coolidge bulb for Röntgen rays. In that bulb the cathode was a spiral of tungsten, which was independently heated by the current from a storage battery of a few volts; cathode rays were then emitted by the spiral, and their velocity was increased by external force. The rays struck the anti-cathode, a block of tungsten obliquely cut off, which then emitted Röntgen rays. The vacuum in the Coolidge bulb was so high that the bulb did not show any green phosphorescence; but a phosphorescent screen showed the green phosphorescence even when held several feet away from the bulb, the intensity of the glow increasing as the particles were speeded up by increasing the potential of the bulb. The bulbs which Sir Joseph used were of a special kind. The target was attached to a long glass rod which could be turned like a tap in its ground-in joint, so that the same rays would strike either the front or the back of the target, and the target was made up of two plates of metals—*e.g.*, aluminium and copper—back to back. From the target the rays passed either into an ionisation vessel charged with sulphur dioxide, or into a second bulb fitted with a similar target; this second bulb was silvered inside, and served for the determination of the total number of electrons given out by the second target. Thus two methods of conducting measurements were available. In the first, ionisation method, the high vacuum in the bulb had to be shut off by a window from the gas pressure of the SO_2 in the ionisation vessel. That had been a matter of extreme difficulty. Very fine celluloid films, shining in interference colours, could be produced by dissolving celluloid in amyl acetate and pouring the solution on to a plate; but those films had cracked when drying until Mr. Everett (the lecturer's assistant) had poured the celluloid solution on mercury. Such a film was mounted in the neck between the ionisation vessel and the bulb, and it had been found that when the pressure of the SO_2 exceeded a certain small value ionisation was no longer observed. That was because the rays were already absorbed in the neck before reaching the metal plates in the ionisation vessel. The

* "The Electrician," Feb. 26, 1915, p. 710.

ionisation curve fell off rapidly, after attaining a maximum, as the pressure increased. When determining the total number of particles emitted no window was needed, a high vacuum being kept in the two vessels. In the neck between the two vessels the rays passed, however, through a gap, across which a P.D. of 600 volts could be maintained, and then fell on the target. The curve showing the connection between the P.D. and the number of negative particles produced indicated that a minimum potential of 15 volts was required to give rise to any appreciable radiation, and the experiments confirmed a view which Sir J. J. Thomson had expressed a few years ago. According to this view, the emission of characteristic Röntgen rays by an atom depended upon the ionisation of the atom; each ionised atom gave one unit of radiation, the kind of radiation depending upon the position of the electrons in the atom; and the radiation was apparently due to the return of the electrons to the atom.

Having exhibited a curve of the total energy of the radiations which ascended at increasing rate as the pressure was increased, Sir Joseph stated that, with the aid of the double-metal targets mentioned, he had been able to show that metals gave spectrum lines in this newly-explored range of soft radiations. The target in the first bulb was, say, aluminium; in the second bulb the rays struck, first, aluminium again, and then, after turning this target, copper. The ratio of the two effects (found by determining the total number of electrons) was 38·21. Thus a hump appeared in the curve, indicating that a characteristic aluminium radiation was being approached. The K and L radiations previously studied were of the hard kind, and they were connected with the inner, more deeply-seated electrons of the atom. These soft radiations came from the outer electrons, upon which the chemical properties of the atom seemed to depend.

BECK'S PROJECTOR ARC LAMP.*

BY W. WEDDING.

In this projector lamp, which is the invention of H. Beck, of Meiningen, the carbons are salted and are of smaller diameter than usual. For example, for a 150-ampere lamp, 16 mm. salted positive carbons are used instead of the 38 mm. pure or unsalted carbons previously employed. The positive salted carbon is arranged horizontally opposite an 11 mm. negative carbon, which may be unsalted, and is inclined upwards towards the positive. The feature of the lamp consists in that the highly heated ends of the two carbons are acted upon externally by a flat non-luminous flame, say from a spirit lamp, or by the products of combustion from this flame. A cooling effect may be said to take place, as the otherwise white hot ends of the carbons are darker in this arrangement. Thus the electric energy supplied is practically limited to the inner part of the positive carbon more especially. There is, consequently, a considerably greater heating of the crater, which, with a carbon of only 16 mm. diameter, burns in very deeply. This crater has the appearance of a small round white disc, the intrinsic brilliancy of which is considerably higher than that of the crater of ordinary arc lamps. The potential gradient at the arc, too, is higher—viz., 75 to 80 volts instead of 60 volts, as in ordinary projector lamps. The radiation is considerably more uniform and is steadier, which much facilitates photometry. During burning of the lamp both carbons are rotated by an electric motor, so as to render uniform both the consumption of the carbons and the effect of the heated gases from the spirit lamp on the exterior of the carbons. The current passes to and from the carbons through terminals arranged on the carbons close up to the arc. To maintain the crater at the focus of the parabolic mirror a selenium cell is employed, on to which the radiation from the crater is directed by means of a reflector when the crater does not stand exactly in the focus. The resultant alteration in resistance of the selenium causes the positive carbon to be adjusted ± 1 mm. by means of an electromagnet. Laboratory measurements of the intensity of the light, without a parabolic mirror, gave a candle-power of 100,000 to 150,000 hefner candles between 0° and 50° on the polar curve, as compared with 30,000 to 35,000 hefner candles in an ordinary lamp using the same current and ordinary unsalted carbons (+ 36 mm. and − 14 mm. coppered). In some experiments in the open air, with a parabolic reflector of 1,100 mm. diameter for a dispersion of 2°, at a distance of 2,073 metres on a clear night, the illumination for the axial rays was 100 lux and for the lateral rays 10 lux, against just under 20 lux for the axial rays and about 10 lux for the lateral rays when ordinary carbons were used in the same projector. At a distance of 8,400 metres the Beck projector gave 3·8 lux for the axial rays and 0·6 lux for the lateral rays, against 0·75 lux and 0·25 lux respectively when ordinary carbons were used. It is estimated that this lamp enables the diameter of the parabolic mirror to be reduced by one-third, and the candle-power to be five times as great for the same current.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Jahrgang 35, p. 901.

PHYSICAL SOCIETY.

At the meeting held on March 26, 1915, at University College, Gower-street, London, W.C., Dr. A. RUSSELL, M.A., Vice-President, in the chair, a Paper entitled

"The Change of Thermal Conductivity with Fusion."

by Prof. A. W. PORTER and Mr. F. SIMEON, was read by the former.

The change in question was determined for mercury and for sodium by finding the temperatures at different points of a cylinder of the metal contained in a glass tube. The ends of the cylinder were maintained at such temperatures that the metal was liquid half-way down its length, the remaining part being solid. The temperatures were taken by means of thermoelectric junctions inserted in narrow tubular depressions which had been formed in the glass tube by forcing a knitting needle down into the locally heated glass. The ratio of the thermal conductivity for solid and liquid was estimated from the slope of tangents drawn to the temperature-curve on each side of the melting point. The values of these ratios are of the same order as the ratio of the corresponding values of the electrical conductivities. The mean value for mercury is 3·91, and for sodium 1·31. A summary list is given of other data concerned with fusion.

Prof. O. W. RICHARDSON congratulated the authors on their satisfactory treatment of an important problem. The change of thermal conductivity with fusion had not, he believed, been attacked experimentally before. In listening to the reading of the Paper one felt impressed by the small amount of effort and the simplicity of the apparatus with which the authors had been able to solve what was generally regarded as a very difficult problem. This research, it was interesting to note, was one of the few of which the results agreed with the deductions from the elementary electronic theory.

Prof. F. G. DONNAN referred to the researches carried out at his suggestion by Dr. C. M. Stubbs on the radiation emitted by copper, silver and gold at high temperatures. These experiments showed that there was a marked change in the distribution of energy throughout the visible spectrum when passing from solid to molten metal, and pointed to some change in the electronic structure, or in the inter-electronic forces, occurring at the transition from solid to liquid. The complexity of the problem had, so far, prevented any mathematical treatment, but there appeared no doubt that results such as these, coupled with the discontinuities in thermal and electrical conductivity, would be of value in throwing light on the inner mechanism of the phenomenon of melting. Photometric measurements of the light radiated by polished plates of metals at high temperatures presented considerable difficulties owing to the tendency of the "flowed" surfaces to crystallise, but in spite of these difficulties Dr. Stubbs had clearly demonstrated the existence of an abrupt change in the radiation-spectrum on passing from solid to liquid in the case of certain metals.

Prof. PORTER, in reply, said that while isolated measurements of thermal conductivity of some substances above and below the melting point had been made by previous workers, in no case that he was aware of had sufficient data been obtained from which to deduce the sudden change which takes place on fusion. He was cognisant of the work of Dr. Stubbs, but had always thought the nature of the surface was of such importance in radiation experiments as to make it difficult, on account of crystallisation and contamination of the surface at high temperatures, to obtain conclusive results. He had forgotten at the moment the degree of consistency obtained by Dr. Stubbs, but if the results were more or less in agreement they would undoubtedly point to a change at the fusion point in the radiation emitted by the substances.

A Paper entitled

"An Instrument for the Optical Delineation and Projection of Physical Curves such as Hysteresis, Resonance and Characteristic Curves,"

was read by Dr. J. A. FLEMING.

This instrument is designed for projecting on to a screen or photographing on a plate such curves as magnetic hysteresis, resonance, or characteristic curves which can be performed slowly, or are non-periodic or non-repetitive. It consists of a base board on which is fixed a thin wooden ring wound over with one layer in close turns of insulated Eureka wire. The insulation on the top surface is removed so as to expose the wire. At the centre of the ring there is a pivot which carries a radial arm the end of which rubs on the bare Eureka wire. The ends of the Eureka wire are connected to a battery of n cells and the middle point of the wire is connected to a terminal, and also the centre of the radial arm to another terminal. The arrangement forms a circular potentiometer so that any required fraction of

the battery voltage can be produced in either direction between the last-mentioned two terminals. On the same base there is a rectangular mirror slung on a longitudinal axis, which mirror is tilted by a thread wound round the shaft of the radial arm of the potentiometer. Hence, if a ray of light from a mirror magnetometer or galvanometer is reflected to the tilting mirror and thence on to another fixed mirror with its axis at right angles to that of the other and thence to a screen, the spot of light will have two motions, one a horizontal, one proportional to the displacement of the radial arm, and, therefore, to the P.D. of the two terminals, and another vertical motion proportional to the deflection of the galvanometer or magnetometer. If, then, we place behind the magnetometer a long coil having a long iron wire within it and send a current through this coil which is supplied from the potentiometer travelling terminals, the spot of light will be actuated by two motions, one a horizontal one proportional to the magnetising force, and the other a vertical one proportional to the central flux density in the iron. It will, therefore, describe a hysteresis curve when the radial arm is moved to and fro cyclically through a certain arc or angle. In the same manner the instrument can be used to delineate characteristic curves of wireless detectors or rectifiers or other devices. By using a rotating condenser of variable capacity in place of the circular potentiometer, the instrument can be used for delineating resonance curves of wireless telegraph plants.

Prof. S. P. Thompson complimented the author on the simplicity and effectiveness of his apparatus, in which, as was characteristic of Prof. Fleming's devices, were embodied the results of much careful thought and painstaking experiment. He himself had often felt the desirability of having an arrangement by which one could vary the magnitude of an electric current in such a way that it should be directly proportional to some movement in a straight line. He had thought out various potentiometers in this connection, but the difficulty with potentiometers was the small current obtainable from them which was a disadvantage in magnetic work. Prof. Fleming had surmounted the difficulty of straight line proportionality by working round an axle instead.

Mr. W. Duddell joined in congratulating the author on the wide utility of his instrument. He recalled that when delivering his first lecture on the oscillograph he had been confronted with the problem of projecting the motion of a spot of light in two co-ordinates on a screen and had used a very similar arrangement to Prof. Fleming's. He also had a circular rheostat, but instead of a string connection to the mirror he had used a cam. This apparatus had worked very satisfactorily.

Prof. E. Wilson said that the apparatus was undoubtedly admirable for demonstration purposes, and one naturally wondered what degree of precision would be possible with it if applied to research. It appeared from the step and stair motion of the spot on the screen that the speed would be limited on account of the damping of the magnetometer or galvanometer employed.

Prof. S. W. J. Smith described a method which he had found to be simple and effective for tracing hysteresis loops. An ingenious rheostat had been devised by Prof. Morris in which by the rotation of a handle two contacts are made to slide in opposite directions along a resistance which is connected directly across the battery. The voltage at the contacts varies continuously between + the whole P.D. of the battery, being zero when they are at the middle. This rheostat is mounted vertically, and a white card of suitable size is attached to one of the moving contacts from which the magnetising current is taken. Then if the magnetometer spot is focussed on the card and its position marked as the current is varied the hysteresis loop is easily traced out. The Morris resistance satisfies some at least of the requirements mentioned by Prof. Thompson, though for the method he had described simpler rheostats of similar type could also be used.

Prof. Morris agreed that the question of getting a current which is proportional to some linear motion was a difficult one. Before arriving at the design of the rheostat mentioned by Dr. Smith he had tried various other types, including a circular one similar to Dr. Fleming's. The main point about his rheostat was the magnitude of the currents which could be taken from it. It would stand 20 amperes for a short time.

Mr. A. F. Hallimond pointed out that in taking the characteristic curve of a contact if the resistance of the potentiometer is comparable with that of the contact the linear relation between the motion of the slides and the P.D. the contact is destroyed. In his instrument, to which Prof. Fleming had referred, and which he hoped to describe more fully at a future occasion, it was possible to make the connections so that the linear relation always held.

Prof. Fleming, in reply, thanked the various speakers for their remarks, and said that he hoped to improve considerably on the apparatus, especially as regards the optical arrangements. When this had been done he thought it would be extremely accurate and quite suitable for research

[illegible]

"The Stability of Some Liquid Films,"

[illegible] and Mr. J. Rose-Innes, was read by the former.

The authors give a simple method of calculating the equilibrium [illegible] of revolution. They then consider [illegible] of displacement of three classes [illegible] the cylinder and the catenoid. The mathematics used is quite elementary throughout and the treatment is rigorous.

Prof. J. W. Nicholson thought the Paper was of considerable interest not only to teachers, as suggested by the author, but to physicists in general. He admired the geometrical construction given and the simple way in which the stability or otherwise of a particular form was determined.

A Demonstration of,

"The Green-flash of the Setting of an Artificial Sun,"

was given before and after the meeting by Prof. A. W. Porter and Mr. E. Talbot Paris.

A large disc of card mounted so that it can be slowly rotated has a hole, 1 in. in diameter, cut in it about 2 in. from the periphery. This is covered with red gelatine films and is illuminated from behind so as to form an artificial sun. The front of the disc is covered with white Bristol board and is moderately illuminated by a lamp in front. This sun is viewed through a rectangular aperture (4 in. wide) in a blackened board, the lower edge of the aperture serving as the horizon. When the disc is rotated the artificial sun sets and green after-images are obtained of characters varying according to the amount that the eye has been exposed to the bright sun. If the sun is not viewed until immediately before the complete setting the after-image represents simply the disappearing segment to which it is due. The authors claim that this phenomenon is what is often described as the green-flash at sunset, though they are ready to admit that other (but probably rarer) phenomena also go under the same name.

IMPROVEMENTS IN THREE-PHASE LOCOMOTIVES ON THE ITALIAN STATE RAILWAYS.*

BY MAURICE D'ASTE.

Forty three-phase electric locomotives of 2,000 H.P. with five axles have now been in use for the last four years on the Italian State Railways in the neighbourhood of Genoa, and on the section from Modane to Bardonèche. Another 75 locomotives of the same type have now been ordered, which embody certain improvements; a full description of them has been given in an article by MM. Vierole and Caminati, from which the present information is taken. The improvements in question consist of an increase in the capacity of the liquid starting resistance, of an alteration of the system at starting from a regulation giving a constant current to one giving a constant output of power, of an improved system of ventilating the motors, and of a decrease in the weight of the mechanical system of coupling rods and levers by which the power of the motors is transmitted to the driving wheels.

As for the new liquid starting resistances, the total amount of fluid contained in one of these is 700 kg., which is an increase of 40 per cent. as compared with the type originally used; further, the fluid is kept in circulation by a pump, which directs a flow of relatively cold water on the electrodes. The motor driving the pump is wound on the star system; the three connections forming the centre of the star are short-circuited by a contact which is closed mechanically as long as the starting resistance is in circuit, and which opens as soon as the liquid resistance is short-circuited. In consequence of these arrangements, the evaporation of the electrolyte is reduced within negligible limits.

In the first locomotives, the regulation at starting was such as to maintain automatically a constant current in the motors, the value of the current being determined by the position of the controlling lever. In the new machines, each position of the lever corresponds to a fixed output of power, and consequently to a definite acceleration, which is maintained constant throughout the period of starting. The voltage varies from 2,700 to 3,100, with a frequency of 15, and from 3,100 to 3,500, with a frequency of 15·7. This is a variation of 13 per cent.; the turning couple for the same current might vary by about 20 per cent. But this reduction of the turning couple is not of importance, as it is within the control of the driver to correct it. Nevertheless, in order to decrease the amount of work falling on the driver, a relay, which depends on the watts passing through it, has been substituted for one depending on the current in the automatic regulator. This new piece of regulating apparatus includes a small monophase motor, which constitutes the wattmeter. Its stator has a winding of thick wire, which carries current in the phase connected to earth (this winding consists of two turns which the speed controller puts in series when the traction motors are in cascade, and in parallel when the motors themselves are in parallel);

* Abstract of an article in "La Lumière Electrique."

its rotor has a winding of fine wire, and is fed through an auxiliary transformer from the two overhead phases of distribution.

The ventilation of the motors has been improved by passing the air through two separate channels in the motor. The mechanism by which the power is transmitted to the wheels has been greatly reduced in weight. This amounts to about 700 kg. for each motor, and practically neutralises the additions which have been made to the weights of other parts, such as are due to the increased capacity of the starting resistance and the use of resistances for heating purposes, which have been found to be necessary on the lines working in the district of Mont Cenis.

Forty locomotives of the improved type, working on the lines Busalla – Sampierdarena—Campasso—Busalla—Bardoneche, and Savona-Ceva, have been tested under working conditions. If it had been required to determine the heating of a 2,000 H.P. motor at 3,000 volts under working conditions, this would have required expensive and complicated apparatus. It was, therefore, determined to have recourse to a simpler, and less exact method. The heating in the iron and in the copper were determined separately by tests which lasted in each case for an hour. In the first test, the motor was driven without load at the normal voltage, and absorbed a current corresponding to the excitation and the friction losses. In the second test, the rotor was kept at rest, and the stator carried a current which was calculated from the known full-load current, the voltage being regulated in such a way that the desired current was obtained. The sum of the two heating effects, thus ascertained, was necessarily higher than the heating which would be obtained after a run at full-load for an hour, but it will at any rate give us a superior limit for the heating effect. These tests led to a figure of 55°C., as being the total rise in temperature, this being the sum of 51 deg. and 4 deg., which were found in the two tests.

Some tests have also been made on the section of the line from Pontedecimo to Busalla, on which the mean gradient is 2·65 per cent. and the maximum gradient 3·5 per cent. The test was on two locomotives coupled in series, each weighing 60 tons, and hauling 18 carriages, each loaded with 18 tons—*i.e.*, 500 tons in all. There were 16 such trains, reaching a speed of 45 km. an hour between Pontedecimo and Busalla, and a like number which reached a speed of 22·5 km. an hour in the opposite direction. The actual temperature of the apparatus has never exceeded 92°C., which corresponds to a rise in temperature of 65°C., although the artificial system of ventilation was suspended in two cases. The mean consumption of energy with regenerative control was about 67·61 kw. hour per ton-kilometre, and without regenerative control it was 81·19. Thus, it may be said that the actual absorption of energy in a daily run of 320 km. with a train load of 500 tons was 13,000 kw. hour. But by regenerative control 13·55 kw.-hours per ton kilometre were returned to the network, and this makes a total of 2,170 kw.-hours. The total work done by the motor amounts therefore to the sum of 13,000 and 2,170, partly absorbed and partly returned to the network. This amounts to 15,170 kw. hours, or to 3·8 kw. hours per horse-power installed. This corresponds to a daily service of 5½ hours—*i.e.*, 1,700 hours per year of 330 days—which is very heavy; on an ordinary suburban line the working extends to 1,000 or 1,200 hours per year of 360 days.

Some tests on the acceleration at starting have given the following results at speeds up to 22·5 km. an hour on a straight line with a gradient of 3 per cent. with a train consisting of 22 coaches, weighing in all 462 tons. The total duration of the test was 48 minutes, and the mean acceleration was 0·002 metre per second, and the mean tractive effort was 16 tons. The mean evaporation of water in the liquid rheostat was 2·3 kg. each time the train was started. Other tests where the train was started from rest and reached a speed of 45 km. an hour on a gradient of 3·55 per cent. gave results as follows: The line passed round curves having a radius of 400 metres, and there were two locomotives hauling 21 coaches with a total load of 500 tons. The mean duration of the test was 170 minutes, the mean tractive effort per locomotive was 11 tons, and the mean acceleration was 0·0012 metre per second per second.

Electrolytic Production of Oxygen.—Several factories in St. Louis (U.S.A.) are now engaged in the electrolytic production of the commercial oxygen gas. According to the "Engineer," the electrolyte used is a 10 or 15 per cent. solution of either caustic soda or caustic potash. As direct current traverses the electrolyte the oxygen given off at one electrode is collected and compressed, while the hydrogen given off at the other electrode is allowed to escape. In one well-equipped oxygen factory in St. Louis it is claimed that the oxygen company can produce about 3 cubic ft. of oxygen gas for each kilowatt hour used.

CORRESPONDENCE.

TRANS-CONTINENTAL TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the close of the article on the "Inauguration of Trans Continental Telephony" in your columns of February 26th, you state "Among the improvements to which the success of the trans-continental telephone service must be attributed, not the least important is the use of the so-called 'loading coils,' the invention of Dr. M. I. Pupin."

In this statement you are perfectly correct. But the trans-continental telephone service would have remained to-day where it was for 10 years after the purchase by the Bell telephone interests of the rights to the Pupin loading coil—an impossibility—were it not for the use by the American Telegraph and Telephone Co. of the De Forest Audion Amplifier as a telephone relay.

At their Demonstration Theatre, Liberal Arts Palace, Panama-Pacific Exposition, some 150 telephone receivers are connected, in any one of which the voice of the speaker in New York is heard actually louder than in ordinary city telephone service. The diffused music of a gramophone played in New York can be heard throughout the small theatre in San Francisco.

While withholding no iota of credit due to the masterful engineering skill involved in the design and construction of this epoch-making line, the fact still remains that it would all be lost labour were it not for the Audion amplifier. Telephone engineers for a generation had sought in vain to solve the repeater problem. It would hardly be exaggeration to state that hundreds of forms of repeaters had been suggested, tried and found wanting by the telephone companies. The majority of these attempts dealt with the old telephone receiver—carbon microphone combination, in an endless variety of forms.

These methods were always mechanical, and always, in the last analysis, failed. If sufficiently sensitive, such repeaters required continual adjustments by experts. Temperature changes upset the delicate balance of parts. Moreover, these devices "packed" or "fried," or were horribly microphonic, if amplifying sufficiently. As a matter of course, such a telephone repeater failed to perform the inconceivably difficult and delicate task asked of it, where current changes representing a fraction of a microwatt of electrical energy were required to push and heave pieces of iron and lumps of carbon. Dr. de Forest chose rather to deal with "ions," gas atoms or sub atoms—matter in its most tenuous form—what Sir William Crookes well styled the "fourth state of matter."

It is only fair, then, to point to the Audion amplifier as a device in a class distinctly alone; epoch-making in telephony as it is in wireless.—I am, &c.,

New York, March 30. F. M. WILLIAMSON, President.
De Forest Radio Telephone & Telegraph Co.

[We have taken the liberty of somewhat abbreviating the letter of our correspondent. ED. E.]

POLYPHASE COMMUTATOR MACHINES AND THEIR APPLICATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Shuttleworth's letter appearing in the last issue of THE ELECTRICIAN, will you please allow me to say that the theory given in my verbal statements was precisely the same as that printed in the "Journal," and, in an extended form, in my letter published by you on March 26th. I admit that there was one (but only one) incorrect sentence in the first proof of my remarks for the "Journal," and that was (I give it literally): "If the brushes are connected to points such as C beyond the star point the motor will run at speeds above synchronism." This statement was incidental and was not deduced from the theory. When I had developed the theory to its ultimate conclusions the statement was negatived, and the sentence was accordingly deleted, but the theory was in no wise interfered with.

It is unfortunate that Mr. Shuttleworth did not see the corrected proof of my remarks, but I can hardly be held respon-

sible for that. The argument has never been altered from the original form in which I stated it and the essence of it is quoted in my letter of March 26th, viz., "In order to produce a rotation in the same direction as the rotating field it is necessary that the auto-transformer apply a greater E.M.F. to the compensating windings than to the armature windings." It is this conclusion that Mr. Shuttleworth left unnoticed and directed his reply to a statement which was not deduced from the theory, and for this reason I suggested that the point of my remarks had been missed.—I am, &c.,

Birmingham, April 12. T. F. WALL.

THE "ELECTRICAL ENGINEER'S DIARY"

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As most of your readers will have understood the moral in the opening part of my review of the above work, it is unnecessary to labour the point for the benefit of your correspondent. Owing to the relatively small importance of the book, I gave only two examples of matter for which the copyright is claimed. Had I been so minded, I could have given two score illustrations. I am still of the opinion that the matter referred to is pseudo-copyright, in so far as it has been "borrowed" from other sources.—I am, &c. THE REVIEWER.

ELECTRIC WATER HEATING. We have received a letter from the "Journal of Gas Lighting" calling our attention to their reply to Mr. Geo. Wilkinson's letter, which latter appeared in our last issue. As this reply does not complete the correspondence, we think it best to refer any interested readers to the issues of our contemporary dated the 6th and 13th inst.

ON THE FORM OF COIL TO GIVE MAXIMUM SELF-INDUCTANCE FOR A GIVEN LENGTH AND THICKNESS OF WIRE.

BY R. E. SHAWCROSS AND E. I. WILLIS.

Maxwell* states that if the section of the coil is square the maximum self-inductance is obtained when the mean diameter of the coil is 3·7 times the side of the square section.

This result is based on the approximate formula

$$L = 1.7\pi a^2 n^2 \left(\log \frac{8a}{R} - 2\right)$$

where n = the number of turns of wire, a is the mean radius of the coil, and R is the geometrical mean distance of the transverse section of the coil from itself.

The above statement gives no indication of the effect on the self-inductance of a departure from the maximum conditions, nor does it show the effect of a variation of the shape of the section. We therefore thought it would be of interest to investigate the above points and at the same time to find the result of omitting the corrections of higher orders in the above formula.

If the coil have a mean radius a and a rectangular section of width b and depth c, the self-inductance may be expressed in the form

$$L = \frac{1.7^2 a^2 n^2}{b} K,$$

and if $l = 2\pi a n$ = the length of wire

$$L = \frac{l^2}{b} K.$$

If n_1 be the number of turns per cm.,

$$l = 2\pi a n_1 bc,$$

or

$$b = \frac{l}{2\pi a n_1^2 c},$$

and therefore, by substituting the value

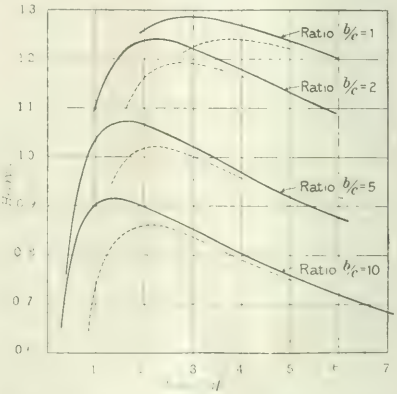
$$L = \frac{l^2}{\frac{l}{2\pi a n_1^2 c}} K = 2\pi a n_1^2 c l^2 K.$$

* Electrician, Vol. 13, [illegible]. Vol. 14, [illegible].

In this form it is evident that for any length and diameter of wire the self-inductance will depend on the relative proportions of the coils. It is, therefore, only necessary to work out the case for one length and diameter of wire and plot the result in terms of $2a/b$ for each section, then any other length or diameter will involve a change of scale but not of shape.

In the diagram such a set of curves has been obtained for a wire of 1 mm. diameter and 1570·8 (500π) meters long coiled up in different forms. The full lines represent the self-inductance obtained by Rosa's correction method,* the dotted lines are by Maxwell's approximate formula quoted above.

The curves show clearly the disadvantage of making the diameter too small. The maximum point indicated by Maxwell was not quite correct but erred on the right side. With regard to the section of the coil, the square is the most economical, and the greater the proportion of b to c the worse the result. Single layer coils, though having many other advantages, are, from the point of view of economy, the worst. The curve for this case is similar in shape to those shown and has a maximum at $2a/b = 2·5$, but it is not given as it would only apply to the particular length and diameter chosen.



SELF INDUCTANCE OF A COIL OF WIRE IN TERMS OF THE RATIO OF ITS DIAMETER TO LENGTH.

In designing a coil for any given purpose it will greatly facilitate obtaining the desired result, having chosen suitable proportions of the coil, that is, the ratios $2a/b$ and b/c, if the following proportionalities are made use of:—

$$n \propto a^2 n_1^2$$
$$l \propto a^3 n_1^2$$

resistance $R \propto l n_1^2$,

thus $L \propto a^5 n_1^4$,

or $L \propto a^2 R$.

ELECTRIC HEATING AND COOKING APPARATUS.†

BY S. M. HILLS.

The author first deals with the subject more or less historically, referring to the various types of electric heating apparatus, and notes certain features of design that are desirable in radiators. As a general rule, 2 watts per cubic foot of air space in the room should be allowed. Gas and electric heating are about equal when price of gas is 2s. 3d. and electricity is at ½d. per unit.

Passing to the question of electric cooking apparatus, the author expresses preference for an enclosed type of hot plate as against the radiant type. The maximum loading permissible for a boiling plate is 25 watts per square inch, and the minimum 20 watts per square inch, it being found that mica will not stand a prolonged temperature above 600° F. to 700° F. Connections to hot plates should be made of the same wire as the element, and are preferably insulated with fire beads.

* Bulletin, Bureau of Standards, Vol. VIII., p. 138.

† Abstract of Paper read before the Junior Institution of Engineers.

Ovens should be loaded to about 750 watts per cubic foot. In the north, preference is shown for heating elements at top and bottom, but in the south they are more generally fixed to the two sides of the oven. Connections are preferably carried out at the bottom of the oven, which is the coolest part. Preference is expressed for controlling the cooker by means of a switchboard distinct from the cooker itself.

The author emphasises the importance of earthing and the desirability of avoiding mixing apparatus, some of which is earthed and some unearthed. With regard to standardisation, the author thinks that it would be a great advantage to standardise hot-plates so that newer types could be fitted without difficulty, thus making it easy to keep a cooker up to date. For this reason the plug method of connection is a step in the right direction, provided that the plug pins are standardised in size and spacing. With regard to the relative amount of energy taken by the oven, the author cites a case in which the daily consumption of the complete cooker was 3·99 units. Of this quantity 2·52 units were used in the hot-plates and grill, the remainder being used in the oven. The oven is already a highly efficient device, and the greatest improvement is to be expected in the hot-plates.

In discussing the heating of water the author refers to the Ferranti heater, the efficiency of which is stated to be 85 per cent., and the British Electric Co.'s electric geyser, of which the efficiency is taken as 92 per cent. The load curve of the former, however, is very much to be preferred by supply authorities, who could, therefore, afford to give a much lower rate for energy consumed by this and similar apparatus.

In conclusion, the author states that manufacturers are gradually getting away from the idea of merely putting heating elements in the carcase of gas cookers, and are seriously studying the problem. Several American firms have produced thermostatically controlled electric ovens, but these have not found much favour in this country. The advantages of electric cooking are now being realised by commercial institutions, showing that the apparatus has passed beyond the experimental stage. There is still, however, much room for improvement, and supply authorities have been a little too keen on cutting the price of the apparatus. If more supply authorities offered electric energy at ½d. per unit for cooking purposes the demand for cookers and heaters would be considerably increased, and the price of apparatus could then be correspondingly reduced.

DISCUSSION.

The CHAIRMAN, in proposing a vote of thanks to Mr. Hills for his Paper, said that the use of electric cooking would depend largely on the cost of the apparatus. The price of gas given in the Paper was a fair average figure, but that for electricity seemed to be the exception rather than the rule. In his own district a much higher figure than 1d. per unit was charged. The utensils for use on electric hot-plates could not yet be obtained from an ordinary ironmonger, and if common patterns were used it would be necessary for the bottoms to be ground up on a surface plate.

Mr. W. A. TOOKEY, in seconding the vote of thanks, dwelt upon the cost of maintenance as a serious item. Also a switchboard in the hands of an Irish cook might not be a success. Large stocks of spare would also be necessary to replace broken elements, &c., but possibly some general system of maintenance would remove this difficulty. It seemed to him that with electric cooking the servants would need to be electrical engineers.

Mr. J. F. SHIPLEY thought the author might have included some reference to the industrial use of electric heating. He mentioned a hat factory at Luton in which 1,000 girls were employed and where a large number of electric irons were installed by him to replace gas irons. The latter gave rise to illness among the workers to such an extent that a temporary hospital on the premises was necessary. After electric irons were installed the health of the girls was greatly improved. He cited a somewhat similar experience in a works where ration tins were soldered with gas-heated irons and where electric soldering irons were introduced with success. He referred to the standardisation of the terminals of cooking apparatus in Germany as having been accomplished in 1912, so that in this matter German electrical engineers had had a year or two's valuable experience. He recommended a flat iron competition on a large scale, remarking that irons obtained in 10,000 loads could be put out at moderate prices, and a 330 watt iron could be used on the lighting circuit.

Mr. WATERS, of the Gas, Light & Coke Co., criticised the Paper in several details, and remarked somewhat superciliously that the example given of electric cooking in a household gave him the impression that the family had very little to eat. He generally dilated upon the infinitely better results to be obtained both in heating and cooking by means of gas.

Mr. F. S. GROGAN said that criticisms were only of value when they were advanced by those who had experience of electric cooking apparatus. He found that cooks who were initially opposed to the electric system, after a short trial were delighted with the results and dreaded the idea of reverting to gas. All cookers should be tested at high pressure at the maker's works in order to reveal any inherent wiring faults. He disagreed with the author that the bright oven was [illegible] to make than the lagged, and pointed out that in its modern form it was provided with an air-jacket. He inquired as to the results obtained with plug connections for hot-plates, and also he recommended that lock nuts should be provided on all connections, specially on alternating-current circuits. Standardisation of apparatus was desirable, and he thought that if the makers would get together some advance in this direction could be made. Hot water could be obtained electrically if only required in small quantities. He recommended the coke boiler where considerable quantities of water were demanded at regular intervals. He thought that lining out was the correct solution of the cooking problem, and in his experience 90 per cent. of the domestic cookers, with which he had had to deal, were installed in houses of an average rental of £30 per annum.

Mr. CROSBIE said that the defects in lamp radiators were probably due to the case being made by art metal workers who had no electrical experience. Referring to the results of electric cooking in his own house he paid a penny per unit, and with four in family he was quite satisfied with paying 4d. per day for electrical energy. He had solved the earthing problem by running a No. 8 galvanised iron wire through the house and teeing on to this from the various pieces of apparatus. The wire was earthed on the water pipe. If the suggestion held good that for electrical apparatus servants required to be electrical engineers, then with gas apparatus they would need to be chemists. In regard to water heating efficiency was not the only factor: convenience must be considered. In his own case, with a 40-gallon Ferranti-type heater, the electrical energy cost him £5 per annum, and he could get all the hot water that he required.

Mr. TWIGG (Davis Gas Stove Co.) said he had not read the Paper, but disagreed with Mr. Grogan's reference to electric cooking as a better form of cooking than anything else. In his experience at Luton, where both gas and electricity were cheap, he did his cooking, heating (five gas fires) and obtained hot water from a gas geyser, for an exclusive cost of 1d. per day, a figure which he considered electricity could not at present approach.

Mr. HILLS, in reply, said that the tariff of ½d. per unit was frequently referred to as though it were the only charge. There was, in addition, a fixed charge, based on the assessment value of the property. The question of spares, in the case of gas cookers, was solved by each company using only one type of oven or fire in each district, and he advocated a similar system with electrical apparatus. He had no trouble with plug connections on hot-plates during a number of years' use. His experience in the installation of cooking apparatus was largely amongst what would be considered humble dwellings, and he found that the artisan class, once they became acquainted with electric cooking apparatus, were unwilling to relinquish its use even though vexatious troubles and breakdowns were experienced. Owing to the lateness of the hour he reserved a fuller reply for the "Proceedings" of the Institution.

ON THE CRITERION OF STEEL SUITABLE FOR PERMANENT MAGNETS.*

BY SILVANUS P. THOMPSON, D.Sc., F.R.S.

In order that a steel shall be suitable for the making of permanent magnets, the prime requisites are that it shall have a large remanent magnetisation and a high coercive force. These two qualities are

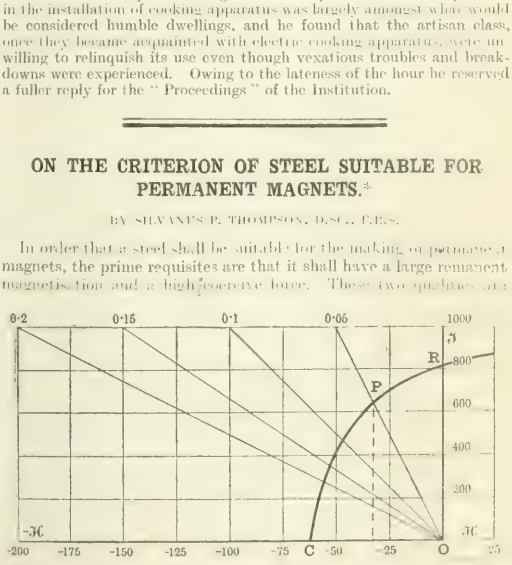


FIG. 1.

independent of any question as to form. According to the evidence to the present time, the coercive force of any given specimen of steel is independent of the form, provided that it has been subjected to a sufficiently great magnetising force, the self-demagnetising coefficient affecting the degree of remanent magnetisation, but not affecting the degree of coercion with which that residuum is held by the steel.

When any specimen of steel is subjected to a cycle of magnetisation so as to obtain its hysteresis loop, the characteristics of the loop provided the maximum magnetising force were sufficient to enable a practical saturation to be attained during the magnetising

* Paper read before the Physical Society, slightly abbreviated.

process—suffice to form a judgment as to its suitability for the purpose of making permanent magnets. A field of intensity $\mathcal{H} = 500$ is amply sufficient for any kind of steel; and for any but the very hardest a field of $\mathcal{H} = 250$ is adequate. Fig. 1 will make the matters at issue plain. It represents, for a fine quality of magnet steel, the descending branch of a hysteresis loop, the ordinates being values of $\mathcal{J}$, the "magnetisation" (magnetic moment per cubic centimetre) and the abscissæ the values of $\mathcal{H}$. The value of $\mathcal{J}_{rem.}$, the remanent magnetism (for a ring or a very long bar), is the ordinate OR, and the coercive force $\mathcal{H}_c$ is the abscissa OC. In this steel $\mathcal{J}_{rem.} = 808$, and $\mathcal{H}_c$ is 63. The lines which slope upward to the left from the origin represent graphically, by the respective tangents of the angles of their slope, the values (to a scale of $\frac{1}{10}$) of the coefficients of self-demagnetisation for bars of about 10, 12, 15, 25 and 35 diameters' length respectively. The abscissa at the point P, where the sloping line crosses the curve, shows the residual magnetisation for a bar that is 25 diameters long which has a coefficient of self-demagnetisation of about 0·05. At this point the residual magnetisation is reduced to about ·640, and the demagnetising force will be about $640 \cdot 0{\cdot}05 = 32$.

For all specimens of steel the hysteresis curves will be of the same generic form; but the two chief parameters OR and OC, that is $\mathcal{J}_{rem.}$ and $\mathcal{H}_c$, will differ. The author gives a table† showing the values of $\mathcal{J}_{rem.}$ and $\mathcal{H}_c$ which have been found by various observers—Ewing, Du Bois and Taylor Jones, Mme. Curie and others—for a number of different brands of iron and steel. The highest value found for $\mathcal{J}_{rem.}$ is 900, in a specimen of unquenched Allevard steel (carbon content 0·59 per cent., tungsten content 5·5 per cent.); but it had only 26 for $\mathcal{H}_c$. The highest value of $\mathcal{H}_c$ is 85, for a molybdenum steel (carbon 1·25, molybdenum 3·36 per cent.), but its $\mathcal{J}_{rem.}$ was only 370. No steel has yet been found which comes up to the quite possible ideal of having $\mathcal{J}_{rem.} = 800$, with a coercive force of $\mathcal{H}_c = 80$. The best magnet steel will have the values of both parameters high. For short magnets where the self-demagnetising influences are great, it is more important that $\mathcal{H}_c$ should be high, than that $\mathcal{J}_{rem.}$ should be great.

Recently the question of the suitability of steels for permanent magnets has been discussed by Mr. J. A. Mathews, in the "Proceedings" of the American Society for Testing Materials, Vol. XIV., p. 51, 1914, who suggests that a new criterion of magnetic hardness should be framed upon the basis of the ratio between $\mathcal{B}_{rem.}$ and $\mathcal{H}_c$, or on the inverse ratio of $\mathcal{H}_c \div \mathcal{B}_{rem.}$, preferably the latter, as the magnetically harder steels then have the higher number. He proposes to call this ratio the "permaverace." Mr. J. R. Ashworth has made precisely the same suggestion.

Now, ever since Hopkinson's determinations 30 years ago, it has been supposed that for purpose of making permanent magnets the best material would be that for which both $\mathcal{J}_{rem.}$ and $\mathcal{H}_c$ should be high; and for which the product $\mathcal{H}_c \times \mathcal{J}_{rem.}$ was a theoretical maximum. To decide between this view and the new suggestion to take their ratio as criterion, instead of the product, the values of $\mathcal{H}_c \div \mathcal{J}_{rem.}$ and of $\mathcal{H}_c \times \mathcal{J}_{rem.}$ have been added to the table given. The results are illuminating. Two of the materials—viz., molybdenum steel and chilled cast iron—have the ratio $\mathcal{H}_c \div \mathcal{J}_{rem.}$ nearly equal, viz., 0·23 and 0·243 respectively. But their products $\mathcal{H}_c \times \mathcal{J}_{rem.}$ are 31,400 and 11,530 respectively! And as molybdenum steel is 1·7 times higher than chilled cast iron in the quantity of magnetism it retains, it follows that to produce two magnets of equal pull of these materials the cast-iron one must have $1{\cdot}7 \times 1{\cdot}7 = 2{\cdot}87$ times the cross-section of the molybdenum steel; and, even then, would have only 0·6 as great a coercive force! Or, again, according to the proposed criterion of Mr. Mathews and Mr. Ashworth, annealed manganese steel, which has a ratio of 0·572, should be six times as good as Remy tungsten steel, which has a ratio of 0·096. But the manganese steel has a remanence of only 43, compared with 800 for the tungsten steel—that is, 18½ times as little—and to make the two magnets of equal power the magnet of manganese steel would have to be constructed with a sectional area 314 times as great as that of the tungsten steel! The respective values of the product $\mathcal{H}_c \times \mathcal{J}_{rem.}$ for these two steels are 1,054 and 61,600 respectively; or, as about 1 to 60. If we have to choose a criterion between manganese steel, which is almost non-magnetic, and the Remy steel, which is one of the finest magnet steels known, we should choose the one which makes out that the Remy steel is 60 times as good as manganese steel, rather than that which pronounces manganese steel to be six times as good as Remy steel.

It was suggested above that a possible rule for permanent magnets would be that which would have $\mathcal{J}_{rem.} = 800$ with $\mathcal{H}_c = 80$, i.e. the ratio is 0·1 and the product is 64,000. I believe the highest $\mathcal{J}_{rem.}$ yet recorded is Mr. Mathew's value of $\mathcal{J}_{rem.} = 1{,}030$. This was for a chrome steel that had $\mathcal{H}_c$ only 22. The highest value of $\mathcal{H}_c$ yet observed is Mme. Curie's figure of 85 for a molybdenum steel; but its $\mathcal{J}_{rem.}$ was only 370. If it were possible for metallurgists to produce steel with $\mathcal{J}_{rem.}$ 1,000 and $\mathcal{H}_c$ 100, the value of the ratio would still be only 0·1; but the product would then be 100,000, and for equal power the sections and weights might be reduced to about 64 per cent. of those of our best permanent magnets of to-day. Or, for given section and weights, magnets made of this ideal steel would have about 24 per cent. greater pull, and 20 per cent. greater coercive force.

† Op. cit., p. 55, in the author's Paper on the "Magnetism of Permanent Magnets," Journal of Institution of Electrical Engineers, Vol. L., p. 89, 1913.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery Lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

6,421 BERRY. Means or apparatus for indicating when the flow of current in an electric circuit is interrupted or varied.
A current indicator in which the thermal conductor comprising one or more loops or turns of a conductor is constrained to move in a definite path upon or within a base or support of insulating material, as by being confined within a recess in said base or support or between pins or blocks, one end of the conductor being fixed and the other being free and arranged by the aid of multiplying means to operate indicating means for giving the required indication.

6,428 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.) Telephone systems.

6,659 MARTIN. Telephone systems. (17.3.13.)

6,918 READ. Electrical generating and control systems.
An electrical generating and control system, having a prime mover, two dynamo electric generators, or generator elements, a secondary battery, a consuming circuit and switching devices for enabling the dynamo or dynamos to be run as a motor or motors to start the prime mover and thereafter to be driven as electric generators, one of which supplies the consuming circuit, while the other charges the battery, and automatic switches of such a nature that when the dynamos or dynamo elements are driven at the requisite speed one switch operates to transfer the consuming circuit from the battery to one dynamo, while the other switch operates to render the second dynamo effective for charging the battery.

6,970 CRAIG. Silent and balanced electromagnetic step-by-step driving or synchronising mechanism, particularly applicable to the control of a system of time-indicating units.

7,513 GREEN. Telephone switches. (Cognate applications, 10,904/14 and 13,281/14.)

8,010 CHEBROU & LEMP. Electric switches.

13,348 W. T. HENLEY'S TELEGRAPH WORKS CO. & SAVAGE. Electrically-heated vulcanising apparatus.

13,523 WESTERN ELECTRIC CO. (Woodward, acting for Western Electric Co.) Telephone exchange systems.

13,960 HOLDAWAY & ANDERSON. Electric wire connection.

18,747 SMITH. Automatic current cut-off for electrical appliances.

18,809 MELLERSH-JACKSON (POSEN). Pocket electric flash lights.

19,976 TESLAN & L[illegible] ELECTRIC WIRE CO. & S[illegible]. Machine for the insulation of electrical conductors.

20,239 B[illegible]. Electric regulating rheostat.
An electric regulating rheostat comprising a main rheostat and a sub-dividing rheostat having their fixed contacts arranged in two concentric circles, and spur gears operatively connecting the movable contacts or bridge pieces of the rheostats.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

March 15, 1915.

4,045 & 4,046 A. P. LUNDBERG, P. LUNDBERG, G. C. LUNDBERG, P. A. LUNDBERG & PEGG. Electrical switches.

4,054 ROYCE & ROLLS-ROYCE (LTD.) Electrical turning gear for starting internal-combustion engines.*

4,079 ROUTIN. Collectively actuating and controlling alternating-current motors (Addition to 735 13.)*

4,083 READ & THOMPSON. Electric clocks.

4,087 TYLER & BEERE. Regulating the voltage of dynamos.

4,097 LILIENFELD. Production of Röntgen rays. (15/11/13, Germany.)*

March 16, 1915.

4,110 BROUGHTON. Connecting electrical conduits to their fittings.

4,130 EBERHARDT & SHORT. Interchangeable gas and electric light fittings.

4,138 TERRY & SONS & TERRY. Electric conductors, cables and the like.

4,144 HOLT & SMITH. Oil circuit-breakers.

4,149 SYKES INTERLOCKING SIGNAL CO. & TARRANT. Railway and like signalling.

March 17, 1915.

4,172 W[illegible] & RESHTON. Automatic internal-combustion engines and electric motors.

4,203 B.T.-H. CO. (G.E. Co., U.S.) Controlling mechanism for electric vehicles.

4,206 FORDER. X-ray plate holder for absorbing secondary rays.

4,209 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co., U.S.) Rheostats.*

4,222 AKT.-GES. BROWN, BOVERI ET CIE. Motor and like control. (19,3/14, Germany.)*

4,229 WADE. (Joseph Robert Leeson, U.S.) Electrical coils and methods of winding the same.*

March 18, 1915.

4,253 GREEN & [illegible]. Electrical [illegible] appliances.

4,263 BABCOCK & WILCOX (LTD.) (Babcock & Wilcox Co., U.S.) Air-cooled tanks for electrical apparatus.*

4,271 WILLIAMS. Aero-electric combined marine and aerial torpedo.

4,285 HULTMAN. Automatic telephone exchange systems. (18.3.14, Sweden.)*

March 19, 1915.

4,331 MURRAY. Motor control.

4,332 MURRAY. Phonic wheel motor for distributors of electric telegraphs. (Addition to 3,436 14.)

4,348 E[illegible] & G[illegible]. Thermic telephones (24,3/14, Germany.)*

March 20, 1915.

4,378 BALSBRA. Telegraphic printing apparatus.

4,411 W[illegible]. Regulating [illegible].

4,412 LANCHESTER. Telephone and like apparatus.

4,430 B[illegible] & W[illegible]. Protective [illegible] alternating-current systems.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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THE "POINT FIVE" TARIFF.

We hesitate to enter into explanations of a matter which we had imagined could not fail to be quite clear, especially to those who "live and move and have their being" in the electrical industry. Just now such matters of domestic electrical interest as electric cooking, heating and water heating are being freely discussed. Three Papers on the subject have been read and debated upon during the past three months, and many important details drawn from extensive experience of the apparatus have seen, for the first time, the cold light of day. The danger of cookers, the problems of wiring, earthing, switchboards, lagged and unlagged ovens, &c., have provided matters for criticism on the part of those fitted and unfitted to sit in judgment upon them, and for reflection by manufacturers and central station engineers. The controversy has also extended to the rates and methods of charging for electrical energy on domestic premises, as it quite fittingly should. References were frequently made to the Norwich system of charging, and to that special form of it which has become inseparably associated with the Point Fives Association. This enterprising body was formed shortly after the Harrogate I.M.E.A. Convention in 1912, and, though the membership is still quite moderate, a large amount of useful work has been done to popularise the domestic electric service. After nearly three years of missionary effort, showing encouraging results, it is a little surprising to find there is still a misconception as to the nature of the tariff which is advocated by the Association. Even among men in the electricity supply business there are to be found those who have not yet grasped the fundamental principle of the special domestic tariff. At the risk of being considered punctilious we would like to repeat that the Point Five tariff is usually an *inclusive* domestic rate. There is a primary charge, based upon the assessment of the residence (sometimes with an allowance where there is a large garden), and a secondary charge of ½d. per unit used. The rate was adopted to obviate the use of a number of meters upon the consumers' premises, and thereby to simplify the method of supply. Obviously, where but one meter is used, the service and the tariff apply to the lighting, heating, cooking and other circuits in the house. In other words, the consumer who adopts the tariff of the Point Fives Association obtains a supply, not only for his subsidiary uses of the service, but for his lighting as well.

In his reply to the discussion on the Paper on "Electric Cooking and Heating" before the Junior Institution of Engineers on Monday last, Mr. S. M. Hills expressed the opinion that the use of the term ½d. per unit was misleading, because it was so often made without reference to the primary charge. But while recommending that engineers should be frank and above board in the matter, advice which does not seem to us to be necessary, Mr. Hills himself did not emphasise the fact that, although there is a primary charge in addition to the metered price per unit, that charge is inclusive of the lighting supply. The Point Five tariff is not, as is often hinted by the gas interests, a subtle method of deceiving the public. It is a straightforward scheme whereby a domestic supply of electrical energy for *all* purposes is given, not only to existing consumers who formerly used the service for lighting only, but to those who have not hitherto been connected to the mains. When, therefore, the rates for electrical energy are discussed in connection with heating and cooking apparatus, and the price of ½d. per unit is mentioned, the extra primary charge should also be introduced, but always as also covering the lighting supply. The gas interests may find it convenient to refrain from detailing all these important facts; indeed, they seem to take a delight in accusing electrical men of deliberate intent to deceive the public where residence tariffs are under consideration. The [illegible] clearly stating the tariff.

The foregoing [illegible] charging based upon the [illegible] some other price per unit than 1d. A number of towns charge ¾d. per unit plus a [illegible] ment, and in the [illegible] lighting supply.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week April 5, 1915, to April 10, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]

£331. *U.S.A.:* Carbon candles, £92; elec. machinery, £80; unenumerated £172. [illegible] £834. [illegible] unenumerated, £90. *Italy:* Wire 34 pkgs.; Elec. machinery, £446.

[illegible]

EXPORTS.

[illegible]

Machinery, £697; wire and cable £710; unenumerated, £2,283. *Wellington:* Machinery, £696; wire and cable, £2,439; unenumerated, £992. *Adelaide:* Elec. machinery, £387; unenumerated, £464. *Brisbane:* Wire and cable, £1,915; unenumerated, £81. *Freemantle:* Elec. machinery, £120. *Hobart:* Unenumerated, £153. *Dunedin:* Glow lamps £80; *Christchurch:* Unenumerated, £46. *New Plymouth:* Unenumerated, £23. *Perth:* Unenumerated, £448. *Rockhampton:* machinery, £111. *Townsville:* Machinery, £89; unenumerated £[illegible]

[illegible] machinery, £48; telegraph material, £107; unenumerated, £224. *Port Elizabeth:* Machinery, £84; unenumerated, £163. *Cape Town:* Machinery, £42; unenumerated, £599. *Napier:* [illegible] £379.

PORT SAID.—Machinery, £209. *Secorde:* Unenumerated, £14.

MALTA.—Unenumerated, £16.

[illegible]

CHINA.—*Hong Kong:* Elec. fans, £58; unenumerated, £12

[illegible] £1,514; unenumerated, £2,707. *Calcutta:* Elec. machinery, £2,859; Telegraph material, £27; wire and cable, £255; unenumerated, £703. *Madras:* Machinery, £30; Telegraph material, £855; wire and cable, £428; unenumerated, £353. *Singapore:* Elec. machinery, £70; unenumerated, £175. *Karachi:* Elec. machinery, £253; unenumerated, £78. *Shanghai:* Unenumerated, £21. *Port Swettenham:* Elec. machinery, £132.

[illegible]

FRANCE.—*Bordeaux:* Elec. machinery, £707; wire and cable, £626; unenumerated, £90. *Havre:* Wire and cable, £3,061; unenumerated, £17. *Dieppe:* Unenumerated, £18. *Boulogne:* Unenumerated, £317. *Treport:* Unenumerated, £22.

SOUTH AMERICA.—*Buenos Ayres:* Elec. machinery, £20; wire and cable, £950; unenumerated, £180. *Monte Video:* Unenumerated, £13. *Santos:* Unenumerated, £110.

GREECE.—*Piraeus:* Unenumerated, £185.

HOLLAND.—*Rotterdam:* Elec. machinery, £350; wire and cable, £165; unenumerated, £582. *Amsterdam:* Unenumerated, £92.

U.S.A.—*New York:* Machinery, £317; *Philadelphia.* Unenumerated, £30.

JAPAN.—*Yokohama:* Unenumerated, £837. *Kobe:* Unenumerated, £51.

WEST INDIES.—*Bermuda:* Unenumerated, £55. *Honolulu:* Wireless telegraph material, £102.

FOREIGN GOODS DUTY (paid and free).

Adelaide: Unenumerated, £20. *Bankok:* Unenumerated, £29. *Bombay:* Unenumerated, £90. *Jamaica:* Unenumerated, £34. *Odense:* Unenumerated, £48. *Port Elizabeth:* Unenumerated, £90. *Sydney:* Unenumerated, £69. *Wellington:* Unenumerated, £10.

IN TRANSIT.

Sydney: Elec. lamps, £490.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The address of Mr. James G. Lorrain, consulting engineer and patent agent, has been changed to 9, John-street, Adelphi, London, W.C.

The Miller Electrical Co., 37, S. Strand, London, W.C., has been formed by Mr. P. M. Miller for dealing in dynamos, motors, &c., of British manufacture.

Mr. W. E. Pott, late general manager of Messrs. Krupkat & Jacoby and British Graetzin Light (Ltd.), has been appointed manager of the electric vehicle department of Messrs. J. S. Hird & Co., 6, Eldon-street, London, E.C., representing the Interstate Electric Novelty Co. of New York, Chicago and San Francisco.

Sale by Auction. Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by public auction at the Royal Arsenal, Woolwich, on Thursday, the 22nd inst. (by order of the Secretary of State for War) at 11 a.m., some unserviceable and obsolete stores, including quantities of cast and wrought iron, brass, copper, mixed metal, copper nickel, and enamelled [illegible] wire, cable, [illegible] cable, rubber, tools, light railway [illegible] and weights &c. The lots may be viewed at the Royal Arsenal, Woolwich, and at Sayes Court, The Cattle Market, Deptford, S.E., on Monday, Tuesday and Wednesday previous to and on morning of sale. Catalogues from the War Office, Whitehall, the Ordnance Office, Tower, and the Ordnance Office, Royal Arsenal, Woolwich. See also [illegible]

Plant for Sale. Advertisement [illegible] for sale [illegible] 75 volt d.c. 800 k.w. steam [illegible] compound Corliss engine. Dewey Pneumatic [illegible] engine plant &c.

Patent Development.—The owner of patent No. 9,000 of 1911, for "Improvements in and relating to Electrical Measuring Instruments" and the owner of patent No. 19,116 of 1911, for "Improvements in and relating to the Manufacture of Electrical Coils," desire to make arrangements for exploiting same in this country. Particulars from Mr. A. E. White, Patent Agent, 88/90, Chancery-lane, London, W.C.

Alien Enemy Patents.—The patents No. 108,959, of 1901, and 24,439, of 1902, relating to the Goldschmidt process of welding, have been avoided on the application of Messrs. W. L. Turner and H. A. Blackwell.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against Albert Whiteley, electrical and mechanical engineer, Tudno Works, Tudno-street, Llandudno, are to be sent by April 28 to Mr. L. H. Jones, Crypt-chambers, Chester.

A meeting to receive an account of the winding up of the Premier Lighting & Engineering Co. (Ltd.) will be held at 4, Charterhouse-square, London, E.C., on May 14.

A meeting to receive an account of the winding up of Metalite (Ltd.) will be held on May 20, at 9.10, Pancras-lane, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Carnarvon. Last week the Council considered a letter from the National Electric Construction Co. referring to the difficulty which would arise if (as was anticipated) the L.G. Board should refuse to sanction loans for further extensions, and suggesting that the Corporation should agree to transfer the electricity works to the company or to a subsidiary company, on terms to be arranged.

The Town Clerk reported that the suggested transfer was ultra vires, and the borough accountant was instructed to reply to the company to that effect. It was resolved that applications be made to the L.G. Board for sanction to the borrowing of £500 to defray the cost of mains extensions.

Hammersmith (London).—The Treasury has allowed the Borough Council to take up a loan of £10,000 for extensions of the electricity undertaking.

Hereford.—The Electric Light Committee recently recommended that application be made for sanction to a loan of £8,000 for extensions of the electricity undertaking, but on the report of the Finance Committee the matter has been deferred by the Corporation.

Hove.—The borough electrical engineer (Mr. C. B. Smith) has reported upon the tenders received for the supply of a turbo-generator and a battery of accumulators.

Mr. Smith stated that the best suited for the Council's requirements was a turbine connected with two generators in tandem, and for that type of machine five tenders were received. When instructions were given to obtain tenders it was contemplated that a delivery could be obtained so that the new plant could be working in time for the next winter's load, but Mr. Smith is of opinion that, owing to the war, the plant could not possibly be got to work before the middle of next December. The prices are 20 per cent. higher than they were three months ago, but the advantages to be gained from economy in working and the savings to be effected in coal cost, outweigh the disadvantages of the increased first cost, and that, had it not been for the Government's request to defer expenditure at present, he would have unhesitatingly advised the acceptance of a tender.

The Lighting Committee has resolved to postpone the installation of the additional turbo-generator plant and to inform the tenderers accordingly.

Nine tenders were received for the battery of accumulators, and Mr. Smith recommends the acceptance of the Tudor Accumulator Company's tender (at £701), in respect of which the company also offered to maintain the same for 10 years at £47 per annum. In connection with the battery it will also be necessary to have two sets of battery boosters. Mr. Smith suggests that separate prices for the dynamos and motor and switchgear be obtained, which would bring the cost of each unit below £100, and would enable the battery to be ready for work in 12 weeks from the date of the order. The new battery should be got to work as soon as possible, as it would enable the Council to give a better distribution of electrical pressure and also effect a good economy in working.

The Committee recommends that, notwithstanding the recommendation of the Government to curtail expenditure, the installation of the battery is of sufficient importance to warrant the expenditure, and recommends the Council to accept the tender of the Tudor Accumulator Co., and to authorise the Committee to obtain and instal the two sets of boosters, &c.

Sheffield.—The Electric Supply Committee is to appoint an assistant mains engineer at £100 a year.

Mains are to be extended in various parts of the city at a cost of £450.

The Electric Supply Committee has received an application from the military authorities for a supply of current to the South Yorkshire Asylum, Wadsley, outside the area of supply, and it is proposed to apply to the Board of Trade for sanction to the supply being given.

Southend-on-Sea.—The Council have received sanction to a loan for certain works, including the erection and equipment of a sub-station.

Torquay.—The Council have decided to press the L.G. Board for sanction to borrow £1,800 for alterations and extensions at the electricity station and the acquisition of new offices and stores.

The Board have intimated that they cannot sanction the loan at present, but, if arrangements were made for completing the purchase now, it would not prejudge an application later for the loan.

Mr. KERSWILL stated at the last meeting of the Council that it was impossible to carry on the work of the electricity undertaking without the proposed extension, and the offices and stores would be convenient for all time.

Walsall.—The L.G. Board has sanctioned the borrowing of £16,700 for the electricity undertaking, viz., £13,300 for mains, £500 for services and £2,900 for transformers.

The Electricity Committee has settled a scale of charges to be made when a consumer is re-connected after disconnection owing to non-payment of account, &c.

In view of the representations made by the Board in favour of reducing capital expenditure, the Committee has decided that further extensions of current which are not required by manufacturers for war purposes will, for the present, be only carried out on the applicant providing the cost of the service. Main extensions are to be carried out at a cost of £420, and the electrical engineer (Mr. H. A. Howie) has been instructed to negotiate for a site for a sub-station in the Bescot district.

Wrexham.—The Council propose to take steps to extend the area of electricity supply, and the Rural Council has been asked to appoint representatives to confer with the chairman of the Electricity Committee, the Mayor and Councillor Stanford on the question of considering the area to be included.

The Electrical Contractors' Association have inquired, in regard to the proposal to undertake the wiring of premises and the sale of fittings, whether the Council have special statutory authority to engage in such work.

GENERAL.

Bexley.—At last week's meeting of the Council the principle of purchasing out of revenue a motor vehicle for the electricity department, estimated to cost £140, was agreed to.

It was also decided to instal a 50 kw. rotary converter at a cost of £350, of which £140 would be provided out of loans already sanctioned and the remainder out of revenue. Great economies were promised when the machine was installed.

The engineer reported that four men on the traffic staff were ill and two more had left, and consequently the full tramway service had not been maintained.

Boston.—At the meeting of the Rural Council last week the clerk (Mr. H. Smith) reported that the Board of Trade had decided to grant a Provisional Order for the supply of electricity to Boston and certain parishes in the rural district.

The clause desired by that Council providing for laying down mains within three years from the commencement of the order was included, but it was announced on behalf of the Board of Trade that the order would not come into operation before the close of the war, the object being to prevent capital being locked up in a private enterprise. The promoters have not settled whether the generating plant is to be in Boston, Skirbeck or Skirbeck Quarter.

Mr. W. F. HARWOOD, one of the deputation who waited upon the Board of Trade, said their representations received every consideration, and surprise was expressed by the Board officials that an area with 20,000 inhabitants such as was affected by the proposal, should be without a public supply of electricity.

Cahirciveen (co. Kerry).—The Rural Council have authorised the Cahirciveen Electric Light & Power Co. to erect masts and poles in the streets for the supply of electric current for private and public lighting.

Cahir (co. Tipperary).—As the local gas company has decided to increase the price of gas to 6s. 6d. per 1,000 cubic ft. for lighting, and to 5s. 6d. for other purposes, a public meeting has been held to consider the question. After discussion it was decided to form a company to establish electric supply works.

Ealing.—At the last meeting of the Council the borough electrical engineer (Mr. J. D. Knight) reported that 12 officials and employés of the electricity department were on active service, and 10 others had expressed a desire to enlist, he asked for instructions upon the matter.

Mr. Knight pointed out the highly technical nature of the work performed by the men, and stated that in his opinion it was undesirable in the interests of the undertaking and safety of the public that any more officials should enlist, and suggested that the Electric Supply Committee should provide all the staff and employés with a distinctive badge showing that they were engaged upon public service.

The committee, therefore, recommended that so far as the electricity undertaking was concerned, the resolution to pay the salary and wages of officials and staff, less Army pay, as regarded those men who in future wished to enlist be suspended, and that the Town Clerk communicate with the War Office to inquire whether there was any objection to the men who appeared to be of military age being provided with a badge to show that they were engaged upon public service.

The recommendation was adopted.

East Grinstead.—A Board of Trade inquiry has been held by the Hon. T. H. W. Pelham, C.B., into the application of the Urban Council for a provisional electric lighting order for the district.

Mr. E. P. WHITLEY HUGHES appeared for the Council, and gave statistics of the population, rateable value, &c. There were many good-class business premises in the town, and for some time past the need of electric light had been felt. At present there were 29 private electric light plants in the district, and many people thought the Council were about 10 years too late in applying for the order. It was one of the largest towns in Sussex without an electric light supply. The Council had erected a dust destructor, and the Council proposed to erect a generating station on the destructor site. The initial cost would be about £10,000. A hurried canvass of the ratepayers was made the week before last, and there were 103 applications by people in the compulsory area and 74 applications by persons outside that area.

Many witnesses were called to prove the demand there was for a supply of electric current for lighting.

The INSPECTOR: I think you have proved a very good demand.

Mr. JOHN B. MORGAN, resident and consulting electrical engineer to Horsham Council, said he had prepared the scheme for East Grinstead. It was proposed to have oil and steam plant, utilising the power from the destructor as far as it would go. At Horsham they had a 780 H.P. plant coupled to the same type of refuse destructor as they had at East Grinstead, and they had never received a complaint of smell, noise or vibration. At Epsom the generating station was run by oil and steam, and no complaints were received. At Basingstoke he had just designed their generating station, and there had been no complaints received. He thought with first-class engineering it was possible to instal machinery so that it would not be a nuisance. At Horsham the destructor gave a net profit to the town last year of £143, and had saved them 340 tons of coal. The modern refuse destructor was a commercial proposition. In regard to smell, he could say that the cremation was absolutely complete, and no smell could be detected outside the building. If the plant was properly installed there would be no vibration. A good deal of the objection at East Grinstead had arisen from the fact that a local firm had installed a plant which had caused a nuisance.

There was some opposition by owners of property on the ground of vibration and noise.

Enniscorthy.—A local inquiry was recently held into the application of the Urban Council for a provisional electric lighting order.

Evidence was given that the Council had promoted the scheme because of the dissatisfaction with the price and quality of the gas. The charge for gas was about 5s. per 1,000 cubic ft. The estimated cost of the electric supply scheme was £5,357.

Glasgow.—About 2,000 of the tramways' staff are now serving with the colours.

Those remaining at home have already contributed over £2,600 to the Prince of Wales' Fund, and every week substantial sums are set aside for Belgian relief and the purchase of tobacco, cigarettes and pipes for those at the front. It is now proposed to endow two hospital beds—one for the British Red Cross Society (Scottish branch), which will be sent to France, and the other for the Scottish Women's Hospital organised for Serbia.

Ilkeston.—The question as to whether electricity supplied for photo printing should be charged at the lighting or power rate is still exciting discussion in local circles, and at the last meeting of the Council it was decided to obtain counsel's opinion on the point. The chairman of the Electricity Committee (Councillor Wm. Smith) put the following questions to the L.G. Board:—

(1) "Is it illegal to supply current for photo printing at power rates?" (2) "If we supply at power rates are we liable to be surcharged?" (3) "Can you quote any test cases bearing on the point?" (4) "Can you give me the names of a few towns where they have Local Government Board auditors?" (5) "Can you tell me where I can get a complete list of the towns who have Local Government Board auditors?" Councillor Smith also asked the Board to issue instructions to the auditors that no surcharge be made in cases where power rates were being charged for photo-printing purposes.

In their reply the Board sent a list of councils of municipal boroughs whose accounts were audited by district auditors, and they stated that the accounts of all urban district and rural district councils were also subject to such audit. In reply to questions (1) and (2), the assistant secretary (D. Dolton) stated that those matters seemed to depend upon the terms of the special act or provisional order under which the supply was given. The Board were not aware of any provision in the general law upon the subject. In further reply to these questions and to question (3), he stated that the Board were not aware of any decision of the

Courts upon the point, and that they did not find that it had arisen on an appeal made to them from a decision of a district auditor. Apart from such an appeal they would have no power to decide the point. The Board were not empowered to give any such instructions as were suggested [illegible] letter.

Lincoln.—The Council have decided to allocate £2,000 of the [illegible] on the electricity department to the relief of rates.

Llantarnan. The Urban Council have asked the Highways Committee [illegible] upon the terms of the South Wales Electric Power Co.'s offer to supply the Council with electricity in bulk for public and private [illegible].

Marylebone (London).—In consequence of the war, the Electric Supply Committee anticipates a considerable reduction in the consumption of electricity for private lighting, and recommends an advance of 10 per cent. on the accounts of consumers, to take effect from the beginning of the June quarter.

The [illegible] quarter's working shows a reduction (compared with December, 1913) of £5,346, brought about by a reduction of income amounting to £6,378, whilst the reduction in expenditure is £1,032. From the station records of the last few weeks, this diminution [illegible] to some extent arrested. In estimating the [illegible] for the ensuing year, the Committee has [illegible] 33 per cent. in the price of coal. This advance [illegible] reduced sales of 16·5 million units involve an extra charge of £6,525. Altogether the Committee has had to allow for special [illegible] of the national crisis to the extent of £12,000 per [illegible]. The [illegible] credit balance on the year is £2,626.

Newport (Mon.—On Wednesday the Corporation authorised the [illegible] to increase the price of electric current by 20 per cent. [illegible] June 24 next, in order to meet the increased prices of [illegible] and labour. The Gas Company has also agreed to [illegible] increase.

Presentation.—Recently the London and provincial staff of [illegible] made a presentation to the chairman, Mr. Henry C. Walker, M.I.Mech.E., in celebration of his 50 years' association with the business. The presentation included a mahogany hall clock and an illuminated album, containing upwards of 700 [illegible]. The album contained 250 blank spaces, these representing the [illegible] of Mr. Walker's good employés at the front.

Public Services and the War.—On Tuesday the Lord Mayor of [illegible] made a statement respecting the arrangements made for the release of Corporation workmen for service in armament factories.

[illegible] with the Lord Mayor and Town Clerk had with Mr. H. R. Hooper, of the L.G. Board, the latter stated that he was requested by the President of the Board (on behalf of Lord Kitchener) to urge the desirability of the Corporation releasing as many of their workmen as possible for employment by the Government in the manufacture of munitions and other materials required in the prosecution of the war. It was pointed out that the needs of the War Office were imperative and must be met even at the sacrifice of some of the public services of the city. The Lord Mayor considered that in the interests of the nation and for the credit of the city, the reply must be prompt and adequate, and he directed the Town Clerk to get into touch with the heads of the various Corporation departments.

In a letter to the L.G. Board the Town Clerk stated that the Corporation would do their utmost to assist the War Office. The Corporation were prepared to curtail the public services so that the largest possible number of men could be released for employment in armament manufactories. Speedy compliance with Lord Kitchener's request was not [illegible] 2,000 employés of the Council were serving with [illegible] and in many cases the departments were now under the [illegible] of age and the reorganisation of duties the Corporation could spare 1,062 men taken from the various departments, including 233 from the public works, 200 from the gas, 57 from the water, 5 from electric supply, 165 from the lighting, stables and refuse disposal, [illegible] 20 from the public health, 9 from the estates, 1 from the asylums, 311 from the tramways, and 13 from the education departments. Out of 15,267 municipal employés, 2,615 (or 17 per cent.) have [illegible] the Army or Navy. Of 3,430 tramway employés 895 (26 per cent.) and of 701 electric supply employés, 155 men (22 per cent.) have joined.

Other Corporations, including Newcastle-on-Tyne and Leeds, are following Birmingham's lead.

Shrewsbury (York—The Town Council have decided to appoint [illegible] Weller [illegible] Co. to [illegible] the supply of electricity [illegible].

Stockton—The Town Council have approved the plans of the [illegible] Co. for the erection of condensers and [illegible].

Rugby—The Electric Lighting Co. have increased the charge for electricity by 10 per cent.

St. Anne's-on-Sea. The electrical engineer (Mr. J. H. Clothier) [illegible] to meet the increase in the [illegible] of coal by [illegible] per ton. [illegible] 1,022 consumers.

Tunbridge Wells. As a result of the recent L.G. Board inquiry into the Council's application for sanction to borrow £8,137 for electric lighting purposes, the Lighting Committee has instructed the Borough Electrical Engineer (Mr. R. N. Torpy) to report—

(1) On the suggestions of the inspector to provide steel headers to two boilers in place of the existing c.i. headers; and (2) on the running of the plant non-condensing, &c., during the proposed re-building of the existing cooling tower. The Town Clerk has also been instructed to complete the contract with Witting & Partners for dismantling the existing cooling tower and re-building the new tower.

It was pointed out at the recent local inquiry that last winter the undertaking was running without any spare plant in the boiler house, and the department had to work two water-tube boilers which had been in commission for the last 20 years, and which were fitted with c.i. headers and mud-drums, although they were considered unsafe for continuous work. In reply the L.G. Board Inspector said that for £500 out of the revenue account new sections might be fitted to those old drums, although it was pointed out that the increase in efficiency of the extension would practically cover the interest and repayment on the boiler extension. The Inspector replied that economy of operation did not enter into the question at all, and that, if they could get through the load at all, the running costs did not matter as long as no further capital was needed. The old boilers, which Mr. Hooper recommended to be patched up at a cost of approximately £500, have only an efficiency of 70 per cent., whereas the new installation had a guaranteed efficiency of 81·5 per cent. With regard to the loan for a cooling tower, it was pointed out that the existing tower, besides being over-loaded, was in such a decayed condition that it must be pulled down and re-built. The same argument was put forward with regard to last winter's load; but, with regard to the condition of the tower, Mr. Hooper said that the department would have to run non-condensing during the summer whilst that was being pulled down and re-built out of revenue, irrespective of whatever revenue cost that would necessitate.

The Committee has adjourned consideration of Mr. R. N. Torpy's report on the extension of mains during the next three years until after the Tunbridge Wells Electric Lighting Extension Order has been granted by the Board of Trade. Application is to be made to the Board for consent to supply energy to Rusthall and Southborough, which are outside the existing area of supply.

Mr. J. Devoy, mains superintendent, has resigned, and the Lighting Committee has decided to grant the chief assistant electrical engineer (Mr. J. E. Pownall) a gratuity of £10 for extra work done since the commencement of the war.

Willesden.—At the last meeting of the Council the chairman (Mr. G. H. Hiscocks) referred to the working of the electricity department during the past year.

They started the year well in advance of all previous years, and up to the outbreak of war the purchase of energy from the North Metropolitan Electric Power Supply Co. showed an increase of 20 per cent. That state of affairs, however, could not continue in view of the large reduction in public lighting; but much new business had been secured, and the probable result of the year's working would be that the purchase from the power company would be about 5 per cent. higher than in 1913-14, while a number of important developments were being put in hand by various firms which it was hoped would substantially and permanently increase the revenue of the department.

Of the staff, seven had joined H.M. Forces, while two others who were desirous of going had to be refused permission by reason of the difficulty in filling their places.

The Finance Committee recommended that the attention of the Electricity Committee be called to the circular letter from the Treasury as to curtailment of expenditure.

The chairman of the Electricity Committee (Mr. H. Davey Turner) said that the matter arose out of items relating to the purchase of motors for new customers. Such expenditure could not possibly be curtailed, as they could not refuse new customers. The money would be paid out of revenue and if any difficulty arose they would have to raise it out of their reserve fund.

LIGHTING, POWER & HEATING NOTES.

Bourton-on-the-Water.—The Parish Council are considering tenders for the public lighting.

The Bourton-on-the-Water Electric Light & Power Co. has submitted two tenders—viz., (*a*) for one year's contract at £52; (*b*) a three years' contract at £47 a year. The local gas company is willing to do the lighting [illegible] at present arranged for the season 1915-16 for £50, but it is not prepared to enter into a three years' contract owing to the condition of the coal market.

Middleton (Lancs.).—The Council have authorised arrangements [illegible] being made with Manchester Corporation for the supply of electricity to the Arrow Mills.

During the past month 132,700 units of electricity were generated, [illegible] 125,982 in the corresponding month last year.

Poor Law Institution Lighting. The Treasury has informed Ballymena Guardians that they have no objection to the raising of a loan of £3,300 by the Guardians for electric lighting and heating installation at the workhouse and new hospital.

Hendon Guardians have approved the specifications prepared by Mr. H. S. Brackenley for the electric light installation, &c.

Swansea. In the course of some remarks made at the recent inspection of a new Curtis turbo-generator at the borough electrical engineer (Mr. J. W. Burr) laid emphasis on the need for economising the day load, particularly for heating and power.

They particularly wanted to develop cooking. The great obstacle was that people were not prepared to pay £20 for the cooker, but those things could be bought out of [illegible] cooker out by the quarter just as the gas company did.

Works Driving. Dunnerdale District Council has let the contract for the construction of the new reservoir at Seathwaite to Messrs. P. & W. Anderson, Ltd., of Glasgow.

The new reservoir, which will be about 5 miles from Ambleside, will have a holding capacity of 950,000,000 gallons. The water from the reservoir will be hastened, as the Admiralty are at present using more water. Messrs. Anderson propose to lay down [illegible] supplying energy for driving the whole of the plant.

TRACTION NOTES.

Bolton. Owing to the large number of tramway employees who have enlisted, the Corporation have been obliged to [illegible] the tramway services.

Halifax. The Corporation have authorised the tramway [illegible] to carry out certain alterations to car bodies at the rate of about 12 cars per annum, at an estimated cost of £20 per car. The alterations provide increased space on the inside, so that there would be more walking and passing room. The cost is to be borne out of revenue.

Walsall.—The re-laying of the portion of the Walsall wood tramway extension from the "Iron Dish" to the canal bridge will be proceeded with as soon as the work in connection with the new road from Ablewell-street to Birmingham-road has been completed.

TELEGRAPH AND TELEPHONE NOTES.

Automatic Telephony in India. Owing to the success of the automatic telephone exchange in Simla, the Member for Commerce and Industry announced at the meeting of the Indian Imperial Council on March 9 that the system was to be extended to other towns in the country.

London Telephone Directory.—Messrs. Stone & Colquhoun, 92, Victoria-street, London, S.W., have published the London Telephone Directory, 1915. This key is arranged [illegible] from A to W Avenue, Willesden. The key enables the address of a subscriber to be found when the number and exchange only are known. This appears to be the second edition of this publication, and an intimation is given that a new edition will follow the publication of the official Telephone Directory from time to time. The price is 2s. net.

Municipal Telephony in S. Africa.—The "Municipal Journal" announces that an arrangement has been made by Durban Council with the Postmaster-General of the Union of South Africa to take over and manage the Government trunk telephone exchange at Durban. The local telephone system [illegible] taking.

Postal Telegraph Factory.—During the current financial year the Government have allocated £1,000 for the completion of a telegraph factory in Birmingham (estimated cost £5,350, in addition to £48,150 chargeable to telephone capital account), and £1,200 for completion of telegraph stores in Birmingham (estimated cost £1,700).

Women Telephone Operators for Night Work.—Owing to the difficulty in obtaining male operators for the London [illegible] changes, the telephone department of the Post Office has decided to engage female operators for night duty during the war.

Already one exchange, the Victoria Exchange, has [illegible] from the trained day operators, and it is proposed that the selected candidates should first attend the training [illegible] efficient they will be passed out to the various [illegible]. During their training the operators will receive 22s. [illegible] out they will get 24s. for a 48 hours week. By [illegible] by rotation, the operators can obtain two hours' rest or sleep. They will come on duty at 8 p.m. and leave at 8 a.m., [illegible] on duty four nights a week out of seven.

EMPIRE NOTES.

Australasia. At a recent meeting of Sydney [illegible] Electric Lighting Committee reported that it was inadvisable to proceed with the proposed purchase of a coal mine.

The annual report of the Metropolitan [illegible] that the gross receipts were £164,000 [illegible] was £84,796 (increase 11 per cent.), [illegible]

The accounts of the Electricity Department [illegible] the past year show total revenue £9,398. 10s. 3d. Expenditure (including interest, sinking [illegible]

Canada. A [illegible] urge upon the Dominion Government the necessity of subsidising the construction of a system of publicly-owned radial electric railways.

The [illegible] of the construction of radial railways. The [illegible] electric railways could be carried out by the Provincial Hydro-Electric Power Commission with Government Bank guarantees.

FOREIGN NOTES.

Argentina. The Nacion says, in reference to the decision of the Supreme Court of the Province of Mendoza declaring the nullity of a concession granted to the Compania de Luz y Fuerza in that Province, that the suspension of the operations of this company is a matter of serious material prejudice.

The company was engaged on an engineering work of great magnitude, which included the diversion of the river Mendoza by means of a tunnel excavated in the solid rock 4 km. from the intake to the terminal, nearly 1 km. of the work having been completed. The water rises to the tunnel by means of three cylinders and falls upon turbines designed to generate 12,000 h.p. The energy was intended to supply the city of Mendoza with light and also power for the tramways, industrial establishments and the Transandine Railway. The Supreme Court declared the nullity of the concession in virtue of a protest authorised by the Government for the termination of the work. It appears that the company had nothing to do with the conflict, and it is stated even supposing the judgment does not permit of appeal, the Government would still have to assume responsibility for the prejudice resulting from its own action, based on provincial laws over-ruled by the Supreme Court on points of interpretation.

The company has now initiated legal proceedings before the Supreme Court of the Nation against the Government of Mendoza for recovery of a deposit of $100,000 m/n. and also interest on that sum. The plaintiffs claim they have a right to withdraw the deposit of $100,000 m/n. when work to the value of double that amount has been completed, and the work done is valued at more than $9,000,000.

Spain. A [illegible] the utilisation of the waters of the Rio Mundo, province of Albacete, for the production of electric power.

MISCELLANEOUS NOTES.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade have issued list 15 of articles of which the sources of supply or markets have been interfered with by the war.

Copies may be obtained by United Kingdom manufacturers and traders from 73, Basinghall-street, London, E.C. The articles include insulating materials and electrical apparatus, beads and bobbins for electrical purposes, &c.

Inquest. An inquest was held last week at Penpych, Rhondda, South Wales, on David Morgan, who was found dead on the Bedlinog and Treharris & Merthyr Railway at Abertridwr.

Evidence was given by a boy named Davis that, while walking from Aberbargoed to Elliot Pit to examine the electric cables connecting the two collieries, he found deceased lying close to a footpath; his hand was ¾ in. from the earth wire, which ran down an electric pole from the cable. Witness saw sparks flying, and ran back to give information to the electrician.

The electrician (Mr. Wm. Lloyd) said the cable carried current at 3,000 volts, and the earth current was 1,700 volts. They had indicators to point out whether there was anything wrong, but there was nothing to show on the day in question that there was a leakage or anything wrong with the cable. One of the insulators carrying the cable at the top of a pole had been broken, and the current, having gone down the earth wire, was transmitted at a point near the band connecting the staple wire to the pole. The current travelling over that had evidently caused the man's death.

A verdict of accidental death was returned.

Switching and Shooting.—Like most other districts, Merrie Islington has its Civic Guards, and a site for their rifle practice has been offered free of charge by Messrs. A. P. Lundberg & Sons, adjacent to their works (in Liverpool-road, N.), which are practically in the centre of the borough.

War Service Badges. [illegible] recruitable age, in the employ of British armament *firms* whose services are indispensable for the execution of certain selected [illegible]

[illegible] Mr. Harry S. Edlin has been in communication with the Birmingham [illegible] question of the supply of [illegible]

Mr. Edlin has consulted [illegible] and the Admiralty, and has also had [illegible] the matter, and has obtained the [illegible] purpose.

TENDERS INVITED.

Diesel Oil Engine Fuel.

AYLESBURY Urban District Council invite tenders for 20 tons of Diesel Engine Fuel Oil. Particulars to be sent to the electrical engineer (Mr. W. A. Turnbull), Electricity Works, Aylesbury, by April 21. *See an advertisement.*

Electrical Stores, &c.

WALLASEY Corporation want tenders by April 22 for 12 months' supply of Meters, Cable and Junction Boxes, Span and Guard Wire, Switches and Cutouts, &c., for the Electricity Department. Forms of tender, &c., from the Engineer.

The Postmaster-General, ALEXANDRIA (Egypt), will receive tenders until noon May 15 for the supply of Lamps, Electric Fans, &c., for one year. Specifications, &c., from the Central Stores Department, G.P.O., Alexandria.

Diesel Generating Set, Balancer and Cables.

BASINGSTOKE Corporation invite tenders for supply and erection of a Diesel Engine Generating Set, a Motor-generator Balancer and Cables. Tenders to the Electrical Engineer by noon April 19.

Testing Instruments.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. May 5 for the supply of one Double-range Ammeter, one Switch Fuse, two double-pole Two-way Switches, two Single-pole Six-way Voltmeter Switches, Graphic Ammeter and Graphic Voltmeter. Specification from the Commissioners' Offices, Spencer-street, Melbourne.

Water Tube Boilers, Fuel Economisers, Feed Pumps, Condenser, &c.

Tenders are invited for the supply, delivery and erection in Melbourne of Four Mechanically-fired Water-tube Boilers, Two Fuel Economisers, One Turbine-driven Boiler Feed Pump, 18 Machines of the Stationary Type for the automatic weighing of coal, and Two Circulating Water Pumping Sets for the CITY OF MELBOURNE. Tender forms, &c., from the agents for the City Council, Messrs. Mellwraith, McEacharn & Co. Propy. (Ltd.), Billiter-square-buildings, London, E.C. Tenders to the chairman, Electric Supply Committee, Town Hall, Melbourne, by June 15.

DUNDEE Corporation invites tenders (by April 28) for supply and erection of Centrifugal Circulating Pumps and about 750 ft. of 42 in. and 30 in. c.i. Pipes.

Wiring and Fittings.

HENDON Guardians require tenders by 10 a.m. April 29 for Electrical Installation Work at the Redhill Institution. Specification may be seen at the Guardian's offices, Edgware.

HULL Education Committee require tenders by 10 a.m. April 29 for Wiring the Girls' Secondary School, Cottingham-road, Hull. Specifications from the City Architect.

Tramway Rails, &c.

MANCHESTER Tramways Committee require tenders by 10 a.m. April 20 for the supply of Steel Girder Tramway Rails and Fishplates. Specifications, &c., from the General Manager.

Track Transformers, Signals, Wheels and Axles, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. May 19 for 120 s.p. Track Transformers and 300 Electric Signals and Spare Parts; and by 11 a.m. June 2 for 300 Electric Tram Stops (and in each case such further supplies of similar goods as may be required during five years); and for Bogie Trucks, Wheels and Axles for 10 Electric Steel Railway Cars. Specifications from Railway Offices, Spencer-street, Melbourne.

Cables, Switchgear, Carbons, &c.

MOUNTAIN ASH Urban Council require tenders (by noon April 26) for Sub-station Building Underground Cables, l.t. Overhead Lines and Public Lighting, e.h.t. and l.t. Switchgear and Transformers.

Tenders are invited for supply of 1,027,900 Arc Lamp Carbons for the CITY OF MELBOURNE. Tender form, specification, &c., from the agents for the City Council, Messrs. Mellwraith, McEacharn & Co. Propy. (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon, April 21.

Telephone Switchboard (Extension of Time).

The Commonwealth of Australia Postmaster-General's Department give notice that the date for the receipt of tenders for a Telephone Switchboard for Warwick (Queensland) is further extended from March 16 to [illegible]

Insulated and Bare Copper Cables.

Tenders are invited for the supply of quantities of Single Conductor Lead-covered Cable to MELBOURNE City Council. Tenders are also invited for the supply of quantities of Bare Hard Drawn Copper Cables to MELBOURNE City Council. Specifications, &c., from the Agents for the Council (Messrs. Mellwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon April 19.

Telegraph and Telephone Material.

The Deputy Postmaster-General, Perth, Western Australia, will receive tenders until 3 p.m. May 5 for the supply to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department of Dry Cells, Syringes, Zincs, Connectors and Sal Ammoniac for batteries. Specification, &c., from the Deputy Postmaster-General, Perth, W.A.

The Deputy Postmaster-General, MELBOURNE, requires tenders by 3 p.m. May 4 for the supply of 5,000 Porcelain Insulators, and by 3 p.m. April 27 for 200 Telephone Transformers. Specification, &c., from Deputy Postmaster-General, Melbourne.

Telephone Systems, Apparatus and Accessories.

The GREEK MINISTRY OF COMMUNICATIONS (Posts, Telegraphs and Telephones Department), Athens, require tenders by April 28 for the supply and installation of a Central Exchange and Telephone System at Salonica, and a Central Exchange at Athens, and the supply of Telephone Apparatus and Accessories. The Greek "Government Gazette" containing the specification, &c. (in French), can be seen at 73, Basinghall-st., London, E.C.

TENDERS RECEIVED AND ACCEPTED.

HAMMERSMITH.—The Electricity Committee recently received 10 tenders for the supply of ordinary meters during the ensuing 12 months.

The tender received of the Electrical Apparatus Co. has been accepted for a period of three years, subject to the condition that the price of brass rod in March, 1916, not being above 9d. per lb. Should this price increase, the company's tender would be advanced 5 per cent. The tender of the Limmer Asphalte Paving Co. (at £17. 10s. less 2½ per cent.), has been accepted for the supply of insulating box filling compound.

WIMBLEDON.—The following tenders have been accepted for annual supplies to the electricity department:—

Western Electric Co., high and low pressure cables for three years; C. Macintosh & Co., two-core v.i.r. cables; British Insulated & Helsby Cables, workshop and cotton-covered and silk-covered flexible cables; Dussek Brunnen Co., joint box compounds; W. Lucy & Co., service boxes, main joint and dividing boxes, sealing ends and box fittings; Sykes & Sugden, house fuse boxes; Callender's Cable & Construction Co., frames and covers; British Electric Transformer Co., transformers; Ferranti Limited, meters; and A. Duckham & Co., oils.

SHEFFIELD.—The Council is recommended to accept the tenders of the General Electric Co. for the supply of spares for the electric power plant at Ewden Valley Waterworks and for cables, lamps and fittings. The tender of A. Reyrolle & Co. (at £235. 15s.) is also recommended for acceptance for the supply of one three-phase e.h.t. oil switch and four sets of metering gear.

BETHNAL GREEN (LONDON).—The Electricity Committee has accepted the tender of Mellowes & Co. (at £52) for patent roof glazing with wired glass at new sub-stations.

BELFAST.—Veamer Time Switches (Ltd.) have again secured the contract from the Corporation for the supply of time switches for the ensuing 12 months.

CROYDON.—Siemens Brothers Dynamo Works (Ltd.) have secured the contract for the annual supply of Wotan, Tantalum and carbon filament lamps to the Corporation tramways.

LOWESTOFT.—The offer of Rowlands & Co. to supply one dozen gear wheels at £3. 6s. each has been accepted.

MANCHESTER.—Messrs. Chamberlain & Hookham have received the contract from Manchester for the year's supply of tramcar meters.

WOLVERHAMPTON.—The Electricity Committee recommends the Council to accept the tender of Mossay & Co. (at £630) for the supply of a 2½ ton Orwell electric vehicle and equipment.

Meter Contracts.—Messrs. Chamberlain & Hookham have secured contracts for the supply of meters for 12 months to Holyhead, Mansfield and Walthamstow Councils.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

CORK ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.) —At the recent meeting the chairman (Mr. A. R. Monks) said that the reserve for depreciation and renewals had been debited with £994, the cost of a condenser dismantled during the year, and also their expenditure on renewing cables at Queenstown. The gross receipts increased by £1,469, and the lighting and power receipts were £1,509 in excess of 1913. They were installing a 1,000 kw. direct current geared Curtis turbine to meet the increasing demands for lighting and power.

EDISON ACCUMULATORS (LTD.). —Mr. Bernard M. Drake, M.I.E.E., who presided over the first annual meeting which was recently held, said the results shown in the balance-sheet were fairly satisfactory, due allowance being made for the abnormal times through which they were passing. The item for staff, offices and selling expenses might appear high, but they would understand that in initiating the industry of the company, which was new to this country, it was necessary to be constantly running cars for demonstration purposes, and inquiries had to be followed up closely so as to educate the public as to the results which might be expected under various working conditions, and the particular ones for which their products were best suited. It had also been necessary to prepare special designs to suit the conditions prevailing in England, which in many cases were different to those in America and elsewhere. At the end of the year there were sufficient unexecuted orders on the books to have enabled them to show a profit had it been possible to obtain the necessary equipment in time. As regarded the future, they would be pleased to hear that encouraging reports were being received concerning the results obtained with the vehicles now at work. Not only was the cost per ton mile comparing very favourably with that of other road transport systems, but the reliability, ease of manipulation and quiet running of the Edison accumulator vehicles were proved to be advantages with which no other system could hope to compete. An objection sometimes raised to the use of electric vehicles was the trouble of recharging and the time occupied in that operation. That, however, would largely disappear with increasing use and additional charging stations. One special feature of the Edison battery was the rapidity with which it could be recharged. Another important point with regard to the working of electrically-propelled vehicles was that the cost of generating and supplying current was steadily decreasing, whereas the cost of petrol or other fuel for the internal-combustion engined commercial and private cars had been continuously rising. He mentioned one borough engineer who had found that four 2-ton tipping waggons had replaced no less than 11 horses and carts, besides doing the work of refuse collection more efficiently. Although the first cost was heavier, it was claimed for the Edison battery that, being composed of more durable materials, it could successfully withstand vibrations and hard work, which would shorten the life of lead batteries, so that in the end the cost for traction work would be lower. The life of a lead battery was now pretty accurately known, and was short, but the life of the Edison battery, judging from examinations of batteries which had been in use and showed no deterioration whatever, would be indefinitely long. The Edison battery had also a very distinct advantage in that it suffered no deterioration from being completely discharged, or even left in a discharged condition, a state of affairs which was very prejudicial to lead batteries. Mr. Edison was reported to have said that in his opinion the nickel-iron-alkali battery would play an important part in the transportation of the future. That statement was already verified in America, but in England they were slow to move in anything new, and it was often difficult to overcome the want of enterprise shown by the older established stores, cartage contractors and other firms, who were content to wait until their more up-to-date competitors had shown what could be done. Arrangements had been concluded with Messrs. Drake & Gorham (Ltd.), of which he was chairman, under which their widely-spread organisation would be available for pushing the sale of Edison vehicles, especially in Lancashire and Cheshire, for which district they had purchased a 2-ton truck which was constantly employed in travelling between stations. The orders received since the expiration of the period covered by the balance sheet had been most satisfactory, and in fact the amount for over three fifths of the total during the period covered by the balance sheet. The report was adopted.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—At the general meeting, which will be held at Copenhagen on the 8th prox., the board will propose to pay a total dividend and bonus of 22 per cent. for the year 1914, including the 5 per cent. already paid, and to transfer to the pension funds £111,111. 2s. 2d. and £11,111. 2s. 3d. respectively.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—At the recent meeting the chairman (Mr. H. P. Smallpiece) said that their business continued to develop, the gross receipts for the past year amounting to £2,550 to 114, an increase of £570. 17s. 5d. The principal items of expenditure were oil waste, water and engine room stores, salaries and wages, rates and taxes, &c. An appeal against the increased assessment of the undertaking for local rates was successful, a considerable reduction in the assessment having been made. Considering all the circumstances they might fairly congratulate the shareholders on the [illegible] in respect of depreciation, put a further £250 to reserve, and still be able to recommend a dividend of 5 per cent. on the ordinary share capital, a percentage which they had been able to declare for the last few years. The £5,000 which had been borrowed was principally for a new engine, extensions of mains and for meters.

CITY NOTES.

MEMORANDA (April 14).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 66¼. Consols Pay Days May 5 and June 1. Stocks and Shares Ticket Days April 28 and May 12. Pay Days April 29 and May 12. Price of silver, 23½d.

DIRECT UNITED STATES CABLE CO. (LTD.)—The board have resolved upon the payment of a final dividend of 2s. per share (less tax), payable on and after the 30th inst., making, with the three interim dividends already paid, a total distribution of 4 per cent. for the year ended March 31. The transfer books are closed from April 15 to 29, inclusive.

EASTERN TELEGRAPH CO. (LTD.)—The company announce payment by warrants on May 1 of interest for the half-year ending 30th inst. on their 4 per cent. mortgage debenture stock. The transfer books will be closed from April 27 to 30 inclusive.

INDO-EUROPEAN TELEGRAPH CO. (LTD.) —The directors recommend a dividend for the six months ended Dec. 31, 1914, of 17s. 6d. per share (making with the interim dividend already paid 6 per cent. for the year) and a bonus of 20s. per share, both tax free. They also recommend a special distribution of 15s. per share (tax free) out of interest accrued during the year upon certain investments and advance accounts.

LONDON ELECTRIC SUPPLY CORPN. (LTD)—The directors are offering to its proprietors £100,000 4 per cent. first mortgage debenture stock at 85. The proceeds are required to liquidate the overdraft for the cost of the plant for the contract entered into with the London, Brighton & South Coast Railway Co. for the supply of power in connection with the further electrification of their system and to meet the increasing demands for power for traction and industrial purposes.

MONTEVIDEO TELEPHONE CO. (LTD.) —The directors have declared interim dividends of 5 per cent. per annum on the preference shares and 6 per cent. per annum on the ordinary shares for the half-year to Jan. 31.

SUBMARINE CABLES TRUST.—Notice is given that in accordance with the terms of the trust deed, tenders are invited from the holders of certificates to be redeemed out of surplus income, accrued to 15th inst., at a price not to exceed £120 per certificate. Certificate-holders desirous of surrendering their certificates should communicate with the secretary, Mr. Sidney Collett.

VICKERS (LTD.)—The directors have decided to place £250,000 to general reserve, and they recommend a final dividend of 1s. 6d. per share (free of tax) on the ordinary shares, making 2s. 6d. per share, or 12½ per cent. for the year. The amount carried forward is £228,876.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, April 14. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Last Dividend	NAME.	Price, Wed., April 14.	Rate per cent Yielded.	Dividend Due.
	Electricity Supply.		£ s. d.	
10 7½	Bournemouth & Poole E.L. Ord.	7½	7 2 8	Mar, Sept
10 12½	Do. 4½ Pref.	9⅞	1 17 11	Feb, Aug
7 10½	Do. 5% Deb. St.	14⅝	1 0 3	Mar, Sept
St. 4½	Brompton & Kensington Ord.	8⅝	5 16 0	Mar, Sept
St. 4½	Central Elec. Supp. 4% Deb. St.	90½	4 8 3	.. ..
St. 4½	Charing Cross, West End & City Deb.	91	4 7 11	Jan, July
3 3	Do. 4½% Pref.	4⅝	6 7 6	.. ..
10 9½	Clyde Valley Elec. Ltd. Ord.	14	6 3 7	Feb, Aug.
10 6½	Do. 6% Pref.	12½	4 14 4	Mar, July
St. 4½	Do. 5% Deb. St.	110	4 10 10	Jun, Dec
10 6½	Croydon (Lambeth's) Pref.	11½	5 4 4	Feb, Aug
St. 4½	Do. 2nd Deb.	99	4 11 10	My, Nov
St. 4½%	Edmundson's Elec. Supp. 4½% Debs.	7⅞	5 13 2	July
5 7½	Kensington and Knightsbridge Ord.	8½	6 4 2	Feb, Aug
5 3½	London Elec. Supp. Corp. Pref.	6⅝	6 6 5	.. ..
St. 4½	Do. 4% Mort. Deb.	89½	4 15 5	Jan, July
7 3½	Metropolitan E. Supp. Ord.	8	5 11 9	Mar, Aug.
St. 4½	Do. 1st Mort. Deb.	94½	4 13 3	Jan, July
10 6½	Newcastle & Dist. E.L. 6% 2nd Dbs.	96½	6 1 10	Mar, Sept
St. 5%	Newcastle-on-Tyne E.S. 5½% 2d Mt. Db. St.	99	5 1 0	Mar, Sept
1 6%	North Metropolitan E. P. Supp. 6% Pref.	1	5 11 4	Apl, Oct
St. 5%	South London E.S. 1st Mort. Debs.	95	5 5 3	Jan, July.
St. 4½	Urban Elec. Supp. 4½% Db. St.	84½	5 6 7	Apl, Oct
5 5%	Westminster E.S. Corp. Ord.	7	6 8 2	Mar, Sept
5 4½	Do. 4½% Pref.	4½	4 15 1	Jan, July.
	Electric Railways & Tramways.			
St. 5%	British Elec. Traction 5% Debs.	94½	5 5 9	Apl, Oct
St. 4½	Do. 4½% Debs. Pref.	69½	8 12 1	Feb, Aug
St. 4½	Central London Guar. Assented Ord.	8½	5 11 11	.. ..
St. 4½	Do. do. Assented Def. Ord.	8½	5 5 1	.. ..
St. 4½	London United Tramways	6½	5 17 11	Feb, Aug

† Ex dividend or interest

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Last Dividend	NAME.	Price, Wed., April 14.	Rate per Annum	Dates of Dividends
	Electric Railways and Tramways.			
				Jan, July
4%			4 13 10	
			3 4 10	
		77		
		41	4 13 8	Feb, Aug
3½%		63		
3½%				Jan, July
	Metropolitan Dist. Ry. Ord.			
	Do. 4% Prior Lien	92½		
	Do. 4½% First Pref.			Feb, Aug
				Jan, July
				Jan, July
				Mar, Sept
	Underground E. Rys. of London Shares.			
	Do. A Ord.			
		13½		Mar, Sept
				Mar, Sept
		1–		Jan, July
	Electric Manufacturing, &c.			
				Apl, Oct
				Mar
				Jan, July.
				Jan, July
15%	Brit. Insulated & Helsby Ord.			
				Jan, July
6%	British L.M. Ericsson Mfg. Cm. 6% Pref.			Mar, Sep
	Brit. Westinghouse Pref.			April
	Callender's Cable, &c., Co. Ord.			Jan, July
	Do. 5% Pref.			Feb, Aug
				May, Nov
				Sept
	Elec. Construction Ord.			Feb, Aug
				May
				Jan, July
		10		Jun, Dec
	W. T. Henley's Telegh. Wks. Co. Ord.	9½		Feb, Aug
	Do. 4½% Cum. Pref.	4	4 14 9	
4½%		49	4 10 11	Jun, Dec
	India Rubber, G. P. &c., Ord.	7		Feb, Aug
				Apl, Oct
	Do. 4% Debs.	47		Apl, Oct
	Telegh. Con. & Main. Co.	36½		Mar, July
				Jan, July
12½%	Vickers Ord.			May, Nov
	Do. 6% Pref.	1		May, Aug
	Do. 1st Debs.	11½		Jun, Dec
4½		103½		Jan, Dec
	Telegraphs.			
	Anglo American 6% Pref. Ord.	1	5 14 3	Feb, May, Aug, N
	Do. Def. Ord.		6 14 9	Feb, May, Aug, N
		7	6 13 1	Ja, Ap, Jly, O
	Cuba Submarine 10% Pref.	1	1 13 3	
	Direct Spanish 10% Pref.	7½	6 13 4	
	Direct United States		5 4 10	Ja, Ap, Jly, O
25/0	Eastern Tel. Co. Ord.	31	5 4 1	Ja, My, Jly, O
		7½	4 15 3	Ja, My, Jly, O
	Eastern Extension Tel. Co., 4% Debs.	9		Feb, Aug
		15		Ja, Ap, Jly, O
	Gt. Northern Tel. Co. with Coup. 6	28½	6 19	Ja, My, Jly
	Marconi's Wireless Tel. Co.			
	Do. 7% Pref.	1½	1	July
	West India & Panama Ord.	1		May, Nov
	Do. 1st Pref.	8½		May, Nov
	Western Telegh. Co.	1		Mr, Jly, O, Dec
				Jun, Dec
	Telephones.			
		1.15		Ja, Ap, Jn, O
				Jan, Jly
				Nov
				May, Nov
	Oriental Telephone Ord.			Apl, Oct
				Jan, July
3½	Telephn. Co. of Egypt Db. St.	82½		Jan, July
				Apl, Oct
	Financial and Investment.			
				Sp, De, Mr, Jn
				Sp, De, Mr, Jn
	Mackay Companies' Common			
				Ja, Ap, Jly, O
				Apl, Oct
	Colonial and Foreign Railways, Tramways, &c.			
				Jun, Dec
	Do. 4½% Debs.			Jan, July
		84		Jan, July
	Do. 5½% 1st Pref.	4		Jan, July
	Do. 5½% 2nd Pref.			
				Fb, M, Aug, N
				Ja, Apl, Jly, O
				May
				Mar, Sep
				Feb, Aug
				Jun, Dec
				Feb, Aug
	Colonial and Foreign Electric Supply, &c.			
				Mar, Sept
				Jun, Dec
			6 10 11	Apl, Oct
				Ja, Apl, Jly, O
		1-2	4 18 0	
			4 17 7	Apl, Oct
		10½		Jan, July
		12		Ja, Apl, Jly, O
				Jan, July
			5 1 0	
				Jan, July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date April 14, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	10½d.	Antimony	£80 0 0
Solid Drawn Copper Tubes	11½d.	English Lead	£23 10 0
Brazed Copper Tubes	11½d.		
Brazed Brass Tubes	12½d.	**Old Metals.**	**per ton**
Brass Wire	9½d.	Clean Scrap Copper	£65 0 0
Copper Wire	11½d.	Brazierv Copper Scrap	£58 0 0
Rolled Brass	9½d.	Clean Scrap Brass	£48 0 0
Brass Sheets	9½d.	Old Lead	£20 0 0
		Old Zinc	£31 0 0
	per ton.	Hollow Pewter	£115 0 0
Copper Sheets	£70 0 0	Black Pewter	£85 0 0
Spelter	£31 0 0	Gun Metal	£59 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date April 14, the following prices of Metals:—

	per ton.		per ton.
Aluminium Cuttings	£66 0 0	Gun Metal	£80 0 0
Clean Mixed Brass	£30 0 0	Old Zinc	£32 0 0
Clean Copper	£60 0 0	Hollow Pewter	£120 0 0
Brazierv Copper	£62 0 0	Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	No. of weeks	Aggregate. Amount.	Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation		1,626	— 110	45	73,748	+ 2,404
Anglo-Argentine			— 12,693	45	709,338	- 91,962
Ashton-under-Lyne		54§	+ 33	2	995	+ 47
Ayr Gas Light					15,658	1,151
Bath Electric Trams, Ltd						
Birkenhead Corporation		1,362	+ 101	2	2,076	— 94
† Birmingham Corporation		12,671			12,671	- 457
Blackburn Corporation		1,632	—	2	2,625	+ 148
Bolton Corporation		2,776	— 760	2	4,600	— 873
† Bournemouth Corporation		2,636		1	2,636	+ 658
Bradford Corporation	March 31	2,735	— 169	53	319,394	+ 11,255
Brighton Corporation	April 11	1,161	— 133	28	1,702	+ 114
† Bristol Trams & Carriage	„ 9	10,520	+ 2,250	14	120,312	+ 13,530
Burmah E. Trams & Ltg.	„ 10	R3,678		14		— R36,357
Burnley Corporation		1,733	— 338	2	3,432	— 264
Burton Corporation	„ 11	350	— 17	28	468	— 96
Bury Corporation	„ 11	1,447	— 287	28	2,428	— 288
Calcutta Tramways Co.	„ 10	R62,354	— R3,670	14	R814,337	— R64,375
Cameorne-Redruth	„ 3		— 13	13	1,577	— 89
Cardiff Corporation						
Central London Railway						
Cork Electric Trams Co.	„ 8	513		14	6,166	— 155
Croydon Corporation	March 31	1,131	+ 169	52	87,833	+ 2,907
*Derby Corporation	April 10	1,188	— 10	1	1,709	— 7
Dover Corporation						
Dublin & Lucan Railway		200		14	1,757	+ 113
Dublin United		6,960	— 52	14	71,988	+ 4,273
Dundee Corporation	„ 7	1,294	+ 30	47½	59,459	— 1,228
East Ham Council	„ 10	1,440	+ 351	1	2,024	+ 7
Erith Urban Council						
Exeter Corporation	„ 9	414	+ 85	1	511	+ 7
Glasgow Corporation	„	21,029	— 163	4	909,719	— 443
Glossop Trams		139	— 4	1	1,641	— 44
Gloucester Corpn.	„	373	+ 55	1	373	+ 55
†Halifax Corporation	„	2,624		1	2,624	+ 366
Hastings Elec. Trams Co.	„	1,074	+ 275	14	10,369	+ 318
Hove Council						
Huddersfield Corporation			+ 1,142		4,634	1 [illegible]
Hull Corporation		3,789	— 20	1	4,763	— 3
Ilford District Council						
Ilkeston Corporation		137	+ 11	1	137	+ 11
Ipswich Corporation	„ 10		+ 36		11	+ 2
Isle of Thanet UC			— 108		8,081	— 1,514
Kilmarnock Corporation	„ 10	157	— 16	47	7,479	— 731
Lanarkshire Trams Co.		1,860	+ 15	14	[illegible]	— 1,343
Lancashire United	„ 7			14	21,653	+ 345
Leeds Corporation		9,878	+ 1,487	2	13,898	+ 2,335
Leicester Corporation		3,217	+ 123	4	40,698	+ 418
Lincoln Corporation	„ 10	719	+ 22	47	32,987	— 178
Lincoln Corporation	„ 10	140		2	269	— 9
Liverpool Corporation		12,171	— 3	4	165,675	— 4,121
Liverpool Overhead Rly.						
Llandudno & Colwyn Bay R		473		13	3,687	+ 292
London County Council	March 31	46,461	[illegible]		2,333,514	+ 130,877
London Elec. Ry. Co.						
London Gen. Omn.						
Lowestoft Corporation	April 10	184		1	4,501	— 470
Maidstone Corporation						
Manchester Corporation	„ 10	18,567	[illegible]	2	26,274	— 870
Mersey Railway						
Nelson Corporation						
Newcastle-on-Tyne Corpn.		6,132	— 38	1	9,101	+ 183
Newport (Mon.) Corpn.	„ 10	870	+ 58	2	1,263	+ 131
Northampton Corporation				14	964	+ 143
Oldham Corporation	„ 11	2,513		3	5,879	— 282
Perth (N.B.) Corporation						
Perth (W.A.) Elec. Trams						
Portsmouth Corporation		2,183	+ 28	1	2,183	+ 28
Preston Corporation	March 31			53	[illegible]	+ 1,936
Rotherham Corporation		1,257		1	1,257	+ 198
Salford Corporation		4,866		1	4,866	+ 134
Sheffield Corporation						
Southampton Corporation			+ 1,094	2	20,525	+ 1,130
Singapore Trams						
Southampton Corpn.		1,478	+ 233	1	1,478	+ 46
Southend Corporation	„ 7	1,078	+ 288	1	1,078	+ 288
St. Lyb'dge, Hyde, &c., Jt. B.						
Sunderland Corporation			+ 35	2	2,417	— 98
	„ 7	764		23	12,123	— 85
Swindon Corporation						— 34
Taff Vale Railway		514		13	6,480	+ 299
Wallasey Corporation		1,384		1	1,899	— 7
Walsall Corporation	„ 10	863		1	9,666	+ 2
Warrington Corporation				1	22,700	— 2
West Ham Corporation		3,394	+ 520	1	3,837	+ 443
Wolverhampton Corpn.		1,283	+ 260	1	1,283	+ 260
Yorkshire W.R. Trams	„ 11	1,844		15	21,7[illegible]	— 3

(a) Increase or decrease as compared with the corresponding period last year. * Partly electrical.
† Including motor omn. &c. ‡ Mileage altered. § Minus 4 days. ‖ Minus 3 days. ¶ Plus 2 days. ** Plus 3 days.

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NOTES.

The Coal Position.

WE are glad to note that the Manchester District Institution of Gas Engineers has passed a resolution suggesting a conference of gas and electricity undertakings to consider what action shall be taken in regard to the high cost of coal. The subject is most important. Quite recently a report was drawn up by a Government Committee on the subject of coal, and it was clear from this report that the prices are at present regulated without proper reference to the increased cost of production and carriage. It appears, according to present conditions, that the owners are able to benefit unduly by increased prices. Although we feel that dividends should be maintained at a reasonable figure, so as not to cause hardship on investors, the present is emphatically not a time for large profits. How can we expect miners and other workers to be satisfied with ordinary rates of pay if it appears to them that coal owners and other employers are making unduly large profits? It is not a time for patriotism from merely one section of our population. The situation, it seems to us, can only be met by Government action, with a view to the limitation of profits under war conditions. Unfortunately, although committees may draw up excellent reports, the Government often seems to think that the matter may then very well end, and so nothing is done. The question of the price of coal, on which the well-being of the community depends so largely, both individually and collectively, is not one which can be left to be taken up some time next autumn when still higher prices will be looming in the immediate future. It is a question which should be taken up with the least possible delay, for it is one that is urgent, and advantage should be taken of the smaller production permitted by summer weather to obtain reserves and to take suitable action. We gather that both the Board of Trade and the Home Office have the matter under consideration, but we should like to see more activity. Under the circumstances we hope that the electricity undertakings will come together and discuss the subject with the gas undertakings, with a view to bringing pressure upon the Government to take immediate action. This is a case in which we think something might be done by the Institution of Electrical Engineers, for there seems to be no other body that can take action quickly, and no association which deals merely with electricity supply on "non-party" lines.

Alumina as Insulation for Aluminium.

THE readiness with which aluminium oxidises to a slight extent upon its surface is at once one of its virtues and one of its vices. As a virtue this property accounts for aluminium acting in so efficient a manner as a rectifier in certain electrolytes, and enables such an electrode to withstand a pressure of several hundred volts after proper treatment. What is surprising is the rapidity with which the blocking action takes place, and that current is able to flow so readily in one direction during half a period, and is practically prevented from doing so during the other half. As a vice, the effect of this ready oxidation has been seen in the difficulties encountered in making satisfactory aluminium joints and solders, and in the methods that have been adopted in electric welding to overcome these difficulties. For some years it has been sought to make use of this easy oxidation for the purpose of insulating wires used in winding bobbins, but, as far as we are aware, no great success has been achieved in this direction until recently. A coating of oxide had been obtained no doubt, but it had always been mechanically weak, and not capable of resisting anything more than very low voltages. For certain classes of work this may be sufficiently good, because the voltage between convolutions is often very small, but, on the other hand, a certain factor of safety is desirable, and probably on this account the method has not found favour.

RECENTLY, however, Messrs. C. E. SKINNER and L. W. CHUBB have obtained very much more satisfactory results, which are described in another column. The process used consists practically in forming a wire into the electrode of a rectifier, using an electrolyte such as borax, ammonium borate, or sodium silicate. A continuous process is used, the wire being passed through at the rate of 40 ft. to 150 ft. per minute. The result is to give wires such a coating that, when twisted together without abrasion, they will stand a pressure from 200 to 500 volts between them. This appears to be a very great advance. On account of its thinness the film is quite flexible, and consequently the wire can be bent sharply without being damaged. It is obvious that such results open up possibilities for the use of aluminium which have not so far been available, and we see no reason why such wires should not take the place of enamelled wire for certain purposes. One great advantage of aluminium when so treated is that, since it is not surrounded by inflammable insulation, it can be run at very much higher temperatures than are customary with copper. Messrs. SKINNER and CHUBB, indeed, mention the fact that such coils can be heated until the aluminium becomes molten, and provided the current is decreased gradually the coil does not fall to pieces in cooling.

Power Supply at Bedford.

IN another column we give the substance of a report by Mr. R. W. L. PHILLIPS, borough electrical engineer of Bedford, on the cost of supplying electrical energy to Messrs. W. H. Allen, Son & Co., the well-known engineers. It is perhaps one of the weaknesses of municipal supply that a subject of this kind, which would certainly be dealt with behind closed doors by a private undertaking, is published to all the world. Obviously, publicity in such a case increases the difficulties. Mr. PHILLIPS put forward a tariff based on 1d. per unit, subject to a discount of 20 per cent. if the consumer's load factor reached 20 per cent., and he gave figures showing that a very considerable profit would result. On the other hand, the proposition was opposed by the MAYOR, whose argument showed the great difficulty experienced by non-technical men in handling matters of this kind. One argument was based on the fact that the charges at Bedford were not the same as those at Chester, whereas the outputs were approximately the same. This is the sort of argument that is often used, it being forgotten that all the conditions must be taken into account. It is admittedly difficult to decide what are fair tariffs for different classes of supply given by a single undertaking, but, generally speaking, the layman would do far better to trust the engineer in matters of this kind than to attempt to solve the problems for himself. We are glad to see that eventually Mr. PHILLIPS [illegible]

Report on Electrical Signalling in Mines. We are [illegible] a report [illegible] by the Chief Inspector of Mines [illegible] of an investigation made by Dr. R. A. Wheeler at the Home Office Experimental Station at Eskmeals on the subject of electrical signalling in mines. We shall [illegible] next issue.

Royal Engineers (T.F.)—The following appointments and changes have been made :—

Cinque Ports (Fortress) Engineers : Sapper H. C. Crosley (from London Electrical Engineers) to be Second-Lieutenant.

Cornwall (Fortress) Engineers, No. 2 Electric Lights Company : Second-Lieutenants N. L. Phipps and Cyril R. Norman to be Lieutenants (temporary). No. 3 Electric Lights Company : Second-Lieutenants Percy H. Bartlett and Cuthbert L. Fox to be Lieutenants (temporary).

Devonshire Fortress Engineers, No. 4 Electric Lights Company : Geo. F. Ball to be Second-Lieutenant.

London Electrical Engineers : Sec.-Lieut. H. F. G. Roose is seconded.

War Commissions and Committees.—Since the commencement of the war no less than 37 commissions and committees have been appointed to deal with public questions arising out of the war. A list of these, together with the names and addresses of the secretaries, was issued last week as a Parliamentary Paper. The latest committee, which has been appointed by the Government to secure the greatest and best possible output of munitions of war from all the available productive resources of the nation is composed of the following : The Chancellor of the Exchequer (Chairman), Mr. Balfour, Mr. E. S. Montagu (Financial Secretary to the Treasury), Mr. G. M. Booth, Major-General Sir Stanley von Donop and Mr. Harold Baker, M.P. (War Office), Sir Frederick Black and Admiral Tudor (Admiralty), Mr. Arthur Henderson, M.P. (Chairman of the Labour Party) and Sir H. Llewellyn Smith (Permanent Secretary to the Board of Trade).

Large Storage Battery Car on U.S. Railway.—A 50 ft. storage battery car, with several interesting features, has been put into service on a 12-mile branch line of the Cambria and Indiana Railroad. From a description in the "Electric Railway Journal," it appears that the railway handles a large coal traffic with steam locomotives, and the lightness of the passenger traffic favours storage battery propulsion. The car is equipped to meet the peculiar feature of operation found on a 2¼ mile section of this line, where a constant gradient of 1 in 20 exists. The batteries are powerful enough in themselves to propel the car up the grade, but, as this would greatly reduce the possible mileage on one charge, 600-volt energy is taken on this section from an overhead wire. To delay corrosion from the exhaust gases of steam locomotives the trolley wire is offset. The trolley board, of course, is also offset. The total weight of the car, including trucks and battery equipment, is about 29·5 tons. The electrical equipment consists of 240 Edison A-12 cells for power and 10 A-12 cells for lighting purposes, and four Westinghouse 25 H.P. motors and control. The battery equipment weighs 14,000 lb. The batteries have a range of 130 miles on level track on a normal 7½-hour charge. The maximum speed is 35 miles per hour. The car has a 32 ft. passenger compartment, a baggage compartment, space for smokers, partitioned section for the motorman and a toilet compartment. The total seating capacity is 52.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Mr. R. D. Gifford contributes a further instalment of an article on the "Direct Measurement of Power Factor" (p. 82).

We publish a further instalment of Dr. H. W. Malcolm's article on the "Future Progress of Cable Telegraphy" (p. 95).

We publish an abstract of Prof. W. C. Unwin's presidential address to the Institution of Mechanical Engineers (p. 78).

An abstract of a Paper on the "Electrolytic Insulation of Aluminium Wire," by Messrs. C. E. Skinner and L. W. Chubb, appears on p. 81.

A Paper on the "Effect of Delta and Star Connections upon Transformer Wave Forms," by Mr. L. F. Curtis, is reproduced (p. 79).

We reproduce the Supplementary Standardisation Rules for Electrical Machinery, issued by the B.E.A.M.A. (p. 86).

We conclude our abstract of Mr. J. H. Rider's Paper on the Power Supply of the Central Mining Rand Mines Group" and give an account of part of the discussion thereon (p. 88). Our Leading Article comments on this Paper (p. 92).

Directors' Reports. The reports abstracted include those of the Alderley & Wilmslow Electric Supply, Anglo-Portuguese Telephone Co., Babcock & Wilcox, Calcutta Tramways Co., Clevedon, Portishead & District Electric Supply Co., Direct United States Cable Co., Indian Electric Supply & Traction Co., Indo-European Telegraph Co., Johnson & Phillips, Oriental Telephone & Electric Co., Potteries Electric Traction Co., Richardsons, Westgarth & Co., Vickers (Ltd.) and West India Electric Co. (pp. 109-111).

OBITUARY.

Baron August Julius Clement Herbert de Reuter. The death occurred, from his own hand, on Sunday last, of Baron Herbert de Reuter, who for 40 years was closely identified with the general management of Reuter's Telegram Co. (Ltd.), the agency whose ramifications are world-wide and whose reputation for telegraphic news is of the highest standing. The agency was established by Baron Herbert's father. Baron Herbert succeeded his father as managing director of this "institution" (for so it may be termed). He was a man of many parts and occupied a high place, not only in connection with the collection and distribution of news, but as a man of great literary and musical tastes. The value and extent of his library is well known. The circumstances under which his death occurred were most pathetic. It was only a few days before that the Baroness De Reuter died, and her funeral was to have taken place on Monday. The relations between the baron and baroness were of a most affectionate character, and her death left the baron prostrate. Just prior to the fatal moment he addressed two letters to his wife; and his last sad act was, doubtless, the result of the intense overstrain from which he was suffering. The Baron and Baroness were buried together at Kingswood Parish Church, near Reigate, yesterday (Thursday).

L. U. la H. Vignoles.—We regret to hear of the death in Argentina, at the early age of 34, of Mr. Leonhard U. la H. Vignoles (commonly known as "Toby"), which took place on April 6. No details are yet to hand, but he was extremely ill some eight years ago, and was believed to have a foreign body in one of his lungs. He then made a marvellous recovery, but was subsequently liable to chronic pneumonia, to which it is to be feared that his early death is due. He leaves a widow and two baby children. He served in South Africa, and was with Cromptons, British Westinghouse and J. G. White & Co.

J. A. Legé.—The death is announced of M. J. A. Legé, a French electrical engineer and instrument maker, who had works in this country but who had retired from business. He was associated with some of the early pioneer work in street arc lighting, and he had acquired a reputation as a good instrument maker.

APPOINTMENTS VACANT AND FILLED.

A chief of the mains department is required for the Gemeente-Electriciteitswerken, Amsterdam. Applications by 28th inst. to the Directie der Gemeente-Electriciteitswerken, Hoogte Hadijk 200, Amsterdam. *See advertisement.*

Instrument testers are required by the British Westinghouse Co., Trafford Park, Manchester. *See an advertisement.*

A first-class turbine mechanic is required for the operation of a large turbine-driven a.c. plant. *See advertisement.*

An electrician is wanted with experience in maintenance of d.c. motors and starters; also two wiremen for screwed conduit work. Applications to the Superintendent, Royal Gunpowder Factory, Waltham Abbey. *See advertisement.*

The Governing Body of Battersea Polytechnic invite applications for the position of principal of the Polytechnic. Commencing salary £800, increasing to £1,000 by £20 per annum. Particulars from the Clerk to the Governing Body, Battersea Polytechnic, London, S.W.

A materials superintendent and clerk with experience of electrical stores is required for the St. Helens Corporation electricity department. Applications to the Borough Electrical Engineer.

Electrical wiremen are required for the electrical department of John Brown & Co. (Ltd.), of Clydebank.

Mr. J. H. Sparrow, of Southsea, has been appointed switchboard attendant at Bermondsey (London) electricity works.

Mr. L. H. Fowles, of Erith, has been appointed chief assistant electrical engineer at Aylesbury. There were 42 applicants for the post.

INSTITUTIONS AND SOCIETIES.

Metropolitan Association of Electric Tramways Managers.—A meeting of the members of this Association was held on the 16th inst., at the Municipal and County Club, Whitehall Court, Whitehall, S.W., when there were present

Messrs. Ullmann (East Ham), chairman; Fell (L.C.C.), Schofield (Leyton), Moffet (West Ham), Harvey (Ilford), Stokes (Bexley), Mackinnon (L.U.T.) and Goodyer (Croydon) hon. secretary. Letters and telegrams of regret at inability to attend were received from Messrs. Bruce (L.C.C.), Murray (Walthamstow), Williams (Erith), Pott and Hammond (M.E.T.), Mason (South Met.) and Birkett (Southend-on-Sea).

Royal Society.—The Papers read before the Royal Society yesterday included the following: "The Difference between the Magnetic Diurnal Variations on Ordinary and Quiet Days at Kew Observatory," by Dr. C. Chree, F.R.S.; "The Effects of Different Gases on the Electron Emission from Glowing Solids," by Mr. F. Horton.

Dynamicables.—The annual meeting, followed by a dinner, will be held on Wednesday next, the 28th inst., at the Trocadero Restaurant, London, when Sir John Snell has consented to take the chair.

Crystal Palace Engineering Society.—The "Wilson Premium" for the best Paper read before this society during the present session has been awarded by the council to Mr. K. Ram for his Paper on "How to Prepare a Sanitation Scheme."

ARRANGEMENTS FOR THE WEEK.

FRIDAY, April 23rd (to-day).

Physical Society.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington, London, S.W. Agenda: Papers on "The Theories of Voigt and Everett Regarding the Origin of Combination Tones," by Prof. W. B. Morton, M.A., and Miss Mary Darragh; "Experiments on Condensation Nuclei Produced in Gases by Ultra-Violet Light," by Miss Maud Saltmarsh; and "On the Self-induction of Solenoids of Appreciable Winding Depth," by Mr. S. Butterworth.

SATURDAY, April 24th.

National Association of Colliery Managers and Association of Mining Electrical Engineers.

3:30 p.m. Meeting at University College, Nottingham. Paper on "Protective Devices against Lightning and Surges," by Messrs. E. Kilburn Scott and L. F. Fogarty.

TUESDAY, April 27th.

Manchester Section of the Institution of Electrical Engineers.

7 p.m. Meeting at the Engineers' Club, 17, Albert Square, Manchester. Paper on the "Bombay Hydro-Electric Scheme," by Mr. A. Dickinson.

Institution of Civil Engineers.

8 p.m. Annual general meeting at Great George-street, Westminster, London, S.W.

Illuminating Engineering Society.

8 p.m. Meeting at 18, John-street, Adelphi, London, W.C. Paper on "Visibility: Its Practical Aspects," by Messrs. C. C. Paterson and B. P. Dudding.

Association of Supervising Electricians.

8 p.m. Meeting at St. Bride Institute, Fleet Street, London, E.C. Paper on "Lightning Conductors," by Mr. H. C. Hands.

WEDNESDAY, April 28th.

Students' Section of the Institution of Electrical Engineers.

7 15 p.m. Meeting at the Institution, Victoria Embankment, London, W.C. Lecture on the "Paragon System," by Mr. W. P. Durtnall.

Royal Society of Arts.

8 p.m. Meeting at 18, John-street, Adelphi, London, W.C. Paper on the "Utilisation of Solar Energy," by Mr. A. S. E. Ackermann.

THURSDAY, April 29th.

Royal Institution.

3 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Lecture on "Advances in General Physics," by Dr. A. W. Porter, F.R.S. (Lecture I.)

Institution of Electrical Engineers.

8 p.m. Meeting at the Institution, Victoria Embankment, London, W.C. Paper on the Bombay Hydro-Electric Scheme," by Mr. A. Dickinson.

PRESIDENTIAL ADDRESS TO THE INSTITUTION OF MECHANICAL ENGINEERS.*

After touching upon various matters connected with the Institution, the author refers to the recruiting of the Engineer Units of the Royal Naval Division, the entrance examination for admission to the Institution, and then goes on to the subject of research work. Many so-called researches, in which well-understood methods are applied to materials or subjects not themselves important, hardly deserve the name. They amount to little more than class exercises. Most scientific societies receive Papers in which a much over-elaborated description is given of known proceedings and precautions, in which the new results are of limited value without establishing any general law. But the value of real research, based on a clear formulation of a definite unsolved problem, cannot be over-estimated. Unfortunately, in engineering, the solution of unsolved but important problems is generally both difficult and expensive. Much, no doubt, is done by manufacturers who have a financial interest in the work. But their researches are, in general, not fully published. It is of great interest to the public at large and to other engineers that a scientific Institution like this feels it part of its duty to advance knowledge by research, and is able to devote a fraction of its income for such researches as are beyond the means of private engineers.

The very close relation that engineering bears to the present war is dealt with and reference is made to the subjects of transport, exemplified by the conveyance of the Expeditionary Force; the recognition of the engineers of the Royal Navy, by reason of the state of efficiency to which they have brought the engine-room branch of the Navy; and the work of the mechanical engineer in furnishing the supply of munitions to our Forces.

Foreign Competition.—A retrospect of our methods and activities is not entirely favourable. *Fas est et ab hoste doceri*, and it is no condonation of the military crime of Germany to recognise that the enormously rapid industrial advance in that country has serious lessons for us. Before the war many of us had an immense respect for German science and learning. We have not lost that because we now appreciate the inordinate vanity, the preposterous political ambitions deliberately fostered among Germans, and the insolence of the army. In 16 years the aggregate income of Prussia has nearly doubled. While our Mercantile Marine increased from 9 to 10 million tons, that of Germany increased from 1 to 2½ million tons. In 1870 Germany had seven shipyards employing 3,000 hands; in 1900 she had 39 shipyards employing 40,000 hands. Although Germany has on the whole poorer qualities of iron ore and coal, her production of pig-iron increased from 11 to 19 million tons annually, while ours increased only from 9 to 11 million tons. To-day her production of steel is nearly twice as great as ours. I am not among those who think that to import materials or products is necessarily to diminish wealth or the demand for labour in this country. On the other hand, it is not satisfactory or safe that we import so many things from Germany, for the production of which she possesses no special advantages, and that in some cases important industries have become absolutely dependent on foreign supplies of manufactured products. It is one thing to exchange goods with another country, it is another thing if from sluggishness, or want of enterprise, we allow another country to obtain a monopoly of things we cannot do without. Various artificial conditions have fostered German trade, some of which might, and others could not, be imitated with advantage. The German Government is poorer than ours, but it has much more clearly recognised the interdependence of science and industry, and the duty of the State to assist industry in matters beyond private initiative.

The most striking examples of the plight to which we have been reduced are found in the chemical industries, which, however, involve a good deal of mechanical engineering. Aniline mauve was discovered in this country in 1856, but the Germans, and to a certain extent the Swiss, have practically captured the whole colour industry. Prof. Meldola stated that, in 1886, nine-tenths of the dyeing colours used in this country came from Germany. Yet these are essential to textile industries having an annual output of £200,000,000, employing 1,500,000 workers. The production of synthetic indigo in Germany has largely destroyed the cultivation of natural indigo in India. The value of imported indigo from India in 1895 was about £[illegible]. At the present time it is about £70,000. Bayer [illegible] synthetic indigo in 1880, but nearly 20 years were employed [illegible] nearly a million pounds was spent before commercial [illegible] was placed on the market. That is immensely creditable to German faith in science. Before the war the world's [illegible] was supplied [illegible] was practically met by Germany [illegible]. These are only other similar cases. In these industries Germany had no natural advantages, but only a greater scientific intelligence and greater confidence of financiers in supporting scientific advisers. To take another instance of more interest to engineers, Germany has acquired a practical monopoly of the treatment of the complex ores of the baser metals. The whole of the ores of zinc, lead, and silver from the mines of Australia, the richest in the world, are under contract sent to Germany for reduction. The Australian Attorney-General stated that "German influence exercised a monopoly over the world's base metal industry, so complete that it excluded effective competition."

Happily, in the iron and steel industries we are in a better relative position. Metallurgists here and in Germany, Belgium and the United States have learned much from each other, and we have no reason for dissatisfaction with our part in the progress made. We had a long lead, and the discoveries of Bessemer, Mushet, William Siemens, Thomas and Gilchrist, and others kept us in the front rank. We have been outpaced in volume of production, but in the higher qualities of steel and steel alloys, both in investigation and the quality of our product, we still hold a lead. The large demand for warships, guns and projectiles has no doubt been a favourable factor. The establishment of laboratories directed by competent experts in steel works and the works of large consumers like the railway companies has tended to the improvement and standardisation of quality. Nevertheless, we do not maintain superiority in all departments. In the case of light and medium steel castings—those required for motor cars, for instance—this country has become almost dependent on Germany and Switzerland. The use of steel castings has very greatly increased, and they add in an important way to engineering resources. So far as a reason can be found for the better and more uniform quality of Continental steel castings, it lies in the adoption abroad of the electrical furnace and great attention to heat treatment. Many of the steel castings come from Switzerland, where the cost of raw materials must be greater than in this country, and the cost of carriage must balance the lower labour cost. There is another point. After the war, when happier conditions return, our manufacturers must be willing to give designs, specifications and estimates in metric measures for countries where the metric system is adopted. The use of the metric system is legalised, but its compulsory adoption is not likely to be enacted, at any rate for a considerable time, if indeed it is desirable, about which a good many of us have doubts. Meanwhile, in many branches the use of a double system of metric and English measures involves little difficulty. In fine machinery no doubt it is troublesome, but that at present must be faced.

Technical Education.—Samuel Butler said that life is the art of drawing sufficient conclusions from insufficient premises. It is certainly true of the engineer, not engaged in mere repetition work, that he has constantly to arrive at conclusions and to act on insufficient data. Probably no difficult engineering problem has ever in the strict sense been completely solved. The engineer has to make assumptions, to use approximate theories, to decide between material and negligible considerations, and to allow for unknown contingencies. Now, scientific training, if sufficiently advanced, does enable us to solve most problems which are clearly stated and data given, but its usefulness does not end there. The trained engineer with incomplete data reasons correctly, estimates probabilities, and knows the limit of the trustworthiness of his conclusions. He does not snatch at a pocket-book rule and ignore the assumptions on which it is founded. Among the various causes which have contributed to German industrial development, a thorough and widely diffused technical education must be given an important place. The branches of industry in which Germany has acquired a dominant position are those in which advanced applications of science are most necessary. In Germany and Austria, excluding chemists, there are four or five times as many students in technical high schools as in colleges of corresponding rank in Great Britain. America, Belgium and Switzerland in this respect have closely followed Germany.

If I speak with admiration of the intellectual efficiency of German education, it is not that I like the Germans or that I do not see some serious evils in their system of education. Our English system is in many ways intellectually deficient, but it encourages initiative, individualism, and a high sense of honour. In Germany all education is State controlled, and made to subserve State interests. In 1868, the Kaiser said that "he had firmly resolved that the theatre, the university and the school should be instruments of the monarch." But now, putting aside political and moral considerations, it is the thorough and advanced character of the education in the technical high schools and the researches of their professors, to which indeed many of us are greatly indebted, which have so directly promoted German industry. There is another aspect of education in Germany which has a lesson for us—the German secondary school is far more efficient than ours. Secondary education in Germany is State supported and definitely graded. A great obstacle to really efficient

* Abstract of the address delivered by Prof. W. C. Unwin, F.R.S.

technical instruction in this country is the inadequate preparation for it in the schools. I am far from advocating the Germanisation of English education. Only it seems to me that some of our educational tools, like some of our workshop tools, are mediaeval and out of date, and that some of our faults need a remedy. If, as I suppose, the cost of the war must be paid out of the profits of industry, it is of importance that our efficiency should be increased. Sir George Reid has said that "Captures of German trade in time of war will only be retained in time of peace by the capture also of the scientific methods of the Germans."

Testing Materials. Half a century ago, most materials of construction were selected and bought on the reputation of the manufacturer. Now hardly any material in large use is accepted without special testing in the interest of the purchaser. Such testing has acted as a stimulus to manufacturers to standardise and improve their products. With the introduction of mild steel, the quality of which ranges between wide limits, the need of systematic testing became urgent. Now there are testing laboratories in the works of most railway companies and in steel works. With the extension of testing has come the need of standardising tests themselves, a work now largely accomplished by the International Association and the British Standards Committee. But with the increasing stringency of specifications, perhaps more attention should be given to the calibration of the instruments used in testing. In physical investigations great attention is given to the determination of the errors of instruments and methods, and perhaps in material testing this has received too little attention. On the Continent and in the United States there are public laboratories, supported by the State, where anyone can have tests made, at moderate fixed rates, by a trained scientific staff and with great accuracy. Such institutions assist industry if, on the one hand, they meet industrial requirements, and, on the other, are unbiased by private interests. They have the advantage over private laboratories that they are under the direction of experts of exceptional experience and reputation, and are able to pursue investigation, continued often for long periods, beyond immediate requirements into fruitful by-paths. The view taken in Germany is that the work accomplished is partly of advantage to the manufacturer who calls for assistance, and so far should be paid for by him, and partly is of advantage to the nation in advancing science, which is the justification for a State subsidy. Hence it is incumbent on the public institution to publish results as freely as is possible without injuring private interests.

At Grosslichterfelde the annual income from fees for testing amounts to £20,000, and the annual State subsidy is £12,000. The Bureau of Standards at Washington is on a still larger scale, and does very similar work. It receives an annual subsidy from the Federal Government of £100,000. The equipment is extraordinarily complete. Happily, we have now a similar institution in the National Physical Laboratory at Teddington. Its functions are somewhat restricted by the characteristic English jealousy of State action, which I think is diminishing. It would be difficult to over-estimate the service it has done in the solution of various mechanical, electrical and physical problems which were unlikely to be attacked by private persons.

It is a condition of commercial testing that the results should be available in a short time and at small expense. Hence ordinary tests are of a somewhat arbitrary character, and do not completely imitate the conditions of actual service. We test specimens of steel to destruction and measure ductility by plastic deformation, though in use the stresses do not exceed the elastic limit and the deformation is elastic. We test cement in tension and use it in compression. There is need for constant examination of methods of testing and for the invention of new tests, such as tests for hardness and brittleness, although new tests must be cautiously introduced.

THE EFFECT OF DELTA AND STAR CONNECTIONS UPON TRANSFORMER WAVE FORMS.*

BY LESLIE F. CURTIS.

Summary.—The purpose of the Paper is to show the distortions resulting from different symmetrical three-phase connections of generator and transformers without transmission line, as dependent upon the hysteresis cycle and the admittance of the transformers at no-load.

It is well known that the method of connecting three-phase transformers, or of single-phase transformers upon three-phase lines, influences the character of the potential and current waves, in that the type of connection limits the percentage of the harmonics of E.M.F. which may appear between lines and the current-waves of the harmonics of current which may appear in any line. It is not the purpose of this Paper to bring forth any new discoveries, but to present a series of wave forms, taken with the oscillograph, showing the wave distortions which are likely to occur in the different symmetrical three-phase connections. Oscillograms of potential and exciting current were taken at no-load upon three single-phase, 10 kw., 1,100-110-volt, 60-cycle step-up transformers when connected in all possible combinations of delta and star. The generator used was a 7·5 kw., 60-cycle machine, so arranged as to give the desired voltages when connected either delta or star. It was thought that any distortions would be a maximum with the large transformers connected to the smaller generator at no-load. Throughout all tests the line

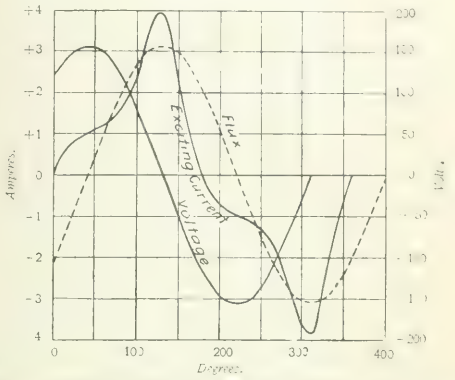


FIG. 1.—POTENTIAL, FLUX AND CURRENT WAVES. SINGLE-PHASE CONNECTION.

voltage was held at 110 when the transformers were connected in delta, and at $110\sqrt{3}$ when the transformers were connected in star. Since the transformers were very nearly balanced, wave forms were not recorded upon all of the phases.

Before investigating the wave forms with the three-phase connections, an oscillogram of exciting current with a sine wave of E.M.F. was taken to determine the hysteresis cycle on normal conditions. This is shown in Fig. 3. Fig. 1 shows the voltage, flux and exciting current, and Fig. 2, the resulting hysteresis cycle scaled from the original oscillogram.

The next set of tests was run with the generator connected in star. This gave practically a sine wave of E.M.F. between lines, except

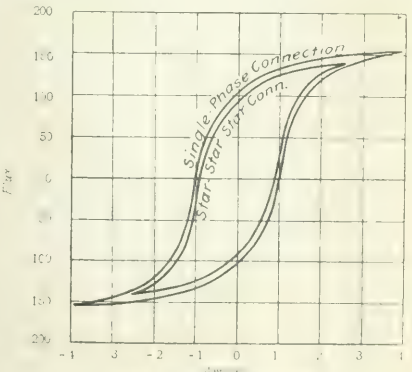


FIG. 2.—HYSTERESIS CYCLES.

when the reactions in the transformers introduced a fifth harmonic. With a star-star connection of transformers, the wave of exciting current is as in Fig. 4. Since no third harmonic can exist in the exciting current, one must appear in the transformer voltage, or the voltage to neutral, even though the line voltage remains a sine wave, because of the definite shape of the hysteresis cycle. This is shown in Fig. 5. Fig. 6 shows the voltage, flux and exciting-current relations for the above connection. The hysteresis cycle is plotted in Fig 3, showing the same general shape as for the sine wave of flux,

* Paper read before the American Institute of Electrical Engineers.

but being smaller in area. For the above test, normal line voltage ($110\sqrt{3}$ volts) was held, but owing to the change in wave shape, the voltage to neutral was 121·0.

With one side of the transformers connected in delta, the third harmonic, which is lacking in the exciting current with the star-star connection, may flow in the closed delta. It appears only in the local transformer circuit. Fig. 7 shows the line current and the transformer current for a delta-star connection of windings. The

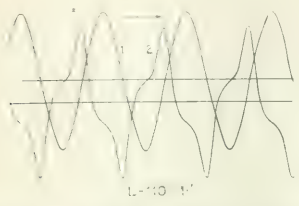


FIG. 3. EXCITING CURRENT AND POTENTIAL WAVES.

Star-star connection. Curve 1, voltage to neutral, 110·0 volts. Curve 2, exciting current, 2.00 amperes.

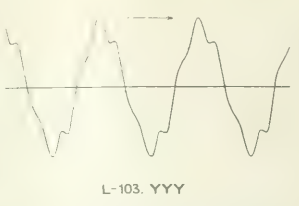


FIG. 4.—EXCITING CURRENT WAVE.

Star-star-star connection.

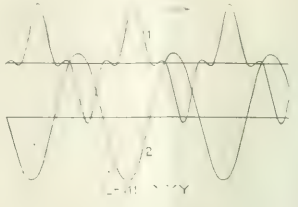


FIG. 5.—POTENTIAL WAVES.

Star-star-star connection. Curve 1, voltage to neutral, 121·0 volts. Curve 2, voltage between lines, 190·3 volts

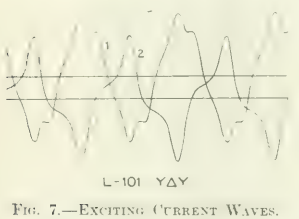


FIG. 7.—EXCITING CURRENT WAVES.

Star-delta-star connection. Curve 1, line current, 3·39 amperes. Curve 2, transformer current, 2·11 amperes.

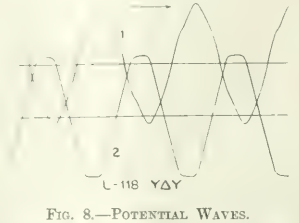


FIG. 8.—POTENTIAL WAVES.

Star-delta-star connection. Curve 1, line voltage 1924·0 volts. Curve 2, delta voltage 110·0 volts.

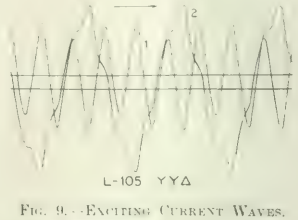


FIG. 9.—EXCITING CURRENT WAVES.

Star-star-delta connection. Curve 1, delta current, 3·074 amperes. Curve 2, line current, 1·94 amperes.

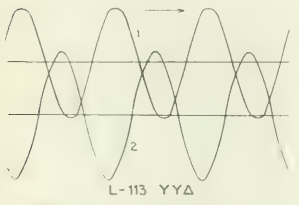


FIG. 10.—POTENTIAL WAVES.

Star-star-delta connection. Curve 1, voltage to neutral, 110·0 volts. Curve 2, line voltage, 190·3 volts.

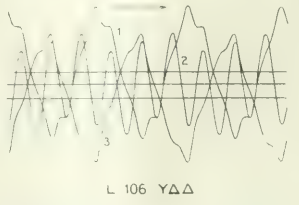


FIG. 11.—EXCITING CURRENT WAVES.

Star-delta-delta connection. Curve 1, line current, 3·49 amperes. Curve 2, high-tension delta current, 0·068 ampere. Curve 3, low-tension delta current, 2·15 amperes.

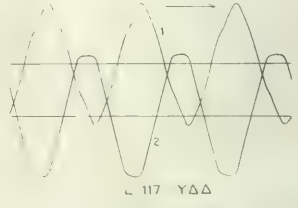


FIG. 12.—POTENTIAL WAVES.

Star-delta-delta connection. Curve 1, voltage to generator neutral, 63·8 volts. Curve 2, line voltage, 110·0 volts.

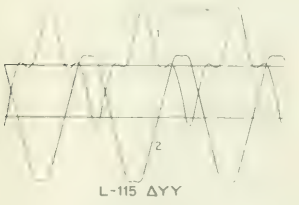


FIG. 13.—POTENTIAL WAVES.

Delta-star-star connection. Curve 1, voltage to neutral, 121·1 volts. Curve 2, line voltage, 190·3 volts.

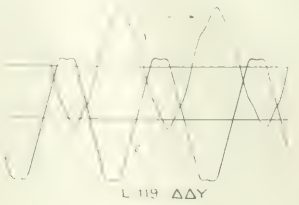


FIG. 14.—POTENTIAL WAVES.

Delta-delta-star connection. Curve 1, line voltage, 1930·0 volts. Curve 2, delta voltage, 110·0 volts.

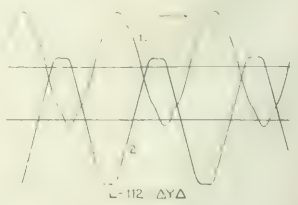


FIG. 15.—POTENTIAL WAVES.

Delta-star-delta connection. Curve 1, voltage to neutral, 110·1 volts. Curve 2, line voltage, 190·3 volts.

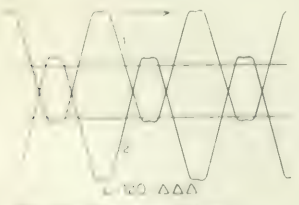


FIG. 16.—POTENTIAL WAVES.

Delta-delta-delta connection. Curve 1, voltage to neutral, 114·1 volts. Curve 2, line voltage, 190·3 volts.

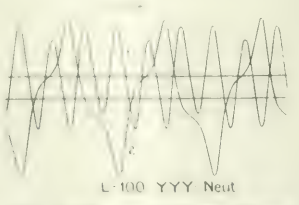


FIG. 17.—EXCITING CURRENT WAVES.

Star-star-star connection. Curve 1, neutral current, 1·80 amperes. Curve 2, line current, 1·89 amperes.

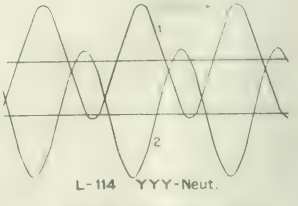


FIG. 18.—POTENTIAL WAVES.

Star-neutral-delta connection. Curve 1, voltage to neutral 110·6 volts. Curve 2, line voltage, 190·3 volts

admittance of the transformers is such that a fifth harmonic in excess of the amount demanded by the hysteresis cycle appears in the line and transformer currents. This causes a fifth harmonic to appear in the E.M.F. waves, as is shown in Fig. 8. Curve 2 shows the characteristic flat-topped delta voltage, or high-tension voltage to neutral, for this connection. Curve 1 shows the high-tension line

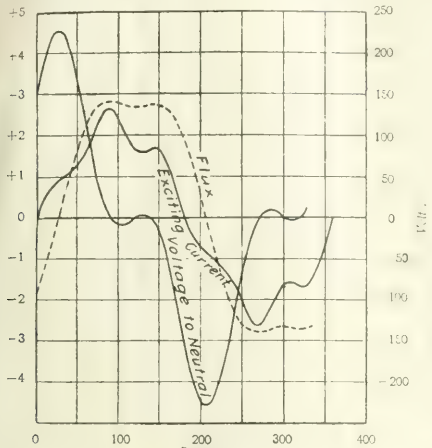


Fig. 6.—Potential, Flux and Current Waves. Star-star-star Connection.

voltage, which is peaked because of the vector difference of waves containing the fifth harmonic similar to that shown in Curve 2 120 deg. apart.

It will be noted that the reaction causing this distortion originates in the transformers since the wave of exciting current is not materially different from that of the star-star connection which did not

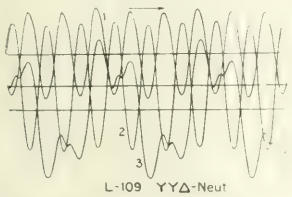


Fig. 19.—Exciting Current Waves.

Star-neutral-star-delta connection. Curve 1, neutral current, 3·55 amperes. Curve 2, delta current, 0·186 ampere. Curve 3, line current, 2·23 amperes.

distort the generator voltage. Fig. 9 shows the exciting currents for a star-delta connection of transformers. The third harmonic of the exciting ampere-turns is now derived from the high-tension delta circuit. The low-tension line current contains an excess of the fifth harmonic as in the previous case, causing the same flat-topped wave of voltage to neutral or delta voltage as before. The transformer

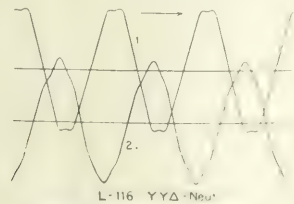


Fig. 20.—Potential Waves.

Star-neutral-star-delta connection. Curve 1, voltage to neutral, 110·2 volts. Curve 2, line voltage, 190·3 volts.

and line voltages are given in Fig. 10. [illegible] connection of transformers, the voltage distortions are [illegible] due to the troublesome fifth harmonics in the exciting circuits. The currents and voltages for this connection are [illegible] Figs. 11 and 12.

With the generator connected in delta, the short-circuit third harmonic current in the armature produces a pulsation at six times the normal frequency in the field flux, which, in turn, introduces a fifth and a seventh harmonic in the armature voltage. Of these, the fifth is the more troublesome, producing the familiar flat-topped wave of delta voltage. Distortions due to the transformer connections are superimposed upon the generator wave. Figs. 13, 14, 15 and 16 show the voltages of the banks of transformers connected in star-star, delta-star, star-delta and delta-delta respectively, when excited from the delta-connected generator. The original wave form of the generator voltage is shown in Fig. 13, since the star-star connection of transformers does not distort the line voltage.

When the generator and the low-tension side of the transformers are connected in star with connected neutral, the third harmonic components of the exciting current may return to the generator over the neutral, each phase constituting a single-phase circuit. The waves of exciting current for a star-star bank of transformers with connection to the generator neutral are shown in Fig. 17. The voltages are shown in Fig. 18, being very nearly sine waves. If the high-tension side is now placed in delta, there exists a short circuit of the unbalanced third harmonics in the three transformers. This causes an excessive third harmonic current to flow over the neutral which reacts upon the generator flux in the same way as that in a delta-connected generator. This is shown in Fig. 19. A flat-topped wave of voltage to neutral and a peaked line voltage result, as shown in Fig. 20.

From the above results it is seen, from the standpoint of wave form, that the banks of transformers connected delta-star, star-delta, or star-star with connected generator neutral give the best results. The latter connection would be ruled out if dissimilar banks were to be operated in parallel.

THE ELECTROLYTIC INSULATION OF ALUMINIUM WIRE*.

BY C. E. SKINNER AND L. W. CHUBB.

Summary.—The author describes a process of treating aluminium wire so as to form an insulating coating on it, rendering it suitable for winding coils where space or the ability to stand high temperatures is a consideration.

The author shows that where the space occupied by the conductor is not a governing factor either iron or aluminium will be cheaper to use than copper. In the construction of electrical machinery, space is usually a governing factor, and copper has been found more suitable in every way than the other metals. Copper, however, requires—for coil work—a certain amount of insulation having a definite thickness (it depending upon the conditions of application), and, consequently, in the average coil the total percentage of copper in the cross-section of the coil is reduced by the insulation requirements. In coil winding, the thickness of the insulation on individual turns does not vary greatly, as a rule, regardless of the size of wire used.

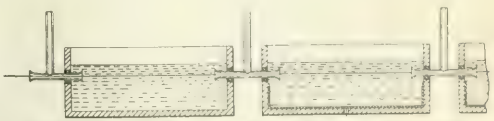


Diagram showing Method of Taking Wire through Baths.

Consequently, the percentage of copper to insulation decreases rapidly as the size of wire is reduced. It is evident that any gain in the efficiency of the conducting material must, therefore, be obtained by increasing the conductivity or decreasing the thickness of the insulation. The authors have found that it is possible to produce an insulating coating on the surface of aluminium wire which is so extremely thin that on many of the smaller sizes of wires it is possible to get a higher space efficiency, so far as the conducting material is concerned, in a coil with aluminium than with copper, even when the thinnest possible insulation is applied to the copper.

The skin or thin layer of natural oxide which is so objectionable in the soldering of aluminium is a non-conductor of high dielectric strength and for several years engineers have been trying to strengthen the film of oxide so that it could take the place of the fibrous insulation ordinarily used on copper wire. Robt. Hopfelt and others in 1906 and 1907 [illegible] wire could be used to wind magnet [illegible]. The wire after being

* Abstract of a Paper read before the American Electrochemical Society.

wound was soaked and then heated by passing current through the coil. This process would form an oxide which was said to withstand a potential as high as 0·5 volt, and if formed between all adjacent turns of the layers of the winding and with insulation between layers, this type of coil could be used as an economical substitute for copper coils. Early in 1907 the authors devised a method of strengthening the coating by means of an electrolytic action which produced a coating of many times the dielectric strength of the coatings which had been obtained by former methods. It was found, however, that the successful production of an insulating coating which would withstand a potential of 500 volts and which proved to be exceedingly thin and which was indestructible, so far as temperature is concerned, was but the first stage in a research looking to the production of commercially satisfactory coils for electrical apparatus. It was found that in the problem, as a whole, there was involved the question of making joints in the wire itself; the question of joining leads to the aluminium wire which could be satisfactorily soldered, as in the copper; the question of winding of the coils which were found to require different treatment from the ordinary coils; the question of securing proper grades of wire; and many other details which had to be taken into account.

It is well known that aluminium as an anode in the solutions of certain salts polarises or films with a coating which tends to prevent the flow of current from the electrode to the electrolyte. The polarisation voltage between the electrolyte and aluminium builds up to a certain critical value, dependent upon the salt dissolved, the density temperature, former history of the solution, &c. The action of the film seems to indicate that a very thin film of alumina of high dielectric strength and high specific capacitance is formed. Nascent oxygen formed by the passage of current from any hole or local weak area of the oxide film would oxidise more metal at that point and increase the thickness of the insoluble compound. In this way the film is built to a uniform strength all over the surface of the anode. After such a film is formed the anode may be withdrawn from the electrolyte, washed, and when dry will be found to have a dielectric strength approximately equal to the voltage at which it was formed. This film after drying is the same as the insulation now used on the bare aluminium wire.

Process of Insulating.—The development of the process for insulating the wire went through several stages. In the first the wire was wound into skeins, dipped into the electrolyte, then treated and finally washed and re-wound. In the subsequent development continuous methods were employed in which the wire as an anode was drawn through a bath of electrolyte. In all these methods of treating, the wire passed over several sheaves with the result that it became hardened in the process. A straight-through method as shown in the figure was, therefore, tried and found to give very satisfactory results. Five tanks arranged in a straight line were used. The first and last contained hot water for washing and the middle three electrolyte. The wire passed from tank to tank through glass tubes and the solutions were kept apart by blowing air through a tube sealed to the centre of the connecting tubes. In this method there was again no column of electrolyte at the point of entrance, and it was at first necessary to form the coating in two steps, of 200 and 400 volts respectively. This was superseded by the present method in which the wire also goes straight through and the increase in voltage is again established through a small weir and spout through which the wire enters. This latest apparatus has the additional advantage of allowing the removal and starting of the wire without threading through.

Electrolytes.—Several electrolytes were used and they gave quite different results. The principal differences were the amounts of current and energy required to bring the wire up to voltage and the possible speed with which the wire could be run through the bath. Solutions of borax, ammonium borate and sodium silicate were the best, the last being the best of the three.

Speed of Treating and Energy Required. It was found that less energy was required per unit of surface if a high-current density was used, and the voltage brought up quickly. The speed and current density were limited in the case of small wires by the fusing of the wire between the tanks, and with the large wires by the limited capacity of the generator used in the experimental work. The speed of treating wire varied from 40 ft. to 150 ft. per minute for the different sizes of wire used and the consumption of energy was from 0·15 to 0·80 watt-hours per square inch of surface treated.

Properties of the Coating. The insulation formed by the above processes is a thin film of alumina which is smooth and irridescent or abrasive and white. The smooth films form with a greater expenditure of energy and in inferior electrolytes. The white film formed in sodium silicate at about 425 volts is rather smooth to the touch but so abrasive that it cuts and grinds the hand while coil winding. In some cases this treated wire running through the hand of the winder has cut through the skin and into the flesh before discovery. The dielectric strength is far superior to the oxide coat formed by the former methods, for instead of standing a maximum of 0·5 volt two wires electrolytically treated and twisted tightly together without abrasion will stand from 200 to 500 volts. The thickness of the film is apparently variable. Tests of change in diameter of wire before and after treating and tests of reduction in metal section by resistance measurements before and after treating show the coating to be from 0·0001 in. to 0·0004 in. (0·00025 cm. to 0·001 cm.) thick.

On account of the thinness of the film it is quite flexible and does not open or appreciably weaken by sharp bends and kinks in the wire. Soft wire can be stretched 30 per cent. of its length without apparently injuring the insulation. Two wires at a P.D. of 250 volts can be crossed and pressed together at the intersection until the wires are dented to such an extent that the intersection is no thicker than a single wire. If there is no relative motion between the surfaces in contact the insulation will not break down, but the slightest movement of one of the wires will cause a grinding between the surfaces which will at once cause a short circuit. The insulating coating is fireproof and has sufficient strength mechanically to support the wire in small coils when the metal is above the melting point. Small coils run with the wire molten will fall to pieces if the current is suddenly stopped, but if the current is gradually lowered the metal will solidify and remain intact.

Application of the Wire.—Electrolytically insulated aluminium wire is suitable for many classes of work requiring wires of relatively small size where the insulation requirements are not excessive and particularly where temperature requirements are severe. The very small sizes, No. 30 B. & S. gauge and smaller, cannot be satisfactorily used on account of the difficulty in drawing the wire and in subsequent handling. In the very large sizes there is no advantage in the use of aluminium wire where the space is restricted. This wire has been found particularly advantageous for use in coils which require light weight and which are subjected to relatively high temperatures, provided the insulation requirements on the individual wires are not excessive. The weight of an aluminium wire coil is from 40 to 50 per cent. of that of the equivalent copper coil. The thermal capacities of the two types of coils are practically the same and the temperature coefficients are equal. The heat dissipation through the aluminium coil is found to be slightly better than the equivalent copper coil. While this new wire has limitations, it has a decided sphere of usefulness, which will probably be greatly extended, particularly in the event of the ratio between the base prices of aluminium to copper being decreased.

ON THE DIRECT MEASUREMENT OF POWER FACTOR.

BY R. D. GIFFORD, M.SC.

(*Continued from p. 50.*)

Summary.—The author deals with the subject under the following headings: I. Description of the Dynamometer and Moving Iron Types of Power-Factor Indicator. II. Description of the Induction-Dynamometer Power-Factor Indicator. III. The Meaning of the Power-Factor of a Three-Phase Unbalanced Circuit. IV. The Theory of the Six Unit Power-Factor Meter. V. Results of Tests Substantiating Theory. VI. The Four Unit Power-Factor Meter on Three-Phase Unbalanced Circuits. VII. Frequency Tests on the Induction-Dynamometer Power-Factor Meter. VIII. Power-Factor Meters with Artificial Scales. IX. The Induction-Dynamometer Synchroscope.

III. The Power-factor of an Unbalanced Three-phase Circuit.

The general expression for the power-factor of a single-phase circuit is

$$\text{P.F.} \quad \frac{\frac{1}{T}\int_0^T ei\,dt}{\left[\frac{1}{T}\int_0^T e^2\,dt \cdot \frac{1}{T}\int_0^T i^2\,dt\right]^{\frac{1}{2}}} \qquad \ldots \quad (1)$$

in which e and i are the instantaneous values of the E.M.F. and current respectively over one complete cycle of time T.

This definition includes the cases in which the pressure and current waves do not conform to the harmonic law, and may not be similar. It is well known that if the pressure and current waves are dissimilar, then under no circumstances can the power-factor of the circuit be unity. The departure from unity of the maximum possible power factor for various wave

shapes is usually not very great, and can be calculated with little difficulty. It can be shown that even if a peaked E.M.F. of triangular form be assumed in combination with a sine current, the power-factor for any given phase displacement differs by less than 1 per cent. from that given by a sine E.M.F. Moreover, the representation of alternating-current phenomena by vector methods becomes three dimensional when upper harmonics are present in the circuit, hence it appears that in the mathematical treatment of the theory of a direct-reading phase-meter, to include the effects of harmonics is hardly justified, as the indications will not be very greatly affected by assuming sine waves of E.M.F. and current, whilst the complication introduced into an otherwise comparatively simple calculation is great.

With this assumption, equation (1) takes the usual form,

$$\cos\varphi = \frac{\text{watts}}{\text{EI}} \quad \ldots\ldots\ldots \quad (2)$$

For a three-phase balanced load, the power-factor of the whole circuit is the same as that of each phase, and may be

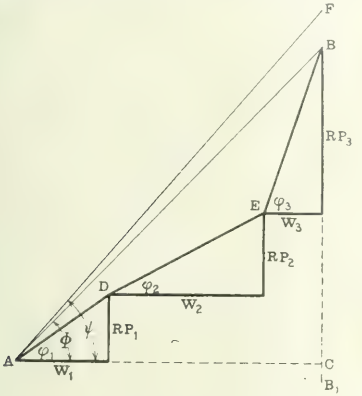


Fig. 8.

written as in (2), where E is the effective star E.M.F., I the effective current in each line, and the watts are one-third of the total power.

The power-factor of an unbalanced three-phase circuit is generally defined as

$$\cos\varphi = \frac{\text{total watts}}{\text{apparent watts}} \quad \ldots\ldots\ldots \quad (3)$$

In this formula the "apparent watts" are taken as the sum of the separate effective volt-amperes $E_1I_1+E_2I_2+E_3I_3$. The use of this formula, however, does not always lead to concordant results, as will be shown later.

A different conception of the apparent watts is due to G. Campos,* who argues that the unbalanced circuit should be treated as a power-delivering unit, and should, therefore, be capable of representation vectorially by a single triangle whose sides are proportional respectively to the true power, the reactive power, and the volt-amperes, just as in a single-phase circuit. To this end Campos takes the three separate triangles obtained from the three phases, and places them end to end, so that the vectors representing the true power in each triangle lie in the same direction, as shown in Fig. 8. In the triangle ABC, AC is ΣW, the total true power, BC is ΣRP, the total reactive power, and AB is, according to Campos, the apparent power. The phase angle of the complete unbalanced circuit is, therefore, BAC$=\Phi$. Hence, the power-factor is

$$\cos\Phi = \frac{\Sigma W}{\sqrt{(\Sigma RP)^2+(\Sigma W)^2}} \quad \ldots\ldots\ldots \quad (4)$$

and

$$\tan\Phi = \frac{\Sigma RP}{\Sigma W} \quad \ldots\ldots\ldots \quad (5)$$

* "Atti della" Assoc. Elettra. Ital., Vol. XIII., pp. 197-210, 1909.

It will be seen that the difference between this method of computing the power-factor and that of equation (3) is that the separate volt-amperes of the three phases are added vectorially instead of arithmetically. If we take the arithmetic sum of AD, DE and EB, and set this off from A, we get the line AF, making an angle ψ with AC, whose cosine is the value of the power-factor given by equation (3). Except when the load is balanced, the three triangles then being similar, AF must always be greater than AB—that is to say, cos Φ will always exceed cos ψ.

The expression for the power-factor given in equation (4) is perfectly general, giving the usual results on single-phase, two or three-phase balanced circuits. The case in which the power-factor as calculated by the two methods shows a large difference, is that in which the load in one phase is condensive and in the others inductive. For example, suppose the loads on the three phases to retain the same values as shown in Fig. 8, except that phase-three is condensive to the same extent as it is there shown inductive, then the third triangle must be rotated through 180 deg. about the line W_3. B would then fall on B_1, giving a slightly leading power-factor for the whole circuit, whereas, according to equation (3), the power-factor is unaltered.

The question which at once arises is: "To which equation, (3) or (4), if either, does the reading of the six-unit dynamometer or induction-dynamometer type of power-factor meter for three-phase unbalanced circuits conform?" We shall now proceed to find an answer to this question.

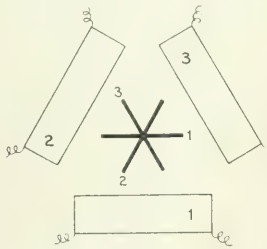


Fig. 9.

It will be shown in sec. VI. that the four-unit meter is incapable of giving correct indications of the power-factor of three-phase unbalanced circuits.

IV. The Theory of the Six-unit Power-factor Indicator.

Let I_1, I_2, I_3 and i_1, i_2, i_3 be the maximum and instantaneous values respectively of the three line currents, and E_1, E_2, E_3 the maximum values of the phase E.M.F.s. Let φ_1, φ_2, φ_3 be the angular lag or lead between the E.M.F.s and their respective currents. Also let α_{12}, α_{23}, α_{31} denote the angular displacements between E_1 and E_2, E_2 and E_3, E_3 and E_1 respectively, and β_{12}, β_{23}, β_{31} be the corresponding angles in the case of the currents.

The currents and E.M.F.s will be assumed to vary according to the harmonic law, for the reasons given in sec. III.

The E.M.F.s acting in the moving coils will not in general be in phase with the primary E.M.F.s. Let their angular lag behind these be δ, and let the moving coil E.M.F.s be e_1, e_2, e_3 respectively. Then counting time from the instant $e_1=o$, we have at any time t, where $\omega=2\pi\times$frequency.

$$\left.\begin{aligned} e_1 &= E_1 \sin(\omega t - \delta) \\ e_2 &= E_2 \sin(\omega t - \delta - \alpha_{12}) \\ e_3 &= E_3 \sin(\omega t - \delta - \alpha_{31}) \end{aligned}\right\} \quad \ldots\ldots \quad (6)$$

Also

$$\left.\begin{aligned} i_1 &= I_1 \sin(\omega t - \varphi_1) \\ i_2 &= I_2 \sin(\omega t - \beta_{12} - \varphi_1) \\ i_3 &= I_3 \sin(\omega t - \beta_{31} - \varphi_1) \end{aligned}\right\} \quad \ldots\ldots \quad (7)$$

These currents and E.M.F.s are acting in coils situated at 120 deg. to each other, and we shall suppose that the moving system is for the time being fixed and that the planes of its coils are parallel to the planes of the corresponding phase coils of the fixed current system, as shown in Fig. 9. It follows that at

time t the instantaneous value of the flux in the direction of the axis of coil 1, due to the line currents, is proportional to

$$I_1 \sin(\omega t - \varphi_1) - \tfrac{1}{2} I_2 \sin(\omega t - \beta_{12} - \varphi_1) - \tfrac{1}{2} I_3 \sin(\omega t + \beta_{31} - \varphi_1) = A, \quad (8)$$

and the instantaneous flux at right angles to the same axis is proportional to

$$\frac{\sqrt{3}}{2} I_2 \sin(\omega t - \beta_{12} - \varphi_1) - I_3 \sin(\omega t + \beta_{31} - \varphi_1) = B. \quad (9)$$

As we are not here concerned with the actual, but only the relative values of these fluxes, we shall write "equal to" for "proportional to." Hence, the total instantaneous current flux is

$$F_1 = (A^2 + B^2)^{\frac{1}{2}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

making an angle θ_1 to the axis of coil 1 where

$$\theta_1 = \text{arc tan } \frac{B}{A}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

It can be shown that in general the locus of the extremity of the flux vector of length $(A^2 + B^2)^{\frac{1}{2}}$ is an ellipse. In the particular case of a balanced circuit the ellipse becomes a circle—that is to say, F_1 rotates uniformly.

The phase E.M.F.s and currents are supposed to attain their maximum values in the order 1, 2, 3, as shown in Fig. 9—*i.e.*, the flux vectors will rotate in a clockwise direction, so that if the currents lag increasingly behind the E.M.F.s the moving system will rotate in a counter-clockwise direction. This we shall term the positive direction.

The instantaneous value of the flux F_V produced by the moving system may be similarly resolved into its components C and D, acting along and at right angles respectively to the axis of coil 1.

Then $$F_V = (C^2 + D^2)^{\frac{1}{2}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

where

$$C = E_1 \sin(\omega t - \delta) - \tfrac{1}{2} E_2 \sin(\omega t - \delta - \alpha_{12}) - \tfrac{1}{2} E_3 \sin(\omega t - \delta - \alpha_{31}) \quad (13)$$

and $$D = \frac{\sqrt{3}}{2} \{ E_2 \sin(\omega t - \delta - \alpha_{12}) - E_3 \sin(\omega t - \delta - \alpha_{31}) \}. \quad (14)$$

The angle between F_V and the axis of coil 1 at any moment is

$$\theta_V = \text{arc tan } \frac{D}{C}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

The extremity of a vector representing F_V traces out an ellipse, as in the case of the current flux vector.

The current and voltage flux vectors are not rotating uniformly, nor is the angle between them in general a constant: the vectors having their maximum and minimum velocities when at the positions of the minor and major axes of their elliptical paths. There is a mutual action between the two fluxes producing a torque between the fixed and moving systems, whose instantaneous value is given by

$$t_r = F_V F_1 \sin(\theta_V - \theta_1). \quad . \quad . \quad . \quad (16)$$

This torque in general varies over a wide range, the average value throughout one complete cycle being

$$T_r = \frac{\int_0^{2\pi} F_V F_1 \sin(\theta_V - \theta_1) d\omega t}{\int_0^{2\pi} d\omega t} \quad . \quad . \quad . \quad (17)$$

This equation expresses the conditions existing when the moving system is held in the position shown in Fig. 9. If it is now freed it will in general rotate through some angle γ, and will be in equilibrium. The values of the instantaneous angles $(\theta_V - \theta_1)$ between the flux vectors will now all be reduced by a common amount γ. Hence, in the position of equilibrium we have for the average torque

$$T_r = \frac{1}{2\pi} \int_0^{2\pi} F_V F_1 \sin(\theta_V - \theta_1 - \gamma) d\omega t = 0 \quad (18)$$

The integration can most easily be effected by writing it in the form

$$\frac{1}{2\pi} \left[\int_0^{2\pi} (F_V \sin\theta_V F_1 \cos\theta_1 - F_V \cos\theta_V F_1 \sin\theta_1) d\omega t \right] \cos\gamma - \frac{1}{2\pi} \left[\int_0^{2\pi} (F_V \cos\theta_V F_1 \cos\theta_1 + F_V \sin\theta_V F_1 \sin\theta_1) d\omega t \right] \sin\gamma = 0 \quad (19)$$

Now,

$$F_1 \cos\theta_1 = A = I_1 \sin(\omega t - \varphi_1) - \tfrac{1}{2} I_2 \sin(\omega t - \beta_{12} - \varphi_1) - \tfrac{1}{2} I_3 \sin(\omega t + \beta_{31} - \varphi_1), \text{ from (8)}$$

$$F_1 \sin\theta_1 = B = \frac{\sqrt{3}}{2} I_2 \sin(\omega t - \beta_{12} - \varphi_1) - I_3 \sin(\omega t + \beta_{31} - \varphi_1), \text{ from (9)}$$

$$F_V \cos\theta_V = C = E_1 \sin(\omega t - \delta) - \tfrac{1}{2} E_2 \sin(\omega t - \delta - \alpha_{12}) - \tfrac{1}{2} E_3 \sin(\omega t - \delta - \alpha_{31}), \text{ from (13)}$$

$$F_V \sin\theta_V = D = \frac{\sqrt{3}}{2} \{ E_2 \sin(\omega t - \delta - \alpha_{12}) - E_3 \sin(\omega t - \delta - \alpha_{31}) \}, \text{ from (14)}$$

Putting in these values on the L.H. side, the first part of (19), after some reduction, simplifies to

$$\frac{\sqrt{3}}{4} \Big[E_1 \{ I_3 \cos(\delta - \beta_{31} - \varphi_1) - I_2 \cos(\delta - \beta_{12} - \varphi_1) \} + E_2 \{ I_1 \cos(\delta - \alpha_{12} - \varphi_1) - I_3 \cos(\delta - \alpha_{12} - \beta_{31} - \varphi_1) \} + E_3 \{ I_2 \cos(\delta - \alpha_{31} - \beta_{12} - \varphi_1) - I_1 \cos(\delta - \alpha_{31} - \varphi_1) \} \Big] \cos\gamma \quad (20)$$

Put (20) equal to $Y \cos\gamma$.

Similarly, the second part of (19) reduces to

$$\frac{1}{2} \Big[E_1 I_1 \cos(\delta - \varphi_1) - E_2 I_2 \cos(\delta - \alpha_{12} - \beta_{12} - \varphi_1) - E_3 I_3 \cos(\delta - \alpha_{31} - \beta_{31} - \varphi_1) + \tfrac{1}{2} E_1 \{ I_2 \cos(\delta - \beta_{12} - \varphi_1) - I_3 \cos(\delta + \beta_{31} - \varphi_1) \} + \tfrac{1}{2} E_2 \{ I_3 \cos(\delta - \alpha_{12} + \beta_{31} - \varphi_1) - I_2 \cos(\delta - \alpha_{12} - \varphi_1) \} + \tfrac{1}{2} E_3 \{ I_1 \cos(\delta - \alpha_{31} - \varphi_1) - I_2 \cos(\delta - \alpha_{31} - \beta_{12} - \varphi_1) \} \Big] \sin\gamma \quad (21)$$

Put (21) equal to $Z \sin\gamma$. Then from (19),

$$Y \cos\gamma - Z \sin\gamma = 0.$$

Hence $$\tan\gamma = \frac{Y}{Z}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

where γ is the angular deflection for equilibrium of the moving system from the position shown in Fig. 9.

At this stage we may test this result by taking two particular cases:—

(*a*) A three-phase balanced circuit at unity power-factor.

(*b*) A three-phase balanced circuit at a lagging power-factor of $\cos\varphi$.

In the first case $\varphi_1 = 0$, all the α and β angles $= 120$ deg., and all the EI products are equal.

Evaluating Y and Z from (20) and (21) we find

$$\tan\gamma = \frac{EI \sin\delta}{EI \cos\delta} = \gamma = \delta. \quad . \quad . \quad . \quad . \quad (23)$$

The negative angle denotes a deflection of the moving system in a clockwise direction.

In the second case (22) reduces to

$$\tan\gamma = \frac{\sin\varphi \cos\delta - \cos\varphi \sin\delta}{\cos\varphi \cos\delta + \sin\varphi \sin\delta} = \tan(\varphi - \delta),$$

or $$\gamma = \varphi - \delta \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

This deflection for the lagging power-factor is positive, and therefore in a counter-clockwise direction. Hence, the nett deflection of the moving system for a change of power-factor from unity to $\cos\varphi$ is

$$\gamma_\varphi - \gamma_{(\varphi=0)} = (\varphi - \delta) - (-\delta) = \varphi.$$

That is to say, the pointer turns through an angle from its position at unity power-factor, equal to the phase angle of the circuit, irrespective of the value of δ, which was taken to represent the angular displacement between the E.M.F.s acting in the primaries and secondaries of the small transformers in the power-factor meter.

Hence, the scale of the meter is unaffected by the angle δ. An allowance for its presence is automatically made in the original setting of the pointer with respect to the moving coils when calibrating the meter, for if we select any given point of the scale to represent, say, unity power-factor, then if the instrument be connected to a circuit whose power-factor is known to be unity the pointer can be turned on the spindle, and set at the selected mark.

We may make use of this result to simplify the investigation by putting $\delta=0$. In this case the theory of the induction-dynamometer power-factor meter becomes identical with that of the plain dynamometer type, in which $\delta=0$, in virtue of the large non-inductive resistances placed in series with the moving coils.

The first term in equation (20) then becomes $E_1I_3\cos(\beta_{31}-\varphi_1)$, and referring to Fig. 10, which represents the unbalanced circuit, it will be seen that $I_3\cos(\beta_{31}-\varphi_1)$ is the projection of I_3 on E_1, so that $E_1I_3\cos(\beta_{31}-\varphi_1)$ may be written $E_1I_3\cos\hat{E_1I_3}$. It will be found that all the other terms in (20) may be correspondingly expressed.

Equation (20) then becomes

$$\frac{\sqrt{3}}{4}\Big[E_1(I_3\cos\hat{E_1I_3}-I_2\cos\hat{E_1I_2})+E_2(I_1\cos\hat{E_2I_1}-I_3\cos\hat{E_2I_3})+E_3(I_2\cos\hat{E_3I_2}-I_1\cos\hat{E_3I_1})\Big]\cos\gamma. \quad . \quad (25)$$

Taking now equation (21), with $\delta=0$, the first term is $E_1I_1\cos\varphi_1$ and the second is $E_2I_2\cos(\alpha_{12}-\beta_{12}-\varphi_1)$. From Fig. 10 it will be seen that $(\alpha_{12}-\beta_{12}-\varphi_1)=\varphi_2$. Similarly, the third term is $E_3I_3\cos\varphi_3$.

Also from Fig. 10 it is clear that the fourth term :—

$$\frac{E_1}{2}\{I_2\cos(\beta_{12}+\varphi_1)+I_3\cos(\beta_{31}-\varphi_1)\}$$

$$=-\frac{E_1}{2}\times(\text{sum of projections of } I_2 \text{ and } I_3 \text{ on } E_1),$$

$$=-\frac{E_1}{2}\times(\text{projection of } I_1 \text{ on } E_1), \text{ since } I_1+I_2+I_3=0,$$

$$-\tfrac{1}{2}E_1I_1\cos\varphi_1.$$

Similarly, the fifth and sixth terms of (21) are $\frac{1}{2}E_2I_2\cos\varphi_2$ and $\frac{1}{2}E_3I_3\cos\varphi_3$ respectively.

The whole of (21) therefore reduces to

$$\tfrac{3}{4}[\Sigma EI\cos\varphi]\sin\gamma. \quad . \quad . \quad . \quad . \quad . \quad (26)$$

In these equations E_1 and I_1, &c., are maximum values. If we now let V_1 and C_1, &c., represent their effective values, we

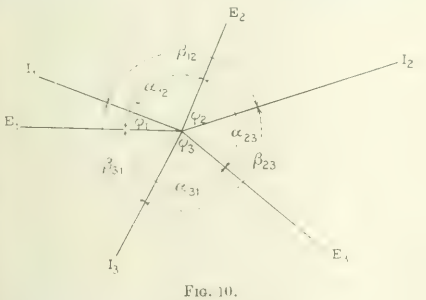


Fig. 10.

nally get for the deflection γ of the pointer on the unbalanced rcuit,

$$\gamma=\frac{\frac{1}{\sqrt{3}}\Big[V_1(C_3\cos\hat{V_1C_3}-C_2\cos\hat{V_1C_2})+V_2(C_1\cos\hat{V_2C_1}-C_3\cos\hat{V_2C_3})+V_3(C_2\cos\hat{V_3C_2}-C_1\cos\hat{V_3C_1})\Big]}{\Sigma\text{ watts}} \quad (27)$$

If we test this formula by taking the case of [illegible] load power-factor $\cos\varphi$, we find

$$\gamma=\frac{\frac{1}{\sqrt{3}}VC[3\cos(120-\varphi)-3\cos(120-\varphi)]}{3VC\cos\varphi}$$

[illegible]

that is to say, the deflection is equal to the [illegible] on load the circuit.

We may now compare the result given [illegible] pressions given in sec. III. for the power-factor of an unbalanced circuit.

We may write equation (3) in the form,

$$\tan\varphi=\frac{\sqrt{[(\Sigma VC)^2-(\Sigma W)^2]}}{\Sigma W} \quad . \quad . \quad . \quad . \quad . \quad (28)$$

and recalling the Campos form given in equation (5),

$$\tan\varphi=\frac{\Sigma RP}{\Sigma W} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (29)$$

it is clear that neither of these appears to agree with (27), the three equations having the same denominators, but differing in their numerators.

Although (27) has been written in its simplest form, the relationship between $\tan\gamma$ and $\tan\varphi$ cannot be readily recognised. By making suitable substitutions,* expanding and regrouping the terms, the numerator of (27) can be written in the form

$$\frac{1}{\sqrt{3}}\Big[V_1C_1\Big\{2\sin\varphi_1\frac{\sin\alpha_{12}\sin\alpha_{31}}{\sin\alpha_{23}}-\cos\varphi_1\frac{\sin(\alpha_{31}-\alpha_{12})}{\sin(\alpha_{31}+\alpha_{12})}\Big\}-V_2C_2\Big\{2\sin\varphi_2\frac{\sin\alpha_{23}\sin\alpha_{12}}{\sin\alpha_{31}}-\cos\varphi_2\frac{\sin(\alpha_{12}-\alpha_{23})}{\sin(\alpha_{12}+\alpha_{23})}\Big\}-V_3C_3\Big\{2\sin\varphi_3\frac{\sin\alpha_{31}\sin\alpha_{23}}{\sin\alpha_{12}}-\cos\varphi_3\frac{\sin(\alpha_{23}-\alpha_{31})}{\sin(\alpha_{23}+\alpha_{31})}\Big\}\Big] \quad (30)$$

It will be remembered that the α angles are the angular displacements between the E.M.F.s E_1, E_2, E_3. Now, if we assume the E.M.F.s of a three-phase system to remain balanced when the currents are unbalanced, then the α angles are all 120 deg., and hence from (30) each of the second, fourth and sixth terms involving $\cos\varphi$ becomes zero, whilst each of the coefficients of the $\sin\varphi$ terms becomes unity.

* The necessary substitutions are (*see* Fig. 10) :—

the angle $\alpha_{31}-\varphi_3$ for $\hat{V_1C_3}$ in equation (27).
.. .. $\alpha_{12}-\varphi_2$ .. $\hat{V_2C_2}$
.. .. $\alpha_{12}-\varphi_1$ .. $\hat{V_2C_1}$
.. .. $\alpha_{23}+\varphi_3$ .. $\hat{V_3C_3}$
.. .. $\alpha_{23}-\varphi_2$ .. $\hat{V_3C_2}$
.. .. $\alpha_{31}-\varphi_1$ .. $\hat{V_3C_1}$

Also $\dfrac{V_1}{\sin\alpha_{23}}=\dfrac{V_2}{\sin\alpha_{31}}=\dfrac{V_3}{\sin\alpha_{12}}$.

The numerator of equation (27) is then :—

$$\frac{1}{\sqrt{3}}\Big[V_3C_3\cos(\alpha_{31}-\varphi_3)\frac{\sin\alpha_{23}}{\sin\alpha_{12}}-V_2C_2\cos(\alpha_{12}+\varphi_2)\frac{\sin\alpha_{23}}{\sin\alpha_{31}}\Big]$$

$$-\frac{1}{\sqrt{3}}\Big[V_1C_1\cos(\alpha_{12}-\varphi_1)\frac{\sin\alpha_{31}}{\sin\alpha_{23}}-V_3C_3\cos(\alpha_{23}-\varphi_3)\frac{\sin\alpha_{31}}{\sin\alpha_{12}}\Big]$$

$$-\frac{1}{\sqrt{3}}\Big[V_2C_2\cos(\alpha_{23}-\varphi_2)\frac{\sin\alpha_{12}}{\sin\alpha_{31}}-V_1C_1\cos(\alpha_{31}+\varphi_1)\frac{\sin\alpha_{12}}{\sin\alpha_{23}}\Big].$$

Taking the third term with the sixth, the second with the fifth and the first with the fourth, on expanding we get :—

$$\frac{1}{\sqrt{3}}V_1C_1\Big[\frac{\sin\alpha_{31}\cos\alpha_{12}\cos\varphi_1+\sin\alpha_{31}\sin\alpha_{12}\sin\varphi_1}{\sin\alpha_{23}}-\frac{\sin\alpha_{12}\cos\alpha_{31}\cos\varphi_1+\sin\alpha_{12}\sin\alpha_{31}\sin\varphi_1}{\sin\alpha_{23}}\Big]$$

$$+\frac{1}{\sqrt{3}}V_2C_2\Big[\frac{\sin\alpha_{12}\cos\alpha_{23}\cos\varphi_2+\sin\alpha_{12}\sin\alpha_{23}\sin\varphi_2}{\sin\alpha_{31}}-\frac{\sin\alpha_{23}\cos\alpha_{12}\cos\varphi_2+\sin\alpha_{23}\sin\alpha_{12}\sin\varphi_2}{\sin\alpha_{31}}\Big]$$

$$+\frac{1}{\sqrt{3}}V_3C_3\Big[\frac{\sin\alpha_{23}\cos\alpha_{31}\cos\varphi_3+\sin\alpha_{23}\sin\alpha_{31}\sin\varphi_3}{\sin\alpha_{12}}-\frac{\sin\alpha_{31}\cos\alpha_{23}\cos\varphi_3+\sin\alpha_{31}\sin\alpha_{23}\sin\varphi_3}{\sin\alpha_{12}}\Big]$$

Collecting the $\sin\varphi$ and $\cos\varphi$ terms, and putting $\sin\alpha_{12}=\sin\alpha_{23}=\sin\alpha_{31}$, &c., the expression becomes :—

$$\frac{1}{\sqrt{3}}\Big[V_1C_1\Big\{2\sin\varphi_1\frac{\sin\alpha_{12}\sin\alpha_{31}}{\sin\alpha_{23}}-\cos\varphi_1\frac{\sin(\alpha_{31}-\alpha_{12})}{\sin(\alpha_{31}+\alpha_{12})}\Big\}+V_2C_2\Big\{2\sin\varphi_2\frac{\sin\alpha_{23}\sin\alpha_{12}}{\sin\alpha_{31}}-\cos\varphi_2\frac{\sin(\alpha_{12}-\alpha_{23})}{\sin(\alpha_{12}+\alpha_{23})}\Big\}+V_3C_3\Big\{2\sin\varphi_3\frac{\sin\alpha_{31}\sin\alpha_{23}}{\sin\alpha_{12}}-\cos\varphi_3\frac{\sin(\alpha_{23}-\alpha_{31})}{\sin(\alpha_{23}+\alpha_{31})}\Big\}\Big]$$

The whole numerator of (27) then reduces to $\Sigma VC \sin\varphi$, that is, to say, ΣRP, the total reactive power, in which case the reading of the meter is given by

$$\tan\gamma = \frac{\Sigma RP}{\Sigma W},$$

which is identical with the Campos formula.

It will also be clear from (30) that for fairly large departures from equality of the E.M.F.s the angle $(\alpha_{31}-\alpha_{12})$, &c., is small in comparison with $(\alpha_{31}+\alpha_{12})$, &c., so that the coefficients of the cosine terms are small compared with those of the sine terms.

Hence, however greatly the currents are out of balance, the power-factor indicated by the meter will agree with that calculated by the Campos method, so long as the E.M.F.s remain balanced, and will depart very little from this for considerable departures of the E.M.F.s from symmetry. This is clearly demonstrated in sec. V. by the figures obtained in actual tests.

It has been said that the extremities of the rotating vectors F_1 and F_y trace out elliptical paths. It may be of interest to pursue this question a little further.

The elongation of the ellipses and the angles which their principal axes make to the axis of coil 1, which has been taken throughout as the direction of reference, is found by equating to zero the first differential coefficient of the expression for the total flux with respect to the generating angle ωt.

Taking the current ellipse, we get from equations (8), (9) and (10),

$$\frac{dF_i}{d\omega t} = \tfrac{1}{2}[A^2-B^2]^{-\frac{1}{2}} \times \Big[2A\{I_1\cos(\omega t-\varphi_1)-\tfrac{1}{2}I_2\cos(\omega t-\beta_{12}-\varphi_1) - \tfrac{1}{2}I_3\cos(\omega t+\beta_{31}-\varphi_1)\} - \sqrt{3}B\{I_2\cos(\omega t-\beta_{12}-\varphi_1) - I_3\cos(\omega t-\beta_{31}-\varphi_1)\}\Big] = 0. \quad . \quad . \quad . \quad . \quad . \quad (31)$$

Equating the first square bracket to zero does not lead to useful results. Taking the second term and putting in the values of A and B, we ultimately arrive at

$$\omega t = \text{arc tan } \tfrac{1}{2}[m-(m^2+4)^{\frac{1}{2}}]. \quad . \quad . \quad (32)$$

where

$$m = \frac{a^2-b^2+c^2-d^2}{cd-ab},$$

in which

$$a = I_1\cos\varphi_1 - \tfrac{1}{2}I_2\cos(\beta_{12}+\varphi_1) - I_3\cos(\beta_{31}-\varphi_1),$$

$$b = -I_1\sin\varphi_1 + \tfrac{1}{2}I_2\sin(\beta_{12}-\varphi_1) - I_3\sin(\beta_{31}-\varphi_1),$$

$$c = \tfrac{\sqrt{3}}{2}I_2\cos(\beta_{12}+\varphi_1) - I_3\cos(\beta_{31}-\varphi_1),$$

$$d = \tfrac{\sqrt{3}}{2}I_2\sin(\beta_{12}-\varphi_1) - I_3\sin(\beta_{31}-\varphi_1).$$

This value of ωt inserted in (10) and (11) for F_1 and θ_1 gives the position and magnitude of the principal axes of the elliptical field produced by the rotating current flux vector, the positive and negative signs applying to the major and minor axes respectively.

In a similar manner the corresponding values of the elliptical field produced by the E.M.F. flux vector are determined from

$$\omega t = \text{arc tan } \tfrac{1}{2}[n-(n^2+4)^{\frac{1}{2}}]. \quad . \quad . \quad . \quad . \quad . \quad (33)$$

where

$$n = \frac{e^2-f^2+g^2-h^2}{gh-ef},$$

and

$$e = E_1 - \tfrac{1}{2}E_2\cos\alpha_{12} - E_3\cos\alpha_{31},$$

$$f = \tfrac{1}{2}(E_2\sin\alpha_{12} - E_3\sin\alpha_{31}),$$

$$g = \tfrac{\sqrt{3}}{2}E_2\cos\alpha_{12} - E_3\cos\alpha_{31},$$

$$h = \tfrac{\sqrt{3}}{2}E_2\sin\alpha_{12} - E_3\sin\alpha_{31}.$$

We have now taken figures from tests made with a [illegible] induction motor of the induction dynamometer type on a [illegible] unbalanced circuit, and compare the results obtained with the theory given above.

(To be concluded.)

STANDARDISATION RULES FOR ELECTRICAL MACHINERY (SUPPLEMENTARY RULES).

We give below the supplementary rules to the standardisation rules for electrical machinery, issued by the British Electrical & Allied Manufacturers' Association. The standardisation rules were provisionally adopted by the Council of the B.E.A.M.A. on April 17, 1913 [THE ELECTRICIAN, May 16, 1913], and finally approved at the meeting of the Council held on February 18, 1915, together with the supplementary rules reproduced below. The standardisation rules deal with the subjects of standard pressures and frequencies, high pressure and insulation tests, types of machines, rating, overloads and temperature rise. The supplementary rules deal with short-circuit tests, commutation, pressure regulation, parallel operation, efficiency and tolerances.

SECTION VII.—TOLERANCES.

1. A tolerance is the amount of permissible difference between the observed results and the guaranteed results.

2. When the difference between the observed and the guaranteed results is not greater than the tolerance, it shall be considered that the guarantees have been met.

3. In the event of the observed results differing from the guaranteed results by an amount greater than the tolerance, the penalty or bonus (if any) shall be taken only on the amount by which the observed deviation from the guaranteed results exceeds the tolerance.

4. The "guaranteed" figure referred to is the figure written in the contract documents, and not that figure plus a margin or tolerance.

THE FOLLOWING TOLERANCES ARE RECOMMENDED.

5. *For Observations of Temperature Rise :* 2°C.

6. *Efficiency :* (*a*) By steam consumption, 2½ per cent. on the guaranteed efficiency. (*b*) Transformers (by summation of losses) :

Full-load efficiency.	Tolerance.
98 per cent. or higher	0·25 per cent.
Below 98 per cent.	0·4 „

(*c*) Generators, motors, converters.

Note.—The following values apply to determination of efficiency by summation of losses. If the efficiency is to be determined by method of input-output test, the tolerance as shown should be increased one-half of 1 per cent. for guaranteed efficiencies not lower than 88 per cent., and they should be increased by 1 per cent. when the guaranteed value of efficiency is below 88 per cent.

Full-load efficiency. Per cent.	Tolerance. Per cent.
95 or above	½
Below 95	
Not „ 93	¾
„ 93	
Not „ 90	1
„ 90	

Full-load efficiency. Per cent.	Tolerance. Per cent.
Not below 85	1½
„ 85	
Not „ 75	2
„ 75	
Not „ 65	3
„ 65	4

7. *Power Factor :*

Full-load power factor. Per cent.	Tolerance. Per cent.
90 or above	2
Below 90	
Not below 85	3
„ 85	

Full-load power factor. Per cent.	Tolerance. Per cent.
Not below 75	4
„ 75	
„ 65	6
„ 65	8

8. *Guarantees at Fractional Loads. Average-Load Guarantee :* When guarantees are required upon performance at fractional loads, they should be given in the form of an "average-load" guarantee, thus :—

Full-load efficiency, ×4. Plus ¾-load efficiency, ×3.
Plus ½-load efficiency, ×2.

The sum of these divided by 9 gives the "average-load" value.

The tolerances for "average-load" guarantees are those shown opposite similar values in the first column of the corresponding tables above.

9. *Speed of Motors.* (*a*) With shunt characteristics (above 3 B.H.P.) tolerance, 5 per cent. above or below guaranteed speed at the temperature of full load.

(*b*) With series characteristic, tolerance, 7½ per cent. above or below guaranteed speed at the temperature of full load.

(*c*) Slip of induction motors, tolerance, 50 per cent. on the listed value of slip.

10. *Interest Pressure Regulation Rise.* Tolerance, two-fifths of the value specified for regulation.

SECTION VIII.—PARALLEL OPERATION OF SYNCHRONOUS MACHINES.

In order to guard against unsatisfactory operation when alternators are run in parallel, it is necessary to satisfy two conditions :

1. There must be a limit to the amount of angular displacement from uniform running due to periodic irregularities in the turning moment of the prime mover. Such recurring angular displacement causes objectionable swinging of the ammeter needles, and, if excessive, will cause fluctuation in lighting, and throw out of step synchronous machines running on the system

Note Relating to Condition (1).—A periodic angular displacement of 2½ electrical degrees from position of uniform rotation with a machine of ordinary type will cause 15 to 20 per cent. excess current; the angular displacement should not exceed this limit of 2½ electrical degrees. This limit will be exceeded if the cyclic speed irregularity of the engine exceeds that given by the expression:

$$\text{Cyclic speed-irregularity} = \frac{k}{6\sqrt{p}}.$$

Where k=engine impulses per revolution, p=number of poles.

It is important that the expression indicating the degree of irregularity should be correctly understood. As most firms have approved the term "cyclic irregularity" with the definition

$$\frac{\text{maximum speed minus minimum speed,}}{\text{mean speed}}$$

members are recommended to adopt this term. The irregularity should not in any case be worse than $\frac{1}{150}$, otherwise there may be objectionable flickering in lamps and difficulty in running other synchronous machinery on the system. (In the case of a continuous-current generator, the limit of $\frac{1}{150}$ to cyclic speed-irregularity also applies, but there is no further limit depending on the resulting angular displacement.)

2. It is necessary to safeguard against hunting due to resonance between any periodic impulses of the engine and the natural oscillating frequency of the electro-mechanical system of which the generator forms a part. This may be met in either of two ways:—

(*a*) By providing a flywheel of such weight that the natural oscillating frequency is sufficiently different from the frequency of the engine impulses.

(*b*) By providing dampers on the generator to check the development of hunting due to resonance.

Note Relating to Condition 2 (*a*).—The natural frequency of the machine when connected to the system should be at least 20 per cent. lower than the frequency of a possible irregular impulse. In a steam engine, either single or double-acting, and also in a two-stroke cycle, internal-combustion engine, this latter frequency corresponds to the crankshaft revolutions per minute, while in a four-stroke cycle engine the frequency is one-half the crankshaft revolutions per minute. To meet this condition with machines of ordinary regulation, the total amount of flywheel effect required is given in foot-tons of stored energy at normal speed by the following formula:—

$$\text{Foot-tons} = 1{\cdot}3 \times \text{poles} \times (\text{strokes per engine cycle})^2 \times \frac{\text{k.v.a.}}{\text{revolutions per minute}}$$

Note Relating to Condition 2 (*b*).—Method 2 (*b*) can only be relied upon so long as the coefficient of fluctuation of energy is kept within the limit specified below, but when this method is employed it avoids the necessity for the heavy and expensive flywheels required by method 2(*a*), particularly in the case of slow-speed gas engine driven sets.

Electrical manufacturers guarantee satisfactory parallel operation only so long as the limit specified herein is not exceeded; if the limit is exceeded due to the engine misfiring, valves leaking, or other abnormal cause, method 2(*b*) cannot be relied upon.

The limit referred to above is as follows: The coefficient of fluctuation of energy should not exceed 10 per cent. This coefficient is defined in the following manner: If a mean-effort line should be drawn, then the largest of the areas lying above or below the mean-effort line is called the fluctuation of energy, and the ratio of this area to the total area bounded by the mean-effort line over one complete cycle is the coefficient of fluctuation of energy.

Section IX.—COMMUTATION.

Direct-current machines must operate throughout the range from no load to the highest specified overload with fixed brush setting. The operation must be practically sparkless from no load to full load, and without injurious sparking up to the maximum specified overload.

Section X.—SHORT-CIRCUIT TESTS ON ALTERNATORS.

Sudden short-circuit tests should not be undertaken, nor guarantees given against short-circuits in service, upon alternators which are required to have close inherent regulation, since such machines, due to their large flux and weak armature reaction, suffer most severely in case of short-circuit. Any regulator which will give close voltage regulation throughout the entire load range will permit of the machine being designed with the proportions best suited to withstand short-circuit. Hence close inherent regulation is an unnecessary requirement.

When, in the absence of restrictions as to regulation, it is still difficult to produce a design sufficiently self-protective, reactances may be employed, external to the machine, to assist in limiting the severity of the short-circuit current. (In case of machines wound for high voltage, external reactances are sometimes employed to protect the windings from voltage surges. Reactances employed to limit the short-circuit current may be arranged to serve as reactance coils for the load mechanical purpose also.)

The severity of short-circuit in any particular machine depends on the amount of flux, and not on the amount of excitation or load present at the instant. Tests should never be undertaken at a voltage higher than the normal for the machine.

When making short-circuit tests a solid connection should be made, as arcing contact might cause puncture between the machine windings. If it is desired to reduce the effect of short-circuit, reactance in preference to resistance should be used, or the voltage of the machine reduced, as resistance tends to improve the power factor of the short-circuit, and thus increase the mechanical shock upon the shaft.

Section XI.—TRANSFORMERS. TERMINAL MARKINGS.

Three-phase Transformers.

1. *Lettering.*—The different phase windings are to be distinguished by the letters A, B, C indelibly marked on their respective terminals.

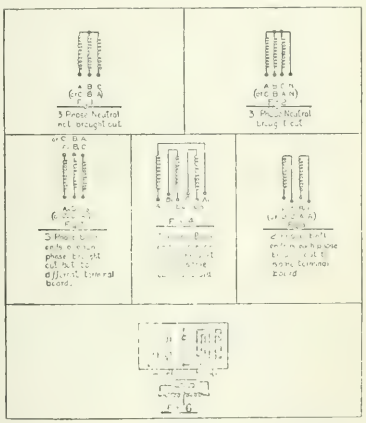
Note.—It is recognised that with some standard makes of transformers it is not possible to arrange the terminals in the order A B C on both high-pressure and low-pressure sides without introducing objectionable crossings amongst the leads within the transformer. Provided the terminals are properly marked in accordance with these rules, their actual position upon the case is of secondary importance.

2. *Similar Letters on High and Low-pressure Windings.*—The same letters are to be used on the high-pressure and low-pressure terminals of similar phases.

3. *Distinction between High and Low-pressure Markings.*—The distinction between "high-pressure" and "low-pressure" terminals in any phase shall be made preferably by using small letters for the low-pressure markings and capitals for the high-pressure markings. It is, however, permissible to indicate the low-pressure winding by the use of capital letters with a circle around each letter.

4. *Marking of Polarity.*—The relative polarity of the two ends of every winding will be shown by the addition of the markings 0 and 1 after the phase-letters.

5. *Polarity of Low-pressure with respect to High-pressure Markings.*—The terminal marked 1 will be referred to as the positive end of the winding. The polarity of the corresponding high-pressure and low-pressure windings must be so marked that the progression of the E.M.F. at any moment from A_0 towards A_1 is in the same direction as from a_0 towards a_1 (and similarly for phases B and C). That is to say, if the negative terminal of the high-pressure winding is connected to the positive terminal of the low-pressure winding, the E.M.F. across the two remaining terminals will be more than that across the high-pressure winding alone.



Arrangement and Markings of Machine Terminals.

6. *Marking of Tappings.*—The markings 0 and 1 are placed on the two terminals which give normal voltage. Each tapping terminal will be marked with its fractional value in terms of the normal voltage; or with an arbitrary number, referring to the diagram under rule 7. The employment of fractional-value markings upon the terminals when adjustment tappings are provided is left optional. When this marking is employed the terminal marked 1 need not be at the extreme end of the winding. If this method of marking is not employed, the taps must be numbered arbitrarily, and the diagram to be provided must show the values of the different tappings. When the adjustment tappings are provided in connection with an independent section of the winding which may be reversed in polarity, this auxiliary winding shall take the same phase letters at the section to which it belongs, and its various leads and tappings will be indicated by arbitrary numbers.

7. *Diagram Permanently Attached to Transformer.*—It is recommended that a diagram of internal connections showing the position of all leads and tappings shall be permanently attached to each transformer.

8. *Marking of Tappings on the Switchboard Diagram.*—On the switchboard diagram adjustment tappings need not be shown.

Single-phase Transformers.

The high-pressure terminals will be marked T_0 T_1 and the low-pressure terminals will be marked t_0 t_1 in accordance with rules 3 and 4. The markings will be so applied as to give the relative polarity of high-pressure and low-pressure windings indicated in rule 5. Rule 6 regarding the marking of tappings applies also to single-phase transformers.

Section XII. MACHINES. MARKING AND ARRANGEMENT OF TERMINALS.

1. For alternating-current machines the letters A B C should be adopted to indicate the external connections of a three-phase machine, and the letter N should be used to indicate a neutral connection. Where

both ends of each phase are brought out, A_0 A_1 B_0 B_1 C_0 C_1 should be used to denote the three phases.

2. The terminals of a synchronous generator should be arranged and lettered consecutively in the order of actual phase progression. The lettering will, therefore, progress from either left to right or from right to left, according to the direction of rotation (*see* Figs. 1 to 5).

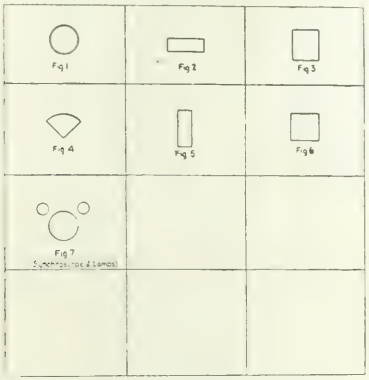
3. In the case of a standard alternating-current motor, where the actual order of phase progression is usually not known, it is recommended that the phase terminals shall always be arranged and lettered in the order from left to right (*see* Figs. 1 to 5).

Note.—Induction motors used with rotary converters are regarded as special, and are not subject to these rules.

4. Terminals on large direct-current machines should be arranged in order of polarity from right to left, looking at the commutator. A standard generator has its positive terminal on the right and should be so marked (*see* Fig. 6). (It is not necessary to mark polarity on motors.)

Section XIII.—Rules for Switchgear Symbols.

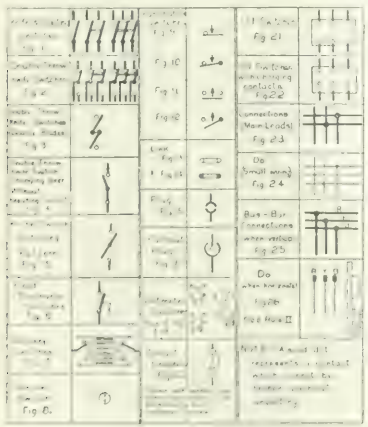
1. *Diagrams.*—In general diagrams the apparatus should be drawn as viewed from the main operating position. Machines and cables in the station should be drawn as viewed from above.



Instrument Outline Symbols (*see* Rule 3).

Note.—Other outlines may be made to indicate instruments of special shape.

2. *Colours and Arrangement of Phases.*—(*a*) The arrangement of bus bars should be such that the red and blue phases are outside, and the bars should be indicated in the order of the national colours—red, white (or yellow) and blue (R, Y, B). (*b*) When arranged horizontally the red phase should be the top, or the bar farthest away as viewed by the



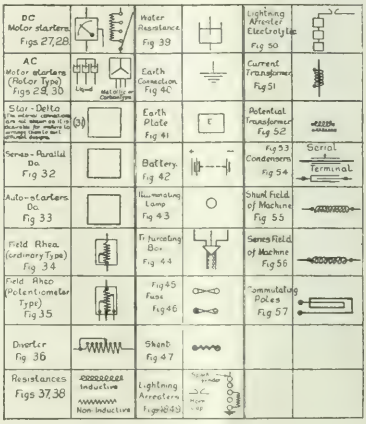
(*see* Rule 5).

3. *Outline Symbols for Instruments.*—(*a*) From the outline symbols shown in diagram, a shape should be selected to suit the instrument. Within this outline will be placed the symbol letter or letters selected from the list, rule (4). (*b*) Instrument terminals if shown should be indicated by dots, the positions of which are varied to suit different makes of instruments. (*c*) Any further features which are desired, such as auxiliary switches, instrument windings, instrument terminals, should be indicated by showing their appropriate symbols within the outline.

4. *Symbol Letters for Instruments* (referred to in Rule 3(*a*)).

Ammeter	A	Overload inverse time limit relay	O I R
Voltmeter	V	Reverse relay	R R
Wattmeter (indicating)	W	Additional letter may be added if desired to indicate a special feature, as	R P R*
Ampere-hour meter	A H		R C R†
Recording (graphic) Wattmeter	G W		
Recording (graphic) Ammeter	G A		
Recording (graphic) Voltmeter	G V	Power factor indicator	P F I
Recording (graphic) and others similarly		Synchroscope	S
Integrating wattmeter	W H	Frequency indicator	F
Overload relay	O R	Earth plate	E
Overload constant time limit relay	O T R	Neutral (D.C.)	±

* Reverse power. † Reverse current.



Symbols for Miscellaneous Gear and Parts of Machines.

5. *Symbols, Switches and Connections.*—(*a*) The symbols to be employed for switches and connections are shown above. (*b*) Fixed contacts are represented by dots; movable contacts are represented by circles. A solid dot represents a contact which cannt be broken without unbolting.

6. *Miscellaneous Gear.*—The symbols to be employed for miscellaneous gear are shown above.

THE POWER SUPPLY OF THE CENTRAL MINING-RAND MINES GROUP.*

BY J. H. RIDER.

(*Concluded from page* 56.)

Summary.—The author deals generally with the electrical energy used by the large Central Mining-Rand Mines group. Reference is made particularly to the question of metering the supply to electric winders and their control, overwinding devices, depth indicators, mill driving and the switchgear for supply of electrical energy to the mines. Lastly the author deals with the troubles that have been experienced.

Electric Compressors.

The compressors are either rope-driven compressors, converted from steam driving, or are direct-coupled. The rope-driven compressors are all of the horizontal two-stage type. The direct-coupled compressors are, with the exception of one high speed turbine type of Messrs. Belliss & Morcom's standard vertical two-stage pattern. Intercoolers are used between the different stages of all the compressors. The driving is by three-phase constant-speed motors, and the governing is done by butterfly valves in the main suction pipe, which are controlled by the air pressure and close as long as the pressure in the receiver is above the normal. As soon as the pressure falls the valves open and the compressors work normally.

The Belliss compressors were purchased under efficiency guarantees

* Abstract of a Paper read before the Institution of Electrical Engineers.

tees, and it is interesting to note that their testing was the means of converting the makers from their practice of stating the output on calculations based on piston displacement and indicator card diagrams to the more accurate method of actually measuring the output by direct means. The difference shown by the two methods, as the result of tests, was that the measured efficiencies were about 10 per cent. below those guaranteed. The guarantee for the larger compressors was 68·8 per cent. at full load, while the figure on actual test was only 58·8 per cent. The larger part of the difference was due to the method of estimating the output of the air by calculations as against direct measurement. The volume of free air (at atmospheric pressure) delivered by reciprocating compressors is generally not more than 88·5 per cent. of the piston displacement, and is very often less. Calculations from indicator cards generally show from 92 to 95 per cent.

By inserting a sharp-edged orifice plate in a straight length of the delivery pipe, and by making the diameter of the orifice about three-quarters of the diameter of the pipe, the pipe diameter being chosen so that the difference in pressure across the orifice is equivalent to about 24 in. of water, very reliable results are obtained from a formula which the author gives in his Paper.

Motor Control Gear.

As a general rule all motors of 50 H.P. and below are wound for 525 volts, and all motors above 50 H.P. for 2,100 volts. Those below 15 H.P. are of the squirrel-cage type, and those above of the slip-ring type. The small squirrel-cage motors are started by switching the stator directly on to the mains. In the future it is intended to use motors with squirrel-cage rotors for much larger sizes, and these will be started by means of compensator transformers. The slip-ring motors use a water tank with three dipping plates in the rotor circuit for starting purposes. The stator is switched directly on to the mains with the plates raised, and they are then gradually lowered until they are short-circuited at the tank. The rings are then short-circuited on the motor and the brushes raised. The usual short-circuiting arrangement is generally so defective that in many cases it has been removed, and the motor run with the brushes always down on the slip-rings.

Electric Distribution.

In the design of switchgear now in use in the majority of the switch houses, the three 'bus bars are carried in brick compartments at the top, and a separate brick cubicle is provided for each line of switch parts. Slate panels, 2 ft. wide, contain an ammeter, an integrating watt-hour meter, and the switch control lever with its overload trip coil. No-voltage trip coils are now only used on the local control gear of individual motors. They were provided in the switch houses on the panels of the original gear, but were soon removed. The openings of the cubicles in the passage way at the back are covered by removable frames of expanded metal.

The oil switches first used had been provided merely on a current-carrying basis for the full load of the circuit which they were to control. This is a very common but most erroneous practice, because it is so often forgotten that an automatic switch should be able to open the circuit with safety to itself under the worst conditions, which will probably be a short-circuit on the cables just beyond it. Frequent switch failures naturally followed. The rules now are : (*a*) that all oil switches in a switch house shall be of the same size ; (*b*) that such switches shall be rated for a current of 800 amperes at 15,000 volts ; and (*c*) that no difference shall be made between the equipment of cubicles for 2,100-volt and 525-volt circuits, except in the current transformers and the meters. Since the above practice was instituted, troubles in switch houses has practically disappeared.

Troubles.

Many and varied troubles have been experienced since the beginning of the power supply, quite apart from those which can be laid to the charge of the power company. They have been very costly in some cases and very annoying in all, and each and every one could have been avoided. The troubles have arisen from two main causes : (*a*) faults in design ; and (*b*) faults in manufacture.

(a) Faults in Design. The want of stiffness in the stator frame some three-phase winding motors has already been mentioned. It has been found both in low-speed direct-coupled motors and in geared motors. The fault is a most serious one and the remedy is obvious. Some makers secure the stator core stampings by means of dove-tailed strips screwed to the inside face of the frame. This is not nearly such good practice as to machine [illegible] out of the solid metal of the frame, into which the dove-tailed projections of the stampings fit, as there is always the risk of [illegible] getting loose under the severe racking strain to which [illegible] motor is always subject. A number of [illegible] were supplied in which the dove-tailed [illegible] by means of studs with nuts on the outside of the frame within the housing. No lock nuts or even spring washers were provided, and, as the practice of the makers was to adjust the air-gap by means of the studs, the results can be imagined.

In motors by the same maker the stator and rotor core-plates were clamped sideways by bolts passing right through, and the nuts were entirely hidden by the end loops of the coils. One motor was delivered in which the width of the stator core was $18\frac{3}{8}$ in. on one side and only 18 in. on the opposite side, while the corresponding dimensions of the rotor core were $18\frac{1}{8}$ in. and $17\frac{3}{8}$ in. It was impossible to get at the nuts to tighten up the core-plates without first removing the windings. This may be considered as a fault in manufacture, but had the design been a good one the fault could not have occurred. The proper way to secure core-plates sideways is to clamp them between stiff end plates and to use circumferential locking keys. Cases were found in which the dove-tailed slots were so wide that packing strips had been inserted to keep the core-plates from shaking. When complaints were made the maker asserted that it was not possible to machine so accurately as to avoid the use of such packings.

It is the practice of some makers to make semi-enclosed winding slots in the core plates by first punching a closed slot, and then, when the whole core has been clamped up, to cut through the periphery of the core at the top of each slot by means of a saw. Quite a number of motors have been made in this way, and it was found that the result of the saw-cutting was to spring out the tips of the teeth on each side of each ventilating space, so that the spaces were almost closed in many cases. It was only by taking out the rotor that the fault could be seen. The correct way to make semi-open slots is to punch them out at one operation. Difficulties were experienced in many cases from the type of distance piece used to form the ventilating spaces in the stator and rotor cores. This was a plain, thin steel strip, placed radially on edge and secured to one of the adjacent core-plates by simple riveting. The necessary pressure used in clamping up the core-plates was too much for many of the distance pieces, and, instead of remaining firmly at right angles to the spaces, they bent over and partially collapsed. The area of contact between the edge of the strip and the face of the plate was in most cases found to be too small to take the pressure, and particularly where the core teeth were wide the teeth at the ventilating spaces were badly bent. Distance pieces of I section which are stiff and have a good bearing face on each side are now insisted on for all motors, and they should be spot-welded to at least one of the adjacent core-plates. They are easily obtained, as instanced by the fact that some makers never use any other form, but from the objections raised by other firms one would think their provision was not only impossible but also meant bad practice.

With a view to produce a three-phase motor with a very high power factor, it is the almost universal custom to make the air-gap exceedingly small, and in many cases this is carried to excess. Instances of rotors of 6 ft. diameter with a radial air-gap of only 1 mm. are not unknown on the Rand, and when such motors also have stator frames which will not retain their shape without external struts, the matter becomes very serious from the operating point of view. Designers seem to forget that motors are required to do work, and to do it continuously, and that, however nice it may be from the selling point of view to have what American engineers call "a good talking point," in the form of a high power factor, what the customer wants is a motor with good working points. A small air-gap and a high power factor do not help him much in that direction. Bearings will wear, and rotors and stators sometimes have a habit of getting out of truth ; and it does not take very much in some cases to let the rotor down on to the stator. Then the customer blesses the motor maker and does not look into the dictionary to find the proper words. A minimum radial air-gap, as expressed by

$$\text{Minimum radial air-gap in mm.} = \frac{\text{sq. root of rotor dia. in mm.}}{20} - 0{\cdot}25$$

is now demanded for all moderate-speed motors, and manufacturing errors are not accepted.

A serious fault with many three-phase winding motors is in the sizes of the rotor slip-rings and brushes. Contact areas which are large enough for motors in which the slip-rings are short-circuited and the brushes lifted as soon as full speed is reached, may be and frequently are quite insufficient when the brushes and rings are in use the whole time. A current density of not more than 60 amperes per sq. inch should be the maximum for carbon brushes. A similar fault is to be found in the motors and generators of some Ward-Leonard winders, and in this case the R.M.S. rating is not the controlling factor. The brush area should be based on the maximum current passing on accelerating the winder, which current is frequently twice the normal.

That slip-ring short circuiting arrangements are generally very defective has already been mentioned. It would appear to be a

difficult matter to design them so that a large area of contact can be provided in the space usually available, and so that the sliding collar which carries the contacts can be accurately centred and held free from shake and side movement when the brushes are lifted. A great deal of the difficulty would, however, be removed if the slip-rings were made only a few inches larger in diameter. The fact that the peripheral speed would be increased would be of no consequence, as the brushes are lifted at full speed. Flimsiness of design is the usual characteristic of three-phase motor brush gear.

Perhaps the most important point in connection with the design of motors and generators is that of the safe maximum working temperature. The altitude of the Witwatersrand is about 6,000 ft. (barometer 24·5 in.) above sea-level, and as the reiteration of that fact in hundreds of inquiries for plant seemed to have no meaning for some makers, recent specifications have had to call for a maximum temperature under test at sea-level which would give a safe working temperature at the mines. The clause provides that no part of the motor, when working continuously at full load at sea-level, shall have a temperature rise exceeding 30°C., with the surrounding air at a temperature of 25°C. This corresponds approximately to a temperature rise of 35°C. at an altitude of 6,000 ft., with a surrounding air temperature of 35°C., or a total temperature of 70°C. (158°F.), which is quite high enough for any machine to work at continuously if a long life is to be obtained. As the supply voltage can, and frequently does, vary between limits of 10 per cent. up and down from the normal, the lowest supply pressure must be taken for the purpose of the test.

The Engineering Standards Committee recently proposed that "a machine intended to operate between two limits of rated pressure shall have its rated current determined at the higher pressure." This would be fatal for motors intended for the Witwatersrand, or any other place where the supply pressure has considerable variations, as they must be able to work continuously with the larger current which is entailed by the lower voltage limit. The great objection which most makers put forward to a lower temperature limit is that it would increase the cost of the motor, or it would mean the use of a larger frame, or any other reason which they can find to avoid giving the purchaser what the latter requires. It appears to the author that he who pays the piper is entitled to call the tune, and, unless the customer insists on his requirements being met, the great competition between various makers will probably result in machines being supplied which are cut finer and finer every time. It is, of course, always assumed that the purchaser has an intelligent knowledge of his requirements, and that they are always reasonable. As an instance of the extent to which some firms will go in under-cutting, the representative of a very well-known firm once remarked to the author, relative to the sizes of the motors kept in stock by that firm, "Output plates are cheap." Some manufacturers have not yet learned the important lesson, that in order to succeed they must be prepared to supply what the customer wants and in the manner that the customer wants it, and not try to prove to the customer that he does not want what he wants but what the manufacturers make. As a matter of fact few manufacturers make any real attempt to find the requirements of any particular market, and a still smaller number make any real attempt to meet such requirements. Then they express surprise when the market leaves them.

(*b*) *Faults in Manufacture.*—For faults in design there may be the slight excuse that the designer is limited in his experience of the particular duty that will be required of the plant which he is designing. For faults in manufacture there can be none. What then can be said of the undermentioned list, the items of which are a few of many that have come under the personal knowledge of the author during the last four years, and all of which occurred in the work of firms of world-wide repute? In one case the several sections of a cast-iron bedplate of an electric winder would not fit together, even by persuasion, although the maker seriously stated that they had been perfectly fitted in his shops. Doubtless the higher temperature and [illegible] with it. The shaft of a 100 H.P. motor, driving a tube mill, broke off just outside the coupling. The shaft had layers just like an onion, [illegible] welded together. A steel pin, 3 in. diameter, supplied for part of [illegible] steel, with a blowhole covering almost the full diameter.

The instance of the three-phase winding motor in which the dove- [illegible] has been mentioned. [illegible] and for this purpose the [illegible] the nuts off one of the nuts the bolt end [illegible] found that the original bolt [illegible] only projecting through the stator frame for a depth of about two threads. A short bolt end had been screwed into the top of the nut to make it appear sound from the outside. There could be no mistake, as the two abutting ends did not in any way match.

Trouble had been experienced with the stator coils of some three-phase, 2,000-volt winding motors, and the external taping of some of the end loops was removed. It was found that the slots were only three-quarters filled with wires, the rest of the space being empty. To make it appear that everything was all right, pieces of tape had been carefully screwed up and pushed for a short distance into the slots. These pieces were gradually tapered off where they followed the coil out, so that the external wrapping of tape gave a smooth finish right up to the core. Every other motor of the same size and make was then examined and found to be in a similar condition. It cost the maker a considerable sum to make the motors even passably right. All stator coils, for 2,000-volt motors are now required to be either semi- or completely-former wound, and to fill the slots completely.

The most costly trouble to either of the mines was the case of the breakdown of the motors of two large Ward-Leonard winders, which failed from the same cause within a few hours of each other, and completely shut down a large shaft for four or five days. The spaces between the turns of the main-circuit coils on the auxiliary field poles had been filled up with some kind of pitch, and the whole was taped over. The armatures had open slots without wedges, and the coils were held down by a number of steel-wire bands. These bands broke away on two of the motors, some of the coils came out, and very bad breakdowns resulted. When the top halves of the field magnet systems were removed, lumps of hard pitch were noticed on the faces

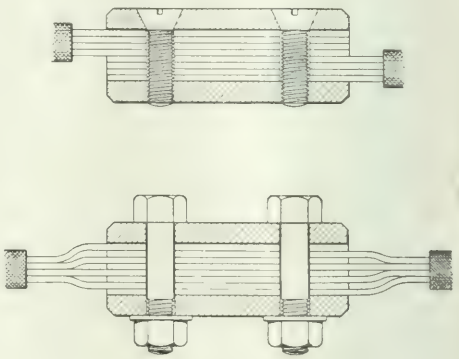


Fig. 2.

of the auxiliary poles, and these showed heavy scoring marks where they had rubbed on the armature bands. An examination of what was left of the bands showed that the first layer had been rubbed right through in some places. There could be no doubt that the pitch inside the coils had melted and run down, that it had set hard during the night and that when the winders were started up in the morning the wearing of the bands began. A further examination showed the original source of the trouble. The external connections between the auxiliary pole coils had been carefully taped up by the maker before the motors were delivered. They were found to have been made as shown at the top of Fig. 2. The windings consisted of four copper tapes in parallel, and the cross-connections from pole to pole were made up from similar tapes. Each set of four had been bunched together, one set was laid on the other with a copper plate at the top and bottom, and four countersunk-headed screws, ½ in. diameter, were used to draw the parts together by a screwdriver. The surfaces of the tapes had been left dirty, the burrs made by the drilling had not been removed, and a number of the screws were found melted off. As the current was frequently as high as 5,000 amperes, this is not to be wondered at. The heat at the contacts had evidently made the whole coil so hot that the pitch had melted out and the breakdown quickly followed. The remedy was a simple one. The faces of the individual tapes were carefully cleaned and then interlaced as shown at the bottom of Fig. 2. Hexagon-headed bolts and nuts instead of screws enabled a heavy pressure to be applied, and the joints now run quite cool. Many other instances of bad work could be cited, but the above examples are characteristic and serve to show what even big firms will sometimes do if they are not carefully watched.

The Use of Compressed Air by the Mines.

The supply of compressed air from very large compressing stations, and its distribution over a wide area, are employed for the first time in connection with the mines of the Central Mining-Rand Mines Group. To the author's predecessor, Mr. A. M. Robeson, belongs the whole credit for this innovation, which has been so successful in practice. The problem has called into existence steam and electrically-driven turbo-compressors of a size quite beyond previous experience. Three of the steam-driven compressors now in use have a capacity of 2,900 lb. of air per minute at 100 lb. gauge pressure, and require 7,000 kw. each to drive them. The distribution pipes vary in size from 9 in. to 27½ in. diameter, with an approximate total length of 28·4 miles and a capacity of about 310,000 cub. ft. At 100 lb. gauge pressure the pipe system will hold about 90 (short) tons weight of compressed air, and such a large receiver capacity must have a material effect in smoothing out the peaks in the supply curve, thus relieving the air-compressing plant.

Compressed air is used chiefly underground, and for (*a*) operating rock-drilling machines, (*b*) working small winches, and (*c*) blowing out the workings after blasting has taken place. As most of the mines have many working levels, and the "stopes" (or working rock faces) are frequently at considerable distances from the shafts, it will be evident that many miles of air pipes are required in most of the mines, while the pipe joints will number many thousands. By inserting air meters in the various pipe lines and measuring the flow at times when it was known that no work was being done by the air, many hitherto unknown leaks were discovered, some of considerable magnitude. These were rectified, and now a systematic inspection of all air-pipe lines and joints is periodically made, while the daily readings of the various air meters serve as a general check.

The Paper concludes with some details of the system adopted to maintain in good condition the compressed-air rock-drilling machines, of which there are about 3,500 in daily use.

DISCUSSION.

Mr. A. E. Hadley, in opening the discussion, said that the Paper described one of the largest, if not the largest, of the installations in the Empire which purchased all their power from a supply company, and at the same time described the operation of a power contract designed so as to share fairly between supplier and consumer the benefits of the improvements in the cost of supply throughout a period of 20 years or even longer. The giving of this supply had involved an investment by the power company of three and a half million pounds; so probably, in all, some five million pounds had been embarked in converting the mines from the old individual steam plants to electric driving, with results which were satisfactory both to the consumer and the investor. The installation in question accounted for exactly half the combined sales of electricity by the Victoria Falls Company and its subsidiary company. When the contract was negotiated, sufficient time was not allowed to raise such a large sum of money, with the result that the supply was started without adequate reserve of plant, and it was satisfactory to note that with the reserve installed the supply had been quite reliable. He thought the success attained by the purchase of power by such an important consumer should show to many a power user the advantages of the electric drive and of purchasing power whenever suitable supply was available. Most of the consumer's plant, especially the winding plant, was selected before the author arrived on the Rand. The plant as selected of a type which was not the most suitable for steady operation of the supply, apparently with a view of saving the consumer a relatively small amount of capital, perhaps about 4 per cent., but increasing the total investment needed to give and utilise the supply. As the consumer was under no obligation when selecting his plant to consider the efficiency and perfect working of the supply system—an obligation not unreasonable or unusual in a contract of such magnitude—the supply company was permitted reasonable latitude in regard to the readiness of the supply. The supply company, therefore, adopted the best practice, in the present state of the art, to furnish the supply, and the consumer knocked the furniture about as much as he liked and frequently gave it sudden bumps of many thousands of kilowatt [illegible]. The author, he noticed, wished the supply was given without any variation, despite of any treatment which his clients might choose to deal out to the system; but, no doubt, the author really knew that such an obligation on the power company would, under the circumstances, have been one-sided and not a fair condition. Further, he (the speaker) thought that Ward direct winders would have been installed had the author specified the plant, and in his opinion that would have led to even better results both commercially and technically to both parties. The engineering difficulties encountered by the power company in giving the air supply appeared to have been successfully overcome from [illegible] point of view; but the satisfaction of the consumer over the great economy in power consumption effected by the genius and ability of the author was not felt to the same extent by the power company, who [illegible] to give the full supply notified by the Rand Mines, thereby increasing their costs and financial responsibilities. In conclusion, he [illegible] the author's statement of the advantage arising from the matters relating to the power contract being dealt with by the Rand Mines (Ltd.) as trustees. In actual fact they had been dealt with by the author, and the success in overcoming difficulties and disagreements had been chiefly due to his broadmindedness, his invariable fairness and his great knowledge of the problems confronting both parties.

Mr. J. Shepherd thought that very few people realised the enormous size of the undertaking in question. If the electrical and air units were added together, a total would be obtained which was more than the total units generated in the whole of London. The remarks he had to make were mostly in the form of questions. On the question of reserve plant, did the author think that 25 per cent. was really sufficient when such plant was of the character of large turbo-generators? As to the variation of pressure, it seemed a remarkable thing to have a total variation of 20 per cent. Were alternating-current winders, with the danger of flash-over, really reliable, and were they reliable without the eddy-current brake mentioned in the Paper? It seemed to him that the control gear shown in Fig. 2 was very small for 2,000 volts, and was the gear shown in Fig. 3 really suitable in every respect for a pressure of 1,500 volts. As to pipe framework not being suitable for mining work, did the author mean the standard framework used by the G.E.C. on their switchboard panels, or was it some other framework not described? He thought that over-winding devices would have been extremely useful, and he could not understand why they had received such little praise. In regard to pumping, could the author give them any idea as to what was the limiting head to which the large multi-stage pumps could work satisfactorily? He would like to have information as to the efficiency of those pumps, and to know whether or not the limiting head had yet been reached. He was surprised that nothing had been said about troubles from insulation or dust. Might they take it that no troubles had been experienced from those causes, and, if that was so, how had they been overcome?

Mr. C. P. Sparks said that the author had added to his knowledge, and no doubt to the knowledge of a great number of the members present, by bringing clearly before them the characteristics of the direct-current and alternating current three-phase winders, especially with regard to control. It seemed that the author had found in South Africa exactly what had been found in England—viz., that while moderate-sized three-phase motor could be efficiently controlled, the difficulties of control were immensely added to with the very large size, and, as he read the Paper, it entirely corresponded with his views that where big winders were used one was bound to use the Ward-Leonard system. Regarding the alternating motor, hitherto he had only used control by liquid resistance, but with that system it was impossible, even with very moderate rotor pressures, to work with a less slip than some 10 per cent., and he thought the reading of the author's Paper would have a great effect upon future control of such motors. In connection with pumping, he would like to know what percentage of the 30,000 h.p. used for that purpose was actually worked by centrifugal pumps. He thought that the efficiency of the labour employed on the Rand would have been vastly improved had more attention been given to the matter of ventilation. As to the question of the very wide limits of pressure and frequency variation, and the disadvantages resulting therefrom, referred to by the author, he was of opinion that had Mr. Rider arrived on the scene a little earlier he would have secured a very much better pressure regulation from the power company. In England they had a frequency regulation of 2½ per cent. up and down, and experience had shown that to be so wide that he thought 1 per cent. could be considered as a practical standard.

Mr. P. V. Hunter said that the Paper was essentially a record of work done, and was not one open to much discussion. He thought that the standard for the oil switch of 800 amperes at 15,000 volts was a very sound one. Had the author found it necessary to use especially stiff tanks and a very mechanical construction in other directions? In regard to the author's experiment in driving, could not the difficulty have been got over by altering the cam profile? The general conclusions arrived at in the Paper very much endorsed experience in the north of England—viz., that when one was dealing with large powers one must not buy cheap apparatus.

(*To be concluded.*)

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"Bulletin" de la Société Internationale des Electriciens. (Paris: Gauthier-Villars et Cie.) No. 40, Tome V. Pp. 35. 3 fr.

"Archives D'Electricite Médicale," by Prof. J. Bergonie. (Bordeaux: J. Bamel.) Nos. 388 and 389. Pp. 37 and 31. 1.50 fr.

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In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY MORNING, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Advertisements of all kinds of which no proofs are required before first insertion can be accepted up to FIRST POST THURSDAY MORNING.

DEFECTS IN DESIGN AND MANUFACTURE.

A Paper like that read by Mr. J. H. RIDER last week before the Institution of Electrical Engineers is useful in more than one respect. The subject chosen by the author was the power supply of the Central Mining-Rand Mines Group, and the scale of operations is so large that there are necessarily many points which must be of interest to those connected with the planning of mining installations of the character described. The Paper is written from the point of view of the mine owner, not from that of the supplier of electrical energy. Since mine owners are naturally anxious to use the purchased energy to the best advantage, all sorts of problems must be considered. These start with the metering of the energy. Then there come the many problems of electric winding, the control of electric winders, the safety devices, depth indicators and so forth. Apart from the electrical distribution, there are the problems of distributing compressed air, which medium is so largely used in South Africa.

The engineer who is planning such installations will find much useful information in this part of Mr. RIDER'S Paper; but there is another part which, we think, will be found even more useful by manufacturers. It is not so often that a user unburdens his soul to describe the troubles which he has experienced through unsatisfactory plant. Troubles must, no doubt, be expected from time to time, but the point that is important in Mr. RIDER'S experience is that all these troubles could have been avoided if the plant had been either properly designed or properly manufactured.

We may mention a few of the examples cited by Mr. RIDER. One of these is want of stiffness in the stator frame of three-phase winding motors. We should have thought it would have been obvious that if a stiff frame is required anywhere it is desirable in a winding motor; but evidently this fact has not been realised by all makers, and the effects can readily be imagined. Another difficulty arises from the fixing of dovetailed strips to the inside face of the frame of winding motors by means of screws. Cases also occurred in which the dovetailed strips were secured by studs with nuts on the outside of the frame. No lock nuts or spring

washers were provided, and the air-gap was adjusted by means of the studs, which seems to be a good way of ensuring trouble. Again, in some cases dovetailed slots were so wide that packing strips were inserted to keep the core plates from shaking, and the plea was put forward that it was not possible to machine so accurately as to avoid the use of such packing!

It is well recognised that it is desirable to keep down the air-gap of induction motors to a small figure, but if this is done in large motors it becomes essential that the frame should be very stiff. In any case, however, as Mr. RIDER remarks, "bearings will wear, and rotors and stators sometimes have a habit of getting out of truth." Consequently, from the user's point of view, it is better to lose something in efficiency by having a larger air-gap, and thus to secure satisfactory running.

Notwithstanding statements to the contrary, it seems that many manufacturers make no real attempt to find out the requirements of any particular market. When it is a case of plant for mining work the conditions are essentially severe, and the manufacturer should make a point of finding out what is necessary to give good results.

Mr. RIDER is discreet enough not to mention any names, but we do not doubt that a good deal of the plant which he describes came from this country—in fact, this was admitted in the discussion. That being so, all we can say is that such defects should not be found in plant of first-class British engineering firms. If they are, then surely it is time that our manufacturers kept a more careful eye on these matters of detail, so as to ensure satisfactory results, not merely in the plant of consumers who have a highly trained engineer to safeguard their interests, but in the plant supplied to those who are less fortunate.

In the discussion on Mr. RIDER's Paper, Dr. A. H. RAILING frankly admitted that the attitude taken by manufacturers in the past had been unsatisfactory, being due to the fact that commercial men, instead of engineers, had been sent out as salesmen. Owing to their lack of the necessary qualifications, they were unable to study the local conditions and to see what was really necessary. During the last five years, however, a change has taken place, and, according to Dr. RAILING's statement, engineers now have a word "at the top" as well as commercial men. We trust this combination will become more general, for it is eminently desirable.

REVIEWS.

Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Electrical Engineering in India. By J. W. [illegible] London: W. Thacker & Co.) Pp. xxxvi.+517. 15s. net.

In this work we have a book that will at last fill a big gap in the library of many electrical engineers. The author has succeeded to a remarkable degree in [illegible] to produce. It is a comprehensive treatise covering the scope of public supply and also the mining and [illegible] of electrical engineering, with special reference to Indian practice. Engineers who are thrown on their own resources, away from immediate touch with sources of information and [illegible] will find it a most invaluable aid when [illegible] the task of the sounding of possibilities in the initial stages of any scheme, and further the close and practical data given should finally enable the engineer to carry his investigations of, for instance, a power supply to a definite conclusion as to the relative advantages of steam, oil or water in any given case both from the engineering and financial points of view.

Its value, however, will not be limited to the isolated engineer. We have our highly technical class of book and our handbooks of bare data, and know what a big gulf there is between the two; but this treatise fills in a most excellent way the need felt by so many for a work in which the scientific padding is eliminated, and the real practical data and formulæ necessary to the "commercially designing" engineer set out and followed through in a clear and practical way. It will be found especially useful by many civil and other engineers, whose knowledge of electricity may not run to any depth, who will find in it *just* what is needed arranged in the most helpful form.

Starting with an explanation of terms, we are given a survey of alternating current and direct current principles to refresh the memory on the more elementary points, although not to the "student saturation" limit. Then the electric wiring contractor is furnished with the most complete treatment of his branch it has been the reviewer's lot to see, including wiring systems, illumination, heating, ventilation, cooking and electric driving; this should prove of immense value to any supply station sales engineer.

Private plants are next discussed, leading on to larger central stations, under which the relative virtues of prime movers are considered and examples of Indian supply costs and tariffs given, and points such as diversity factor, maximum demand, &c., treated from a practical standpoint.

The treatment of the development of water power covers in a most thorough way the problems one would be actually confronted with, and this is followed by the mining and traction branches treated respectively in an equally useful manner.

Transmission of power is given the full treatment it calls for in a book purporting to be for use in a country with natural water power resources; questions of the economical point of line losses, impedance, power factor, transformer losses and connections, &c., are followed by constructional considerations —pole strengths, stresses and strains of lines, poles, stays and insulators, and other details being treated most ably and practically.

Specifications, depreciation and maintenance are followed by a concluding chapter on testing, the I.E.E. model general conditions forming an appendix.

There are a few misprints, which will no doubt be corrected in the next edition.

Throughout the whole book the practical side is kept strictly in sight. At all necessary points formulæ are given and the value greatly increased by worked out examples. Vector and wave diagrams are brought into good requisition, but they might perhaps, with advantage, have been used a little more liberally in places. Another useful side is the inclusion of the approximate cost of all apparatus and machinery referred to, which prices, by the way, are *not* inflated. The cost of labour, however, is not discussed. Indian and I.E.E. Rules which bear on each question are embodied in the text at that particular point, lending completeness to each section.

The title might be considered a little misleading for, although the book is designed for, and will be of peculiar service to, P.W.D. men in India, its value should not be much lower to engineers in other countries. Taking the title in conjunction with the author's name, some readers might look for a rather different construction; for instance, a wide survey of the present status and extent of the electrical industry and public supply in the country as a whole with a comprehensive deduction of future possibilities of development, both from the engineering and financial points of view, as a guide and incentive to engineering firms and capitalists outside the country to join in the progress.

For the consumption of the average engineer the style is, in many parts, of rather too popular a nature, and might with advantage have been curtailed, although the sectionising

of the whole work mitigates this defect to a certain extent, giving clearness; and if the reader will have a little patience at these parts he will be well repaid, for he will certainly find what he requires.

In conclusion, the reviewer would say that he intends to keep the work close at hand as a most valuable book of reference and information. C. F. MOUNSDON.

Brown's Marine Electrician for Seagoing Engineers. By A. E. and A. H. LEIGHMAN. (Glasgow: James Brown & Son.) Pp. xv.—244. 5s. net.

In this book the authors seek to give practical information on such matters as the installation, repair and use of electric lighting, heating and other appliances suitable for use in ships. A former edition was published in 1905, and the present edition, to quote the preface, "has been thoroughly revised and brought up to date."

The opening chapter deals with first principles of electromagnetic action in a lucid manner, but on page 2 the impression is given that permanent magnet steel is used for field magnets of dynamos and motors. Chapters II., III. and IV. deal with dynamo-electric machinery, and could be revised and condensed with very great advantage. They are loosely written and incorrect in many places. Armature and commutator connections are not properly described, and on page 16 the position of brushes is given wrongly. This error is repeated on pages 20 and 51, while on page 21 armature reaction is referred to as "magnetic drag, which may be defined as the lagging of a magnetic effect behind its cause."

Reference is made to alternating-current machines, and on page 23 we are told that a high-tension current at, say, 5,000 volts, is generated at the dynamo, transformed to about 2,000 volts, and again reduced to about 50 volts by a second transformer near the lamps. On pages 26 and 27 we learn that the shunt dynamo would seem to be very suitable for working arc lamps in series, while in the event of a short-circuit it will lose its magnetism, and the engine, relieved of its load, will race away. One is tempted to ask what engine governors are for. Other mistakes and inaccuracies are too numerous to mention, and well-known engine makers are referred to as "Brotherhead," "Williams" and "Belliss & Marconi."

Chapter V. deals with motors and starting switches, together with some of their applications. We read on page 66 that the shunt motor does not start well, and needs the assistance of a starting resistance; while on page 70 we are told that inserting resistance in the field circuit of a shunt motor decreases the speed of the motor.

Primary batteries are explained in Chapter VI. and accumulators in the following chapter. The theory of accumulators given is weak, but otherwise the chapter is quite good.

The succeeding chapters describe the manufacture of incandescent lamps, which is hardly necessary in a book of this kind. Arc lamps and searchlights are lucidly and well described.

On page 97 we learn that for a 100-volt installation the dynamo voltage should be 110 volts, instead of 102, as usual; and on the same page, after computing the output of the dynamo correctly at 4 kw., a reference to 95 per cent. efficiency is made, which is unnecessary and wrong.

And now we come to the part of the book most necessary for an engineer in this class of work—viz., wiring. The description and illustration of the joints is very good, but Britannia joints and overhead wires are not used on steamers. Lead-covered wiring and wood casing are dismissed in a few words, and the Simplex Conduit system as applied to house wiring is neatly described, including flexible pendants and illustrations of brick walls. One is tempted to remind the authors that we are supposed to be on a ship, and that the system described would not last long on account of the very condensation he makes light of.

The remaining chapters are devoted to a description of some examples of switchgear, testing instruments, heating apparatus, electric bells, telephones, revolution indicators, stoking indicators, telegraphs, torsion meters, &c., and the Hele-Shaw Martineau system of steering gear, all of which are interesting to marine engineers.

Space does not permit us to mention all the errors, but we would point out that on page 164 an ammeter is described as being protected by a fuse, on pages 176 and 177 time lag is referred to as time log. On page 179 a circuit-breaker is shown upside down, and on page 180 the time limit action of a circuit-breaker is described as being on the reverse current trip, instead of on the overload trip. It seems that (page 191) an "earth" can only occur on a single-wired ship, and can usually be found by feeling for a hot spot on the wiring. The wrong reason is given on page 218 for providing high-class insulation on bell and telephone circuits. Induction from adjacent lines cannot be prevented by insulation, however good.

In closing, we would say that engineers who require a general idea of apparatus on board ship will find much to interest them in this book; but as it will find its way into the hands of many young engineers who are real students with a determination to learn, it is to be regretted that there are so many errors. G. A.

Clauses and Precedents in Electricity, Gas and Water Legislation. By JACQUES ABADY. (London: Walter King.) Pp. xix.—331. 15s. net.

Private Bill Legislation is now so extensively employed that the search for the latest precedents and clauses often entails a considerable expenditure of time and energy, and in compiling the present work Mr. Abady has rendered a signal service to engineers, agents and all who are interested in the legislation governing electricity supply, gas and water undertakings. A perusal of the book has impressed us with the industry, patience and skill of the author, for the examination and comparison of the clauses of all the local Acts and Provisional Orders relating to the three public services for the five years from 1910 to 1914 must have been a most laborious and uninviting task. The five years covered by the author is an important period for both the electric supply and gas industries, for not only does it embrace the various changes introduced by the Electric Lighting Act, 1909, but it has witnessed a material advance in the forms of certain special clauses in electric supply bills, and also the substitution of the calorific power for the illuminating power standard in gas bills, the gradual introduction of higher distribution pressures and other changes. There is no other book published which covers quite the same ground, for not only does it give the text of the latest clauses and precedents, but it gives a clear idea of the trend of legislation during the past five years by setting out the changes in form which clauses have undergone since 1910. To the ordinary man procedure by Private Bill is an exceedingly complicated, extravagant and uncertain method of legislation, but Mr. Abady's book removes some of the difficulties of the process, for in his analysis he constantly keeps in mind the difference between "standard" and "special" clauses in Bills, and we are able to follow and understand the transformation of "special" into "standard" clauses. The method adopted by the author is as follows: The "Model Bills and Clauses" for the five years were first examined, and the relevant clauses as amended in 1914 are printed in full, the changes made in the period being set out in explanatory notes; then the special clauses in the various Acts and orders, which vary the Model Bills, are set out, so that it is easily seen what amount of authority there is for a clause on a particular subject. The present volume consists of five sections, viz.: (1) Model Clauses (gas, water and miscellaneous), (2) Electric Lighting Provisional Orders, (3) Electricity (with Gas and Electricity) Acts, (4) Gas Acts and Orders, and (5) Water Acts and Orders. About one-third of the book is devoted to electric lighting provisional orders and electric supply Bills, and this part has been dealt with in a thorough and systematic manner. All the latest topics of discussion among managers of electric supply undertakings which have formed the subject matter of legislation are included, and not only is the standard form of clauses given, but changes made during the past five years are carefully set out in notes by the author. Among the special subjects may be mentioned "stand-by" and

"bulk" supply, the hiring of motors and fittings, mains laying in private streets, overhead wires, defective meters, discounts, purchase of undertakings, finance, bye-laws and many others. The portions devoted to gas and water supply are equally good, and as there are excellent tables of contents, and of Acts and orders examined as well as a full index, the book forms a most useful and reliable work of reference on the current legislation of three important public services.

Annuaire Français de l'Electricité. 2nd Edition. Pp. xii. 146. (Paris: La Lumière Electrique.) 4 fr.

The present volume is the second edition of the Handbook issued by our contemporary and referred to in our issue of April 10 of last year. Presumably, the present volume is intended for the year 1915. It contains brief particulars of electric distribution undertakings, electric tramways and railways, companies concerned in electrical work, and the members of certain committees and associations in France. It is interesting to notice the comparatively high prices charged for electrical energy in France, 60–80 centimes per unit being quite a common figure. English readers will no doubt find the short chapter on French legislation of considerable value, as brief particulars are given of various enactments, and details of this kind are of commercial value to all who are concerned with the exploitation of French concessions.

Annuaire pour l'An 1915. Publié par le Bureau des Longitudes. Pp. viii.+995. (Paris: Gauthier-Villars et Cie.) 1 fr. 50c., net.

The present edition of this well-known volume, which first appeared in 1796, shows that the work tends to increase in size, notwithstanding the efforts made to the contrary. Most of the modifications from the previous edition are concerned with astronomical matters, and some are due to the recent war in the Balkans and other changes in territory. It will be interesting to see what other alterations will be necessitated by events now in progress in the course of another year or two.

THE FUTURE PROGRESS OF CABLE TELEGRAPHY.*

BY H. W. MALCOLM, D.SC.

(*Continued from page* 886, *Vol. LXXIV.*)

Summary.—An analytical study is made of the problem of increasing the speed of the submarine telegraph cable, and of rendering it, if possible, distortionless. The problem is attacked from first principles in order that clear ideas may be obtained. The discussion comes under three heads: (*a*) Distortion and how it is produced; (*b*) Present-day methods of reducing distortion; and (*c*) The loaded submarine telegraph cable. Tables and diagrams are given throughout so as to render the results readily available to those who have not the time to follow the processes by which they are obtained.

Coil Loading and Spacing.

If the inductance of the cable is to be high the use of loading coils is necessitated. Now, as the wave-front travels along the cable and strikes an inductance coil it is partially reflected, and may undergo considerable loss before reaching the receiving end. It is, therefore, of primary importance to give attention to the spacing of the coils.

The fewer the coils and the more concentrated the loading the greater can their time-constant be made, and the higher the proportion which the added inductance bears to the added resistance; but at the same time their influence tends to become localised instead of distributed, and the wave-front tends to lose its steepness. Take as a possible compromise that the coils are placed at intervals of 100 miles instead of at every mile, as in telephone cables. In a cable 2,000 miles long there would, therefore, be 20 coils. If the San Francisco-Honolulu cable is to have 20 coils to bring its inductance up to 0·0951 henry per n.m., the inductance of each coil must be 10·8 henries.

Table XXIX.—*Fig. 45, Curve A.*

t (secs.)	0·4	0·5	0·6	0·7	1·0	1·5	2·0
$e^{-\frac{R}{2L}t}$	0·000102	0·000010	...	...	...	...	...
$e^{-\frac{R}{L}t}$	0·010102	0·003203	0·001015	0·000322	0·0000	...	...
Sinh term	0·9614	0·7566	0·5952	0·4682	0·2279	0·0686	0·0207
First 3 terms (mm.a. per v.)	7·6	48·9	81·4	106·9	155·2	187·2	196·9

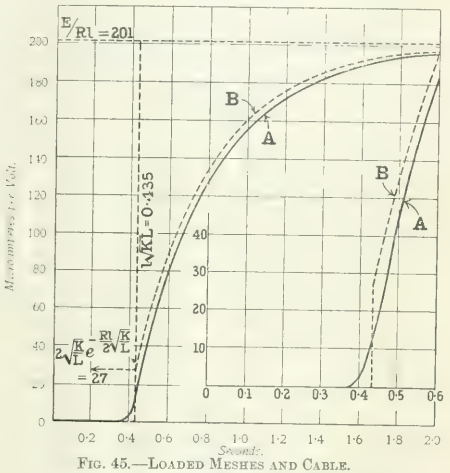


Fig. 45.—Loaded Meshes and Cable.

Curve A.—20 loaded meshes. L R $\frac{KR^2}{100}$: L 0·095 h. per n.m.

Curve B. Loaded Cable Inset: the discontinuity to a greater scale

In order to investigate the influence of the spacing, suppose that the cable is replaced by a system of 20 loaded meshes. The formula for the arrival current may then be obtained from the general formula (10) by putting G=0. This leads to

$$C_n = \frac{E}{Rl}\left[1 - e^{-\frac{Rl}{L}} + 2e^{-\frac{Rl}{2L}} \sum_{m=1}^{m=n-1} \frac{\left(1+\cos\frac{m\pi}{n}\right)\cos m\pi \sinh\frac{Rl}{2L\lambda}\left(1 - \frac{8Ln(n-1)\left(1-\cos\frac{m\pi}{n}\right)}{R.KR^2}\right)}{\lambda \left(1 - \frac{8Ln(n-1)\left(1-\cos\frac{m\pi}{n}\right)}{R.KR^2}\right)}\right] \quad . \quad . \quad . \quad (27)$$

Table XXVIII.

m.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
$1-\cos\frac{m\pi}{20}$	1·951	1·891	1·809	1·707	1·588	1·454	1·309	1·156	1	0·844	0·691	0·546	0·412	0·293	0·191	0·109	0·049	0·012
$\frac{3040L\left(1-\cos\frac{m\pi}{20}\right)}{R.KR^2}$	1·515	3·313	5·806	8·903	12·53	16·60	21·01	25·65	30·40	35·16	39·79	44·20	48·27	51·89	54·99	57·49	59·31	60·43
$\sqrt{\text{do.}-1}$	0·718	1·521	2·192	2·811	3·396	3·950	4·473	4·964	5·422	5·844	6·228	6·573	6·876	7·133	7·348	7·516	7·636	7·709
$\frac{2\left(1+\cos\frac{m\pi}{20}\right)}{\lambda^{-}}$	5·436	2·487	1·650	1·214	0·935	0·736	0·585	0·466	0·369	0·289	0·222	0·166	0·120	0·082	0·052	0·029	0·013	0·003

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When $L/R=KR/2\cdot100$ and $n=20$, the first term of the series is a hyperbolic sine and the remaining 18 terms are sines. The approximate values of the principal constants are contained in Table XXVIII., and Fig. 45, Curve A, is plotted from Table XXIX.

Curve B, Fig. 45, is the arrival current when the loading is uniformly distributed. In order to trace the mesh curve at its steepest part, where it crosses the vertical through $t=l\sqrt{KL}$, or 0·435 sec., points have been calculated on it for the instants $t=0\cdot40$, $0\cdot42$, $0\cdot44$, $0\cdot46$, $0\cdot48$ and $0\cdot50$ second.

The effect of the sub-division into meshes is seen in Curve A in the rounding-off which the steep part of curve B has undergone. The slope of the curve is now everywhere finite, instead of being infinitely great, as in curve B, when $t=l\sqrt{LK}$. The height of the signals built up from curve B would therefore depend on the speed of signalling, on which would also depend whether the distortion that would be present to some extent would be harmful or not.

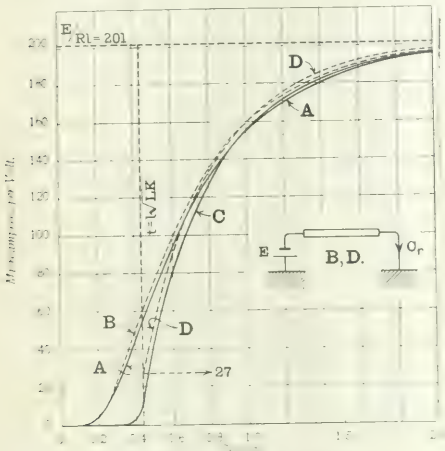


Fig. 46. Plain and Loaded Meshes.

Curve A.—20 plain meshes. Curve B.—Non-loaded cable.
Curve C.—20 loaded meshes. Curve D.—Loaded cable.

In Fig. 46 the arrival current for 20 loaded meshes is compared with the current for 20 plain meshes. The required formula may be obtained from (27) by making L vanishingly small. The formula then reduces to

$$C_r = \frac{E}{Rl}\left[1 - \sum_{n=1}^{n=19} \cos\frac{n\pi}{20}\,\cdot\cos\frac{n\pi}{20}\,\cdot t\,\frac{2\sin\frac{n\pi}{20}}{\sin\frac{n\pi}{20}}\right] \quad (28)$$

which is the same as (13) of Part I.

Curve A, Fig. 46, is plotted from (28) and Table XXX.

Table XXX. Fig. 46, Curve A.

$t=$	0·1	0·2	0·3	0·4	0·5	0·7	1·0	1·5	2·0
Steady	201·0	201·0	201·0	201·0	201·0	201·0	201·0	201·0	201·0
$n=1$.	322·2	250·9	209·6	169·1	136·4	88·7	46·6	15·9	5·4
$n=2$.	166·8	71·0	30·2	12·8	5·5	1·0	0·1		
$n=3$.	56·7	8·4	1·3	0·2					
$n=4$	13·0	0·5							
$n=5$.	2·1								
C_r	0·1	4·1	20·1	41·6	70·1	113·3	154·5	185·1	195·6

Curve B is the arrival current for the non-loaded cable. Curves A and B coincide initially; afterwards the cable current is [illegible] For purposes of comparison [illegible] of Fig. 46 are reproduced in curve C for the loaded [illegible] for the loaded cable. Curve C in its later stages is less than curve D, in the same manner and to [illegible] curve A is less than curve B; the slight [illegible] is to be attributed to the [illegible] of capacity and loading. Again, curve D rises in its later stages above curve B, and similarly curve C rises above curve A so as nearly to coincide with curve B; in other words the influence of loading is shown in a slight increase in the height of the tail, whether in the loaded cable or in loaded meshes.

It has been shown, however, that the tail is unimportant as it is practically eliminated at high speeds. Now, so far as the head is concerned sub-division into meshes does not cause much difference to exist between the plain curves initially. Hence it is not unreasonable to suppose that sub-division of capacity will not cause any great change when the cable is loaded, and that the loaded mesh curve is a close approximation to the cable curve with concentrated loading.

Influence of Terminal Apparatus—Single Condenser.

It is possible that signalling condensers may continue to be used in the loaded cable in order to eliminate earth currents. In any case some kind of apparatus must be used at the ends of the cable to form the arms of the bridge in duplex working. Suppose first that a single condenser is placed at one end of a loaded cable. The periodic solution is

$$C_r = \frac{V_r}{Z_0 \sinh Pl - Z_r \cosh Pl}$$

where Z_r is the impedance of the end apparatus. Let Z_r be the reciprocal of a conductance, and consist of a condenser K_r shunted by a leak G_r, so that

$$Z_r = \frac{1}{G_r - ipK_r}.$$

The denominator of C_r is

$$\varphi(y) = \sqrt{\frac{R-yL}{G-yK}}\sinh l\sqrt{(R+yL)(G+yK)} + \frac{\cosh l\sqrt{(R+yL)(G+yK)}}{G_r+yK_r}.$$

Let $\frac{Gl}{G_r} = \frac{Kl}{K_r} = \frac{l}{\lambda} = i$, and put $l\sqrt{(R+yL)(G+yK)} = xi$. The roots of $\varphi(y)=0$ are given by

$$\tanh l\sqrt{(R+yL)(G+yK)} = \frac{1}{G_r+yK_r}\sqrt{\frac{G+yK}{R+yL}}$$

which reduces to $\tan x = \frac{l}{\lambda x}$. Also y is connected with x by the relationship

$$y = \frac{(LG+KR)+\sqrt{(LG-KR)^2+4LKx^2/l^2}}{2LK}.$$

Further, $\varphi(0)$ is $\sqrt{\frac{R}{G}}\sinh l\sqrt{RG} + \frac{\cosh l\sqrt{RG}}{G_r}$.

Hence, finally, forming $y\varphi'(y)$ and substituting for y in terms of x, after some manipulation the complete solution is found to be

$$C_r = \frac{E}{\sqrt{\frac{R}{G}}\sinh l\sqrt{RG} + \frac{\cosh l\sqrt{RG}}{G_r}} \cdot \frac{\sinh\left(l\sqrt{(LG-KR)^2+4LKx^2/l^2} - \theta\right)}{2LK}$$

$$\frac{Et}{Rl} - \sum \frac{\sqrt{1-\frac{GR/l^2}{x^2}}\sqrt{1+\frac{LG}{KR}+\frac{4Lx^2}{R\,.\,KR/l^2}}\left[\frac{1}{\cos x}\,\frac{\sin x}{x}\right]}{\sqrt{1+\frac{LG}{KR}+\frac{4Lx^2}{R\,.\,KR/l^2}} + \frac{2x^2}{GR/l^2}}$$

where $\tan x = \frac{Gl}{G_r x} - \frac{Kl}{K_r x}$ and $\tanh\theta = \frac{\sqrt{1+\frac{LG}{KR}+\frac{4Lx^2}{R\,.\,KR/l^2}}}{1+\frac{LG}{KR}+\frac{2x^2}{GR/l^2}}$ (29)

When G and G_r are zero, $\tanh\theta$ and θ are zero, $\cosh\theta = 1$ and $\sinh\theta = 0$. The formula becomes

$$C_r = \frac{4E}{Rl}\sum \frac{\sinh\frac{Rt}{2L}\sqrt{1+\frac{4Lx^2}{R\,.\,KR/l^2}}}{\sqrt{1+\frac{4Lx^2}{R\,.\,KR/l^2}}\left[\frac{1}{\cos x}\,\frac{\sin x}{x}\right]} \quad (30)$$

where $\tan x = Kl/K_r x$ . . . . . (31)

If, in addition, L be zero, the formula reduces further to that for a single condenser with a plain cable.*

Let $K=Kl/10$, and let $L/R = KR/100$, as before. The roots of (31) are contained in Table XXXI., and are taken from Table XII.† The first and second terms of the series are hyperbolic; the subsequent terms are circular. Fig. 47, curve A, is plotted from (30) and Table XXXII. The sine terms have been calculated for the times 0·50, 0·55 and 0·60 second, and the curve is shown dotted in its probable course to meet the ordinate through $t=l\sqrt{LK}$. Comparing Fig. 47 with Fig. 40, it is seen that the effect of the condenser is to produce a marked improvement in the shape of the curve. The tail is now much reduced, and the curve runs horizontally from the head for some distance before eventually sinking to zero. Curve B is the condenser arrival curve without inductance. The total area between the time axis and the curves is the same in both cases, being equal to the charge in the condenser. What is cut away from curve B by the vertical at $t=l\sqrt{LK}$ is added in its later stages to curve A. If Q_t be the quantity at time t by which the condenser is short of its full charge, then $Q_t = \int C_r dt$, which, from (30),

$$-2E \cdot Kl \cdot e^{-\frac{Rt}{2L}} \sum \frac{\sinh \frac{Rt}{2L}\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}} - \sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}} \cosh \frac{Rt}{2L}\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}}}{x^2\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}}\left[1-\frac{\sin x}{x}\right]}$$

This series, containing as it does the factor x^2 in the denominator, is much more rapidly convergent than the one from which it is derived, and it furnishes a useful check on the calculation.

Table XXXII. *For curve A.*

t (sec.)	0·4	0·5	0·55	0·6	0·7	1·0	1·5	2·0
$\frac{Rt}{2L}\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}}$	0·1917	0·2396	0·2634	0·2875	0·3355	0·4792	0·7188	0·9584
$e^{\frac{Rt}{2L}}\sinh\frac{Rt}{2L}\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}}$	0·8256	0·7869	0·8843	0·7501	0·7150	0·6193	0·4874	0·3835
1st term.	44·63	42·55	41·55	40·56	38·66	33·48	26·35	20·73
$\frac{Rt}{2L}\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}}$				3·105				
$e^{\frac{Rt}{2L}}\sinh\frac{Rt}{2L}\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}}$	0·0517	0·0296	0·0221	0·0168	0·0096	0·0015	0·0001	
2nd term.	29·84	17·06	12·90	9·72	5·55	1·02	0·06	
1st and 2nd	14·79	25·49	28·65	30·48	33·11	32·47	26·29	20·73

Influence of End Apparatus on Height of Signal Head.

To find the height of the ordinate marking the head of the signal, return to the periodic case. The sinusoidal current through sending apparatus Z_s and receiving apparatus Z_r is

$$C_r = \frac{V_s}{(Z_s+Z_r)\cosh Pl + (Z_sZ_r/Z_t + Z_t)\sinh Pl}$$

$$\frac{V_s}{(Z_s+Z_r+Z_sZ_r/Z_t)\sinh Pl}$$

when Pl is big. Now, $Z_t = \sqrt{\frac{R+pL}{G+pK}} \sqrt{\frac{L}{K}}$ in the limit when p is great. Also, if Z_s and Z_r are condensers, $Z_s=1/ipK_s$ and $Z_r=1/ipK_r$, and both are zero when p is infinitely great. Hence, when the frequency is great,

$$C_r = \frac{V_s}{Z_t \sinh Pl} = 2E\sqrt{\frac{K}{L}} e^{-\frac{Rt}{2L}} \sinh p(t-l\sqrt{LK}),$$

as before when there was no apparatus. A square-topped oscillation of high frequency is not affected by the sending and receiving condensers. *The current is propagated unchanged through sending and receiving apparatus which is initially of zero impedance.* The height to which the current jumps at the beginning of the signal in curve A, Fig. 47, is, therefore, the same as in Fig. 40, curve A.

When Z_s or Z_r is an impedance of the form R_s+pL_s, it is infinite when p is infinite, and therefore C_r is zero when p is infinite. The arrival curve in this case starts from zero, and the delay which the signal head would experience in rising to its full value would depend on the time constant of the coil. When Z_s and Z_r are pure resistances, it is easy to see that the height of the signal head is reduced in the proportion,

$$\sqrt{L/K} : R_s + R_r + R_sR_r\sqrt{K/L} : \sqrt{L/K},$$

or

$$1 : 1 + R_s \cdot R_r \cdot K/L + (R_s+R_r)\sqrt{\frac{K}{L}}.$$

If $R_s=R_r=Rl/m$, the proportion may be written

$$1 : 1 + \frac{KR l^2}{L/Rl} + \frac{2}{m}\sqrt{\frac{KR l^2}{L/R}}$$

When $L/R = KR l^2/100$, this simplifies to

$$1 : 1 + \frac{100}{m^2} + \frac{10}{m}.$$

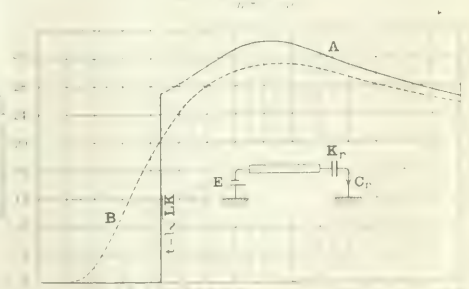


Fig. 47.—Effect of Condenser on Signal Head.

Table XXXI.

x	$\frac{4Lx^2}{R \cdot KR l^2}$	$\frac{R}{2L}\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}}$	$e^{\frac{Rt}{2L}\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}}}$	$\frac{1}{x^2\sqrt{1-\frac{4Lx^2}{R \cdot KR l^2}}\left[1-\frac{\sin x}{x}\right]}$
1·429	0·08168	11·011		−108·13
4·306	0·74168	5·839		−577·12
7·228	2·0898	11·993		427·17
10·200	4·1616	20·428		99·87
13·214	6·9844	28·106		45·15
16·260	10·5756	35·551		31·44

* Formula (63). † Thesis, The Electrician, vol. lxxiv. p. 191.

and if $m=10$ the proportion is 1 : 3. The head of the signal would be reduced to one-third the height of the end of the arrival curve. From Fig. 20, curves A and B, it is seen that the resistance would not affect greatly the subsequent course of the curve.

It is clear that the existence of appreciable impedance at the end of a cable to which the head of the arrival curve is steep would be [illegible] to the shape and size of the received [illegible]. Nevertheless, even although reflection losses arising from discontinuity in loading—which

[illegible] The Electrician, vol. lxxiv. p. 191.

will be considered immediately—were eliminated by the employment of continuous loading, it does not follow that the wave-front would be perpendicular. For that to be strictly true all the fundamental cable constants R, K, L, and G would require to be true or geometrical constants and quite independent of the frequency when measured with alternating current. It is the same difficulty as is met with in telephony, where it necessitates careful design if the attenuation at the higher frequencies is not to be prohibitive. Yet if the same care were given to the design of the telegraph cable we may conclude that the departure of the signal head from the rectangular form would not be so serious as to reduce the speed of transmission to any great degree.

(To be continued.)

CORRESPONDENCE

COIL HAVING MAXIMUM SELF-INDUCTANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with the interesting Paper by Messrs. Shawcross and Wells, which you published in your last issue, I should like to point out that their results are limited to coils having rectangular cross-sections with two sides parallel to the axis of the coil. As a matter of fact, for a given area of cross-section the inductance of a ring coil of given volume is greater when the cross-section is circular than when it is square. This can be proved by comparing Rayleigh's formula for a ring coil given in the "Proceedings" of the Royal Society, Vol. LXXXVI., p. 562, 1912, with Maxwell's corrected formula for a coil of rectangular section, given in the "Bulletin" of the Bureau of Standards, Vol. VIII., p. 137, 1911.

The authors state that the inductance of a single layer coil of cylindrical shape is a maximum when the ratio of its diameter to its height is 2·5. Presumably this number has been obtained by computing the formula for various cases and then drawing a graph of the results. It can, however, be readily shown, by differentiating the elliptic integrals in Lorenz's formula and equating to zero in the ordinary way, that the inductance of the coil is a maximum when this ratio is 2·4525, approx. When this is the case Lorenz's formula simplifies to

$$L_{max.} = 1{\cdot}32214(l^{3/2}/b^{1/2}) \quad 10^{-9} \text{ henrys,}$$

where l is the length of the wire and b its breadth including the insulation.

For a coil of circular cross-section the following formulæ, generally attributed to Maxwell, are sometimes used by engineers:—

$$L_{max.} = 6{\cdot}7N^2a \quad 10^{-9}$$
$$3Nl \quad 10^{-9} \text{ henrys,}$$

where N is the total number of turns, l the length of the wire and a the radius of the circular axis of the ring coil, these formulæ being applied when $a = 3{\cdot}22c$, where c is the radius of the circular cross-section.

Using Rayleigh's more accurate formula, we find that when $a = 3{\cdot}22c$,

$$L = 6{\cdot}17N^2a \quad 10^{-9} \text{ henrys,}$$

and thus the results obtained by the preceding formulæ are about 2 per cent. too small. If we assume Rayleigh's formula to be true in all cases it can be shown that the inductance is a maximum when $a = 2{\cdot}575c$. In this case we get

$$L_{max.} = 5{\cdot}35N^2a \quad 10^{-9} \text{ henrys,}$$

as the formula which gives the maximum self-inductance. To make sure, however, of the last figure in this formula, it would be necessary to carry Rayleigh's formula to a further approximation. This, although a straightforward operation, entails a very great deal of hard labour.—I am, &c.,

London, April 17. ALEXANDER RUSSELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the article on "The Form of Coil to give the Maximum Self-inductance," in the current issue of your Paper, a statement is made to the effect that the calculated value of $2a/b$ (diameter of coil / length of coil) $= 2{\cdot}5$, which gives the maximum inductance in the example chosen for the single layer coil, applies only to the particular wire there chosen; or, in other words, a generalisation as to the shape to give the maximum inductance cannot be made for single-layer coils. I should like to point out that this is apparently incorrect, as the following reasoning shows:—

Using the notation of the article, in the case of the single-layer coil, $n_1 c = 1$, so that we may write $l = 2\pi a n_1 b$,

or $$b = \frac{l}{2\pi a n_1}.$$

The l can be written in the form, $l^2 = \pi n_1 \cdot \frac{l}{2a}$; whence, by substitution in the original expression for the inductance of the coil, we obtain

$$L = \frac{l^2 K}{b} = \frac{l^2 K}{\sqrt{\frac{l}{2a}}} = (\sqrt{\pi n_1 l^3}) \frac{K}{\sqrt{b/2a}}.$$

This form shows that for *any* given wire (of given length and diameter, or of given length and winding pitch, if the turns do not touch one another), the maximum value of the inductance will be obtained when $K\sqrt{2a/b}$ has its maximum value.

From the values of K tabulated in the "Bulletin" of the Bureau of Standards (Vol. VIII., p. 224, 1912), it is easy to show that this is the case when $2a/b = 2{\cdot}415$, *i.e.*, for coils of length $= 0{\cdot}414 \times$ diameter.—I am, &c.,

London, April 17. PHILIP R. COURSEY.

"DIRECT MEASUREMENT OF POWER FACTOR."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Mr. Gifford's article in your issue of the 6th, I would like to point out that the rather obvious expedient of replacing the ligaments in a power factor meter by transformers with floating secondaries is not new. I tried the scheme myself some two years ago and abandoned it for all but unbalanced meters, on account of the great complication and poor ratio of operating torque to weight of movement. In connection with unbalanced meters, however, and then only when a complete circular scale is desired, the scheme offers some advantages over the moving iron type, though it is also quite possible to construct this type for unbalanced loads. I think Mr. Gifford will find also that besides the added complication, neither scheme is equal to a modern plain dynamometer instrument (with ligaments) for accuracy or sensitiveness. In addition, one has to resort to alternating current calibration, which is neither so accurate or convenient as the continuous-current method.

With regard to the development of the unbalanced type, I may say that my designs have made considerable progress with regard to reduction of movement weight, as compared with those illustrated by Mr. Gifford, which are, in fact, very like my first model.

Referring to three-phase balanced load meters, I would point out, further, that it is now quite easy to design either the dynamometer type or the moving iron type for use with three currents or three pressures. No doubt the early moving iron types were limited in this respect, but the question now mainly resolves itself into one of convenience. If there are two potential transformers available, polyphase pressure excitation is to be recommended, since the readings of a balanced load instrument are then correct for unbalanced loads, if the power factors of the various phases should happen to be alike. An instrument excited from three currents and one pressure is rendered inaccurate as soon as the magnitude of the currents in the various phases differ slightly.

Mr. Gifford is also in error when he states that the "drag" torque due to the rotating field in this type is proportional to the current. This should, of course, be the square of the current, and the instrument readings are not therefore independent of load with any arrangement, unless this drag is negligible.

Perhaps Mr. Gifford will also deal with the question of

frequency variation later, but I find personally that it is impossible to make either the moving iron or the "induction-dynamometer" type independent of frequency, as is the case with the plain dynamometer form.

In conclusion, I would like to point out, as it does not appear to be generally known, that the controlling torque due to the ligaments in a modern dynamometer instrument is of no importance down to currents as low as 5 per cent. of full load. The disability to obtain a complete scale in the reverse power direction is now the sole practical disadvantage of these ligaments.—I am, &c.,

Edgware, April 17. LEONARD MURPHY.

THE EXTENSION OF THE OPERATOR $\sqrt{-1}$ TO THE MEASUREMENT OF ANGLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. C. Turnbull's letter in your issue of the 9th inst. is interesting. As the writer points out, "j" can be extended to vectorial rotations other than 90 deg. It is entirely a matter of definition. Thus:—

$\sqrt{-1}$ turns a vector through $\pi/2$.
$\sqrt[3]{-1}$,, ,, ,, $\pi/3$.
$\sqrt[6]{-1}$,, ,, ,, $\pi/6$.

&c. Mr. Turnbull will find the matter treated by Steinmetz in his "Engineering Mathematics."—I am, &c.,

Porthcurno, April 19. B. DAVIES.

TRANS-CONTINENTAL TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The remarks of the De Forest Radio Telephone & Telegraph Co. in their letter of last week are likely to give a wrong impression of the performance of my telephone relays using carbon microphones. These instruments have not the faults attributed to them, and they have been used by the British Post Office to carry traffic on trunk lines. During these trials the telephone relays required no attention, and maintained a good and steady magnification, giving excellent articulation throughout prolonged trials.

The real difficulty does not rest with the telephone relays themselves, but in enabling trunk lines to carry speech in both directions when the relays are inserted.

In my opinion the solution of this problem rests rather in the application of automatic switching devices operated by the voice currents than by means of maintaining a delicate electrical balance on a variable line.—I am, &c.,

London, April 19. S. G. BROWN.

THE ELECTRIFICATION OF SURFACES AS AFFECTED BY HEAT.*

BY F. E. SIDGW[illegible], D.Sc.

The uncertainty as to sign of the charge produced on rubbed solids when rubbed together has long been known. The particular irregularity with which this Paper deals is that produced if the surfaces about to be rubbed are heated. Thus, when smooth glass is rubbed with silk we have, as shown by the action of the gold-leaf electroscope, glass/silk+. Call this the *normal* action. If the glass be passed to and fro in a flame for a few seconds we find on rubbing glass—/silk+. Call this the *abnormal* action. Two methods I have found unfailing to bring the glass back to normal: (1) Long continued rubbing with silk or cotton; (2) passing the rod of glass through the hand or a sheet of indiarubber. This is much quicker in action than (1). If a systematic examination of the common hard solids and rubbing materials be made the abnormal effect will be found universal, though in varying degree.

The author describes a series of experiments on the pair *glass/silk*. Having obtained the normal relation glass+/silk−, the former is placed in a clear bunsen flame and the relation glass−/silk+ is found. A smoky bunsen flame, an alcohol flame and a benzene flame give the same results, so that the effect cannot be attributed to chemical peculiarity. After the glass has been in the flame there is a sticky feeling about it which may be due to moisture, but does not seem like it. The abnormal effect is greater when the stickiness is greater. Nothing is visible on the surface of the glass under a high-power microscope. In one instance the abnormal glass was put aside for 12 days. It remained abnormal at the end of the time. If the glass is dipped in water and the latter dried off the abnormal state remains. If, instead of letting the water evaporate off the rod, it is wiped off with a cotton duster, then, if the duster be dry, the result is glass+/cotton−, but if damp glass−/cotton+. The latter effect will pass away in time as friction continues, leaving the rod normal. A rod of normal glass is placed in an electric furnace and the temperature raised to 650 deg., which is just short of the melting point of the glass used. The glass becomes abnormal when cold, independent of the rate of cooling. No matter in what manner the glass is heated or cooled, the glass is always abnormal when cooled. In the case where normal glass is placed in the cold furnace, the temperature raised slowly to 700 deg., the current then stopped and the whole cooled very slowly, thus annealing the glass, it is slightly abnormal when cooled; but the effect is so slight that we here have confirmation of the theory that the abnormal effect is due to strain.

Normal glass excited with indiarubber becomes +. When passed through a flame and excited again it is feebly −. When excited with silk it is strongly −. Thus glass, which normally is fifth in the electrification series, comes when abnormal below indiarubber, which is 15th in the series.

The foregoing experiments show that (*a*) glass when heated has its surface so transformed that it descends in the series from its usual high place to one at least below indiarubber. (*b*) The effect is superficial, being found after fusion of the material as a whole, and also after the glass is warmed slightly in a flame; though, no doubt, in the latter case, the surface layers are subject to high temperature and great strain. (*c*) The effect does not pass away by immersion in water or if the surface is breathed on, or (*d*) by contact with the air for a week or two.

Vitreous Silica/Silk.—The after effect observed in glass is more pronounced. In all the following pairs the substance placed first becomes abnormal after passing through the flame: Ivory/silk, wood/indiarubber, copper/indiarubber, copper/brown paper, steel/indiarubber, lead/indiarubber, brown paper/sealing wax, gas carbon/indiarubber, slate/indiarubber, vulcanised fibre/silk, and ebonite/indiarubber. Of some 18 pairs tested only one failed to give the abnormal effect. This was indiarubber/sealing wax. But rubber was the softest substance used, and the general law is that hard substances show the effect well and soft ones ill. Probably the effect occurs in rubber, but can only be observed by more delicate means. All substances when abnormal stand below indiarubber in the electrification series. In making these observations some general precautions are to be observed: (*a*) Many of the substances conduct more or less well. These must be mounted for a short length in a tube of glass or silica to avoid conduction and induction of the hand. (*b*) When the abnormal effect is slight, care is required to observe whether a downward movement of the gold leaf is due to charge on the rubbed body or is merely an induction effect by it. When in doubt the leaf is used discharged. (*c*) In many cases the charges are only producible by *lightly* brushing one solid by the other. Thus the — charge, when abnormal metal is excited by rubber, can only be produced in this way.

As to the cause of the abnormal effect. It cannot be attributed to any organic substance deposited by a flame, since the effect is producible without flame. It cannot be due to the removal of a layer of condensed water vapour, since after immersion in water the effect remains on the surface. Nor is it due to the deposition by flame of water on the cold surface, since flame is not necessary. Again, it seems unlikely to be caused by removal by heat of the air film, since it remains on the surface 12 days or more after the time of production, the solid being in the air during the whole time. If, then, the effect is not due to a layer *on* the surface of the solid, we must regard the surface layers of the solid as the seat of the action. Whether in producing the effect the solid be surrounded by air in a furnace or by flame, there must be sudden great agitation and subsequent strain imposed on the surface layers of molecules. Under these circumstance, the surface readily produces — when excited. The process of rubbing, especially in the case of soft bodies, would relieve the state of strain and the surface would be restored to normal. Any closer conjecture would seem out of place at present. One or two tests were applied as to the surface action. (*a*) The orientation of surface atoms in the magnetisation of steel might have some relation to the strain effect under consideration. A strong magnetic field was applied to a steel bar both when normal and abnormal. The bar was also subject to repeated reversals of field. But no change seemed to occur in any case. (*b*) It was thought that sudden lowering (like sudden raising) of temperature might

* Abstract of a Paper read before the Physical Society.

have an effect on the surface layers, causing the body to rise or fall in the electrification series. The lowest available temperature was that of freshly-prepared liquid air. This seemed to have no influence on silica, glass, brass or sealing wax, whether these were normal or abnormal. But this lowering of 200 deg. is small compared with the rise, 1,600 deg. in the case of a bunsen flame, so the negative result here may merely indicate that the shock is not severe enough. One objection to cooling the solid is that water vapour soon condenses from the air on the surface, and this freezes and thus alters the conditions for rubbing.

The author has added the following to the original Paper:—

A glass rod was raised in temperature slowly to dull redness and slowly cooled (say in two hours) to ordinary temperature. It was then found to be abnormal. The annealing here attempted may be imperfect, but if the best possible annealing leaves the substance "abnormal" we shall have to reverse the terms normal and abnormal as used above, since the annealed state must surely be the normal one and the state attained after rubbing would be abnormal or strained. With a view to removing the surface layers, hydrofluoric acid was applied to an abnormal glass rod. After washing in water and wiping, the glass surface was slightly abnormal. From this it might seem that the layers of glass under the surface are always abnormal. This we should expect from the experiment immediately preceding. But the result appears nugatory for two reasons: (1) A foreign substance which acts chemically on the surface upsets all the conditions. (2) The acid etches and roughens the glass surface, and it is well known that "rough" glass is in general negative to silk.

As a further test on the after effect mentioned above, a glass rod was made abnormal, then thoroughly normal—*i.e.*, it was not possible to get any after effect in the usual way. It was then put aside for several days. It was then found to be normal still. Hence we see that the normal and abnormal states are both stable if well established, but that there is an uncertain intermediate state. As one result of these experiments we obtain a rule for discharging charged surfaces: Place the charged surface some distance, say 15 cm., above or at the side of a flame, *never in* the flame, and keep it there for a few seconds only at a time. If the body be kept in the flame for a second or two, or be kept over the flame for a minute or two, it will be discharged, but it will also be abnormal.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The [illegible] of the specifications recently published have been specially [illegible] Messrs. Marks, Clerk, Maclean, Ellis & Pryor, Chartered Patent Agents, 70 and 72 [illegible], London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1913 Specifications.

[illegible]

1914 Specifications.

4,[illegible] [illegible]

4,131 [illegible]

track a wave wire or conductor from which electromagnetic waves or pulsating magnetic fields are caused to emanate, and in which the track is divided into block sections, to which sections are allotted independent wave wires with a detecting device or devices on the train so arranged that, if danger is indicated in a block, and the train proceeds against this indication, a second brake application is made to prevent entry into the next block if a train is in that block.

4,542 Greville. Electrically-driven pendulum contact makers and breakers for the control of currents for electromedical purposes. (Addition to 11,274, 13.)

4,758 Cclby. (Wizard Electric Lamp Co.) Electric lamp stand.

6,424 Scott. Electrically-operated steering gear and analogous apparatus.

The provision in electrically-operated steering and analogous apparatus of means whereby the substantial current which passes through the legs of the Wheatstone bridge and the armature of the auxiliary motor is used to operate (through a controller worked by the auxiliary motor) contactors which operate the switch-gear controlling the main motor, and cause it to turn in one direction or the other.

7,218 Betullander Automatic Telephone Co. & Bryant. Electrical impulse transmitters and the like.

7,311 Weissmann. Means for supporting electric incandescent lamps. (31 3 13.)

[illegible] by said perforator and transmitter independently [illegible]ting to stop the action of said transmitter when

[illegible] to load the main lines at branches of the duplex lines, whereby

10,516 Campbell. Electric safety control apparatus for steam engines and other prime [illegible]

[illegible] Manchester & [illegible] Electric [illegible] controllers.

20,308 Ester & Co. & Strohmenger. Apparatus for converting electric currents.

Rotary commutator apparatus for converting direct current into alternating current, wherein a condenser is connected across the terminals of the alternating brushes which supply current to the load circuit, in which a resistance in series is [illegible]

23,495 Gmur-Zehnder. Electric resistance furnaces.

[illegible]

767 McColl. Door lock and contact for electric elevators. (23 1 14.)

1,376 Negus & Negus. Electric cooking ovens. (Divided application on 9,213 14, April 14.)

[illegible]

APPLICATIONS FOR PATENTS.

*Note.—The [illegible] Applications [illegible] marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

March 22, 1915.

4,483 Dehn. (Schweitzer & Conrad, U.S.) High tension protective device.*

March 23, 1915.

4,495 Lunnis. Frame and cover for motor cars, motor omnibuses, trams and like vehicles.

4,524 Damey. Electric candle lamps.

4,[illegible] [illegible] Electric [illegible]

(23 3 14, U.S.)*

4,561 Igranic Electric Co. (Cutler-Hammer Mfg. Co., U.S.) Electric switches.*

March 24, 1915.

4,564 Hornby. Electric motors.

4,567 Zeiss. Telemeters. (11 4 14, Germany.)*

4,575 Cowper-Coles. Electrolytic process for the production of iron tubes, sheets and the like, with an incorrodible surface.

4,576 Cowper-Coles. Electro-deposition of lead.

4,577 Cowper-Coles. Electro-deposition of iron.

4,582 Smith. Telephone systems. (25, 3 14, U.S.)*

4,585 Bowden & Thompson. Protection of electric cables.

4,588 Kamm. Rheostats.

4,595 B.T.-H. Co. & Wedmore. Protection of alternating-current electric systems.

4,600 Hearn. Electric heating element for kindling.

4,604 Field, Fortescue & Gossling. Receiving instrument for wireless telegraphy.

4,615 Perrino & Sesti. Purification of tungsten and tungsten compounds.

4,625 Perreur-Lloyd. Production of zinc by electrolysis. (28 5 14, France.)*

March 25, 1915.

4,658 Cowper-Coles. Electrolytes for the electro-deposition of zinc.

4,663 Rose & Rose. Electric torches and other forms of electric hand lamps.

4,664 B.T.-H. Co. & Young. Magneto-electric machines.

4,675 Sterling Telephone & Electric Co., Bell & Barclay. Mine and other signalling systems.

4,681 Perreur-Lloyd. Electrolytic production of metals. (28 5 14, France.)*

4,696 Lamkin. Sparking plugs for internal-combustion engines.

March 26, 1915.

4,706 Cowper-Coles. Coating metallic articles with lead.

4,719 Walker & Smith & Coventry. Magnetic clutches.

4,722 Rolinson & Wilson. Arc lamps.

4,728 Kerr. Railway and like signalling.

4,736 Henderson. Application of radio-active ores and substances as fertilisers [illegible] plant life.

4,738 B.T.-H. Co. & Wedmore. Protection of alternating-current electric systems.

4,747 Igranic Electric Co. (Cutler-Hammer Mfg. Co., U.S.) Electric motor controllers.*

4,748 Radley. Circuit controllers. (30 3 14, U.S.)*

March 27, 1915.

4,761 British Insulated & Helsby Cables & Brotherton. Electrical cables, especially applicable to cables having a protective sheathing of rubber.*

4,766 Ellison & Ordnance Accessories Co. & Etchells. Electric switches.

4,788 Gramm. Power transmission mechanism.

4,795 Kapp. Phase advancers for dynamo-electric machines.

March 29, 1915.

4,808 Crosbee & Sons & Spicer. Sparking plugs and manufacture of the same.

4,812 Soutter. Electrically-heated kettles and analogous vessels.

4,835 Wood. Magneto generator-operated telephone bell signals.

4,849 Gottschalk. Apparatus for electrically-detecting vibrations.*

4,862 Rivers-Moore. Electric oscillating systems. (Addition to 1,649 10.)

March 30, 1915.

4,885 Broughton. Means for connecting electrical conduits to their fittings.

4,895 Duca, Naldini, Massavelli & Bellone. Combined electric lighting and starting apparatus for motor vehicles.*

4,896 Sharp. Electric switches as applied to stop motions on textile machinery.

4,911 B.T.-H. Co. (G.E. Co., U.S.) Electromagnetic switches.

4,912 Tigerstedt. Transmission of sound waves. (30 3 14, Germany.)*

March 31, 1915.

4,949 Field. Magnetic compasses.

4,953 Smith. Sound-magnifying appliance for telephonic and telegraphonic purposes (18 4 14, U.S.)*

4,955 Clark. Apparatus for obtaining unidirectional electric currents from sources of alternating electric currents.

4,967 Dobie. Emergency electric lighting system.

4,978 Jobl, sen. Pipes and electrical conduit fittings.

4,987 Wessel. Hot-wire alternating-current limiters.*

4,999 Mordey. Electrical welding.

5,001 Igranic Electric Co. (Cutler-Hammer Mfg. Co., U.S.) Electric motor controllers.*

5,002 Igranic Electric Co. (Cutler-Hammer Mfg. Co., U.S.) Regulating electrical circuits.*

5,007 Landis & Gyr Akt.-Ges. Spring arrangement, especially for use in electric con[illegible]

[illegible]

5,061 Hall. Electrical circuit fittings.

[illegible]

5,079 Bohn. Dynamo-electric machines.*

5,088 Shibko. Metering in telephone systems.

5,089 Sterling Telephone & Electric Co. & Ward-Miller. Telegraph key.*

5,104 Igranic Electric Co. (Cutler-Hammer Mfg. Co., U.S.) Electric motor controllers.*

5,106 Mond. Electric heaters. (Soc. Anon. Electrocalor, Switzerland.)

April 3, 1915.

5,145 Yates & Miller. Signalling apparatus.

[illegible] railways.*

April 6, 1915.

[illegible]

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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NEIGHBOURLY POWER STATIONS.

The site selected for the majority of electric power stations is usually in a low part of the town, adjacent to what was once a crystal river and within sight and sound, and smell, of the local gas works. There are very few electricity works, large or small, in these islands of ours which might, even by a powerful effort of imagination, be considered as placed in idyllic surroundings. The very few exceptions are small hydro-electric plants and country house installations. As one travels up and down the country by train one occasionally sees a wayside station with flower beds near the platform and creepers and ferns about the walls and buildings. We cannot think of a single power house in an industrial district which has a square yard of ground about it which could be laid out as a landscape garden. There are some stations run by municipalities and power companies which occupy extensive sites, upon which something in the nature of miniature garden cities could be laid out. Unfortunately, there seems to be no particular incentive to the management to pursue such a course. They remain satisfied that the station turns out so many hundreds of thousands or million units per annum, that the duties of the staff keep them within the confines of the works, and that they are able to reside in more or less congenial lodgings anywhere within easy call of the station. Tendencies in power-house design are, however, towards the pattern of station which employs considerable numbers of men, and a distinct problem is presented in providing quarters for these operators. Our American friends look a little more ahead than British engineers do in these matters, even at the expense of technical and engineering considerations, and practice in the States has proceeded along the line of the large power station for some years past. Closely identified with this movement are the commercial, and what are described as the human, elements, which are regarded as being of equal, if not of greater, importance than technical and engineering details. We judge this to be the case from an interesting illustrated article which appears in the "Electrical World" of April 10th, which appeals both textually and pictorially for "good neighbourliness" in power-house location. Specific reference is made to the work of the Commonwealth Edison Co. in the lay-out of its mammoth North-West Station, a plant of exceptionally large capacity. We quote the following passage from this article :—

> It is only natural when a corporation of reputed wealth and power apparently gives up its entire thought and purpose to administrating a system of commercial exploitation to which the people all pay tribute that the public should subconsciously rebel and that antagonistic sentiment should breed and grow. But if the visible character of that corporation is distinguished most by human qualities, what a difference it does make! If this corporation takes its natural place among the other factors in the life of the community, and plays the part of a good neighbour, how soon the public recognises and approves.

A publication issued by the company has prompted this outburst, and, although every allowance must be made for the peculiar local conditions, there can be no denying that the action of the company suggests a peep into the future at what will undoubtedly be the arcadian power house. The illustrations, which at the moment we are unable to reproduce, show how Nature has been called in to clothe the site of the power house and make it a thing of beauty and a joy for ever. By comparison with the works and sites upon which gas is generated, the electric power house presents possibilities for "natural treatment" which can under favourable circumstances be made to represent a distinct commercial asset to the undertaking. The electric service essentially stands for cleanliness of the atmosphere as well as of the immediate surroundings of the power plant. Evidently American engineers do not despair of applying the horticultural touch to city stations, and the article to which we make reference above concludes with the following admonition which we earnestly recommend to the attention of those in charge of British undertakings :—

> The principle is everywhere the same. The opportunity stands awaiting every central station that is eager for a better public existence. Let it demonstrate the spirit of good neighbourliness by the natural beautification of the station and the right of way. Unnecessarily obtrusive pole lines, unrelenting expanses of bare cinder yard, and offensive junk piles and dump heaps have never won a friend for any company. But lawns and flower beds and vines and eager effort to protect your neighbour's property and peace of mind, by making all your system just as inconspicuous as possible—these are things that do make friends. Money invested here pays dividends in comprehensive public interest and appreciation.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week April 12, 1915, *to April* 17, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]

Carbon candles, £762; elec. machinery, £582; elec. lamps, £150; telephone material, £1,690; wire and cable, £89; unenumerated, £393. *Canada:* Elec. lamps, £220. *Denmark:* unenumerated, £185; *S. Australia:* wire and cable, £49. *Holland:* Elec. lamps, £2,795—486 pkgs. *Sweden:* Elec. machinery, £614. *France:* Carbon candles, £420; elec. lamps, £27; unenumerated, £58. *Italy:* Wire and cable, £7,390; carbon candles, £159; elec. machinery, £119; unenumerated, £993.

LIVERPOOL.—*Spain:* Elec. carbons, 54 pkgs. *U.S.A.:* Unenumerated, £268.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Wire and cable, £165; unenumerated, £401. *Melbourne:* Elec. machinery, £3,047; wire and cable, £120; unenumerated, £638. *Sydney:* Telegraph material, £86; wire and cable, £464; unenumerated, £864. *Wellington:* Wire and cable, £404; unenumerated, £1,380. *Adelaide:* Elec. machinery, £20; wire and cable, £1,682; unenumerated, £399. *Brisbane:* unenumerated, £105. *Freemantle:* Unenumerated, £52. *Dunedin:* Elec. machinery, £10; wire and cable, £108; unenumerated, £712. *Christchurch:* Elec. machinery £776; unenumerated, £755. *Perth:* Unenumerated, £165. *Lyttleton:* Unenumerated £106. *Nelson:* Telegraph material, £33.

AFRICA.—*Durban:* Elec. wire and cable, £22; machinery, £145; unenumerated, £644. *Port Elizabeth:* Wire and cable, £29; unenumerated, £216. *Cape Town:* Machinery, £698; telegraph poles, 9 tons; wire and cable, £75; unenumerated, £466. *Napier:* Unenumerated, £30. *East London:* Elec. machinery, £289; telegraph material, £59; wire and cable, £47; unenumerated, £205.

Freetown: Unenumerated, £95. *Alexandria:* Elec. machinery, £210. *Aden:* Unenumerated, £22. *Port Soudan:* Elec. machinery, £92. *Mauritius:* Telegraph material, £30.

PORT SAID.—*Seconde:* Unenumerated, £102.

GIBRALTAR.—Unenumerated, £47.

ITALY.—*Leghorn:* Unenumerated, £23.

RUSSIA.—*Petrograd:* Unenumerated, £72.

SPAIN.—*Huelva:* Unenumerated, £225. *Valencia:* Elec. cable, £635.

[illegible]

CHINA:—*Hong Kong.* Unenumerated, £133.

INDIA, CEYLON AND INDO-CHINA.—*Bombay:* Elec. machinery, £31; wire and cable, £363; unenumerated, £405. *Calcutta:* Telegraph material, £29; wire and cable, £108; unenumerated, £429. *Madras:* wire and cable, £19; unenumerated, £47. *Karachi:* Unenumerated, £117. *Shanghai:* Unenumerated, £1,068. *Port Swettenham:* Wire and cable, £45. *Kilindini:* Unenumerated, £45. *Sourabaya:* Unenumerated, £30.

CANADA.—*St. John's:* Telegraph material, £86; unenumerated, £25. *Montreal:* Unenumerated, £447. *Vancouver:* Elec. machinery, £26.

NORWAY.—*Christiana:* Wire and cable, £78; Unenumerated, £88.

SWEDEN.—*Gothenburgh:* Elec. machinery, £312; unenumerated, £77. *Stockholm:* Wire and cable, £398; unenumerated, £82.

FRANCE.—*Dieppe:* Unenumerated, £29. *Treport:* Elec. machinery, £72. *Rouen:* Unenumerated, £61; *Paris:* Unenumerated, £21.

SOUTH AMERICA.—*Buenos Ayres:* Unenumerated, £89. *Batavia:* Wire and cable, £103; unenumerated, £161. *Valparaiso:* Unenumerated, £48. *Savarilla:* Telegraph material, £394.

GREECE.—*Piræus:* Wire and cable, £37.

[illegible]

FOREIGN GOODS DUTY (paid and free).

Bombay: Unenumerated, £21. *Sydney:* Unenumerated, £1,548. *Wellington:* Unenumerated, £472. *Brisbane:* Unenumerated, £829. *Melbourne:* Unenumerated, £53. *New York:* Unenumerated, £220. *Hong Kong:* Unenumerated, £64.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

ELECTRIC POWER TARIFFS.

At the last meeting of Bedford Corporation the Electricity Committee reported that the special agreement with Messrs. W. H. Allen, Son & Co. for the supply of electric current came to an end on Jan. 31, and that it had been extended by mutual consent to March 31.

The Committee submitted two reports by the borough electrical engineer (Mr. R. W. L. Phillips), dated March 5 and 19, upon the subject of the price to be in future as covered with Messrs. Allen, and they stated they were advised that any alterations made in the tariff for the supply of current should be fixed for all manufacturers in the same category as Messrs. Allen, and they suggested that the charge to manufacturers taking current up to and above 300,000 units be as set out in the proposed tariff. They recommended that the tariff for lighting and also for power, heating and cooking purposes should remain at 1d. per unit, but that for power and lighting combined, manufacturers taking 300,000 units and above per annum be charged ½d. per unit, subject to a scale of discounts if account be paid within time limit stated (approximately one month), varying from a deduction of 2 per cent. for a load factor of 12 per cent. or over, to a deduction of 20 per cent. for a load factor of 20 per cent.

In his last report Mr. Phillips said that the power and heating business had grown from nothing in 1906 to 1,646,634 units per annum in 1914. During that period the capital expenditure amounted to £31,825, but the capital debt had decreased by £1,435. Of that amount £12,500 was attributable to power and heating consumers, and £19,325 to lighting consumers. During the same period the loan instalments and interest had increased by £1,882 per annum, of which £740 was attributable to power and heating consumers, when divided pro rata to the principal spent on each. For that expenditure the amount of new connections secured was: Increase in lighting connections, 1,458 kw.; increase in power connections, 1,779 kw.; total increase, 3,237 kw. Therefore the lighting connections had cost £13 2s. per kilowatt, and the power £7·03 per kilowatt. The increased revenue from those sources was: Lighting, £1,380; power, £6,044; total, £7,424 per annum. The increased works cost of supplying the power units amounted to £4,310 per annum, leaving a gross profit on the supply of £1,734, which, after deducting £740 for capital charges, left a net profit of £994 per annum attributable to the power and heating business. He had carefully worked out the additional cost of supplying Messrs. Allen's premises when operating under conditions that would secure their highest discount—viz., 20 per cent. Proportion of fixed costs at works, £194 per annum; works running cost of supplying 613,250 units, £1,276 per annum; total, £1,470 per annum. The revenue for 613,250 units at 0·8d. was £2,040 per annum, leaving a gross profit of £570 to meet the proportion of capital charges allocated to the service, which amounted to £260 per annum. In order to demonstrate why that source of revenue was so profitable he had had prepared curves showing the working of an average day at the works, and that proved that whenever the demand fell the cost of production increased. The value of having a supply that was maintained for many hours a day, as against a supply that was only maintained for a short period during the day (such as the lighting consumers) was clearly shown by the curves. Not only were these extra units cheap to supply, but they reduced the cost of supply of all other units. In his second report, Mr. Phillips said that in electricity supply the standing costs increased year by year as connections increased—or with the maximum demand expected—and the running costs varied with the number of units sold. The standing costs depended upon the maximum productive capacity of the factory. In electricity supply the article was consumed in the same instant that it was produced, and it was not possible to level the rate of production by making up stock during a slack time and supplying from stock during a busy time; hence the productive capacity must be increased with the obligations undertaken. Again, it was compulsory to keep the generating station at work for 24 hours every day throughout the year. Lighting consumers made a demand which was practically simultaneous; consequently, a certain increase in plant was required for every lamp connected, and the plant, labour and other establishment charges incurred for lighting were only utilised for from 3 per cent. to 12½ per cent. of the total time they could be utilised, and the undertaking was earning nothing for the balance of the time; but it must keep running. It followed that nearly all the annual costs were standing charges; in fact, on a purely lighting supply those were from 85 per cent. to 90 per cent. of the total. For the first 10 years or so their undertaking catered for a lighting load only, and it was found that the revenue barely covered the standing charges which were being built up rapidly each year to meet obligations, and each year a loss resulted. The specific cost of plant in those early days was very high and a large amount of the capital so spent was now a dead load. By strenuous economies, and by replacing uneconomical plant both at the works and in the sub-stations, during the next few years, it was possible to make the revenue meet all charges, with a small carry over; and he said, without hesitation, that had the conditions that obtained up to 1908 been maintained it would still have been possible in Bedford to continue to make a small profit on a purely lighting load. But it must be fully realised that, as 90 per cent. of the cost of supply was fixed, it needed only a small economy on the part of lighting consumers to bring the revenue below the cost—a partial changing of 16 c.p. lamps for 12 c.p. lamps would do it. After 1908 the effect of the metal filament lamp was felt, and in 1909 the lighting revenue again failed to cover the standing charges incurred. In 1909 the lighting revenue was £879 lower; in 1910, £1,183 lower; in 1911, £1,371 lower; and in 1912, £679 lower than that obtained in 1908. It was not until 1913 that the lighting revenue reached, and only slightly exceeded, that obtained in 1908. He did not think that the effect of the metal filament lamp was fully realised. If the 1908 conditions had maintained for the succeeding six years, and not another consumer connected, the lighting revenue would have been £2,796 (or an average of £466 per annum) more than it actually was; and, if the rate of increase for the four preceding years had been maintained, the lighting revenue would have been over £11,196 more (or an average of £1,866 per annum). Standing charges, when once incurred to meet certain obligations, could not be materially reduced, and, as those had been increased to meet the 1908 conditions, it was obvious that the bad years' trading that followed was entirely due to the failure of the lighting revenue. The worst power consumer began where the best lighting consumer left off—*i.e.*, his load factor was anything between 13 per cent. and 100 per cent., usually varying between 13 and 35 per cent. Consequently, any increased standing charges incurred in meeting the demand of a power consumer were productive for three times as many hours per annum as those incurred in meeting the lighting consumer's demands, and the whole economy of the plant improved by longer running hours. The result of the eight years' working if there had been no power consumers, would have realised a deficit of £4,621, instead of a surplus of £855. The misapprehension that had arisen—viz., that the bad years' trading was due to the loss on power supply, was entirely due to the fact that the early growth of the power business happened to coincide with the introduction of the metal filament lamp. If the power business had been larger the losses would have been covered, and, providing the power business still further developed, he was confident that if any further improvement was effected in the make of lamps, any consequent falling off in revenue from lighting would not have been nearly so serious an effect on the accounts. The terms which he had recommended the Council to offer Messrs. Allen left a net profit beyond which he understood a municipality ought not to go. From his negotiations he had formed the opinion that Messrs. Allen were in a position to refuse any higher terms. If that custom were lost to the undertaking the standing charges incurred became a dead loss, and the effect on the economy of

production would be such that any profit on the coming years' working would be problematic.

The chairman of the Committee (Ald. KILPIN) said the report had been very carefully considered by the committee on several occasions, and as the electrical engineer had gone into the matter very fully, he contented himself with formally moving its adoption.

The MAYOR said he thought the Committee's proposal was a very bad business proposition. The recommendation would leave no profit to the concern, and must eventually, if pushed for any considerable time, lead the undertaking into serious trouble. It was essentially an undertaking to provide light to the town. The supply of power was not an essential business, but if it paid them to supply it they ought to supply it for the benefit of the ratepayers. But the price proposed was such a small one that he could see nothing except loss on it. Over £4,000 was charged for public lighting, and that was based upon nearly 3d. per unit more than any other town of the same size. If they took even one-third off that £4,000 that would do away with the whole of the profit shown in the balance-sheet. Then something like £700 or £800 was put down for power at the sewage works. They paid 1d. net per unit for it, and if their departments paid 1d. net for it why should not other people? The question was not whether it was Messrs. Allen or anyone else (and he was sorry their name had ever been mentioned), but of making the concern a paying one. In Bedford they were generating 2,421,000 units, and at Chester the total was 2,372,000; but in Bedford they were charged for lighting 5d., and in Chester 3½d. In Bedford 1d. was charged for power, and in Chester 1½d. and 1d. was charged. He moved as an amendment that the price for power to all persons should be 1d. per unit subject to a cash discount of 5 per cent. if paid within a month. He proposed further that the ordinary unit charged be 5½d. for lighting.

Ald. KILPIN put in figures which showed that profit on the street lighting was only 0·363d. per unit.

Mr. DEACON seconded the amendment, and said the proposal was to lose a half-penny on every unit of power, and to make it up on the general lighting, so that the public had to pay an extraordinary price for public lighting.

Mr. SOWTER supported the Committee's recommendation, and congratulated the engineer upon his interesting report. He claimed that the profit on power supply for the year was £994. In Messrs. Allen's last year they consumed 613,250 units, which at 0·8d. per unit came to £2,040. The expenses were: Generation, £1,276; works cost (pro rata), £194; repayment of capital, £260; total, £1,730, leaving a profit of £310, or 18 per cent. This would be considerably improved under the proposed schedule of charges, as the load factor was for the whole time they were taking the power, whereas at present they took it for a few hours per day only. There would be a further gain in the reduction in the cost of producing other units of 0·24d. per unit. They generated 2,000,000 units per year, and that at 0·24d. brought them to £2,000, plus that £310, or 122 per cent. He had been at considerable trouble to ascertain from various other corporations at what rate per unit they would supply energy if they had a consumer like Messrs. Allen, based on a 20 per cent. load-factor. He submitted the letters, and in every case they said they would supply the energy on the suggested terms if they had the application. All authorities made special terms for large consumers. It might be argued that Messrs. Allen should pay extra for light as something separate from the power, but they could manufacture their light and power with their own engines. The more the Council had of such large power consumers the cheaper it would be to the ordered ing. He thought the street lighting was also a matter which needed clearing up. The charge was 3½d. in round figures, of which the greater part was made up of capital charges, interest and taxes. Why was it necessary for Bedford to have such a large capital on the street lighting? The fact remained that in the early years of the undertaking they ran duplicate high and low-tension cables for the whole town, with transformers, because the former engineer thought it would be better to have control of the street lighting at the electricity works, and the result was that sufficient copper lay in the streets of Bedford to fill the German emperor with envy. The engineer had stated in committee several times his opinion that they were charging too much for street lighting, but the matter had been gone into, and in the revised estimates [illegible] that the committee did not make the slightest profit on the street lighting or the sewage pumping. Next year the town would benefit to the reduced charge to other committees, and he hoped that before long, owing to the improved plant and less cost of generation, the lighting consumers would benefit.

Mr. J. F. WALKER said that if the Council did not accept the report of their engineer they would probably lose their best customer, and have to make up the deficiency out of the rates.

Mr. AUSTIN said he had seven or eight years' experience of electric lighting at Luton, and the engineer there had explained to him why the present recommendations should be carried into effect.

Mr. HOCKLIFFE said the mover and seconder of the amendment had not called in question one single paragraph of their engineer's report, and he therefore did not feel any confidence in the position which they had taken up. He had no hesitation in supporting the recommendation.

Ald. KILPIN said the cost of coal was 0·346d. per unit consumed, and 1·543d. last year, due to the improved conditions of generation. During the 10 years their engineer had been with them he had prepared some important reports and suggested great alterations which promised certain economies, and every one of those reports and every estimate of saving had been effected by putting down plant, had been more than fulfilled. That had occurred four or five times; he had remodelled the undertaking and made a betterment of £6,000 a year. In the [illegible] there would be £1,900 profit after paying to redemption, [illegible] compliment to the engineer, after giving his best services for 10 years, [illegible] which his reports had always been borne out, not to place confidence in his recommendations.

The MAYOR said everybody appreciated the ability of the engineer and the Town Clerk. He had known the Town Clerk [illegible] and the Council not take it, but that did not imply a vote of censure.

The amendment was then put and lost by 10 votes to 8. [illegible] amendment to the effect that an expert be called in to report fully on the electricity undertaking was also defeated by 10 to 8, and the original proposition was then carried.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.

The annual report for the year ended December 31, 1914, presented at the annual general meeting on Monday, states that the total income was £3,379. 14s. 2d. (compared with £1,362. 18s. 9d. in 1913), or £3,470. 3s. 10d. including £90. 9s. 8d. for sale of tickets at annual dinner and contribution towards same. Out of this, £2,806. 13s. has been invested in stocks, making the total of the invested funds £7,727. 1s. The receipts included £1,353. 11s. by subscriptions, £1,785. 19s. 1d. by donations and £225. 6s. 7d. by dividends on investments. The amount paid out for temporary relief was £252. 13s. (compared with £153.14s.); employment was found for many applicants. Secretary's salary and commission and office expenses amounted to £179. 2s., and the annual dinner cost £100. 6s. 2d.

Mr. E. GARCKE, who presided, in proposing the adoption of the report and accounts, reviewed briefly the figures in the report and said: The income is the largest received in any year, mainly due to the magnificent efforts made by Mr. Hirst and his friends. The present methods of raising funds consist in obtaining subscribers, donors, members and bequests. The subscriptions and donations are collected mainly by means of the annual festival and to some extent by means of collecting books entrusted to employés of large firms. The roll of membership increases very slowly, there being only about 170 members at present, an increase of 60 over 1913. No estimates can be made of the amount likely to be received in future from bequests. So far only one bequest of £100 has been received.

Viewed from the standpoint of the objects of the Institution, it is difficult not to agree with the criticisms which have come from various directions to the effect that the results achieved by the Institution fall very far short of what is desirable and should be possible; but it is only during the last three years, since Mr. Hawes accepted the secretaryship, that there has been any systematic and sustained effort to increase the funds of the Institution. It is quite impossible for this Institution to relieve even a small part of the distress which exists. Our efforts, therefore, are not confined to making gifts of money, and the work done by the Institution cannot be expressed in figures only. The objective of the Committee is always to so assist those in need that they may be able to obtain new appointments or more permanent relief in other ways. The proportion of our expenses to our income is improving. The dividends and interest received last year amounted to £240 and the grants to £252. If, therefore, we take as a basis for our future estimate the figures for the past two or three years, I should have to live another three score years before I could enjoy the prospect of being accommodated in the Institution almshouses, and it would take at least two centuries before any child in the electrical industry could be offered the shelter of an [illegible]. The Committee are always considering new suggestions for raising funds. The two most obvious suggestions are that electrical firms should be asked to become regular annual subscribers, and that everyone who is engaged in the industry should become a member of the Benevolent Institution. There are 5,000 or 6,000 electrical firms in this country, and if each firm subscribed £5. 5s. per annum, or even only £1. 1s. per annum, we should have a substantial income; better still, if everyone engaged in the industry became a member of the Institution, and paid 10s. per annum, or even only 5s. per annum, we should soon be in a position to give relief to everyone in distress and to promise a moderate pension to everyone in need of it. The suggestion has been put forward whether the best course would not be to restrict the benefits to such persons as have been members of the Institution continuously for, say, at least five years, the rule to this effect to come into force, say, six years after the date of its adoption. That would give us a decided leverage in our propaganda to secure members. Another suggestion is that electrical men should agree to make a collection after every staff dinner or public banquet. One other suggestion, for which I think I am responsible, is that the directors of the electrical companies should ask their shareholders' permission to make a deduction of, say, 1d. in the £ from every dividend paid as a contribution to the Benevolent Institution; but I recognise that it would not be right to ask this unless the men engaged in the industry themselves show sufficient interest in the Benevolent Institution to become members. That our charitable instincts are capable of being roused is shown by the splendid responses made at recent festival dinners to the appeals made by Mr. Sutton and Mr. Hirst.

Mr. JUSTUS ECK (Chairman of the Committee) seconded the resolution, and said it had recently been impossible for many to set aside the usual amount for a rainy day, because salaries had been reduced. Then they had the great rise in all living costs. The large number of grants they had made [illegible] of their utility. About three-fourths of the recipients of those grants had been assisted to [illegible] employment—certainly employment for a series of years—and the other one-fourth [illegible] people who could not [illegible]

through ill-health. The report showed that they had received donations of £100 each from Mr. Hirst, Sir David Salomons, Mr. Garcke, the General Electric Co. and the Osram Lamp Works.

The report and accounts were then adopted. The retiring members of the Committee of Management, Mr. E. J. Clark, Mr. Guy Burney, Mr. H. Bevis, Mr. H. H. Berry, Lieut.-Col. H. M. Leaf, Lord Vaux of Harrowden, Mr. F. J. Walker, Mr. R. J. Wallis-Jones and Mr. S. D. White were re-elected. (Mr. Clark had asked that he should not be re-elected, but it was decided to endeavour to persuade him to continue.)

Mr H Bevis [illegible] that the Benevolent Fund of the Institution of Electrical Engineers [illegible] month [illegible]

Mr Jesse Lock [illegible] proposed [illegible] Council [illegible] this year as usual, but it had been difficult to see the gentleman selected to preside.

Votes of thanks to Mr. Garcke, to the honorary auditors, Messrs. Price, Waterhouse & Co.), and to the honorary solicitors (Messrs. Sugden & Hextall) concluded the proceedings.

LEGAL INTELLIGENCE.

Worksop & Retford Brewery Co. v. Worksop Palace Co.

Last week Mr. Justice Eve heard a motion by plaintiffs for an injunction to restrain defendants from creating a nuisance by noise and vibration from their electric plant.

Mr. JESSEL, K.C., said his clients were owners of licenced premises adjoining the picture theatre of defendants, who had agreed to the injunction being made, and he asked the judge to treat the motion as the trial of the action.

His Lordship assented, and granted plaintiffs a perpetual injunction against defendants.

Prize Court Case.

On Tuesday Sir Samuel Evans continued the hearing of the case in which the Crown asked for condemnation of five cases of electric fans seized on board the P. & O. s.s. "Poona" in London on Oct. 17. The goods were claimed by Isaria (Ltd.), a company incorporated in England.

Mr. A. W. ELKIN, on behalf of the claimants, produced certain documents, including a duplicate of the agreement between claimants and Messrs. Lascelles, Parrington & Brasche, of Melbourne, appointing the latter their agents in Australia. The original was in Melbourne. He submitted that proved that Messrs. Lascelles, Parrington & Brasche were claimants' agents. He produced a bundle of reports from Mr. C. Brandt, claimants' traveller in Australia, and a number of commission notes between claimants and their agents.

The PRESIDENT said it rather looked from these documents as if the goods belonged to the claimant company, and that Messrs. Lascelles, Parrington & Brasche were only the agents for sale, and Mr. Brandt was the traveller. He would like to see the share register of the company.

Mr. J. B. ASPINALL (for the Crown) said he had a list of the shareholders dated July 18, 1914. There seemed to be seven shareholders, all German. He gathered that his Lordship was satisfied that these [illegible] were the property of the [illegible]

Mr. FRANK MORTON, manager of the company, stated that the document appointing him manager was signed by Mr. L. Schoenmann, the engineer and secretary, and by Mr. Carl Seiber, the commercial manager, on Aug. 3. They left the country on the night of Aug. 3, to the best of his knowledge. He thought they went to Germany, via Copenhagen. He had had no communication with any of the directors since he was appointed; he accounted to no one but the Board of Trade supervisor.

Mr. ELKIN submitted that Mr. Morton was properly appointed, and that having regard to the fact that the claimants were a duly incorporated company in this country they were entitled to the release of those goods, on the authority of the decision of the Court of Appeal in the case of the Continental Tyre & Rubber Co. *v.* Tilling.

The PRESIDENT said he was willing to pay all deference to a decision of the Court of Appeal, but it did not bind him in that Court. He might, after careful consideration, come to the conclusion that he might agree with Lord Justice Buckley's dissenting judgment.

Ultimately, his Lordship reserved judgment.

PARLIAMENTARY INTELLIGENCE.

Tramway Bills.

Last week the Rotherham Corporation and Sheffield Corporation Tramways Bills came before a joint committee of the House of Lords. The former sought powers to acquire compulsorily [illegible] of a tramway through Tinsley, which connects the Rotherham and Sheffield systems, and to prevent the Sheffield Corporation from running motor omnibuses in competition with the connecting tramway. The Sheffield Bill sought the compulsory purchase of the connecting tramway [illegible] to be leased and worked by Rotherham until 1926.

Mr. VESEY KNOX, K.C. (for Rotherham Corporation) expressed [illegible] Sheffield Corporation by an [illegible] to the [illegible] at Tinsley at halfpenny fares and to [illegible] the Rotherham tramways [illegible] should have adopted a revengeful policy towards its smaller and poorer neighbour. Sheffield have behaved in an extraordinary manner, and now proposed to annex a most valuable asset without compensation.

Ald. D. L. WINTER, chairman of Rotherham Tramway Committee, gave evidence, and said if an equitable arrangement could be come to, he thought it would be a very satisfactory outcome of the present proceedings for Sheffield to purchase the tramway, but he was opposed to their scheme on any other terms. No reasonable proposal had hitherto been submitted.

After hearing evidence the Committee decided to strike out the clause by which Rotherham Corporation sought to prevent Sheffield Corporation running motor omnibuses at halfpenny fares along the Tinsley route, and to allow the running powers over the tramways to continue, subject to the Board of Trade deciding the question of the running of motor 'buses. They also approved an agreement come to between Sheffield Corporation and the County Council, whereby the former engaged to pay the latter ¾d. per omnibus-mile for road maintenance in respect of the motor business service on the Swallows Nest and Aston-road routes.

On Monday it was announced that the parties had agreed upon the clauses.

Mr. LLOYD (for Sheffield) said the Bill would not take effect until the Royal Assent was given, but, as far as Sheffield was concerned, they were quite willing to start at once. The removal of the proposed purchase clause meant certain delay and adjustment of clauses, and those would go before the Lord Chairman of Committees, who would make the necessary amendments. The clause for the protection of Rotherham Corporation provided for the adaptation and maintenance of the tramways, the Sheffield Corporation would pay compensation for any obstruction and maintain the junction tramways, any difference arising under the section to be settled by arbitration. A new clause also provided for payment to the County Council by Sheffield Corporation of an annual sum equal to ¾d. per car-mile run by their motor omnibuses on the main roads towards the cost of maintenance, and should not be liable for any claim in respect of extraordinary traffic by reason of the use of such main roads by the Corporation omnibuses.

The Bills were passed by the Committee and sent on for third reading.

Metropolitan District Railway Bill.—This bill has been read a third time and passed in the House of Commons. The time for the completion of the Wimbledon and Sutton electric railway, is extended to July, 1918, in respect of the purchase of land, and to July, 1921, in respect of construction. The Bill confers capital and other powers on the Metropolitan District Railway Co., and additional powers are also conferred on the London and South Western Railway Co. in relation to their Wimbledon and Fulham line.

BUSINESS NOTICES.

It is announced that Messrs. Vickers (Ltd.) have acquired the Ipswich works of the Consolidated Diesel Engine Manufacturers (Ltd.) (in liquidation).

The telegraphic address of the Westminster Tool & Electric Co. has been changed from "Aphasite Cannon London" to "Westeleleo Cannon London."

The partnership between Alfred N., Arthur N., and J. Harold Price trading as Price, Powell & Co.), stoneware manufacturers, 39-46, St. Thomas-street, Bristol, has been dissolved so far as concerns Alfred N. Price. Messrs. Arthur N. and J. Harold Price continue under the same style and at the same address.

Osram Half-watt Lamps.—The General Electric Co. announce that Osram half-watt lamps are now known as Osram Atmos type lamps.

Government Contracts.—Notice is given in an advertisement that firms engaged in the manufacture of armament and munitions of war and requiring additional machinery are requested to communicate with Mr. George M. Booth, Room 367, War Office, Whitehall, S.W., giving particulars of the machinery, the purpose for which it is required and the date when it can be installed.

BANKRUPTCIES, LIQUIDATIONS, &c.

The examination of G. J. T. J. Parfitt, electrical engineer, took place at the Bristol County Court last week.

Debtor stated that he had filed an amended statement of affairs showing gross liabilities £4,973. 3s. 4d., deficiency £2,615. 14s. 9d., assets £1. He commenced business in 1888 with his brother as Parfitt, Webber & Co. They paid £320 for the business, and subsequently he and his partner put into the business further capital to the amount of about £2,600. In 1912 his partner went to South Africa, and the business was made over to the Gidson Electrical Works. In consideration he received £1,650 in £1 ordinary shares. He entered into a contract to supply electrical fittings, plant and buildings to the Bristol International Exhibition for the pageant. He made a loss of £24. 19s. 1d. on the contract and he owed £94. 18s. 7d. for goods in respect of it. He did not supply goods to the exhibition but his loss was for work done as consulting engineer. The main cause for his failure was the failure of the exhibition company, of which he was a director without fees or salary. He ha[illegible]

charge of the electrical installation, and exhibited and to take current from him. He held £750 first debentures, £710 second debentures and £271 ordinary shares. A judgment for £551 was obtained against him in respect of guarantees. Since the war began his trade had been cut off, and he estimated that he had lost orders to the amount of £2,500. Examination was adjourned until May 11.

A dividend is to be paid to creditors of Cecil Wray, mechanical and electrical engineer, formerly trading as 24, Simes-street, Bradford. Claims are to be sent to Mr. W. Durrans, 42, Drake-street Bradford, by May 1.

An application for the discharge of Jas. Wm. & Tom W. Tattersall, electrical engineers, Kimberley-rd., Walle-de-clame, London, N.W., will be heard on May 11, at Bankruptcy Buildings, London, W.C.

Claims against the Spanish National Submarine Telegraph Co. (Ltd.) are to be sent by May 31 to Mr. J. Jas. Jeffrys, 105, Cannon-st., London, E.C.

Claims against Consolidated Dust Exhaust Manufacturers (E.) Ltd. are to be sent by May 4, to Sir W. B. Peat, 11, Ironmonger-lane, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barrow-in-Furness. The L.G. Board have sanctioned a loan of £12,500 for extensions of the electric supply undertaking.

Bolton. An enquiry has been held into the application of the Corporation to borrow £45,032 for extensions of the electricity supply undertaking.

Clacton. A Local Government Board inquiry was held last week into the Council's application for sanction to borrow £1,300 for a new storage battery at the electricity works.

Dover.—An inquiry was held last week into the Council's application for sanction to borrow £6,000 for a 1,000 kw. turbo-generator, &c.

The TOWN CLERK stated that the debt on the electricity undertaking was £141,748, and he asked for a loan for 20 years. The price was based on the lowest tender from seven firms. The present plant consisted of two 400 kw., two 100 kw. and one 75 kw. generators. They anticipated a load of 600 kw., next winter if the war continued, and 680 kw. after the resumption of peace. Two sets (of 100 kw. and 75 kw.) which were to be taken out were valued at £1,000.

The INSPECTOR said £1,000 would have to come off the loan.

Newcastle-under-Lyne. As the L.G. Board have refused to sanction a loan of £1,250 for the extension of electric supply mains in three streets the Town Clerk has informed Callender Cable & Construction Co., that the Council were compelled to cancel their tender of £1,240 4s. 2d.

At last week's Council meeting Ald. MYOTT, chairman of the Electricity Committee, asked the Council to refer back the Committee's instruction. The tender was accepted subject to the sanction of the L.G. Board, but it would be a great mistake to cancel the tender. When they asked for tenders for the work the price of copper had fallen considerably, and they got tenders on the low price. Since then copper had advanced £20 a ton. The Callender Co. were prepared to adhere to the prices quoted in their tender, and to carry out the work when the war was over.

West Hartlepool.—The L.G. Board recently intimated that no further action must be taken in respect of [illegible] which had not then been acted upon without further sanction.

The Corporation have now applied for sanction to cover the necessary expenditure for extension of mains and services [illegible] and for the purchase of a water softening apparatus.

Wigan. Application has been made to the L.G. Board for sanction to a loan of £6,000 for the supply and [illegible] new boilers at the electricity works.

GENERAL.

Barking. On the recommendation of the [illegible] and Tramways Committee, the Council have decided to increase the charge for electric current for light and power [illegible] per cent., except those power users consuming [illegible] units per month, who will have to pay 5 per cent. extra. A minimum charge of 3s. per quarter will be made to [illegible] consumers.

Belfast. Last week a special meeting of the [illegible] was held to consider the following reference from the Council:—

That all the matters of the Tramways and Electricity Committee relative to the reorganisation of the [illegible] be deferred, and that the subject be referred to the Council [illegible] to be dealt with.

Ald. TYRRELL, chairman of the Tramways and Electricity Committee, addressed the Council at some length, [illegible] the first step to be organisation a change be made in the superintendence of the department.

The motion was seconded, but was defeated, 41 voting for and 43 against it.

After a long debate the matter was again referred to the Committee.

Dublin. On Monday the Corporation decided to form a Special Committee to inquire into and report upon the following subjects:

The whole question of the administration of the electricity undertaking; the prices charged for light and power; the number of engineers and workmen employed and paid out of revenue; the salaries and wages paid out of revenue; the procedure adopted with regard to purchasing coal; charges for interest and repayment of moneys borrowed. The Town Clerk is to act as Secretary of the Special Committee; the City Treasurer, Accountant, the Electrical Engineer (Mr. M. Ruddle), Mr. F. J. Allan and Mr. L. J. Kettle are to be present at all meetings if required, and are to prepare reports and produce all books as requested. The Committee will have power to consult any independent expert, if deemed advisable, and have authority to pay for any such services.

Dundee.—It has been reported to the Electricity Committee that the department is running the risk of being seriously hampered on account of the number of enlistments.

There have been 72 enlistments from the staff and many more were on the point of joining the Army. The Convener said Lochee sub-station had already been shut and if more men went away there would need to be further curtailment. It was pointed out that, in addition to the inconvenience which might be caused locally, the department might be unable to supply the current to the foundries and jute establishments now engaged on pressing Government work, and it was agreed to ask the Government for an exemption for the staff still at work.

Edinburgh.—The Electric Lighting Committee have settled their coal contracts for the current year.

For the M'Donald-road station 25,500 tons, and for Dewar-place 15,000 tons have been ordered, and the price shows an increase of about 4s. 6d. per ton, compared with 1914. This represents an increase in the coal bill for next year of £10,000.

Fowey. The Council have authorised Mr. Wenman to proceed with his scheme for the erection of electric lighting plant.

Mr. Wenman proposes to employ overhead wires on street poles for distribution purposes.

Grimsby. On Monday the Public Lighting Committee considered a report by the electrical engineer and manager (Mr. W. A. Vignoles) on "Business policy during the period of the war."

In his report Mr. Vignoles suggested that the load should be kept to the lowest limit, that no capital expenditure should be incurred except what could be met out of profits, that there should be no further extension of mains, and that no additional motors be purchased for hire, &c. The effect of the war had not yet been seriously felt, and for the year ending March 31 there would be no reduction in the revenue. If, however, no public lighting was allowed for twelve months there would be a decrease of about £1,600 for next year. The extension of the time switch method was recommended for power consumers, and various measures were suggested for economical working.

The report was approved by the Committee.

The CHAIRMAN announced that several men wanted to enlist, but they were men whom they could not spare. The committee would, however, procure badges showing that these men were not shirkers.

Itchen. The Urban Council have assented to the application of Southampton Corporation for a provisional order for the district.

Kingstown.—Mr. J. P. Tierney has been appointed consulting electrical engineer to the Council, with instructions to prepare a scheme of electric supply for the district, and supervise the carrying out of the work.

London Electricity Supply.—Marylebone Borough Council have appointed the Mayor, the chairman of the Electricity Supply Committee and the general manager (Mr. A. H. Seabrook) to attend the conference which the London County Council propose to convene for the purpose of discussing the most advantageous terms dealing with the whole question of electricity supply in London.

Islington Borough Council have appointed the chairman of the Lighting, Finance and Parliamentary Committees to attend the conference.

London Electricity Supply Return. The annual return relating to electricity supply in and around London, showing the various electricity undertakers and areas of supply, together with an analysis of accounts for year ended March 31, 1913 (or Dec. 31, 1912, for companies), has been recently published by the London County Council.

The return contains statistics relating to the capacity and output of the generating plant, the number of units sold for lighting and power, the average price obtained, the load factor, tariff system, &c. There is a detailed analysis of the capital and revenue accounts of the London undertakings, together with a less elaborate analysis of those of the extra-London undertakings. Included in the return are three diagrams relating to the London undertakings, showing the growth in the number of units sold, the gradual improvement in the average load factor and the decrease in the average price obtained for private supply. There are also two good maps, one of the [illegible] County of London and another of the

whole of the area dealt with. The Return is published at 1s. net by Messrs. P. S. King & Son, 2/4, Great Smith-street, S.W.

Morecambe.—On Monday Ald. Snowden, in submitting the annual estimates to the Council, said that considerable progress had been made in the electric light department, and the Council would be able to redeem their promise to the L.G. Board to reduce the deficit by £2,000 each year.

Presentation. Mr. J. C. Williams, chief assistant and deputy electrical engineer at Rotherham, who was recently appointed chief electrical engineer at Erith, has been presented with a gold watch by the staff, and with a set of silver entrée dishes by the Executive Committee of the Rotherham Municipal Officers' Guild.

Southport.—The Council have adopted a recommendation of the Electricity Committee to make arrangements for having the gas and electrical meters read by the same person.

Sussex.—The Board of Trade have decided to defer for 12 months the question of the revocation of the Mid-Sussex Electric Lighting Order.

Truro. The Council have been informed by the L.G. Board that the present is an inopportune time for raising a loan for electricity supply works, and the Board of Trade notify that they have no power to extend the time of the order, but it would remain in force notwithstanding any default in respect of compulsory works until it was revoked by them.

Tynemouth.—The Electricity Committee proposes to charge consumers whose accounts are on a net basis 5 per cent. extra for current supplied, and to return such additional 5 per cent. as discount, provided the account is paid within the ordinary period allowed for discount.

Wimbledon.—The Electric Light Committee has refused the request of a consumer that, during the war, the number of units per annum by which he falls short of the minimum consumption under his agreement shall be added to such minimum during the year following the war.

Woodford.—The County of London Electric Supply Co. have decided not to proceed with their application for a provisional electric lighting order for Woodford, Wanstead, Buckhurst Hill and Chigwell.

LIGHTING, POWER & HEATING NOTES.

Aylesbury. At the last meeting of the Urban Council a letter was read from the L.G. Board, stating that they were not at present prepared to sanction a loan of £400 for additions and alterations to the public lamps.

It has, therefore, been decided to suspend the provision of the new lamps and the work of altering the positions of certain existing lamps, which was recently decided upon, is to be carried out under the instructions of the electrical engineer (Mr. W. A. Turnbull) and charged to the district fund, and Messrs. Johnson & Phillips have been instructed to carry out the connections.

Belfast.—The report of the Engineer to Belfast Harbour Commissioners for 1914, stated that the contract for a 120-ton electric derrick crane, at Alexandra Wharf is approaching completion.

The cost of the crane and foundations will be about £21,000. Four 5-ton electric gantry cranes, to cost about £10,000, are in course of erection on the County Down side of the harbour.

Cork.—The Corporation have decided to allocate £50 for installing an electric motor to work the organ in the city hall.

Glasgow.—The Corporation have now finally approved of the arrangement recently made between the local electrical contractors and the Electricity Committee in regard to the hiring of electric cooking and heating apparatus, &c. Full particulars of the arrangement were given in our issue of the 26th ult.

Islington (London).—The Lighting Committee has agreed to a reduction of £400 in the charge for street lighting during the last quarter.

St. Pancras (London).—Owing to the greatly increased cost of carbons and of arc lamp globes since the commencement of the war, the Electricity Committee has been considering the question of substituting half-watt lamps for arc lamps.

An experimental circuit of 14 half-watt lamps has been in operation for the past 10 months, and the chief electrical engineer (Mr. S. W. Baynes) reports that they have proved exceedingly successful, the lamps having burned for nearly 3,500 hours without a breakage. Calculating on 2,000 hours burning for natural lamps, and the increased cost of carbons, &c., Mr. Baynes estimates that if 172 half-watt lamps were substituted for open type arcs a saving of about £132 per annum in maintenance charges could be effected. Therefore, a scheme submitted by him for carrying this out has been approved by the Committee. The cost is put at £500.

Works Driving.—The Burry Tinplate extension works at Llanelly, which have for some time been at a standstill owing to difficulties in regard to the equipment, have been restarted.

Recently two large new steel furnaces were started at the Stockwood and the same firm and the difficulty with regard to labour has been overcome by the men working 12-hour shifts instead of eight hours. Electric power plant has been installed, and the latest labour saving devices have been introduced.

TRACTION NOTES.

Barnes.—The L.G. Board have intimated to the Council that in view of the action taken by the Treasury to restrict capital issued to local authorities within the narrowest limits, they would not be able to sanction the loan for the purchase of electrically-propelled dust vans at present.

Burnley.—Corpl. A. E. Irving, a conductor on the Corporation tramways, has been awarded the Distinguished Conduct Medal for gallantry in the Neuve Chapelle engagement.

Glasgow.—It is announced that the employment of women as tramcar conductors has proved a complete success. Ten women, eight of whom had no previous experience of tramway work, are now employed, and the manager (Mr. J. Dalrymple) has reported that they discharge their duties in a businesslike and satisfactory manner, and it has been decided to engage as many additional women as will be necessary to fill the vacancies created by men flocking to the Colours. Nearly 400 women will be required. The Corporation offer a wage of 27s. weekly with a service uniform.

Hull.—Owing to the shortage of men, the Tramways Committee have been obliged to reduce and rearrange the tramway services.

Newcastle-on-Tyne. The tramway employés have taken a ballot on the question of a strike to secure 3s. bonus all round, with the result that 541 voted for a strike and 49 against. The Corporation offered 2s. 6d. and 1s. 6d., according to grade, but this was rejected.

The chief industrial Commissioner (Sir Geo. R. Askwith has, however, consented to act as arbitrator in the dispute.

The Tramways Committee has been asked to release from 200 to 300 men for work on munitions of war. The men's union do not object if the men are guaranteed reinstatement at the end of the war and if their work in the factories counts as tramway service. The introduction of women to fill their places will not be objected to, provided the women join the union and are not underpaid.

Northampton.—The Corporation have agreed to liberate 140 employees, including 40 men of the tramways department, for Government work. A 10-minute tramway service will be substituted for a seven minute one.

EMPIRE NOTES.

Australasia.—The annual report of Launceston (Tasmania) city treasurer (Mr. C. James) states that for the 11 months ended June 30, 1914 (the ending of the financial year having been changed from July 31 to June 30).

The income of the electricity department was £21,942, working expenses £8,099; total carried to net revenue account £14,259. Interest required £7,369 and sinking fund £1,522. Of the balance, £2,500 has been transferred to general account and £2,868 to reserve. Income from all sources was equal to 2·466d. per unit sold; working expenses was 0·917d.; interest absorbed 0·834d., and sinking fund 0·173d.; total 1·924d., leaving net profit 0·542d. Gross capital expenditure is £190,155 and net £159,178. The revenue of the tramways was £17,885, working expenses £10,246, gross profit £7,639. Interest required £2,889 and sinking fund £647. After providing 2d. per car-mile (£2,610) towards cost of maintenance, £1,557 was carried to reserve. Income from all sources averaged 13,704d. per car-mile, working expenses 6·426d., power 1·424d., interest (2·214d.) and sinking fund (0·496d.); total 12·391d.; surplus 1·313d.

Mr. J. Wilson, manager of the Melbourne branch of the British General Electric Co., has written to the Australian "Mining Standard" taking exception to a remark of Ald. Cabena, with respect to the Melbourne City Council's purchase of metal filament lamps, to the effect that "hitherto all the lamps have come from Germany, but an English company can supply them," adding that "that firm holds a lot of American capital and a little German money." Mr. Wilson states that the British General Electric Co. has the largest metal filament lamp factory in England, at Hammersmith, and continuously employs 1,500 British workpeople in making the metal filament lamps, every portion of which is made at their Hammersmith works. 99·12 per cent. of the capital is held in Great Britain and its dependencies, 0·66 per cent. in allied and neutral countries and 0·22 per cent. in enemy countries.

At a recent meeting Sydney Council resolved, before accepting certain tenders of Siemens Bros. & Co. for underground cables, to refer the matter to the Agent-General, for him to communicate with and ascertain if, since the outbreak of war, the British War Office has placed orders for war material with the company. Subsequently the Council decided to accept the company's order.

Wollongong (N.S.W.) Council have adopted the specification for an electricity supply scheme which was prepared by Mr. J. B. Rumford, and it has been decided to invite tenders for the supply of current, and also

for distributing mains, &c. Two collieries, a local electric light company and the Government power-house at Port Kembla are likely to tender for the supply of current.

The first section of the Kew (Victoria) electric tramway from the local post office to the Victoria-street bridge) was opened recently.

South Africa. "South Africa" contains details of a report by the Electrical, Tramways and Telephone Committee of Durban Council on the question of the appointment of a Commission of Inquiry to review the whole situation of the generation and distribution of electricity in South Africa, and to report on the steps necessary to co-ordinate and standardise the lines on which development could be carried out.

The report (which has been adopted by the Council) states that the question of the extension of the electricity mains in the suburbs has engaged the attention of the Council's technical adviser and the committee for some time, and the committee propose to approach the Union Government with suggestions on the matter. The Council has received applications from outside the borough for the supply of electricity, which, if accepted, would necessitate the erection of lines from 10 to 12 miles beyond the municipal boundaries. The committee understand that the Railway Administration are contemplating the substitution of electricity for steam for working certain sections of their railways.

The Municipality of East London (Cape Province) propose to borrow £45,709 for public works, including £20,034 for extensions of the electricity station and distributing system.

The Municipal Council of Worcester (Cape Province), propose to borrow £15,000 for a hydro-electric scheme.

FOREIGN NOTES.

Argentina. Preliminary official statistics show that imports to Argentina in 1914 included electrical goods to the value of £1,405,000 (compared with £2,022,000 in 1913), vehicles, including locomotives, railway and tramway rolling stock, &c., £4,591,000 (£7,444,000), and manufactures of iron and steel £7,031,000 (£10,007,000).

Santa Fé Municipality recently decided to invite tenders for the supply of electrical materials for the public lighting service at an estimated cost of $6,000 m/n (about £520).

The power station of the Compania Alemana Transatlantica de Electricidad, in the South Dock, will shortly commence to use petroleum fuel instead of coal.

Brazil. A consular report from Pernambuco for the year 1913 states that the Pernambuco Tramways & Power Co. runs electric cars in the more central parts of the town and its system is to be extended to the suburbs.

The lighting of the city is carried out by the same company and is stated to be exceedingly satisfactory.

Thirteen warehouses are being constructed on the quays at Recipe with a total surface space of 26,400 sq. metres; also a coal yard, with a surface of 23,000 sq. metres and an electric power station covering 500 sq. metres. Each warehouse will be provided with semi-portable electric cranes, with a lifting capacity of 1½ to 5 tons. The electric generating plant will be driven by five Diesel engines.

Cuba.—It is announced that the following persons have been granted permission to instal electric power and lighting plant in Cuba: Senor F. A. y Bentancourt, at Jobabo (district of Victoria de las Tunas); Senor D. Vazquez, in Florida (Province of Camaguey); and Senor Rodriguez, in Florida.

Sweden. Amongst the articles of which exportation from Sweden is prohibited as from April 8 are the following:—

Wire of copper and of alloys of copper with zinc, tin or other non-precious metal—twisted into cords or cables, not insulated; and wire of copper and of alloys of copper with zinc, tin or other non-precious metal; also electric cables or lines furnished with sheath of lead or other metal, with or without armouring, or insulated with rubber, gutta-percha, textile materials, paper, asbestos or varnish, or in any other way.

Uruguay. The "Review of the River Plate" says the electricity works at Pando, a suburb of Montevideo, [illegible] and under work will shortly be completed at Canelone.

Senor Lasgotty, the new President of the Board of the Uruguayan National Electrical Department, recently made a public declaration of policy. He said the power-house would give good service and the profit would be devoted to improving the service and reducing the tariff. It was intended to carry the light and energy to the principal towns. La Paz would enjoy the benefit of electric light in a few days, and La Piedra a few weeks later. At Pando and Tacuarembo power-houses were being erected and would be ready in four or five months. It was proposed to acquire (on account of the State) the private-owned power houses. That at Paysandu was nearly purchased and negotiations had been opened for those at Rivera and San José. In the case of [illegible] per unit for power for small industries would be reduced from 5½ to 4½ cents. The present charges to larger industries vary from 5½ to 2 cents. It was proposed to supply current to persons earning low wages and living in workmen's dwellings and lodging houses at 3 cents per unit, with the present charge of 12 cents. Part of the profits would be invested in constructing the national telephone, which would be subterranean in the capital and aerial in the interior. The cost would be $2,500,000. The power house machinery would at once be [illegible] 8,000 kw. turbo-alternator. A suggestion to adapt some of the boilers to burn crude petroleum was being considered.

Passengers carried on the Montevideo electric tramways in 1914 were 81,188,721 (compared with 85,806,425 in 1913).

During 1914 five portable electric cranes were purchased for the port of Monte Video. It is intended to erect 24 electric transporters in the deposit warehouses.

Venezuela.—The Ministerio de Fomento has granted permission to Senor J. C. Espana to construct a telephone line (about 9 miles in length) in the district of San Casimiro (State of Aragua).

Permission has also been granted to Dr. J. A. Tagliaferro, of Caracas, to construct a telephone line connecting Timotes with the settlements of San José de Palmira and Piñango (State of Mérida) and with Monte Carmelo (State of Trujillo) (about 37 miles), and to Señor F. Remien, of Carayaca, to construct a telephone line (about 5 miles in length) in the neighbourhood of that town.

MISCELLANEOUS NOTES.

Coal Supplies. Progress is being made with Home Office inquiry into the conditions prevailing in the coal mining industry, so as to secure the necessary production of coal in view of the large number of miners who are on active service.

The investigation has been pushed forward with the utmost despatch, and it is expected that the Committee over which Sir R. Redmayne presides, will shortly be able to proceed to the consideration of their report.

The Board of Trade are also considering the recommendations recently made by the Select Committee on Retail Prices. It is stated, and we are pleased to learn, that "all the interests concerned are being consulted," that no action will be decided upon until the Home Office Committee on Output has reported.

Customs Decision. It has been decided that Kelvin's composite balance can be imported into New Zealand duty free under either the general or the British preferential tariff.

Municipal Employees and the War.—The employees of the electricity department of Carlisle Corporation have set a good example of patriotic zeal, as 35 per cent. of the total staff have joined the colours, and we give below a list of those at present serving, and the units to which they belong. Those still employed by the department are provided with a badge indicating that they are engaged on public service.

H. P. Baynham, station superintendent (Royal Engineers), J. H. Hay, chief clerk (4th E. Lancs. Howitzer Brig. Cumberland R.F.A.), W. Fraser, storekeeper (7th Battn. Border Reg.), G. Stephens, assistant storekeeper (Border Depot), W. V. Thompson, consumers' assistant (A.S.C.), H. S. Ballantyne, switchboard attendant (4th Battn. Border Reg.), F. Fairclough, meter reader (4th Battn. Border Reg.), J. Mannion, jointer (4th E. Lancs. Howitzer Brig. Cumberland R.F.A.), R. Baxter, stoker, (2nd. Battn. Border Reg.), M. Berry, coal trimmer (4th Battn. Border Reg.), A. Wright, coal trimmer (R.E.), W. H. Clark, porter (4th Battn. Border Reg.), R. H. Sanderson, engine room attendant, J. Simpson, apprentice, and G. Todd, apprentice (4th E. Lancs. Howitzer Brig. Cumberland R.F.A.), R. Gem, apprentice (Royal Engineers).

Reduced Telegraph Rates.—The tariff for telegrams, routed "via Eastern," between Europe and the Dutch Indies will be reduced as from May 1. The rate from the United Kingdom will be: For ordinary telegrams, 3s. 2d. per word; deferred telegrams, 1s. 7d. per word.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during March, 1915, and (*b*) the aggregate figures from Jan. 1 to March 31, with the increases or decreases compared with the corresponding periods of 1914:

Electrical machinery, (*a*) £135,234 (including generators and motors other than for aeroplanes, motor cars and cycles, £41,704, and electrical machinery unenumerated, £93,530) (decrease £7,732). (*b*) £441,155 (including generators and motors other than for aeroplanes, motor cars and cycles, £161,469, and electrical machinery unenumerated, £376,486) (increase £58,693); telegraph and telephone cables other than submarine, (*a*) £1,678 (decrease £6,027), (*b*) £5,207 (decrease £11,770); telegraph and telephone apparatus, (*a*) £3,151 (decrease £19,091), (*b*) £11,097 (decrease £58,475); other electrical wires and cables, rubber insulated, (*a*) £9,981 (decrease £24,948), (*b*) £16,330 (decrease £74,608); with other insulation, (*a*) £2,240 (decrease £2,857), (*b*) £6,036 (decrease £20,729); carbons, (*a*) £5,727 (decrease £9,849), (*b*) £20,729 (decrease £25,946); glow lamps, (*a*) £13,079 (decrease £7,481), (*b*) £34,677 (decrease £15,951); arc lamps and electric search lights, (*a*) £361 (increase £85), (*b*) £863 (increase £236); parts of arc lamps and search lights (other than carbons), (*a*) £4,218 (decrease £3,743), (*b*) £18,826 (decrease £7,214); primary and secondary batteries, (*a*) £13,336 (increase £6,514), (*b*) £35,211 (increase £11,703); meters and measuring instruments,* (*a*) £2,005, (*b*) £6,071; switchboards, [illegible] and [illegible] and apparatus unenumerated, (*a*) £11,292, (*b*) £35,588. Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £67,626 (decrease £80,392), (*b*) £193,569 (decrease £236,160).

Exports.—The exports of electrical machinery, material, &c., (*a*) during March, 1915, and (*b*) from Jan. 1 to March 31, with the

increase or decrease compared with the corresponding periods of 1914, were as follows:

Electrical machinery, *(a)* £115,964 (including railway and tramway motors, £8,099, generators and motors other than for aeroplanes, motor cars and cycles, £50,945, and electrical machinery unenumerated, £47,920) (decrease £131,717), *(b)* £298,920 (including railway and tramway motors, £18,576, generators and motors other than for aeroplanes, motor cars and cycles, £130,336, and electrical machinery unenumerated, £150,008) (decrease £414,175); telegraph and telephone cables, submarine, *(a)* £5,5611 (increase £45,414), *(b)* £130,475 (increase £76,895); other than submarine, *(a)* £40,083 (decrease £10,730), *(b)* £87,948 (decrease £17,306); telegraph and telephone apparatus, *(a)* £13,483 (decrease £14,282), *(b)* £42,202 (decrease £33,918); other electrical wires and cables, rubber insulated, *(a)* £21,256 (decrease £9,086), *(b)* £64,690 (decrease £29,779); with other insulation, £27,552 (decrease £16,429), *(b)* £91,609 (decrease £10,038); carbons, *(a)* £524 (decrease £547), *(b)* £1,519 (decrease £896); glow lamps, *(a)* £10,618(decrease £340),*(b)*£29,922 (decrease £4,503); arc lamps and searchlights, *(a)* £209 (decrease £1,167). *(b)* £623 (decrease £3,163); parts of arc lamps and searchlights (other than carbons), *(a)* £612 (decrease £3,160), *(b)* £2,320 (decrease £8,933); primary and secondary batteries, *(a)* £22,040 (increase £9,890), *(b)* £55,577 (increase £15,342); meters and measuring implements,* *(a)* £15,023, *(b)* £40,608; transformers,* *(a)* £5,107, *(b)* £9,958; switchboards,* *(a)* £6,607, *(b)* £14,042; electrical goods and apparatus unenumerated, *(a)* £22,360 (decrease £58,245), *(b)* £149,240 (decrease £91,085). Total of electrical goods and apparatus, other than machinery and uninsulated wire, *(a)* £276,970 (increase £25,400), *(b)* £720,733, (decrease £42,776).

* Not enumerated separately in previous years.

TENDERS INVITED.

Water Tube Boilers, Fuel Economisers, Feed Pumps, Condenser, &c.

Tenders are invited for the supply, delivery and erection in Melbourne of Four Mechanically-fired Water-tube Boilers, Two Fuel Economisers, One Turbine-driven Boiler Feed Pump, 18 Machines of the Stationary Type for the automatic weighing of coal, and Two Circulating Water Pumping Sets for the CITY OF MELBOURNE. Tender forms, &c., from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Propy. (Ltd.), Billiter-square-buildings, London, E.C. Tenders to the chairman, Electric Supply Committee, Town Hall, Melbourne, by June 15.

DUNDEE Corporation invites tenders (by April 28) for supply and erection of Centrifugal Circulating Pumps and about 750 ft. of 42 in. and 30 in. c.i. Pipes.

Wiring and Fittings.

HENDON Guardians require tenders by 10 a.m. April 29 for Electrical Installation Work at the Redhill Institution. Specification may be seen at the Guardian's offices, Edgware.

HULL Education Committee require tenders by 10 a.m. April 29 for Wiring the Girls' Secondary School, Cottingham-road, Hull. Specifications from the City Architect.

Cables, Switchgear, Carbons, &c.

MOUNTAIN ASH Urban Council require tenders (by noon April 26) for Sub-station Building, Underground Cables, l.t. Overhead Lines and Public Lighting, e.h.t. and l.t. Switchgear and Transformers.

Electrical and General Stores, &c.

The Postmaster-General, ALEXANDRIA (Egypt), will receive tenders until noon May 15 for the supply of Lamps, Electric Fans, &c., for one year. Specifications, &c., from the Central Stores Department, G.P.O., Alexandria.

WANDSWORTH (London) Guardians require tenders by noon April 28 for three months' supply of Electrical Fittings, Engineers' Fittings and Sundries, Oils, &c. Forms of tender from the Clerk, St. John's-hill, Wandsworth, S.W.

Steel Constructional Work.

ST. PANCRAS (London) Council require tenders by noon May 11 for Steel Constructional Work of extension to power house. Drawings may be seen at 57, Pratt-street, Camden Town N.W.

Circuit-Breakers.

JOHANNESBURG Municipal Council require tenders by noon June 1 for the supply of 24 Double-pole Automatic Oil-immersed Circuit Breakers of 200 amperes capacity. Specification from the Controller of Stores, Phillip-square, Johannesburg.

Testing Instruments.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. May 5 for the supply of one Double-range Ammeter, one Switch Fuse, two double-pole Two-way Switches, two Single-pole Six-way Voltmeter Switches, Graphic Ammeter and Graphic Voltmeter. Specification from the Commissioners' Offices, Spencer-street, Melbourne.

Track Transformers, Signals, Wheels and Axles, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. May 19 for 120 s.p. Track Transformers and 300 Electric Signal Spare Parts, and by 11 a.m. June 2 for 300 Electric Locking Stoves and in each case such further supplies of similar goods as may be required during five years; and for Engine Trucks, Wheels and Axles for 10 Electric Street Railway Cars. Specifications from Railway Offices, Spencer-street, Melbourne.

Telephone Switchboard (Extension of Time).

The Commonwealth of Australia Postmaster-General's Dept. give notice that the date for the receipt of tenders for a Telephone Switchboard for Warwick (QUEENSLAND) is further extended from March 16 to June 1.

Telegraph and Telephone Material.

The Deputy Postmaster-General, Perth, Western Australia, will receive tenders until 3 p.m. May 5 for the supply to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department of Dry Cells, Syringes, Zincs, Connectors and Sal Ammoniac for batteries. Specification, &c., from the Deputy Postmaster-General, Perth, W.A.

The Deputy Postmaster-General, MELBOURNE, requires tenders by 3 p.m. May 4 for the supply of 5,000 Porcelain Insulators, and by 3 p.m. April 27 for 200 Telephone Transformers. Specification, &c., from Deputy Postmaster-General, Melbourne.

Generators (Extension of Time).

The time for the receipt by the NEW ZEALAND PUBLIC WORKS Dept. of tenders for the supply of a Three-unit Exciter Set and a 1,500 kw. Generator in connection with the Lake Coleridge power scheme has been extended to noon May 21. Particulars from the Public Works Offices, Auckland, Wellington, Christchurch and Dunedin.

Railway Carriage Lighting, &c. (Extension of Time).

The time for the receipt of tenders by the VICTORIAN RAILWAY COMMISSIONERS for the supply of Material for Railway Car Lighting and Electric Lighting Material for Car Repair Shops is extended to June 2. Specifications from the Commissioners' Offices, Spencer-street, Melbourne.

Telephone Systems, Apparatus and Accessories.

The GREEK MINISTRY OF COMMUNICATIONS (Posts, Telegraphs and Telephones Department), Athens, require tenders by April 28 for the supply and installation of a Central Exchange and Telephone System at Salonica, and a Central Exchange at Athens, and the supply of Telephone Apparatus and Accessores. The Greek "Government Gazette" containing the specification, &c. (in French), can be seen at 73, Basinghall-st., London, E.C.

TENDERS RECEIVED AND ACCEPTED.

HALIFAX.—The Corporation electricity department have placed a contract with Messrs. J. H. Tucker & Co. for 12 months' supply of 10, 25 and 50-ampere d.p. ironclad switches.

DEWSBURY.—The Council have placed an order with the Premier Cooker & Engineering Co. for a [illegible] at the electricity works.

BATLEY.—The Corporation have accepted the tender of the Brush Electrical Engineering Co. for transformers, and that of the British Thomson-Houston Co. for switchgear.

BURTON-ON-TRENT.—The Council recently placed an order with Ed. Bennis & Co. for two stokers and c.a. furnaces.

ACCRINGTON.—The Urban Council have accepted the tender of Bruce Peebles & Co. for the supply of Peebles'-La Cour motor converters and switchgear. 17 tenders were received.

BRADFORD.—The following tenders have been accepted by the Tramways Committee:

John Brown & Co., 200 tons [illegible], £136 13s. 6d.; H. Summerskill, iron castings; Colam Bros., wrought iron work; Ward & Goldthorpe Library, Smith & Croft, cable [illegible]

BOLTON.—The Electricity Committee have accepted the following tenders :

J. H. Tucker & Co., service fuse boxes ; Warning Lines, candle, chamber oil and turpentine ; W. Priestley & Co., oils, paints, &c. ; T. Moscrop & Co., oils and lubricants, &c. ; M. Isherwood, joint material and tools ; Bolton Brick Co., trough covers.

ILFORD.—The following tenders have been accepted by the Council for annual supplies to the tramways department :—

British Westinghouse Co., armature coils ; Le Carbone (Ltd.), carbon brushes ; A. Wiseman (Ltd.), trolley heads and lamps ; Siemens & Co. and British Thomson-Houston Co., pinions and gear wheels ; John Brown & Co., tyres ; British Insulated & Helsby Cables, P. & S. substitute tape and Para tape ; L. Andrews & Co., Blackley tape ; F. Smith, piano wire ; R. H. Howes, thin copper washers and vaseline ; Wm. Wood & Co., thick copper washers ; Dussek Bros. & Co., graphite grease ; Joslins (Ltd.), oil ; R. Kearsley & Co., varnishes.

ISLINGTON (London).—The following tenders have been accepted for annual supplies for the electricity department :—

Callenders' Cable and Construction Co. and Lucy & Co., cable terminal, service and network boxes, tapes and sundries ; Sheepbridge Coal & Iron Co., c.i. tanks ; L. Andrew & Co. and Ediswan & Swan United Electric Light Co., carbon lamps and electrical sundries ; Wm. Geipel & Co., arc lamp carbons ; Fleming, Birkby & Goodall, Pryke & Palmer, A. B. Bosher & Co. and Sheepbridge Coal & Iron Co., steel, iron, tools, &c.

SYDNEY (N.S.W.).—The City Council have accepted the following tenders :—

Lawrence & Hanson Co., fuse boxes and fuses, £663. 15s. ; W. T. Henley's Telegraph Works Co., rubber-insulated and lead-covered wires and cables for 1915, at schedule rates.

The Corporation have also received the following tenders :—

For vehicle charging apparatus—Australian General Electric Co. (*recommended for acceptance*), £1,711. 5s. 6d. and £2,209. 3s. ; Gardner, Waern & Co., £701 ; Standard Waygood Hercules (Ltd.), £1,381 ; Warburton, Franki (Ltd.), £1,465 ; Haes & Eggers, £1,667 ; W. G. Watson & Co., £1,668, £1,793 and £1,928 ; India Rubber, Gutta Percha & Telegraph Works Co., £1,708 ; British General Electric Co., £1,800 ; N. Guthridge, £1,842 ; Siemens Bros. Dynamo Works, £1,925 ; Noyes Bros., £1,989 ; W. Adams & Co., £2,266 and £2,232.

Travelling Cranes for sub-stations—L. Muras (*recommended for acceptance*), £284 ; Haes & Eggers, £234, £264, £277, £331 and £380 ; Hartley & Doyle, £310 ; Warburton, Franki, £480 and £500.

Copper-clad steel cable—Western Electric Co. (*recommended*), £373. 16s.

Motor-driven centrifugal pumps—Falkiner Electric Co. (*recommended for acceptance*), £165, £131 ; Zollner (Ltd.), £140, £156, £177, £180, £218 and £262 ; Gibson, Battle & Co., £164 ; Standard Waygood (Ltd.), £172 ; Australian General Electric Co., £204 and £326 ; Simpson Bros., £214, £220, £227, £251 and £267 ; Haes & Eggers, £226 ; W. G. Watson & Co. £233 and £243, £272 and £295.

Meter Contracts.—Swindon and West Hartlepool Councils have accepted the tender of the Bastian Meter Co. for the supply of Bastian meters from 3 to 10 amperes, and 2½ to 5 amperes respectively.

The Electrical Apparatus Co., Vauxhall Works, London, S.W., have recently received orders from Hammersmith (London) Borough Council for the sole supply of ordinary meters to the Council for three years ending March 31, 1918, and from Dundalk Urban Council for the supply of house service meters for 12 months, ending March 31, 1916.

Among other contracts for single-phase a.c. house service watt-hour meters, the British Westinghouse Electric & Mfg. Co. have recently received orders from the following authorities : —

Bath, Blackburn, Bristol, Croydon, Eccles, Ipswich, Leeds and West Ham Corporations, and from the Beckenham, Rhondda and Watford Urban District Councils.

Messrs. Chamberlain & Hookham have also obtained contracts from Kirkcaldy, West Hartlepool, Swindon and Pontypridd Councils for the supply of meters for 12 months.

Government Contracts.—The following tenders were accepted by the British Government Departments during March :—

War Office.—F. Darton & Co., Hy. Hughes & Co., Kelvin, Bottomley & Baird, Short & Mason, W. F. Stanley & Co., and E. R. Watts & Son, magnetic and prismatic compasses ; General Electric Co., W. G. Pye & Co. and Reid Bros., galvanometers ; Siemens Bros. & Co., telephone board, &c. ; Automatic Telephone Mfg. Co., Gent & Co., New Phonopore Telephone Co. and Siemens Bros. & Co., telephones ; British Insulated & Helsby Cables, Connolly Bros., London Elec. Wire Co. & Smiths and Siemens Bros. & Co., steel wire ; C. Cooper & Co., electric light installation, Northolt ; S. Dixon & Sons, ditto, Ripon ; W. G. Tackley & Co., electric lighting of huts, Woolwich ; W. J. Furse & Co., electric lifts, Whalley ; Stothert & Pitt, electric cranes, Deptford.

India Office.—British Aluminium Co., aluminium ; General Electric Co., carbons ; Siemens Bros. & Co., cells ; Bullers (Ltd.), insulators ; India Rubber, Gutta Percha & Telegraph Works Co., searchlights ; Callender's Cable & Construction Co., Shropshire Iron Co. and T. Bolton & Sons, wire ; London Zinc Mills, zinc plates.

Crown Agents for the Colonies.—Siemens Bros. & Co., telegraph poles ; Shropshire Iron Co., copper wire.

Post Office.—Automatic Telephone Mfg. Co., telephone apparatus, and accumulators for Leeds Exchange ; British Insulated & Helsby Cables, telephone apparatus and bronze wire ; Western Electric Co., telephone cable and apparatus, and telephone exchange equipment extensions, Lee Green and Sydenham ; British L. M. Ericsson Mfg. Co. & Phœnix Telephone & Elec. Works and London Elec. Wire Co. & Smiths, telephone apparatus ; General Electric Co., testing apparatus ; W. T. Henley's Telegraph Works Co., electric light and telephone cable ; Siemens Bros. & Co., submarine cable and g.i. wire, and laying ducts, Bellshill, Motherwell ; Johnson & Phillips, telephone cable ; Dussek Bros. & Co., compound chalk, tar and pitch ; C. M. Powell Bros., brass jointing sleeves ; Bullers (Ltd.), insulator spindles ; Shropshire Iron Co., bronze wire ; Connolly Bros., insulated bronze wire ; C. Macintosh & Co., flameproof wire ; J. C. Fuller & Son, enamelled flameproof wire ; T. Spencer, laying ducts and pipes, Jamestown ; Peel-Conner Telephone Works, telephone exchange equipment, Willesden and Wishaw.

H.M. Office of Works.—Western Electric Co., renewal of electric cables, Houses of Parliament ; Pratt Bros., electric bellhanger's work, Edinburgh ; Union Cable Co. and W. T. Henley's Telegraph Works Co., electric cable and wire ; Bennett & Rutherford, electric bellhanger's work, Glasgow.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Leeds.—The total revenue of the tramways department for the year ended March 31 was £433,940, an increase of £6,485 over 1914. After deducting £115,601 for traffic expenses, £40,347 for general expenses, £43,610 for repairs and £28,577 for power [illegible] the gross surplus is £205,805, compared with £201 071. After [illegible] interest and dividend on redemption fund [illegible] charges for interest on capital, income tax, & [illegible] appropriation account is £151,529. From this £57,773 [illegible] contributions towards redemption of capital. The [illegible] steam coal £7,472, against £31,976 ; £4,140 [illegible] rotary converters, &c., and income tax [illegible] The net profit is £81,567, against £70,994. The [illegible] per car mile were 5·74d., compared with 5·90d.

Liverpool.—The accounts of the electric supply department for the year ended Dec. 31, 1914, show capital expenditure [illegible] increase £26,975), of which £1,395,539 is outstanding.

Revenue was £321,577 and the costs included generation £64,220 ; distribution, £10,057 ; rents, rates and taxes, £31,[illegible] 16,327 ; meter services, £2,[illegible] 4,979, and the balances carried to net revenue account, [illegible] interest required £64,993, and the [illegible] £3,218, and the contribution to rates was £20,000.

Marylebone (London).—The accounts of the [illegible] year for the quarter ended December last show [illegible] £614,201 (compared with 5,391,954 in corresponding quarter of 1913), the decrease being due to the lighting restrictions by the authorities, and to a general tendency to economy in consequence of the war.

Income was £64,169 (compared with £74,447) and working and general expenses were £24,371 (£29,303), leaving £39,798 (£45,144) to meet interest, depreciation, special charges, repayment of loans and parliamentary charges.

The Electric Supply Committee's report, in dealing with the estimate for the year ending March 1916, says [illegible] to the extent of £12,000 per annum, due to the national crisis, have had to be allowed for, including extra cost of coal, allowances to employés serving with H.M. forces, increasing the [illegible] and increase in the [illegible] income tax. The net credit balance for the year is estimated at £2,626.

COMPANIES' MEETINGS AND REPORTS.

ALDERLEY & WILMSLOW ELECTRIC SUPPLY (LTD.).—The profit on the past year's working was £3,122, to which [illegible] was brought forward and [illegible] leaving [illegible] £1,111 to [illegible] reserve, carried over £1,000 [illegible] £1,042 to be carried forward. The [illegible] the year from 9¼d. to 1,056 [illegible].

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.).—The gross revenue for 1914 was £71,339 of which [illegible] maintenance and general expenses absorbed £47,681 and [illegible] to the Portuguese Government

£2,024, leaving £26,664. After providing for debenture interest (£2,046) and sinking fund (£1,553) the amount available (including £6,869 brought forward) is £29,993. It is proposed to place £2,500 to exchange fluctuation account, and to apply £10,000 to the formation of a renewals fund. The directors recommend a further dividend of 5 per cent. making 8 per cent. for the year, leaving £5,472 to be carried forward. The directors have decided to appropriate £30,000 of the reserve fund to the reduction of the capital expenditure account.

BABCOCK & WILCOX LTD.—The directors' report for 1914 states that the net profit was £402,947. 5s. 5d., and with £73,834. 18s. 4d. brought forward the total was £476,782. 3s. 9d. Deducting the interim dividends paid in October of 3 per cent. on the preference shares, 2½ per cent. on the second preference and of 5 per cent. on the ordinary shares (£90,431. 6s. 5d.) the balance is £386,350. 17s. 4d. The directors recommend that the following dividends be paid for the half year ending Dec. 31, 1914—viz., 3 per cent. on the preference shares, 2½ per cent. on the second preference shares and 9 per cent. on the ordinary shares. These dividends will absorb £156,858. 18s., and after placing to reserve fund £150,000 and granting £10,000 to staff pension fund, a balance of £69,491. 19s. 4d. remains to be carried forward. The company's business followed its usual course until the war broke out, and after that the volume of new orders for stationary boilers decreased. The firm have been able to manufacture some war material required by the Government at their Renfrew works, and, having suitable buildings available at their tube works at Dumbarton, they have equipped them with tools and appliances for machining shells, which are forged at the Renfrew works. Regular operation of this equipment has now commenced. The works at Renfrew have been well maintained, and we have also added plant and machinery there to provide increased output of Government orders. The activity of their works and administrative organisations is unremittingly and preferentially devoted to Government requirements. About 800 of the staff and workmen have joined the Forces, and the company contributed to the maintenance of their dependants and to the various war charities upwards of £7,000 to the end of 1914. In common with other engineering firms, the output has been interrupted by strikes and other labour restrictions, and they have been hampered likewise by the scarcity of skilled men owing to so many joining the Forces. Apart from affecting the cost of Government work, these labour troubles affect the cost of our other contracts, particularly those entered into some time before the outbreak of war, which are now in course of being carried through.

CLEVEDON, PORTISHEAD & DISTRICT ELECTRIC SUPPLY CO. (LTD.).—At the recent meeting the chairman (Mr. Thos. Richards) said they were looking forward to an increase of business in the current year. The directors had recently made a contract with Bristol Corporation for the supply of electricity in bulk, and an arrangement had already been made with the South Liberty Colliery Co., at Long Ashton, to supply them with electric power upon mutually advantageous terms. The residents of Long Ashton being desirous of having an electric supply for lighting their village, the company hoped to arrange for the extension, as the colliery was in the immediate vicinity. It was also proposed to extend the mains for the delivery of current to Portishead, with the hope of being able to arrange with the Docks Committee for the supply of electricity for power and lighting at Portishead Docks, negotiations for which were in progress. In any case it was desirable that the cable should be extended to Portishead from Long Ashton, because that would afford facilities for the supply of electric light to the residential suburb of Leigh Woods, and the villages of Abbot's Leigh, Pill and Portbury. Those contemplated extensions would, of course, require additional capital, and upon further consideration the directors thought that rather than issue debentures at present it would be better to offer £1 6 per cent. preference shares to the extent of £10,000. Financial arrangements had already been made to the extent of £9,000, and it was hoped shareholders and their friends would subscribe the remaining £3,000 to make up the total £12,000, the approximate cost of the proposed extension. The sanction of the Treasury had been received for the issue of additional capital.

CALCUTTA TRAMWAYS CO. (LTD.).—The report for 1914 states that the revenue is £109,035 and with £8,405 brought forward the total is £117,440. The directors propose to pay a final dividend of 6s. 6d. per share, making 9½ per cent. for the year; to transfer to reserve for depreciation, Act, £1,000, to contribute £1,250 to staff provident fund, leaving to be carried forward £7,466. After adding premium on reserve £14,442 on the issue of the renewals during the year and adding £15,000 proposed to be allocated as above, the account will stand at £80,550.

DIRECT UNITED STATES CABLE CO. (LTD.).—The report of the directors for the year ended March 31 states that the reserve fund account shows a balance of £476,986. 1s. 6d., compared with £451,490. 11s. 2d. in 1914, an increase of £25,496. 10s. 4d. The cable is stated to be in good repair having been exceptionally well during the past year, and while the directors are pleased to report that the cable is now in good working order, they believe, in view of past experience, it is in the best interests of the company to continue the policy of building up the reserve fund to such a figure as will provide for any contingency. Three quarterly interim dividends of 2s. each per share (less tax), amounting to £33,643. 9s. 2d., have been declared and paid during the year, and a final dividend of 2s. per share (less tax) is now proposed, making a total distribution of 4 per cent. for the year.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.).—The report for 1914 states that the net profit on the year's working (after charging £187 interest accrued) was £12,724, against £10,145 in 1913), and including further interest, &c., carried forward has the total of £12,758.

London expenditure was £1,537 (against £1,335 in 1913), and after providing £3,856 for debenture interest the net profit is £7,365. With amount from last year (£939) the balance is £8,304, of which the directors have placed £3,000 to reserve and £686 against expenses of debenture issue. They recommend a dividend of 5 per cent. for the year, and that the balance of £717 be carried forward.

INDO-EUROPEAN TELEGRAPH CO. (LTD.).—The directors' report states that in consequence of the state of war between Great Britain and Germany, the German section of the company's lines has been interrupted since July 31, 1914. The question of re-establishment of the company's through route at the earliest possible moment is engaging the earnest attention of the directors. Owing to existing arrangements with other companies, the receipts derived from telegraphic traffic for the year have been maintained. The state of war has also put an end, for the time being, to practically all experimental work on wireless telegraphy, and the development of the Galletti system, previously referred to, has been accordingly suspended. The revenue from message account and other sources amounts to £189,383. 18s., compared with £172,532. 2s. 4d. for 1913, an increase of £16,851. 15s. 8d. The expenses are, on commercial and general account, £59,855. 16s. 2d., and on maintenance account £28,539. 12s. 1d., a total of £88,395. 8s. 3d., against £91,441. 9s. 1d. for 1913, a decrease of £3,046. 0s. 10d. The balance is £100,988. 9s. 9d., and after deducting income tax and adding balance brought forward from 1913 (£6,461. 6s. 11d.), the total is £98,092. 4s. 9d. Deducting £25,000 provided for investment fluctuations, and interim dividend of £10,625 already paid, there remains available for distribution £62,467. 4s. 9d. The directors now propose to declare a dividend for the six months ending Dec. 31, 1914, of 17s. 6d. per share (making with the interim dividend already paid 6 per cent. for the year), and a bonus of 20s. per share. They also propose to provide £10,000 for wireless and other technical development work, carrying forward £20,592. 4s. 9d. They propose further to make a special distribution to the shareholders of £12,750 (equivalent to 15s. per share) out of interest upon certain investments and advance accounts. This distribution also will be tax free. The names of Herr Kochler as German Official Director, and of Herr Carl Joerger, Berlin, have been removed from the directorate. The directors desire to alter the minimum and maximum numbers of directors to the more convenient numbers of 5 and 10, and they ask the formal approval of the shareholders to this alteration.

JOHNSON & PHILLIPS (LTD.).—The profit for 1914 on trading accounts &c., after making provision for bad and doubtful debts, and after charging to revenue upwards of £7,000 for maintenance of buildings, plant, &c., amounts to £37,119. 4s. The balance from 1913 was £12,755. 7s. 4d., making £49,874. 11s. 4d. Deducting remuneration of directors, &c. (£1,862. 0s. 6d.), interest on debenture stock (£6,085. 1 s. 3d.), reserve re debenture sinking fund (£6,823. 10s. 2d.), interest on second debentures (£2,500), depreciation on machinery and plant, &c. (£8,158. 9s.) and interest on loan (£149. 18s.), the available balance was £24,295. 12s. 5d. The directors recommend payment of a dividend at rate of 5 per cent. per annum on the ordinary shares (£8,759), leaving to be carried forward £15,545. 12s. 5d.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.).—Including £43,220. 18s. 6d. brought forward from 1913, and after deducting the interim dividends paid in November on the preference and ordinary shares, and making the necessary provision for redemption of debenture stock and other charges, the amount to be dealt with is £78,128. 0s. 10d. The directors recommend payment of a final dividend of 3 per cent. (less tax) for te year on the preference shares and a final dividend of 6 per cent. (tax free) on the ordinary shares (making 10 per cent. for the year), the transfer to reserve of £5,000 and to staff pension fund of £2,000, leaving to carry forward £58,869. 5s. 3d. The revenues and number of new subscribers at the various exchanges of the company and of the subsidiary companies increased during the year in every instance. The Bombay Telephone Co. increased its dividend to 16 per cent., whilst the Telephone Co. of Egypt, the Bengal Telephone Co. and the China & Japan Telephone & Electric Co. have paid the same dividends as last year—viz., 10 per cent., 7 per cent. and 5 per cent. respectively. To meet the cost of further large extensions and improvements, the Bengal Telephone Co. has increased its capital by an additional Rs.1,000,000 in Rs.100 shares, of which one half were issued. The new exchange premises of the company at Port Louis, Mauritius, were opened in May last. New subscribers continue to join, and a small sub-exchange has been opened at Moka. It will shortly become necessary to lay an underground cable from Port Louis to Curepipe in order to provide a thoroughly efficient trunk telephone service between these two places and other up-country exchanges.

POTTERIES ELECTRIC TRACTION CO. (LTD.).—The capital expenditure during 1914 amounted to £1,052. The year's revenue was £129,856. 6s. 9d. Traffic receipts £114,082. 11s. 3d.) show an increase of £5,151. 12s. 9d., compared with 1913. After deducting expenses (including £11,303. 3s. 7d. for debenture and other interest) the balance is £35,824. 12s. 11d against £38,528. 13s. 1d. With £749. 2s. 11d. brought forward, £36,573. 15s. 10d. is available for distribution. The directors recommend that £6,500 be placed to reserve, and £10,000 to renewals account, and that a dividend at rate of 5 per cent. per annum on the preference shares (£12,250), and a dividend at rate of 4½ per cent. per annum on the ordinary shares (£6,125) be paid, leaving £1,698. 15s. 10d. to be carried forward. Negotiations are proceeding with Stoke-on-Trent Corporation with the object of securing the postponement by the Corporation of their right to purchase certain portion of the company's undertaking in 1917 and 1918

The War Office have recently impressed six of the company's omnibuses and owing to the difficulty in replacing them at present the services have had to be curtailed. On the outbreak of war Mr. G. F. M. Cornwallis West, the late chairman, was recalled to the Colours, and has since retired from the Board. Mr. R. J. Howley, one of the managers of the British Electric Traction Co., was elected a director and appointed chairman of the Board.

RICHARDSONS, WESTGARTH & CO (LTD.) For the year 1914 the profit (after providing £19,014, Ex. 5d. for maintenance, buildings and plant) was £66,170. 12s. 2d. After paying interest on the 4 per cent. perpetual debenture stock for the year, directors' fees (£1,700), and writing off £8,000 of cost of starting and developing business of Heavy Stampings (Ltd.), the credit balance is £40,720. 12s. 2d. The directors consider the results of the year's working satisfactory, considering the difficulties encountered, and the fact that no assistance has been obtained from Government work. A moderate amount of Admiralty work has been placed with the company.

VICKERS (LTD.)—The directors' report for 1914 states that the whole of the issue of new shares which took place last year was more than subscribed for by the shareholders of the company. The directors consider it fortunate, in view of the circumstances which have arisen, that the large extensions of the company's works described in the report for 1913 had been undertaken. The war is necessarily entailing an excessive strain upon the whole of the company's staff and the vast number of workmen which the company employs; the directors wish the shareholders to feel assured that every effort is being made on all sides to satisfy these abnormal conditions, and that all the resources of the company and of its subsidiaries are being employed to their utmost capacity to meet the requirements for the successful conduct of the war. After providing for debenture interest and for the depreciations, the profits for the year were £1,019,034. 14s. 2d., and with £222,810. 17s. 8d. brought forward, the total is £1,241,845. 11s. 10d. Of this amount the directors have placed to credit of general reserve account £250,000, and after deducting the interim dividends paid in August (2½ per cent. on the preferred 5 per cent. stock and on the 5 per cent. preference shares and 1s. per share on the ordinary shares) the disposable balance is £679,107. 2s. 10d. Out of this sum the directors paid in March, 1915, the final dividend of 2½ per cent. on the preferred 5 per cent. stock and on the 5 per cent. preference shares, and they recommend a final dividend of 1s. 6d. per share (tax free) on the ordinary shares, making, with the interim dividend, 2s. 6d. per share, or 12½ per cent. for the year, and leaving a balance to be carried forward of £228,876. 10s. 10d.

WEST INDIA ELECTRIC CO. (LTD.)—The report submitted at the recent meeting of this company in Montreal stated that the total receipts for 1914 were $288,925 (against $284,842 in 1913), and operating expenses were $155,229 (against $147,740), leaving $133,696 net earnings. After deducting fixed charges of $59,327 the net profit was $83,369.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

CLEMENT GARRETT'S AUTOMATICS (LTD.) (139,905)—Reg. April 9, capital £1,000 in £1 shares, to carry on the business of electrical and general engineers, automatic machine manufacturers, &c. Private company. First directors are N. Husbands and J. Sedgwick. Secretary: Sedgwick. Reg. office: 3, St. Mary's-gate, Derby.

PEARSON'S ELECTRIC MINERS LAMP CO. (LTD.) (139,974). Reg. April 15, capital £5,250 in 5,000 participating preference shares of £1 each, and 5,000 "B" shares of 1s. each, to carry on the business of manufacturers of and dealers in electric miners' safety lamps, accumulators, batteries, switchboards, electric light bulbs and fittings, lamps, radiators, &c. First directors are: G. J. B. Porter, E. F. Hilton, B. R. Cole, G. Pearson and L. R. Pearson.

SALSBURY CO. (LTD.) (139,910)—Reg. April 9, capital £100 in 1s. shares, to take over the business carried on as Salsbury Lamps, Ltd., and carry on the business of manufacturers of and dealers in lamps, electricity, gas and other illuminants, cycle and motor accessories, &c. Private company. Reg. office: 11, Regent Ave., W.C.

MORTGAGES AND CHARGES.

ELECTRIC REDUCTION CO. (LTD.)—Particulars of £25,000 debentures, dated Feb. 9, 1915, have been filed. Whole amount has been issued. Charged on property, present and future. No trustees.

H. F. FOSTER & CO. (LTD.)—Particulars of £1,000 debentures, dated March 23, 1915, have been filed, amount of present issue £500. Charged on property charged, company's undertaking and property, uncalled and unpaid capital. No trustees.

H. F. FOSTER & CO. (LTD.)—Declaration dated March 31, 1915, supplemental to series of which particulars have already been filed.

MIDGET LAMP CO. (LTD.)—Particulars of £500 debentures, dated Feb. 8, 1915, have been filed, amount of present issue £500. Charged on property charged: Company's property, present and future. A memorandum of satisfaction in full on April 8, 1915, of debenture dated Dec. 30, 1911, covering £100 has also been filed. No trustees.

CITY NOTES.

MEMORANDA (April 21).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 66⅝. Consols Pay Days May 5 and June 1. Stocks and Shares Ticket Days April 28 and May 12. Pay Days April 29 and May 12. Price of silver, 23 13/16 d.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended March 31 of 1.5s. per cent. on the ordinary stock, and £1. 10s. per cent. on the preferred stock (less tax), payable on the 1st prox.

BARCELONA TRACTION, LIGHT & POWER CO. (LTD.)—A meeting of bondholders has been called to consider a scheme by which cash payments of interest on the 5 per cent. bonds will be suspended up to and including the instalment due in June, 1918, and also including the instalment due last December. Five per cent. 10-year notes of an equal amount will be issued in payment, and they are to be redeemed by instalments in the last five years. Two new series of 7 per cent. prior lien bonds, each for £2,000,000, are to rank before the 5 per cent. bonds. The beginning of the operation of the sinking fund is to be postponed until June, 1927. In a report by Mr. H. F. Parshall, consulting engineer to the committee representing the bondholders, it is stated that £1,631,000 is required up to June, 1918, to complete the works, and he estimates that the earnings up to that time (if the work of completion is put in hand at once) will be £524,050, and it is proposed to raise £850,000 by the issue of prior lien A bonds. Unless funds are at once provided the vast amount of capital already expended will be lost.

DEUTSCH-ATLANTISCHE TELEGRAPHENGESELLSCHAFT.—It is announced, as an item of the German war news, that the Deutsch-Atlantische Telegraphengesellschaft, which own the cut submarine cable from Emden to New York (via Fayal, Azores), has declared a dividend of 6½ per cent. for 1914, against 7½ per cent. for 1913.

HUELVA GAS & ELECTRICITY CO. (LTD.)—The net profit for 1914 was £2,051. It is proposed to pay the dividend on the preference shares and write £1,400 off plant, leaving £574 to be carried forward, subject to directors' fees, &c.

MEXBOROUGH & RAWMARSH CONSTRUCTION SYNDICATE (LTD.)—The report for 1914 states that the balance is £4,707. The directors recommend a dividend of 2½ per cent. and £14 is carried forward (against £119 in 1914). Last year 2½ per cent. was paid.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE ELECTRIC POWER CO.—An extraordinary general meeting will be held on May 3, to consider resolutions dividing the existing £5 shares into shares of £1 each, converting 150,000 unissued ordinary shares of £1 each into 150,000 6 per cent. preference shares of £1 each, and authorising the borrowing on mortgage, of an amount not exceeding £100,000.

SUBMARINE CABLES TRUST.—Notice is given that, in accordance with the terms of the trust deed, 62 certificates will be redeemed from the surplus funds of the Trust by a drawing which will take place on Thursday, the 29th inst., at 2.30 p.m., at the offices of the Trust, 34, Electra House, Finsbury-pavement, London, E.C., for payment at £120 per certificate at Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, April 21. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Stock	Last Dividend	NAME.	Price, Wed., April 21.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
	10 7½	Bournemouth & Poole E.L. Ord.	9½	6 13 0	Mar, Sept
	4 4½	Do. 4½% Cum. Pref.	9⅝	4 13 11	Feb, Aug
	5 5	Do. 5% Cum. 2nd Pref.	11⅝	5 17 3	Feb, Aug
	5 5	Brompton & Kensington Ord.	8⅛	5 1s 0	Mar, Sept
St.	4½	Central Elec. Supp. C. Deb. St.	90½	4 8 5	..
St.	4½	Charing Cross West End & City Debs.	91	4 7 11	Jan, July
	5 5 3	Do. 4½% Pref.	4⅜	5 7 6	..
	10 9	Consol. London Elec. Lt. Ord.	14½	6 5 2	Feb, Aug.
	11 6	Do. 6% Pref.	11⅜	5 3 2	Mar, Sept
St.	5 5	Do. 5% Deb. St.	110	4 12 10	Jun, Dec
	11 6	County of London 6% Pref.	11⅛	5 5 6	Feb, Aug
St.	4½	Do. 2nd Deb.	97½	4 12 1	Mar, Nov
St.	4½	Edmundson's Elec. Supp. 4½% Debs.	79½	5 13 .	July
	6	Kensington and Knightsbridge Ord.	7⅛	6 4 2	Feb, Aug
	3 3	London Electric Supply	3⅛	3 17 3	..
St.	4½	Do. 4½% Mort. Deb.	86½	4 13 6	Jan, July
	4½	Metropolitan E. Supp. Ord.	8⅛	5 12 0	Mar, Aug.
St.	4½	Do. 1st Mort. Deb.	93½	4 15 3	Jan, July
	6	Newcastle & Dist. E.L. 6% 2nd Dbs.	99½	6 1 10	Mar, Sept
St.	5½	Newcastle-on-Tyne E. S. 5½% 2d Mrt. Db. St.	99	5 1 0	Mar, Sept
	1 1½	North Metropolitan E. P. Supp. 6% Pref.	1	5 14 4	Apl, Oct
St.	5	South London E.S. 1st Mort. Debs.	95	5 5 3	Jan, July.
St.	4½	Urban Elec. Supp. 4½% Db. St.	94½	4 6 .	Apl, Oct
	6	Westminster E.S. Corp. Ord.	7	6 3 .	Mar, Sept
	4½	Do. 4½% Cum. Pref.	4⅝	4 17 3	Jan, July.
		Electric Railways & Tramways.			
St.	5½	British Elec. Traction 5% Debs.	94½	5 14 .	Apl, Oct
St.	6½	Do. 6% Cum. Pref.	7⅜	6 1 0	Feb, Aug
St.	4½	Central London Guar. Assented Ord.	7⅜	5 4 10	..
St.	4½	Do. do. Assented Def. Ord.	7⅜	5 4 10	..
	5½	Lancashire Tramways	9⅛	5 17 11	Feb, Aug

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share.	Last Dividend	NAME.	Price, Wed., April 21.	Rate	Dividend Due.
		Electric Railways and Tramways.			
10	5	Lon[illegible]			Jan, July
St.	4½	Do. 4½ [illegible]			Mar. Sept.
St.	4	Do. 4% [illegible]	85½		Jan, Jly.
	4	Metropolitan Ry. Con. Ord.		4	
		Do. [illegible]			Feb, Aug
		Do. [illegible]			Jan, July
St.	3½	Do. [illegible]	83	3	Jan, July
St.		Met[illegible]			Feb, Aug
St.	4½	Do. 4% Prior Lien		4	Mar, Nov
St.	4½	Do. 4½% First Pref.		5 14 8	Feb, Aug
St.	6½	Do. 6% Perp. Debs.		4 13 3	Jan, July
St.	4½	Do. 4% Debs.		4	Jan, July
St.	4½	Do. [illegible]		1 12	Jan, July
St.	4½	Do. 4% Guar. Stock		4	Mar. Sept
10	..	Underground E. Rys. of London Shares	1	..	
10	..	[illegible]			
St.	6½	Do. [illegible]	11½		Mar, Sept
..	6½	Do. 6% Inc. Bds,, with coup. 15			Mar. Sept
..	4½	C[illegible]	1		Jan, July
..	..	Yo[illegible]			March
		Electric Manufacturing, &c.			
1	1 0	Brit[illegible]	2½	1	Apl, Oct
1	1	Brit. Aluminium Ord			Mar
100	7½	Do. Prior Lien Debs			Jan, July.
1	7½	Do. [illegible]			Jan, July
5	15	Brit. Insulated & Helsby Ord.	1½	1	Aug, Feb
5	3	Do. [illegible]	5		Jan, July
1	6%	British L.M.Eriesson Mfg. Cm.6% Pref.	1	1 11	Mar, Sep
5	7½%	Brit. Westinghouse Pref.	5		Apl, Oct
5	5/0	Callender's Cable, &c., Co. Ord.	1		Jan, July
5	2/0	Do. [illegible]			Feb, Aug
1	15%	C[illegible]		1 1 4	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.		1 11 10	Sept
5		E[illegible]			Feb, Aug
1	6%	Elec. Construction Ord		1 11	May
St.	4½	[illegible]		1 11	Jan, July
10	6/0	General Electric 6% Pref.		6	Jun, Dec
St.	20%	W. T. Henley's Telegh. Wks. Co. Ord.	14	1 11	Feb, Aug
5		Do. 4½% Cum. Pref.	4	4 14	
St.	4½%	[illegible]	4½	4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.		10	Feb, Aug
		Do. Pref.	8½	1	Apl, Oct
100	4%	[illegible]	57	4	Apl, Oct
12	3/	Telegh. Con. & Main. Co.	9½	1 11	Mar, July
10	4	[illegible]	5½	1 4	Jan, July
	1 12½	Vickers Ord.	1	1	May, Aug
1	4	Do. 5% Pref.	1	1 1	May, Aug
St.	4	Do. 1st Debs.	5½	4	Jun, Dec
100	4½	Do. 4½% 2nd Debs.	1½	4 11	Jun, Dec
		Telegraphs.			
St.	3	[illegible]	1½	1	Mr, My, Aug, N
St.	3	Do. Def. Ord.			Feb, My, Aug, N
St.	4%	Commercial Cable 4% Debs.		3	Ja, Ap, Jly, O
10	10	Cuba Submarine 10% Pref.	15	1 3 4	
	5	[illegible]	7½	1 3 4	
1	4	[illegible]		1	Ja, Ap, Jly, O
St.	25/0	Eastern Tel. Co. Ord.	13½	5 2	Ja, My, Jly, O
St.	17/6	Do. 3½% Pref.		3	Ja, My, Jly, O
St.	4	[illegible]		4 5	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.		4	Feb, Aug
10	2/0	[illegible]	13		Ja, Ap, Jly, O
1	22%	Gt. Northern Tel. Co.	28½	1 3 1	Ja, My, Jly
1	2/0	Marconi's Wireless Tel. Co.			April
1	1	[illegible]			July
1	1 3	West India & Panama Ord.	1		May, Nov
1	1	[illegible]			May, Nov
1	1	Western Teleph. Co.	1		Mr, Jly, O, Dec
St.	4	Do. 4% Deb. St.		4	Jun, Dec
		Telephones.			
..	$2	American Telephn. & Teleh. $100 Cap.	1		Ja, Ap, Jn, O
..	5%	Cuban Telephn. Co. 5% Bds.			Jan, Jly
1	5%	[illegible]			Nov.
..	4½%	New York Telephone 4½% Bds.	1		May, Nov
1	9/	Oriental Telephone Ord.			Apl, Oct
St.	4%	Do. Db. St.			Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St			Jan, July
	3/0	United River Plate Ord.			Apl, Oct
		Financial and Investment.			
1		[illegible]			Sp, Dc, Mr, Jn
1		[illegible]			Sp, Dc, Mr, Jn
1		[illegible]			Ja, Apl, Jly, O
1		[illegible]			Jan, July, O
1	4	Submarine Cable Trust Certs.	12½		Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	[illegible]		5 10	Jun, Dec
St.	4½	[illegible]			Jan, July
St.	4	[illegible]			Jan, July
St.	4	[illegible]			Jan, July
		[illegible]			Jan, July
1	5½	Brazilian Traction Ord.	58½		Feb, M, Aug, N
1	5½	[illegible]			Ja, Apl, Jly, O
		[illegible]			
		[illegible]			
		[illegible]			
		Calcutta Elec. Trams. Ord.			Mar, Sep
		[illegible]			
		Madras Elec. Trams 6% Cum. Pref.	8½		
1		[illegible]			Jan, July
		Mexico Trams Common St.	3½		
		[illegible]			
		Montreal Street Ry. 4½% Debs. (1922)			Feb, Aug
1	4	[illegible]	79½		Jun, Dec
		[illegible]			
		Colonial and Foreign Electric Supply, &c.			
		[illegible]		5 14	Mar, Sept
		[illegible]			
		[illegible]			
		[illegible]			
		[illegible]			
		[illegible]			
		[illegible]			
		[illegible]			
		[illegible]			
		[illegible]			
		[illegible]	10½	4 18	
		& Power 5% Bds.	102½	4 17	Apl, Oct
		[illegible]			Jan, July
		Debs. St.			Ja, Apl, Jly, O
		[illegible]			Jan, July
		[illegible]			
		[illegible]			Jan, July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date April 21, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	10½d.
Solid Drawn Copper Tubes	11½d.
Brazed Copper Tubes	11½d.
Brazed Brass Tubes	12½d.
Brass Wire	10½d.
Copper Wire	11½d.
Rolled Brass	9½d.
Brass Sheets	[illegible]

	per ton.
Copper Sheets	£[illegible] 0 0
Spelter	£[illegible] 0 0

	per ton.
Antimony	£80 0 0
English Lead	£23 10 0

Old Metals.	per ton.
Clean Scrap Copper	£65 0 0
Brazierv Copper Scrap	£58 0 0
Clean Scrap Brass	£48 0 0
Old Lead	£20 0 0
Old Zinc	£31 0 0
Hollow Pewter	£115 0 0
Black Pewter	£85 0 0
Gun Metal	£59 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date April 20, the following prices of SCRAP METALS:—

	per ton.
Aluminium Cuttings	£66 0 0
Clean Mixed Brass	£50 10 0
Clean Copper	£70 0 0
Brazierv Copper	£64 0 0
Gun Metal	£64 0 0

	per ton.
Lea[illegible]	£14 0 0
Te[illegible]	£17 10 0
Old Zinc	£33 0 0
Hollow Pewter	£120 0 0
Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	[illegible]	1,520	[illegible]	46	75,368	+ 2,362
Anglo-Argentine	..	53,734	[illegible]	15	763,072	— 91,757
Ashton-under-Lyne	..	425	[illegible]	3	1,420	— 108
Ayr Corporation	..	279	— [illegible]	43	15,938	— 1,227
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	..	1,253	- [illegible]	3	3,329	— 315
† Birmingham Corporation	..	12,256	- [illegible]	3	31,978	— 2,522
Blackburn Corporation	..	1,167	- [illegible]	3	3,793	+ 484
Bolton Corporation	..	2,612	- [illegible]	3	7,211	— 1,274
† Bournemouth Corporation	..	2,164	— [illegible]	2	4,800	— 37
Bradford Corporation	..	[illegible]	+ 1,290	2	10,445	+ 424
Brighton Corporation	..	[illegible]	- 418	3s	2,648	— 562
† Bristol Trams & Carriage	..	9,957	1,540	1s	130,270	+ 11,990
Bristol Electric Tramways & Light	..	£3,473	[illegible]	1s	..	— £38,583
Burnley Corporation	..	1,541	[illegible]	3	4,973	— 558
Burton Corporation	..	267	[illegible]	3	735	116
Bury Corporation	..	1,329	- [illegible]	3s	3,757	— 484
Calcutta Tramways Co.	..	[illegible]	— £2,[illegible]	15	£878,330	— £66,870
Camborne-Redruth	..	138	- [illegible]	14	1,715	— 92
Cardiff Corporation	..	..	..	..	..	..
Central London Railway	..	..	..	..	..	..
Cork Electric Trams Co.	..	[illegible]	[illegible]	10	6,645	— 286
Croydon Corporation	..	[illegible]	[illegible]	1*	2,686	+ 202
* Derby Corporation	..	[illegible]	[illegible]	3	2,669	— 270
Dover Corporation	..	[illegible]	[illegible]	1	457	+ 68
Dublin & Lucan Railway	..	[illegible]	[illegible]	1	1,884	+ 59
Dublin United	..	6,326	[illegible]	1s	85,884	+ 101
Dundee Corporation	..	1,346	[illegible]	4½	60,806	— 1,260
East Ham Council	..	1,285	[illegible]	2	3,309	+ 616
Erith Urban Council	..	..	..	..	..	..
Exeter Corporation	..	[illegible]	- [illegible]	2	840	123
Glasgow Corporation	..	[illegible]	[illegible]	4½	930,925	— 8,646
Glossop Trams	..	[illegible]	[illegible]	1s	1,757	— 182
Gloucester Corpn.	..	[illegible]	[illegible]	2	664	105
† Halifax Corporation	..	2,080	[illegible]	2	4,705	— 438
Hastings Elec. Trams Co.	..	915	[illegible]	1s	11,284	+ 356
Hong Kong	..	..	..	..	..	..
Huddersfield Corpn.	..	2,387	- 755	3	7,021	247
Hull Corporation	..	[illegible]	- 472	2	7,745	- 1,003
Ilford District Council	..	588	- 28	2	1,589	- 246
Ilkeston Corporation	..	[illegible]	51	2	252	- 41
Ipswich Corporation	..	[illegible]	[illegible]	2 -	1,[illegible]	— 143
Isle of Thanet Co.	..	[illegible]	547	28	8,407	- 2,364
Kilmarnock Corporation	..	162	[illegible]	1s	7,641	— 751
Lancashire Trams Co.	..	1,533	197	13	26,316	- 1,540
Lancashire United	..	1,567	820	1s	23,222	444
Leeds Corporation	..	8,398	- 2,081	3	21,997	33
Leicester Corporation	..	2,800	708	1s	43,499	35
Lea[illegible]	..	[illegible]	[illegible]	4s	33,663	- 198
Lincoln Corporation	..	122	[illegible]	3	391	- 37
Liverpool Corporation	..	12,562	- [illegible]	1s	192,010	- 4,792
Liverpool Overhead Rly.	..	[illegible]	[illegible]	..	..	..
Llandudno & Colwyn Bay R	..	[illegible]	[illegible]	1	4,911	+ 570
London County Council	..	[illegible]	[illegible]	1	91,847	+ 7,859
Lon[illegible]	..	..	..	..	..	..
Lon[illegible]	..	[illegible]	[illegible]	2	[illegible]	[illegible]
Lowestoft Corporation	..	[illegible]	- [illegible]	2	4,[illegible]	— 328
Maidstone Corporation	..	[illegible]	[illegible]	2	[illegible]	[illegible]
Manchester Corporation	..	[illegible]	— [illegible]	1	45,[illegible]	— 1,[illegible]
Mersey Railway	..	..	..	..	..	..
Nelson Corporation	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Newcastle-on-Tyne Corpn	..	[illegible]	[illegible]	2	11,[illegible]	+ 188
Newport (Mon.) Corpn.	..	769	— 262	2	1,[illegible]	383
Northampton Corporation	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oldham Corporation	..	2,137	[illegible]	4	[illegible]	— [illegible]
Perth (N.B.) Corporation	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Perth (W.A.) Elec. Trams.	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Portsmouth Corporation	..	2,455	[illegible]	3	[illegible]	[illegible]
Preston Corporation	..	[illegible]	[illegible]	[illegible]	1,893	[illegible]
Rotherham Corporation	..	[illegible]	[illegible]	[illegible]	2,255	101
Salford Corporation	..	4,900	[illegible]	1s	13,835	705
Sou[illegible]	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
South Shields Corporation	..	8,226	[illegible]	[illegible]	[illegible]	729
Southampton Trams Co.	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Southend Corporation	..	1,296	[illegible]	2	[illegible]	[illegible]
Southend Corporation	..	754	[illegible]	1	1,[illegible]	[illegible]
St'lyb'dge, Hyde, &c., Jt. B.	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sunderland Corporation	..	1,357	[illegible]	3	[illegible]	[illegible]
Swindon Corporation	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Tyneside Tram Co.	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wallasey Corporation	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wa[illegible]	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Warrington Corporation	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wa[illegible]	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wo[illegible]	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Yorkshire W.R. Trams	..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Including [illegible] &c. ‡ Mining 2 years. § Mining 3 days. ‖ Plus 3 days.

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NOTES.

Yorkshire Electric Power Bill.

WE have more than once referred to the Yorkshire Electric Power Co.'s Bill, by which powers were sought to supply energy for electric light, as distinct from electric power, in certain districts of the Company's area. A good deal of opposition was aroused originally, probably on account of the old idea that a purely local municipal supply is the best thing to have. More recently, however, there has been a change in this attitude. The Company's area includes a large number of districts of a rural character, where it would be out of the question to lay down a purely local supply, which, in any case, could not give electricity on cheap terms. Under these conditions a power company is at a great advantage, and many local authorities now see the force of this situation. They realise that the Company is in a position to give a supply which is not easily obtainable otherwise. Consequently, many Urban and Rural Councils passed resolutions in favour of the Bill, and several gave evidence in its support at the Parliamentary inquiry. In fact there was no opposition from the 63 districts which were included, and out of this number 13 gave active support. The main local opposition to the Bill came from the County Boroughs—from Bradford, Barnsley, Brighouse, Halifax, Huddersfield, Leeds, Rotherham, Sheffield and Wake field. It was, therefore, a case largely of the opposition of large towns towards the supply of electrical energy to country districts. The idea underlying this opposition seems to have been that, in the event of these cities extending their boundaries, they might embrace some districts receiving a supply from the Power Company. Such opposition does not seem to be on the basis of the greatest good for the greatest number, but assuming the attitude of the big towns to be justified, the Select Committee could have easily inserted a clause or clauses protecting their future interests.

APPARENTLY, however, the opposition which carried the greatest weight with the Parliamentary Committee came from the Board of Trade; this was based on the facts that the Bill did not give any right of purchase, and that local authorities could only purchase works which were exclusively used in their own district. Actually, however, this question appears to be provided for by the Yorkshire Power Company's Act of 1901, and this fact, as admitted by Mr. BOOTH in evidence, escaped the attention of the Board in reporting on the present Bill! It is regrettable that this idea of purchase, with its supposed benefits, should be allowed to interfere with a Bill of this kind; but, even so, it seems to us that it should have been possible to arrange matters instead of the Committee adopting a course which led to the withdrawal of the Bill. The attitude adopted by the Board seems to be that any course, contrary to the Electric Lighting Acts, however beneficial to the community, should not be permitted. There is little doubt that a rigid adherence to the principle of purchase by small local authorities as enshrined in the Electric Lighting Acts of 1882 and 1888 is not in the public interest, and that it is economically unsound. Further, it is obviously a wrong policy to separate the supply of lighting from that for power in rural districts. The electrical industry of this country has suffered badly from hasty and rashly conceived legislation, and we regret to see a Department of the Government, whose province it is to look after the interests of the industry and trade of the country, acting in a manner which we consider to be highly prejudicial to the progress and development of the electrical industry.

High Permeability Iron.

IT is now many years since the mechanical idea of explaining ferro-magnetism by means of molecular magnets was emphasised by EWING, and yet not very much progress has been made in this direction since that time. EWINGS'

theory explained a great deal, and groups of small magnets illustrating what takes place have often been exhibited; but it still remains to be shown how we can make these small magnets turn with the greatest possible ease in a magnetic field—in other words, how a medium is to be provided for them which has but little viscosity. Research during recent years has thrown a good deal of light on the composition of iron and steel as obtained commercially. It has been shown that such iron is by no means a very simple body, and that its properties depend considerably upon the allotropic modifications that are present along with various carbides. Some light is thrown upon this subject by an interesting investigation made by Mr. T. D. YENSEN, an account of which we give in another column. This investigator shows the enormous effect produced by melting iron *in vacuo*. Even when commercially good iron, such as Swedish charcoal iron, is taken, the melting of such iron *in vacuo* produces a great improvement in the magnetic qualities, and when electrolytic iron is taken the results obtained are still more marked. If melting is not carried out *in vacuo*, impurities seem to be introduced, partly by the metal decomposing the carbon-monoxide, which thus permits carbon to pass into the iron, and partly by ferrous-oxide, which is absorbed. When these two substances are interspersed among the ferrite crystals there appears to be a lowering of the permeability and an increase in electrical [illegible].

On the other hand, if the iron is melted *in vacuo*, there appears to be a tendency for carbon to come out of the iron and to form carbon-monoxide with the residual oxygen; thus the carbon content is reduced. For example, Swedish iron so melted lost 95 per cent. of its carbon. By taking electrolytic iron the author obtained the extraordinarily high figure of 19,000 for the permeability in one instance, and an average of 12,950 as the maximum permeability for a number of samples. It is interesting to note that the hysteresis loss is decreased by this treatment, but the conductivity increases, so that the eddy-current loss would be greater. Very possibly, therefore, the combined iron losses would remain much about the same. As to whether this method of treating iron will become commercial must depend largely upon the cost. Generally speaking, nothing material is gained by carrying permeability above a certain figure, because other considerations enter into the designs of electrical machinery, so that the magnetic circuit cannot be cut down indefinitely. It is obvious, however, that there are certain cases in which very high permeability might be most important, and in such cases the cost, even if high, would be a secondary consideration. In any case, it is well to bear in mind that our ideas of permeability being limited to a few thousands are now out of date.

Safety Lamps Approved by the Home Office.—On April [illegible] the Home Secretary made an order approving Davy, Lyell and Marsaut Lamps Nos. 1 and Patterson & Co.'s Safety Lamp Type B, to be added to those to which the Coal Mines Act, 1911, applies. A complete list of approved safety lamps is printed as an appendix to the order.

Royal Engineers (T.F.)—The following appointments have been made:—

Hampshire (Fortress) No. 4 Electric Lights Company: Norman M. Radermacher to be Second-Lieutenant.

London Electrical Engineers: Corpl. Thos. H. Gotch, Lance-Corpl. Gerald F. Wood and Pte. Alfd. Blackie (from Artists Rifles) to be Second-Lieutenants.

German Chemical Industries.—An interesting Paper on this subject was read recently by Prof. Percy P. Frankland, F.R.S., before the Society of Chemical Industry, and is given in the "Journal" of the Society for the 15th inst. Apart from purely chemical products, on which a great deal of information is given, the author gives interesting details in regard to the various products which are made electrically, such as nitrates, hydrogen and bleach.

Weathering of Coal.—The loss in calorific value that coal undergoes when it leaves the pit head has been investigated by Prof. S. W. Parr and Mr. W. F. Wheeler, of Illinois University, from whose conclusions the following passage is taken: Coal of the type found in Illinois and the neighbouring States is not affected seriously during storage when only the change in weight and losses in heating power are considered. The changes in weight may be either gains or losses of probably never over 2 per cent. in a period of one year. The heating value decreases most rapidly during the first week after mining, and continues to decrease more and more slowly for an indefinite time. In the coals that have been tested 1 per cent. is about the average loss for the first week and 3 to 3·5 per cent. would cover the losses for a year. A table of values showing the results of six weathering tests of Vermilion, Williamson and Sangamon (Ill.) nut and screenings is given below.

			Heat units [illegible] unit coal.	Loss. per cent.
Stored in open bins—				
Same day as mined	15·26	4·03	14,787	...
Seven days after mining	15·13	3·53	14,666	0·82
Two months after mining	15·68	3·61	14,606	1·22
Six months after mining	14·96	3·36	14,525	1·77
One year after mining	14·33	3·29	14,379	2·76
Stored in covered bins—				
Same day as mined	15·26	4·03	14,787	...
Seven days after mining	15·13	3·53	14,666	0·82
Two months after mining	15·07	3·53	14,605	1·22
Six months after mining	14·42	3·37	14,453	2·26
One year after mining	14·77	3·57	14,323	3·14
Stored under water—				
Same day as mined	15·26	4·03	14,787	...
Same day as submerged	15·13	3·53	14,666	0·82
Six months after mining	15·84	3·69	14,532	1·73
One year after mining	15·02	3·81	14,567	1·49

Effect of Gases on Electron Emission from Glowing Solids. The results of an investigation made by Mr. F. Horton on the ionisation produced by a glowing Nernst filament when used as a cathode in a discharge tube in the presence of various gases of different chemical affinities for the material of the filament were communicated in a Paper before the Royal Society recently. It has been found that the actual electron emission from the filament is independent of the nature of the surrounding gas—at least for the gases air, nitrogen, oxygen and hydrogen—for at low pressures the thermionic currents measured under similar conditions in these gases were practically the same. At higher pressures the thermionic currents differ considerably owing to the effect of ionisation by collisions being different in the different gases. The increase in the current due to ionisation by collisions in hydrogen is much greater than it is in air, oxygen or nitrogen. The experiments were repeated with a Nernst filament covered with lime, and it was similarly found that the electron emission from lime under these conditions was not increased by hydrogen, although earlier experiments have shown that lime heated on platinum gives a much larger electron emission in hydrogen than it does in air. This appears to be caused by the hydrogen increasing the emission from the platinum, an effect which has been shown by H. A. Wilson to be due to the absorption of hydrogen by the metal. Lime and the oxides of a Nernst filament do not absorb hydrogen, and the electron emission from these sub-

stances is therefore unaltered by the presence of this gas. That the electron emission from an oxide cathode is the same in oxygen and in hydrogen, gases which have very different chemical affinities for the material of the cathode, is evidence against the theory, which has lately been put forward, that the electron emission from a glowing solid is due to chemical action between the solid and the surrounding gas.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. R. D. Gifford concludes the article on the "Direct Measurement of Power Factor" (p. 125).

The first part of an article on the "English Electrotechnical Industry and the Russian Market," by Mr. P. Gurewitsch, appears on p. 128.

We give an abstract of the Paper on the "Bombay Hydro-electric Scheme," by Mr. A. Dickinson, which was read last night before the Institution of Electrical Engineers (p. 117).

We conclude our account of the discussion which took place in London, Manchester and Birmingham on Mr. J. H. Rider's Paper on "The Power Supply of the Central Mining-Rand Mines Group" (p. 122).

A Paper on "Magnetic and other Properties of Electrolytic Iron Melted in Vacuo," by Mr. T. D. Yensen, is abstracted (p. 119).

A Home Office Report by Dr. R. V. Wheeler on "Battery Bell Signalling Systems for Mines" is abstracted on p. 132.

Our Leading Article deals with this question (p. 130).

Companies' Meetings and Reports.—Meetings of the Anglo-Portuguese Telephone Co., Direct United States Cable Co., Indian Elec. Supply & Traction Co., and the Launceston & District Elec. Supply Co. are reported, and the directors' reports abstracted include those of the Cuba Submarine Telegraph Co., Dudley, Stourbridge & District Electric Traction Co., O. C. Hawkes, Kidderminster & District Elec. Lighting & Traction Co., North of Scotland Elec. Light & Power Co., and Willans & Robinson (pp. 144-145).

OBITUARY.

H. Ward Leonard. We regret to record the death of Mr. H. Ward Leonard, which occurred very suddenly at the banquet of the American Institute of Electrical Engineers at the Hotel Astor, New York. Mr. Leonard was well known as an inventor and patented over 100 inventions, which covered a wide field on the heavy commercial side of electrical engineering. Mr. Leonard was born in Cincinnati in 1861 and graduated at the age of 22 at the Massachusetts Institute of Technology. A year later he became associated with Thomas A. Edison as a member of Mr. Edison's staff of four engineers selected to introduce the Edison central-station system. At the age of 26 he was made general superintendent of the Western Electric Light Co. at Chicago. The following year he formed the firm of Leonard & Izard, which made many important installations of central stations and electric railways. In 1889 the firm was bought out by the Edison interests and Mr. Leonard became general manager of the combined Edison interests for the United States and Canada, with headquarters in New York. In 1891 he completed his inventions of the Ward Leonard system of motor control, and in 1892 he gave the world his multiple-voltage system. His system of "regenerative braking," the double-arm circuit-breaker and his lighting system for trains and automobiles are other well known inventions due to him. For electrical research work the Franklin Institute of Philadelphia in 1903 conferred upon Mr. Leonard the John Scott Medal. He was awarded a gold medal at the Paris Exposition in 1900 and also at the St. Louis Exposition in 1904. Mr. Leonard was a frequent contributor to scientific societies and to the technical press. He was a life member and Fellow of the American Institute of Electrical Engineers and served as vice-president and manager and as a member of the Edison Medal Committee.

APPOINTMENTS VACANT AND FILLED.

A chief of the mains department is required for the Gemeente-Electriciteitswerken, Amsterdam. Applications by May 15 to the Directie der Gemeente-Electriciteitswerken, Hoogte Hadijk 200, Amsterdam. *See advertisement.*

A first-class turbine mechanic is required for the operation of a large turbine-driven a.c. plant. *See advertisement.*

Two assistant storekeepers are required by the Government of Nigeria for the Posts and Telegraphs Department. Commencing salary £250, rising to £300. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W. *See advertisement.*

A physical and mechanical laboratory assistant is required in the research department of Hadfields (Ltd.), Sheffield. *See advertisement.*

Electrical wiremen are required for the electrical department of John Brown & Co. (Ltd.), of Clydebank.

Applications are invited for the position of principal of the Wigan and District Mining and Technical College. Forms of application from Mr. A. M. Lamb, chairman, General Purposes Committee, to whom applications by May 12.

Applications will be received by the Academic Registrar, University of London (S. Kensington, S.W.), until May 4 for the University (Quain) Chair of Physics, tenable at University College. Salary £1,000 a year.

Mr. J. S. Badger, manager of the Brisbane Tramways Co., has been appointed managing director, and Mr. J. W. Gillette has been appointed manager.

Mr. Norman Tuck has been appointed electrical engineer to Donald (Victoria) Shire Council.

Mr. Ashley Plowman, electrical assistant, Sydney Technical College, has been appointed assistant lecturer in Christchurch (N.Z.) University School of Engineering.

Mr. T. C. Winfield, of the Metropolitan Electric Tramways (Ltd.), has been appointed works superintendent of the West Ham Corporation Tramways. There were 127 applicants.

INSTITUTIONS AND SOCIETIES.

Manchester Section of the Institution of Electrical Engineers.—The annual report of the Committee to this section, which was submitted at the fifteenth annual meeting held on Tuesday last, shows that 12 meetings were held during the past year. The number of members show a considerable decrease over the figures for the year 1914. The officers for the session 1915–16 have been elected as follows: *Chairman*, Mr. B. Welbourn; *Past Chairmen*, Prof. E. W. Marchant and Mr. P. P. Wheelwright; *Vice-Chairmen*, Messrs. C. J. Beaver and A. E. McKenzie; *Hon. Sec. and Treas.*, Mr. Julius Frith; *Committee*, Messrs. H. Allcock, C. C. Atchison, W. Cramp, Prof. A. B. Field, A. P. M. Fleming, S. L. Pearce, J. S. Peck, H. A. Ratcliff, J. A. Robertson, H. D. Symons, Ald. Wm. Walker and S. J. Watson.

Institution of Civil Engineers.—The Council have made the following awards for Papers read and discussed during the session 1914-15: The Telford gold medal to Mr. A. L. Bell (Rosyth); Telford premiums to Mr. C. W. Anderson (Chakradharpur, India); Sir Thomas Mason (Glasgow); Dr. H. F. Parshall (London); and Mr. H. E. Yerbury (Sheffield); and the Crampton prize to Mr. F. D. Evans (Kuala Lumpur, F.M.S.)

Iron and Steel Institute.—The annual meeting of the Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, London, S.W., on Thursday and Friday, May 13 and 14, 1915, at 10:30 a.m. At the meeting on the Thursday morning the general business of the Institute will be transacted, and the Bessemer gold medal for 1915, which has been awarded to Mr. Pierre Martin, will be received on his behalf by the French Ambassador. A selection of Papers will then be read and discussed. At 3 p.m. Prof. Hubert (Liége University) will deliver a lecture on "Large Gas Engines." On the Friday the meeting will be at 10:30 a.m., when the Andrew Carnegie Gold Medal (for 1914) will be presented to Mr. E. Nusbaumer (Paris) and the award of Research Scholarships for the current year will be announced, after which a selection of Papers will be read and discussed.

Institute of Chemistry.—The Councils of the Institute of Chemistry and of the Society of Public Analysts have issued a list of analytical reagents, in which are indicated the standards of purity regarded as necessary for analytical work, together with a circular urging purchasers to deal with British manufacturers, wherever it is found that these can meet the purchasers' requirements.

Electric Vehicle Committee.—A meeting of this committee was held in London under the chairmanship of Mr. R. A. Chattock on April 13th. The question of increasing the sales of the "Journal" was considered, the committee feeling that electric supply undertakings might do much more to encourage the reading of the "Journal" for distribution among prospective users in their districts. It was resolved to make a further appeal to the undertakings to support

the efforts of the committee in this direction. It was reported that many undertakings were restricting their expenditure on publicity material during the war, owing to the regulation of the Government prohibiting further capital expenditure on ordinary mains extensions, and also limiting expenditure generally. It was resolved to point out to the undertakings that the adoption of electric vehicles in their districts did not necessarily require any extension of the mains or plant. The supply was entirely an "off peak" load, and undertakings on that account should, at the present time, use every endeavour to make known the advantages of electric vehicles. Undertakings are to be asked to make use of the publicity mail cards prepared by the committee, the demand for which has been very small indeed and confined to a very few undertakings up to the present. Regarding those electric supply undertakings in the metropolitan area that charge more than 1d. per unit for electric supply for vehicles, the secretary reported that, in accordance with the instructions of the committee, he had written to them, asking them if they could see their way to come into line with the committee's recommended tariff of 1d. per unit. No satisfactory reply, however, had been received from any undertaking to which the letter had been addressed. It was reported that certain undertakings had found it necessary to advance prices all round owing to the increased cost of coal, &c. It was decided that where such advance in price is only of a temporary nature the undertaking concerned shall still have its name in the list in which it at present stands on the tariff sheet of the "Journal." The committee have had reported to them that there are vehicles not fitted with the standard receptacle which come for charging at certain stations. The committee decided to insert a paragraph in the next issue of the "Journal," advising electric supply undertakings to do what they can to persuade the owners of such cars to have the standard receptacle fitted. The secretary was also instructed to get into touch with the American manufacturers of electric vehicles, pointing out the necessity of fitting the standard receptacle. As to the standardisation of metal filament lamps for use on electric vehicles, another meeting has taken place between representatives of the Tungsten Lamp Association and the E.V.C. technical sub-committee. As a result of the report of the latter sub-committee, it was decided to adhere to the previous recommendation —*i.e.*, that the lamps used should be for a pressure of 12 volts, and in accordance with the requirements of the British Engineering Standards specification No. 69. Further progress has been made with the preparation of the report upon battery charging equipments and methods of charging, and it is hoped to have this ready for issue shortly.

Diesel Engine Users' Association.—At the April meeting of this association a standard policy for insurance at Lloyd's against breakdown, which had been formulated and considered at several meetings of the committee, was submitted for consideration and adoption by the association. After some discussion, and a few minor amendments, the policy and its conditions were approved and adopted. The advantages of this insurance include periodic inspections of the plant and advice and full reports by fully qualified Diesel engine experts acting for the underwriters. The question of lubrication of Diesel engines was then brought forward for consideration, and the discussion of this subject was opened by Mr. H. L. Alderton, of Guildford, who referred to the three classes of lubrication in connection with Diesel engine plant—namely, the bearings, cylinders and compressors. In the lubrication of bearings he included the top and bottom connecting rod ends, and, in fact, all the moving parts, with the exception of the pistons. The various methods of lubrication by means of ring lubricators, ordinary drip or forced feed with pumps or centrifugal rings, were referred to. Mr. Alderton emphasised the importance of carefully selecting the best oil for cylinder lubrication, so as to avoid troubles from carbonisation and gumming. He further referred to the fact that apparently large engines required more oil in proportion to their output than did the smaller engines. In the further discussion which ensued it was shown that practice varied considerably in regard to the use of one or several oils with Diesel engines. In some cases one class of oil was used throughout the engine, and in others different oils for the bearings, cylinders and compressors. The methods of filtration of oil, and the extent to which filtration is carried out, also showed a considerable amount of variation and difference of opinion. It was decided to ask for returns from the various members of the association, giving information as to the methods of lubrication with quantities and costs in [illegible] various plants.

British Association.—The following sectional presidents have been appointed for the meeting of the British Association which is to be held at Manchester from September 7th to 14th next, under the presidency of Prof. A. Schuster: *Section A* (Mathematics and Physics), Sir E. W. Dyson; *Section B* (Chemistry), Prof. H. B. Baker; and *Section G* (Engineering), Dr. H. S. Hele Shaw.

Engineer Volunteer Training Corps.—The replies received to the circular recently issued by the Institution of Electrical Engineers to the members residing in the London district have been communicated to the Central Association of Volunteer Training Corps, whose engineering adviser is of opinion that the response received is sufficient for the matter to be proceeded with, and enrolment forms have accordingly been sent to all those who have expressed willingness (conditional or unconditional) to join the proposed Corps. Further enrolment forms for members whose residence or occupation is in the London district can be obtained at the Institution of Electrical Engineers, Victoria Embankment, W.C.

EDUCATIONAL NOTES.

Glasgow University.—The whole of the staff of the engineering department (lecturers, assistants, demonstrators and workmen) have offered their services to the military authorities.

The Major-General of the Ordnance Department, in acknowledging the value of the offer, states that in a short time he will indicate how the services of the staff may best be utilised. The Admiralty has asked the University Court to put their workmen and testing machines at the disposal of the Admiralty for testing steel, used in shell-making in the district.

University of Hong Kong.—We have received a copy of the calendar for the 1914-15 session.

The calendar gives a list of the officers, a historical sketch of the University, the general regulations, particulars of scholarships and regulations for the matriculation and local examinations, schemes of study and syllabus for each of the faculties of engineering, arts and medicine.

In the faculty of engineering the subjects include pure and applied mathematics, physics, chemistry, civil, mechanical and electrical engineering and the University confers the B.Sc. (Eng.) degree in either of the three branches. There are well-equipped laboratories for the engineering department, and an electric power station, in which the students take duty as shift engineers. Prof. C. A. M. Smith, M.Sc., occupies the Taikoo Chair of Engineering and is dean of the faculty.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, April 30th (to-day).

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. Meeting at the Literary and Philosophical Society Rooms, Westgate-road, Newcastle-upon-Tyne. Lecture on the "Modern Aeroplane," by Dr. R. T. Glazebrook, C.B., F.R.S.

SATURDAY, May 1st.

Royal Institution.

3 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Lecture on "Photo-Electricity," by Prof. J. A. Fleming, F.R.S. (Tyndall Lecture I.)

Graduate Section of the North-East Coast of Engineers and Shipbuilders.

7.15 p.m. Meeting at Bolbec Hall, Newcastle-upon-Tyne. Paper on the "Making and Filing of Engineering Notes," by Mr. E. W. F. Smith.

WEDNESDAY, May 5th.

Royal Society of Arts.

8 p.m. Meeting at 18, John-street, Aldephi, London, W.C. Paper on the "Measurement of the Efficiency of Domestic Fires, and on a Simple and Smokeless Grate," by Dr. A. V. Harcourt, F.R.S.

THE NATIONAL RELIEF FUND.

(Treasurer H.R.H. The Prince of Wales.)

This great National Fund, for the relief of those amongst the needier classes who are widowed, orphaned and otherwise affected by the fighting in which our troops and ships are now taking part, urgently seeks contributions however small. These can be sent with the following note, which can be cut out, filled in, put in an envelope and sent *unstamped*, addressed H.R.H. The Prince of Wales, Buckingham Palace, London.

Date.....

I enclose £ *s. d. toward the Prince of Wales*

NATIONAL RELIEF FUND.

Name .....

Address.....

.....

THE BOMBAY HYDRO-ELECTRIC SCHEME.*

BY A. DICKINSON.

It is proposed in this Paper to give particulars of not only the electrical but also the hydraulic sections of a large hydro-electric scheme known as the Tata Hydro-Electric Power Supply Company, Ltd., Bombay. The main object of this company is to supply electrical energy for use in Bombay, principally for power in cotton mills.

The hydraulic section of the scheme is exceptional, inasmuch as special lakes have been created, and the whole of the water for supplying the power is collected from the rain falling during the monsoon. Three reservoirs are being formed by constructing dams across valleys known as Lonawla, Walwhan and Shirawta. From the reservoirs the water is conveyed in an open duct to the forebay, and thence through pipe lines to the power house, a distance of 13,000 ft., in which length there is a fall of 1,725 ft. The power house is situated at a place known as Khopoli, which, as the crow flies, is some 43 miles from the receiving station on the Island of Bombay.

The present scheme is to instal in the power house eight sets, each of 11,000 B.H.P., and in the receiving station the plant necessary to deal with the power-house output. Five sets only are now installed in the power house, and the remaining three sets will be put down as water becomes available. Generation is at 5,000 volts, three-phase, 50 periods, the energy being transformed up to a line pressure of 100,000 volts.

The author describes the construction of the dams, ducts and forebay in detail. The gates at the forebay are operated by racks, either by hand or by an electric motor. The motor is of 12 H.P. at 600 revs. per min. This gives to the gates a lifting speed of about 13½ in. per minute, so that fully to open the gates takes about 8 minutes.

Special provision has been made for speedily closing the gates from the power house in case of a burst pipe, or due to any other necessity. This is accomplished by a solenoid releasing the ratchet wheels so that the gates close by their own weight, the weight being such as to overcome the water pressure. On the gates is a device which automatically disconnects the electric motor before the gates reach the highest or the lowest positions. The gates are also fitted with automatic brakes so that when operating the gates from the power house they cannot be damaged by falling too quickly. After describing the pipe line the author passes on to power house.

POWER HOUSE.

The scheme has been designed for a normal plant capacity of 88,000 H.P. in eight main 11,000 H.P. sets, two 850 H.P. exciter sets, eight step-up three-phase 10,000 k.v.a. transformer banks with the necessary switchgear, station auxiliary apparatus, and four outgoing lines. The present building shown in the sectional elevation, which is capable of extension as required, will take five main and two exciter sets, five transformer banks, switchgear and auxiliaries, and two outgoing lines, of which five complete units are now being installed with two outgoing lines. The building consists of a turbine and generator room, spanned by a 67-ton electric travelling crane, 5,000-volt 'bus bar and oil-switch rooms, transformer compartments with a tramway passage and turntable for handling the transformers by means of trucks, a repair shop, all these being on the ground floor, together with a 100,000-volt 'bus bar and oil-switch room and transmission-line outlet tower located on the floors above.

The main sets consist of Escher-Wyss hydraulic impulse turbines of the horizontal type running at 300 revs. per min. and direct-coupled to Siemens Brothers three-phase generators. The exciter sets consist of Escher-Wyss tangential wheels, running at 600 revs. per min. and direct-coupled to Siemens Brothers compound-wound generators. The turbine wheels consist of cast-steel discs and buckets carried by Siemens-Martin steel shafts with two ring-lubricating bearings provided with water cooling. The nozzles are of the cast-steel deflecting type, and the governors are of the oil-pressure type fitted with hydraulic automatic servo-motors, guaranteed to limit the speed variation to 2½, 5 and 12 per cent. when 25, 50 and 100 per cent. of the load is suddenly thrown off. The deflecting nozzle is fitted in the inlet pipe by means of two bearings, and is made water-tight on both sides by means of leather washers. It is operated by the servo-motor, which consists of a casing with a differential piston, of which the lower small piston is under constant water pressure and the upper large piston under variable water [illegible] and connects the deflecting nozzle and the automatic speed governor, only the needle being connected rigidly to the governor.

The main generators are of the rotating-field totally-enclosed type, designed for a normal load rating of 8,000 k.v. [illegible] factor of 0·8 and 4,000 to 5,300 volts 50 periods, three-phase, with a temperature rise not exceeding 60°F. above air at 110°F., and 20 per cent overload for 10 hours without injury. Induced ventilation is provided by means of fans on the rotor shafts, each machine being connected to the main inlet air-duct by a shutter and to the outlet air-duct to the atmosphere. These shutters are motor-operated with automatic control, so arranged that when the field switches are closed the shutters are open, and vice versa. The bearings are supplied with oil under pressure and are provided with water cooling. Each three-phase transformer bank consists of three single-phase General Electric, oil-immersed, water-cooled, static transformers, delta-delta connected and designed for a full-load output of 3,333 k.v.a. at 0·8 power factor when stepping up from 5,000 to 100,000 volts, 50 periods, the temperature rise not exceeding 70°F. above cooling water at 75°F., with a water circulation of 950 gallons per hour. These sets are capable of 20 per cent. overload for 10 hours with a water circulation of 1,200 gallons per hour without injurious heating. The terminal leads from the primary and secondary windings are brought out through the cover by suitable bushings of ample surface to prevent leakage. The high-tension bushings are of the compound-filled type, and consist of a conductor rod from the top to the bottom which is surrounded by several concentric pressboard insulating cylinders, separated by spaces, outside which the exterior wall of the bushing is built up of a number of annular rings of moulded insulating compound, interspaced with impregnated press-board discs of larger diameter than the rings in order to prevent leakage. These discs and rings are cemented together and are tightly clamped by nuts at the top and bottom of the rod. The bushings are supported on cast-iron rings attached to the cover. The low-tension bushings are of porcelain. The oil used is a specially-prepared mineral oil, treated before filling, and from time to time in service, in a drying and purifying outfit in order to remove moisture and foreign matter, which affects or endangers the insulating properties of the oil. This outfit consists of a portable set comprising a filter-press, a motor-driven centrifugal pump, and a strainer, and is mounted on a truck. It is capable of treating 1,500 gallons of oil per hour, the filtering medium being blotting paper. Provision is made in the oil-pipe system for connecting this set to any transformer the oil of which requires treatment. The oil is tested in a standard testing set, consisting of an oil receptacle with a 0·2 in. spark-gap and contacts, and a testing transformer, and the oil is filtered until the puncture voltage is raised to 40,000 volts.

Each bank of transformers on overload rating takes 3,600 gallons of water per hour at a temperature of 75°F., and the total requirements of the plant now being installed will be 18,000 gallons of water per hour. Provision is made for operating each main unit with its own transformer bank, or through a 5,000-volt transfer 'bus bar with any bank as required, and on the high-tension side the transformer banks and out-going lines are operated in parallel.

The equipment consists of remote-control, electrically-operated oil switches and other apparatus operated from the benchboard located on a gallery overlooking the generator room at a point which will eventually be the centre of the building. The high-tension oil switches are automatically tripped by inverse time-limit, overload, series relays which are mounted on post insulators, a long rod from the relay closing a switch on the wall in the opening-coil circuits of the solenoids in the control wiring. Each switch unit is designed to operate as one switch with a breaking capacity of 40,000 k.v.a. The transfer 'bus-bar system consists of a copper bar carried on insulators and sectionalised by means of disconnecting switches, and the high-tension 'bus-bar system of copper tubing which is carried on post insulators, suspended from the roof, sectionalised with disconnecting switches and provided with three single-pole, automatic, solenoid-operated oil switches in tanks between the fourth and fifth banks. The low-tension wiring consists of varnished cambric-insulated, fireproof-treated cables, and the high-tension copper tubing on post insulators arranged for a phase-spacing of 5 ft. and a striking distance to earth of 3 ft., the circuits being taken through the roof of the transformer compartments in compound-filled bushings.

The control switches are of the "push-and-pull" button type, single-pole double-throw, a green pilot lamp indicating the open position of the oil switches and a red pilot lamp the closed position. The system is operated at 220 volts from a 60-ampere 8-hour battery, or from the 18 kw. motor-generator charging set if required. From this supply are also operated the motors of the generator field-rheostats, air-duct shutters and turbine governors.

The voltage on the high-tension 'bus bars is automatically maintained between certain limits by means of a Tirrill or Brown-Boveri regulator operating from a 100,000/100-volt potential transformer. Each outgoing line is protected with choke coils and an aluminium cell lightning-arrester equipment complete with horn gaps, discon-

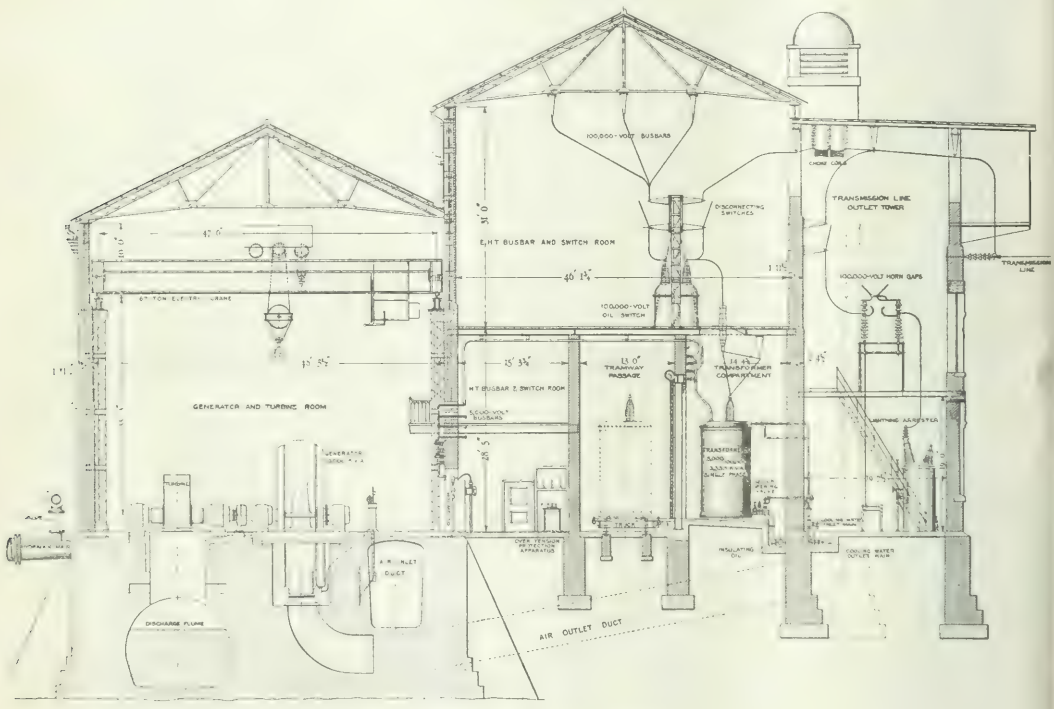
* Abstract of a Paper read before the Institution of Electrical Engineers.

necting switches, a discharge alarm and discharge recorders. The generators are star-wound for operation with an unearthed neutral, and for protection against pressure rises are provided with "over-tension" apparatus, consisting of insulating switches, static dischargers and star-delta horn-gap arresters. Earthed 'bus bars are run throughout the length of the building, and copper earth plates are provided for connecting up to the lightning arresters and other apparatus.

Transmission Line.

The present installation covers two transmission circuits on one line of towers, designed for a working pressure of 100,000 volts between phases. The conductors consist of seven-strand hard-drawn copper wire, the area of each wire being 0·095 sq. in., and its weight being between the limits of 364 lb. and 378 lb. per 1,000 ft. The conductivity of the copper is 97 per cent. of Matthiessen's standard, and the maximum allowable resistance is 0·255 ohm per 1,000 yds. at 60°F. Samples of the standard conductor are taken at random from each coil during manufacture and are tested in tension and torsion machines. The mechanical tests are a breaking stress of

The conductors are spaced 10 ft. 6 in. apart, and in the case of the intermediate towers are arranged delta fashion on either side of the tower, suspended on six-unit insulators. In the case of the anchor towers the conductors are arranged vertically on either side of the tower and are suspended on six-unit insulators. For the creek-crossing towers seven-unit insulators are used, the conductors being arranged vertically over one another on either side. The suspension insulators, which are 10 in. in diameter, are of two types, viz., of the metal-hooded type with ball joints for using vertically on intermediate towers, and of the link type for using horizontally on anchor towers. They are made from the best grade non-absorbent porcelain, highly vitreous, of uniform hard glaze, dark grey in colour, with metal hoods of malleable cast-iron and suspension links of galvanised mild steel, the threaded parts being sherardised and a special non-hygroscopic cement being used for cementing up the parts. The arrangement for attaching the suspension insulators consists of a sleeve in which the conductor is clamped, and for the anchor insulators a gripping sleeve through which the wire is passed and fastened with a split nut, all the parts being galvanised. Each unit with fittings



Sectional Elevation of Power House.

5,400 lb., an elongation of 1 per cent. in 6 in., an elastic limit of 3,800 lb., a torsional test of 15 twists in 3 in., and a wrapping test of six times round its own diameter, unwrapped and re-wrapped. For the creek-crossing spans a seven-strand hard-drawn silicon bronze conductor is used, having an area of 0·169 sq. in., a weight between the limits of 648 lb. and 676 lb. per 1,000 ft., and a resistance of 0·514 ohm per mile at 60°F.

The mechanical tests are a breaking stress of 14,000 lb., an elongation of 1½ per cent. in 6 in., and an elastic limit of 10,500 lb. A torsional test of eight twists in 6 in. and a wrapping test of six times round its own diameter unwrapped and re-wrapped. Individual [illegible] each conductor are drawn in as long lengths as possible, and where joints are used they are silver brazed, the conductors being supplied in standard lengths of 2,200 yds. For jointing up on the [illegible] a mechanical joint is used, which is made by [illegible] the ends of the conductors in opposite directions through [illegible] the wires and sleeve together with two clamps and rotating the clamps in opposite directions until the joint [illegible] twists.

in place is subjected to a mechanical test of 1½ tons tensile stress for the suspension type, and 1¾ tons for the strain type, the stress being applied for 10 seconds in a tension testing machine. The completed units are subjected to an electrical dry test of 60 kv. for five minutes and 70 kv. for one minute, the pressure being obtained from a transformer giving a 50-period sine-wave single-phase supply, and the insulators have to withstand such tests without flashing over or showing any defects.

Particulars are given of the steel towers. One of each type was tested to destruction at the maker's works and showed the required factor of safety of four.

The telephone equipment consists of two circuits of No. 14 S.W.G. copper-clad wire having a conductivity of 45 per cent., a resistance of 17·38 ohms per mile, a breaking stress of 41 tons per square inch, and a weight of 103 lb. per mile. On the land portion of the line the telephone circuits are arranged below the power circuits, one on each side of the towers, and are carried on transposition pin-type insulators, intermediate telephone poles being placed midway between the towers; whilst where the transmission line crosses the creeks the

telephone circuits are placed above the power circuits. The instruments consist of water-tight, high-tension, terminal telephones, which are installed at the power house, switch towers and receiving station, and are mounted on marble panels with protection devices. A transformer is interposed between the speaking and ringing apparatus and the line, and hearing takes place through a rubber tube, which provides for safety in the event of the telephone lines becoming crossed with the power circuits. For removing static disturbances in the telephone line in the event of a fault on a power circuit, a special type of drainage coil is used. Portable telephone sets are also provided. A guard wire for protection against lightning is arranged over each power circuit, and consists of a seven-strand steel cable, 0·295 in. in diameter, 0·188 lb. per foot maximum weight, and 6,400 lb. minimum breaking strength for the land portion of the line, and 0·378 in. in diameter, 0·309 lb. per foot maximum weight, and 11,000 lb. minimum breaking strength for the creek crossings. These cables are double galvanised and are boiled in linseed oil.

The equipment at the change-over stations in the line consists of four triple-pole, single-throw, 100,000-volt, bolt-type, out-of-door, disconnecting, air-break switches, which are mounted on seven-unit insulators fixed on wooden supports on the towers and are operated by rods fron the ground through bevel gears and rack. Each of the present circuits will transmit a load of 15,000 kw. at 0·8 power factor with a regulation of 11 per cent. and a line efficiency of 93 per cent., and a load of 20,000 kw. with a regulation of 14 per cent. and a line efficiency of 91·5 per cent.

Receiving Station.

The receiving station is situated at Parel on the Island of Bombay. It has been designed for an ultimate plant capacity of 74,880 k.v.a. in eight three-phase step-down transformer banks of 9,360 k.v.a. each, and four incoming lines with the necessary switchgear and station auxiliary apparatus, of which five complete units and two incoming lines are now being installed. Each step-down transformer bank consists of three General Electric oil-immersed, water-cooled, single-phase transformers, delta-delta connected. These lower the pressure from 85,800 to 6,600 volts, 50 periods.

For improving the power factor and regulation of the system, duplicate synchronous condenser sets are provided, each consisting of a 6,600-volt, 50-cycle, 500 revs. per min. three-phase synchronous motor with a 125-volt exciter on the overhung part of the shaft. The motors are started up direct from the 6,600-volt bus bars through compensators, the starting current not exceeding full-load current; and the total running losses, including the power taken by the exciters, do not exceed 153 kw. at full load and 167 kw. at 20 per cent. overload.

Dividing boxes on the wall of the 6,600-volt bus bar room connect the varnished cambric, single conductor feeder cables to the armoured three-core cables, which are run out of the building in an alleyway to a cable chamber where they are connected to the feeder distribution system.

Feeder System.

The feeder distribution system from the receiving station to the mills is designed for a 6,600-volt, 50-period, three-phase supply with an unearthed neutral. The cables are of the three-core paper-insulated, lead-covered type, in standard sizes (viz., 0·1, 0·15, and 0·2 sq. in. section) and are laid on the solid system in bitumen in earthenware troughing in trenches 18 in. deep below the footway and 24 in. to 30 in. below the surface in side and main streets. They are designed for continuous operation at a current density of 1,050 amperes per square inch for the 0·2 sq. in. size, 1,240 amperes per square inch for the 0·15 sq. in. size, and 1,560 amperes per square inch for the 0·1 sq. in. size, with a reduction of 5 per cent. in the carrying capacity when two, and 15 per cent. when four cables are laid side by side. The mills are arranged in groups, each group having a feeder to each mill, with an emergency ring-feeder connecting up all the mills of the group. The street distribution system was supplied by Callenders' Cable Co.

Mill Equipments.

The problem presented by the Bombay Mills was the conversion of mechanical to electrical drive utilising the present shafting, the change being effected with as little interference as possible with the production of the mills. The problem was thoroughly investigated, and after due consideration group driving with direct-coupled motors was adopted as being best suited to the requirements of the Bombay industry. Standard speeds of 265, 290 and 365 revs. per min. were adopted. The motors are of the slip-ring induction type, wound for 1,000 volts, three-phase, 50 periods and provided with brush-lifting and short-circuiting gear, and are in standard sizes ranging from 0 H.P. to 500 H.P. They are designed for full-load rating with a temperature rise of 70°F. above air at 100°F., and for 50 per cent. overload for half-an-hour without undue heating. The starting switches are of the liquid type, the electrodes being operated through slow-motion gear and the motors being designed to start up against the full-load torque with a starting current not exceeding the full-load current. In the case of callender machines special starters are required in order to meet the conditions of the service.

The mill transformers are of the three-phase 6,600 2,200-volt, 50-period, oil-insulated, air-cooled, core type, are star-connected on both sides, and are provided with an earthing device. They are supplied in four sizes, viz., 500, 600, 700 and 900 k.v.a., from which the power requirements of each mill are met. The mill equipments are supplied by the British Westinghouse Co. A sub-station is provided at each mill for the transformers and switchgear, the feeders being connected up to the high-tension bus bars through trifurcating boxes, single conductor cables, a triple-pole oil emergency switch and disconnecting links.

The present electrification contract covers 30 mills, requiring 63 transformers aggregating 39,500 k.v.a. and 199 motors aggregating 37,525 H.P., the power requirements of individual mills ranging from three motors aggregating 325 B.H.P. to 19 motors totalling 2,400 B.H.P. All the mill engines were indicated for maximum and average indicated horse-power and tachograph tests were made of the loads on the shafts, the steam-driven rope drivers being replaced by direct-coupled motors which are installed in most instances in the rope races, on stagings built up of rolled-steel joists, the motor feet being fastened to the steelwork by means of foundation bolts.

The terms of the agreement between the company and the mill owners cover the supply of energy for power purposes in Bombay at 0·55 anna per unit in the case of mills where the company supply the complete equipment, and at 0·5 anna per unit in the case of mills which provide their own motor equipment, the company providing and maintaining the mill transformers. Energy for lighting is supplied at 1·25 annas per unit. The agreement is for a period of 10 years.

MAGNETIC AND OTHER PROPERTIES OF ELECTROLYTIC IRON MELTED IN VACUO.*

BY TRYGVE D. YENSEN.

Summary.—While pure iron melted in an atmosphere of carbon monoxide, under atmospheric pressure, will absorb both carbon and oxygen, with the result that the iron thus produced is of an inferior magnetic quality, low carbon iron melted in vacuo will lose 50 to 90 per cent. of its original carbon content. The magnetic quality of electrolytic iron melted in vacuo is decidedly superior to any grade of iron thus far produced, the maximum permeability obtained being 19,000 at a flux density of 9,500 gausses. The average hysteresis loss obtained is less than 50 per cent. of that found in the best grades of commercial transformer iron.

In 1911 the writer commenced an investigation of the magnetic properties of iron in the Electrical Engineering Department of the University of Illinois. Doubly refined electrolytic iron, deposited according to the methods used by Burgess, has formed the basis for the investigation. It was deposited from Swedish charcoal iron, and contained 0·006 per cent. of carbon, 0·01 per cent. of silicon and only a trace of sulphur.

For fusing and annealing the iron, the crucibles used were made from electrically fused magnesia containing about 2 per cent. silica, and these crucibles were placed in graphite crucibles and securely covered. If a resistance furnace was used for this process, the iron was contaminated. If the crucibles were left exposed in the furnace the iron was so badly oxidised that it cracked to pieces under the hammer in the attempt to forge it. If buried in crushed carbon the iron absorbed comparatively large quantities of carbon. Burgess used the latter method and found that the iron absorbed from 0·05 to 0·15 per cent. carbon, probably by reducing the carbon monoxide gases surrounding it. The results obtained by the writer agree with those obtained by Burgess, so far as the carbon is concerned, but as will be shown later, carbon alone does not account for the properties of the iron thus produced.

In order to overcome the difficulties above referred to, a vacuum furnace was constructed in the shops of the department. The inside parts consist entirely of graphite cut from solid graphite electrodes, with the exception of the water-cooled copper tubes, that serve as supports as well as leads. A Geryck pump is capable of maintaining a pressure of 0·5 cm. or less with 500 to 600 grams of molten iron in the furnace. The state of the charge may be observed through a mica window in the top.

A number of different instruments for the magnetic measurements were tried and discarded. The main defect of most of them was

* Abstract of a Paper read before the American Institute of Electrical Engineers.

that large and uncertain corrections had to be made to the readings in order to arrive at the correct results. An instrument was needed that could measure accurately the magnetic properties of relatively short rods. The one finally decided upon was constructed by the writer in the shops of the department in accordance with the recommendations of the Bureau of Standards.* Briefly stated, it consists of a double bar and yoke with one main solenoid, and one auxiliary solenoid, separately controlled, and four compensating solenoids, next to the yokes connected in series.

For the determination of B a ballistic galvanometer of a 15-second period was at first employed. This served the purpose very well until the electrolytic vacuum iron was ready to be measured in the annealed state. On account of the high permeability and low electrical resistance of this iron, the change of magnetism was found to be too sluggish for accurate determinations with a ballistic galvanometer. This was particularly true for hysteresis determinations. Five or six seconds were sometimes required for the flux to complete the change, so that by the time the galvanometer coil had reached its maximum deflection the flux was still changing. It was, therefore, very evident that the galvanometer had reached its limit of usefulness, even though its period had been doubled. To overcome this difficulty a Grassot fluxmeter was used for all the final measurements. A slight difference is shown between the author's results and the calibration of the standard rod by the Bureau of Standards. Corrections have been avoided so that any error is on the safe side.

Details of the Experiments.

The electrolytic iron previous to being placed in the crucible to be melted was crushed into small pieces and thoroughly cleaned with hydrochloric acid, boiling distilled water, and alcohol. It was then transferred to the crucible, covered with a magnesia cover and placed in the vacuum furnace. The furnace was exhausted immediately and heated up, slowly at first, so as to give the absorbed gases time to escape without too much loss of vacuum. With the furnace at a dull red heat the melting would then require about half hour with an input of 15 kw. In order to insure homogeneity 12 kw. was left on for another 15 minutes, and the furnace then allowed to cool.

When removed from the furnace the ingots were as bright as silver and so soft that they could be cut with a knife. They were reheated in a coke forge to ordinary forging temperatures, 1,000°C. to 1,100 C., and forged into rods about ¼ in. by 20 in. (1·25 cm. by 50 cm.). From these rods the test pieces were prepared.

After being tested as forged, the test pieces were sent through different heat treatments. If they were to be annealed they were packed in pulverised magnesia in an iron cylinder, A, and placed in an annealing furnace. In order to minimise the formation of oxide the magnesia was moistened with alcohol to drive out the air. After reaching the annealing temperature desired, the cooling was slow in all but the preliminary tests, in accordance with definite cooling curves. The temperature was measured by means of a platinum-platinum +10 per cent. rhodium pyrometer, calibrated from time to time.

Quenching was done by placing the test pieces in a cylinder filled with magnesia and moistened with alcohol. When the desired temperature was reached, the cylinder was removed from the furnace, tipped up, and the contents plunged into the quenching bath by means of a sharp blow on the top of the cylinder.

The final heat treatment received by all the rods consisted in annealing at about 900°C. and cooling in 48 hours according to a straight time-temperature curve, correcting 900°C. and 200°C. Fig. 1 shows the magnetisation curves for the average and best electrolytic vacuum iron, and Fig. 2 shows the hysteresis loops and permeability curve for the best rod, No. 3-38.

For the sake of comparison a number of other rods have been tested, and the results included in this Paper. A sample of Swedish charcoal iron showed a maximum permeability of 4,870, and the same specimen after remelting in vacuo, gave a maximum permeability of 10,350.

Figs. 3 and 4 show the magnetisation curves for all the rods, compared with the average for the electrolytic iron melted in vacuo, all after having received the final heat treatment.

Discussion of Results.

The magnetic qualities of iron at different qualities depends upon the proportions of ferrite, cementite and pearlite that are present and upon the allotropic modifications of Alpha, Beta and Gamma iron. The Beta and Gamma modifications are weakly paramagnetic, while Alpha iron is ferromagnetic. Another factor that may influence the magnetic properties of iron is mechanical strain, either due to outside influence or due to rapid cooling. It is not definitely known which is the more important, removing mechanical strain, or changing all the iron into Alpha iron. It is certain that both are important, and that both may be accomplished by proper annealing. It is well known that if, subsequent to annealing, the iron be mechanically strained, its magnetic quality is depreciated.

It is apparent from the author's experiments that the melting of electrolytic iron, or low carbon iron in general, in an atmosphere of carbon monoxide gases, gives the iron a chance to absorb carbon, the amount absorbed varying from 0·05 to 0·15 per cent. This result is in agreement with the experiments of Burgess and Aston. It is furthermore seen that carbon is not the only factor that affects the magnetic properties of iron. Swedish charcoal iron, with a carbon content of 0·163 per cent., and an electrolytic iron-carbon alloy melted in vacuo, with a carbon content of 0·181 per cent., both have a decidedly higher permeability than the electrolytic iron melted in the resistance furnace, although the latter has an average carbon content of only 0·10 per cent. Again, the electrical resistance of the resistance furnace iron is 13·52 microhms while that of the above mentioned two samples is 10·57 and 12·40 respectively. The carbon content of 0·1 per cent. does not by itself account for a resistance of 13·52 microhms. According to Barrett this resistance corresponds

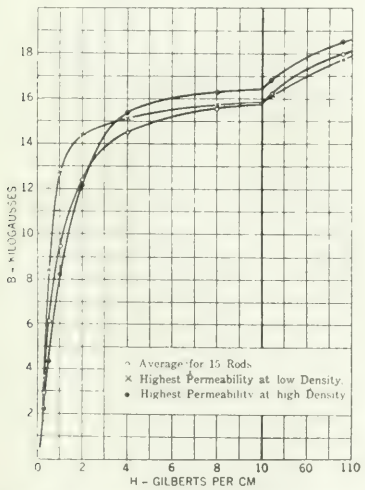


Fig. 1.—Magnetisation of Electrolytic Iron.

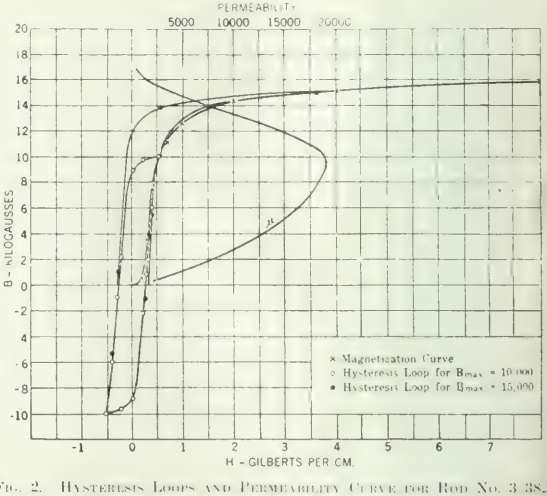


Fig. 2.—Hysteresis Loops and Permeability Curve for Rod No. 3-38. Annealed at 900° C., Cooled in 48 hours.

* Bulletin, Bureau of Standards, Vol. VI, No. 1. Reprint No. 117.

to a carbon content of 0·6 per cent. As carbon is probably absorbed from CO according to the reversible reaction

$$Fe + CO \rightleftarrows FeO + C$$

it seems natural to assume that not only carbon but also FeO is absorbed by the iron. In that case the result would be an alloy of ferrite, cementite (Fe_3C) and iron oxide (FeO). For a carbon content of 0·1 per cent. the alloy would contain 1·5 per cent. cementite, and 0·59 per cent. FeO. While cementite is slightly ferromagnetic, as shown by Hadfield and Hopkinson, FeO is paramagnetic, and a very poor conductor of electricity. With these two substances interspersed among the ferrite crystals, the low permeability and high resistance can be satisfactorily explained. The results also show that the Swedish charcoal iron lost nearly all of its carbon by being melted in vacuo, the carbon content in the final iron being only 0·008 per cent. At the same time, as would be expected, its electrical resistance has been slightly lowered and its magnetic permeability considerably increased. Similarly, the three iron-carbon alloys melted in vacuo, lost the larger part of the carbon added to them. The loss for the Swedish iron was 95 per cent. of the carbon. The Bureau of Standards has demonstrated that such a loss occurs by melting electrolytic iron in vacuo, the loss found being in one case 67 per cent., in another case 87·5 per cent. * In the present case the electrolytic iron melted in vacuo not only did not lose any carbon, but actually gained a slight amount. In order to explain this apparent discrepancy it should be mentioned that the pressure used by the Bureau of Standards investigators in their vacuum furnace

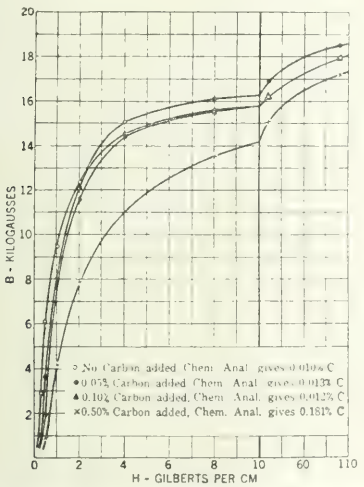


Fig. 3.—Magnetisation Curves for the Iron Carbon Alloys Melted in Vacuo.

was 0·01 mm. of mercury, while the pressure used by the writer was from 2 mm. to 5 mm. Based upon the facts enumerated above, the following explanation is now offered. Any oxygen left in the furnace combines with the carbon of the heating element and forms carbon monoxide (CO). This gas, as already stated in connection with the results obtained with the resistance furnace, reacts with the iron according to the reversible equation

$$Fe + CO \rightleftarrows FeO + C$$

until equilibrium is established. If, now, the pressure in the furnace be lowered the reaction will take place from right to left; that is, any FeO that may be present will be reduced by the carbon in the iron, with the result that the carbon content will be reduced until equilibrium is restored. Conversely, with an increase of pressure due to an admission of oxygen, the reaction will take place from left to right, and the carbon content, as well as the FeO, of the iron will be increased. Upon this hypothesis the difference between the carbon content obtained by the Bureau of Standards and that obtained by the writer is immediately explained.

The permeability increases quite uniformly as the annealing temperature is raised, at first slowly, and then very rapidly as the annealing temperatures are raised from 700°C. to 800°C. Above 800°C. some uncertainty appears. The permeability is decreased for 950 deg. and again increased for 1,000°C. Whether this result is due to mechanical strain in clamping the rod in the permeameter or whether it is due to different rates of cooling or to some other cause, the writer is not prepared to say. From the experience previously related it seems most probable that the drop for 950 deg. is due to mechanical straining, as it occurs for low values of H only. For values of H=8, or above, the permeability is decreased by annealing at temperatures above 900°C., and does not return to the higher value by further annealing at lower temperatures. Furthermore, upon annealing successively at decreasingly lower temperatures, the permeability is increased for low values of H. Such a process is, of course, equivalent to annealing at the highest temperature and cooling at a slower rate than was used for each of the successive annealings.

The average magnetisation curve for electrolytic iron melted in vacuo, as shown in Figs. 3 and 4, is based upon the results obtained after the final heat treatment, whether this gave the best results for each particular rod or not. This average also includes the results for a rod that perhaps should have been thrown out. The average curve is, therefore, somewhat lower than might be expected for 15 rods treated under more favourable conditions. However, it serves to indicate the place occupied by electrolytic vacuum iron, in relation to other grades of iron.

While the curve for the electrolytic vacuum iron is the highest of those represented in Fig. 4, the curve for the Swedish charcoal iron remelted in vacuo is a close second, and these two are far above the curves for commercial iron used at present for magnetic purposes. The maximum permeability for the average magnetisation curve is

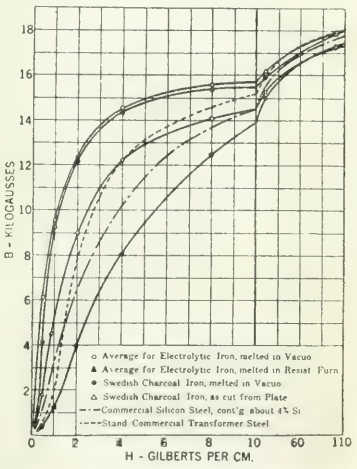


Fig. 4. Comparison of Magnetisation Curves for Different Grades of Iron.

12,950, occurring at a flux density of 6,550 gausses. The maximum obtained, however, is 19,000 for rod No. 3-38 (electrolytic), at a flux density of 9,500 gausses.

While high permeability is of interest for certain purposes, the characteristics of iron that are of special interest to the manufacturer and user of electrical machinery are hysteresis and eddy current losses, the latter depending largely upon the electrical resistance of the iron. The author's results show that the hysteresis loss for $B_{max} = 10,000$ is less than one-half as high for the average electrolytic vacuum iron as it is for the commercial silicon steel, while for $B_{max} = 15,000$, the corresponding figure is about two-thirds. The reason why the hysteresis loss for the vacuum iron is not even still lower, compared with commercial iron, is readily seen by looking at the figures for retentivity. While the retentivity for $B_{max} = 15,000$ is 9,940 for the average electrolytic vacuum iron, it is only 5,400 for silicon steel. The hysteresis loss for Hadfield's best magnetic steels, the 2½ per cent. silicon alloy and the 2½ per cent. aluminium alloy, as reported by Barrett, Brown and Hadfield, for $B_{max} = 9,000$ is 1,550 and 1,440 ergs, respectively, per cubic centimetre per cycle. Comparing these results, it is seen that in spite of the high retentivity, the hysteresis loss for the electrolytic vacuum iron is much lower than for any material thus far produced, of which the literature gives information. This is due to the low coercive force, namely,

0·34 gilbert per centimetre, this being the average value for the 15 rods.

The electrical resistance for the average vacuum iron is 9·96 microhms per centimetre cube. The resistance for the standard transformer steel is 11·09 microhms, while that for the silicon steel is 51·15 microhms. Thus the eddy current losses per unit volume, for the same thickness of sheet and for the same maximum flux density, would be much in favour of the silicon steel. However, it is definitely known that the resistance of the latter can be raised by the addition of silicon or aluminium. What the effect of such additions upon the magnetic quality of the iron will be remains to be seen, but judging from the effect they have upon commercial grades of iron, it seems probable that it will not be harmful.

THE POWER SUPPLY OF THE CENTRAL MINING-RAND MINES GROUP.

We conclude below our account of the discussions, which took place before the Institution of Electrical Engineers in London, Birmingham and Manchester, on Mr. J. H. Rider's Paper on this subject. An abstract of this Paper appeared on pp. 53 and 88 of our issues of April 16th and 23rd respectively.

Mr. Roger T. Smith said that where the supply was measured by three meters in series it was in general very important to get types of meters which had different sorts of errors, so that the errors might more or less cancel out. He would like to ask the author whether the A.E.G. and the General Electric meters were of sufficiently different types for the errors to cancel out more or less. The alternating-current measurements of variable load were, of course, much simpler than direct-current measurements; but the temperature rise errors were of particular importance, and he would like to know if the author's meters were adjusted after the average load had flowed through them for some hours, so as to get an average of the temperature error. The Paper stated that the meters were calibrated on the site or in the laboratory. Had the author found that there was considerable difference between the results obtained in the laboratory and on the site? The Paper dealt with the troubles from large liquid resistances, but had the author tried the type of water resistance consisting of a drum half filled with liquid with the plates in the upper part, the drum being slowly revolved? He knew that such types of water resistance had been used up to 1,000 kw. at about 2,000 volts, but he believed only for starting, and not for regulating purposes. If such a system were applicable to those very much larger powers it would appear to be a great simplification. All users of induction motors would agree with the author's strictures on the troubles with slip-rings. With one or two exceptions, it seemed to him that the design and installation of slip-rings in induction motors was the weakest point, and in his own experience it was almost the only part of an induction motor which ever gave trouble. He thought the matter should be taken up more seriously by manufacturers than it had been in the past. He agreed with the author that it was quite worth while to use contactor switches. The contactor never went wrong, and the master controller, besides being a small and handy piece of apparatus, gave one the advantage of being able to have automatic control of auxiliaries if the limit was reached. Finally, on the question of the resistances themselves, had the author ever tried to use iron tube resistances with water circulating through them? That method had been used successfully for laboratory purposes for absorbing quite large quantities of current.

Dr. A. H. Railing endorsed the author's remarks about manufacturers. There was no doubt that manufacturers had sinned in the past, and had had to learn and re-model their arrangements. One great fault in the past had been that commercial men were sent as salesmen to the foreign branches, instead of men who were able to study the local problems with a view to meeting them. The author would, however, find that during the last three or four years matters had altered very much, engineers now being given a greater voice at the top. With regard to Mr. Shepherd's remark that the total number of units taken by the Rand mines was greater than the total number of units sold in the London area, he was given to understand that the total number of units generated in the London area (including railways) amounted to more than one thousand million.

Mr. R. Hammond regarded the Paper as a "gold mine." The point that especially appealed to him in the Paper was diversity factor. The author had shown how, when generating from a central supply, one got the immense advantage of diversity. When Mr. Rider was seeking to obtain a bulk supply for London there were those who ridiculed the idea that there would be such a great cheapening of the electricity supply due to the diversity factor, but the author had now given some very remarkable figures in that connection.

Mr. Ll. B. Atkinson referred to Mr. Sparks' remark that had the author been on the spot earlier probably much more satisfactory and economical arrangements from the consumer's point of view would have been made. The scheme emanated from the consumer, and not from the power company, and they did not succeed in convincing their own group that the scheme was good enough for them to put their own money into, with the result that it was put on the financial market. There were English financiers quite ready to find the money, but they were advised by engineers that the consumer had so much the better end of the stick that it was not good enough to put their money into. He was, therefore, quite convinced that even Mr. Rider could not have obtained better terms for the consumer. He was of opinion that the project would last a good deal longer than the 20 years of the contract.

Mr. J. J. Fasola said that the Paper could be referred to as a strong argument for the electrical conversion of steam winders, but a still more powerful argument would be available if energy consumption figures had been given, such as, for instance, some statement that the energy consumption during normal winds per short ton raised 1,000 ft. vertically ranged between, say, 1¼ units to 2 units, with an average of 1½ units. By simple multiplication with the price per unit of the local supply company a sufficiently attractive idea of the cost of electrical winding could be obtained to induce engineers to carry out further investigations by means of diagrams. There appeared to be a considerable diversity of opinion among manufacturers as to whether the equivalent continuous rating of the motors at full speed should be the root mean square diagram output taken over the running and stopping periods, or whether more or less large marginal corrections should be allowed for reduced ventilations during acceleration, retardation and stops. It would be interesting to know the Rand practice in this respect. In connection with the improved design of liquid controller mentioned in the Paper, it occurred to him that, instead of using two tanks with a change-over rotor switch, it might be feasible to arrange two sets of differently spaced straight rods in one tank connected in parallel during starting, and to arrange for the starting electrodes to be simply disconnected from the circuit by means of a double grip level during counter-current braking. In comparing the Ward-Leonard and three-phase controls, the author did not deal with the great advantage of the Ward-Leonard control being dependent upon the position of the lever and independent of the load, and the consequent advantage with this particular system of being able to arrange cams on the depth indicator to limit automatically and mechanically the speed at which the winder could be manipulated near the tip, and prevent starting up in the wrong direction, without otherwise interfering with the driver's useful command of the winder. Was the Phillip's device still considered desirable in that case? He was glad to hear the author's views in respect to low temperature rises and large air-gaps, even at a small sacrifice of power factor. The serious losses which might accrue from stoppages of some motors on gold mines seemed in many cases a sufficient reason to warrant preference being given to motors with former wound stator coils in open slots and rotor bars clipped at both ends to facilitate rapid repairs. Further, owing to troubles which had arisen with eccentric gaps, the practice of grinding all rotors and grinding or turning up the stators as well had led to increased freedom from troubles. He had not been able to detect any appreciable extra temperature rise on stator stampings ground or turned with a sharp tool. What seemed to be the best prevention against most troubles was to carry out severe inspection, running and flash tests at maker's works, and have necessary alterations and adjustments made to short-circuiting gears, &c., before allowing the motors to be sent out to the mines.

Mr. E. J. Fox, referring to Mr. Atkinson's remarks, said that the Victoria Falls Power Co. was one of the glaring cases of the weakness of British methods of finance. The superior German methods of finance enabled them to undertake the underwriting of the capital, but in point of fact he believed that the only capital the Germans found were the debentures, which, from a financial point of view, were fairly safe, and at the same time they reserved for themselves the right to supply the plant. The greater part, if not all, of the ordinary capital was found by the City of London, which therefore took all the risks but got none of the plums.

Mr. J. H. Rider, in reply, stated that Mr. Shepherd had asked whether he considered 25 per cent. reserve plant sufficient. Like most things, that all depended upon whether the plant was a good one to start with, but he thought 25 per cent. was enough. The troubles in the supply mentioned in the early part of the Paper took place at a time when there was not 25 per cent. spare plant, and since there had been this amount troubles had been almost unknown, at any rate so far as failure of supply was concerned. Of course, part of the plant would always be undergoing its periodical inspection; but even if only half the 25 per cent. was ready to start up at a moment's notice he was sure that was sufficient. With regard to the range of pressure, it should be understood that he was not speaking of variations of pressure such as would be seen upon an ordinary recording chart, but that he was referring to the trouble one got when for many hours the pressure was very high or very low. On a large system with three-phase motors quick variations of pressure lasting for only a short time did nobody any harm, but it was the long-continued running at low pressure that give rise to the troubles mentioned in the Paper. The variations of pressure were mentioned for two reasons; firstly, to show what kind of thing consumers had to put up with, and, secondly, to show that it was not until those limits were exceeded that they could put the screw on the power company and get a penalty. He thought it should be possible to screw the power company up long before the pressures got to anything like the limits mentioned. He did not at all agree with Mr. Atkinson that had he arrived on the scene earlier he might have arranged better terms. With regard to Mr. Shepherd's question as to whether alternating-current winders were reliable without eddy current brakes, his experience had been that, since they had altered the control tanks and made them safe from the risks of flashing over when reverse current was applied for braking, they had been perfectly safe, although he admitted that there was a little greater risk with an alternating-current winder if the supply should go off. They had had

trouble with the old converted steam winders, which was only to be expected; but they had never had a case of any accident due to the electrical winding of the three-phase type which had been made for the purpose. The contactor gear was quite satisfactory for 2,000 volts on the stator and for as high as 1,500 volts on the rotor. The pipe framework referred to was, of course, that made and supplied by the General Electric Co. (U.S.A.). He did not like pipe framework, and, as was pointed out in the Paper, it had had to be replaced on that particular job. Speaking frankly, he had not much faith in overwinding devices, because he had found that the more devices put upon a winder which took the control of the winder out of the driver's hands, the worse it was. The use of the Phillips' indicating device had practically got rid of the risk of starting the hoist in the wrong direction. The centrifugal pumps described, were working to a head of 2,400 ft., but he did not think that that by any means represented the limit of the centrifugal pump, although it had got very close to the limit of the pipe line, which was the thing that gave the trouble. As to insulation, fortunately the atmosphere on the Rand was exceedingly dry. If it had been London air they would have had a good many more breakdowns. With regard to driving the tube mills, he would not like to go in for worm driving, because of the difficulty of lining up. In reply to Mr. Sparks, the largest winders on the Rand were of the Ward Leonard type. There were, however, a great many three-phase winders as large as 1,500 H.P. in single motors. The 30,000 H.P. referred to in the Paper as being the power used for pumping was the total power, and only about 5,000 of that was for driving centrifugal pumps. In connection with Mr. Sparks' remarks on ventilation, he did not want it to go abroad by any means that the ventilation of the gold mines on the Rand was neglected. That was certainly not so. Many of the mines had natural ventilation by two or more shafts, and the enormous amount of compressed air used in the rock drills was always discharging out into the workings, and therefore supplying a great quantity of fresh air. He was glad to have Mr. Hunter's appreciation of the large-sized switches adopted, and, of course, in selecting them, they took care that the mechanical parts should be exceedingly strong. Mr. Hunter raised a very interesting point about the possibility of making improvements in some of the mechanical arrangements on the mines, and referred to the experiment of trying to drive the cam shaft at double the speed. It was quite true that cam profiles could be altered, but the stamp mill was a satisfactory article, and would remain, because of its extreme simplicity, and efficiency in cam driving meant to the mines something that would not stop. As to the metering, they had separate transformers for each of the three meters, and, in reply to Mr. Roger Smith, they did not, speaking generally, find any very great difference in the curves of the two types of meters. As a matter of fact, metering was one of the most satisfactory points of the whole supply. The meters were calibrated half on the mines and half in the laboratory, and, of course, care was taken to see that both the meters and the transformers were at ordinary working temperature when tested. He was interested in the type of water resistance referred to by Mr. Roger Smith, but, however satisfactory that might be for starting up motors once a day, it would be entirely out of court for a three-phase winder. He had never tried water cooling of iron tubes, because he rather thought that they would have difficulty with the earthing system generally in consequence. He did not think Mr. Atkinson's remarks called for any reply, as the Paper was not concerned with the financial history of the power company. He would reply to Mr. Fasola's remarks in the "Journal."

DISCUSSION AT BIRMINGHAM.

Mr. N. B. Rosher said that the Paper fell under the category of descriptive Papers, but it differed from most in that it admitted that there had been troubles and failures of the plant. The author was to be commended for having made these admissions, and he would ask him to furnish further particulars in addition to those he has given in his Paper. It was from records of failure and troubles experienced that frequently most was to be learned. Under the heading "Troubles," on page 20 of the Paper, some rather astonishing particulars were given of bad design and workmanship in the plant installed. It would be interesting to know where the plant was made; he would be surprised to hear that it came from this country. When he was in Cape Colony some years ago he remembered that at that time a large proportion of the electrical apparatus was purchased from the United States on account of the exceedingly low freights by comparison with those quoted for goods from Europe. He had had but little experience of electrical machinery of foreign make, but as regards British products he could not agree with the author that flimsiness of design was the usual characteristic of three-phase motor brush gear. Neither did he believe that it would be easy to find British made motors in which the stator frames became distorted under load or in which a 6 ft. rotor had a radial air-gap of only 1 mm., a more usual figure being at least double that amount. The remedy for such troubles lay in the hands of the purchasing engineer; for instance, he could either specify the air-gap or alternately he could request firms tendering to state their proposed air-gap. With regard to the author's formula for minimum radial air-gap it would appear that the figure obtained by this formula for the 6 ft. diameter rotor was cutting it rather fine. A rough approximation for the air-gap which he had found [illegible] with the gap as measured on a large number of motors of various makes and sizes was to take the gap as being 1/500 of the rotor diameter. This formula was, of course, not strictly accurate, and gave rather too large a gap for motors having rotors of such large diameters as the one in question. He would ask the author why the drills were not electrically operated, instead of by compressed air as was being done with success in this country. The efficiency of a compressed air system did not as a rule exceed 30 per cent., whereas the efficiency of the electric system might be taken at 80 per cent. Assuming that compressed air must be retained for blowing out the workings, would it not on the whole be more advantageous to instal electrically-driven compressors at each mine?

Dr. C. C. Garrard said that there was no doubt that for large power consumers the system of having three separate meters in series was a very good one. He would like to ask whether each separate meter of the three was provided with its own current and potential transformers. With regard to Fig. 6 in the Paper it appeared to him that this diagram had a very serious fault, in that should the apparatus go wrong in any way, warning was not given, and an accident might happen. For example, a break in the battery connection would prevent the warning hooter sounding. It seemed to him that any such apparatus should be so constructed that in the event of its going wrong it gave the danger signal and prevented an accident. This was, of course, a rule which was absolutely followed in all railway signalling. Mr. Rider took up the thorny subject of the alleged inability or unwillingness of manufacturers to supply what the customer wants. He trusted Mr. Rider would not think he was referring to him when he said that in the majority of cases the manufacturer knew very much better what the customer should have than the customer did himself. This was only as was to be expected, as the manufacturer dévoted his life to manufacturing, say, a particular article and knew everything about it from A to Z; whereas probably the purchaser had a much more superficial acquaintance with the article in question. The fine art of salesmanship, of course, was to conceal carefully this fact and, while letting the customer believe he was getting what he asked for, actually to sell him what he should have. In this way future trouble was avoided which if it did occur the manufacture, was bound to get blamed for whether it was his fault or not. He thought the very fact that these disputes could occur showed the great need which existed for an increased standardisation of electrical apparatus. Taking the case of electrical oil switches, the state of manufacture of these was at the present time quite chaotic. Mr. Rider apparently had specified a rating of 800 amperes, 15,000 volts for his 2,000 volt switches. This, however, was quite an arbitrary figure. As far as he knew, the only attempt which had been made to standardise oil switches had been made by Verband Deutscher Elektrotekniker in a number of proposals and suggestions issued by them about a year ago. In these suggestions was laid down a rule that the rating of an oil switch must correspond to the maximum current which it would have to break on short circuit in the situation where it was situated. This was undoubtedly right.

Mr. F. Greenhalgh said that with reference to the operation of oil-immersed stator switcher or liquid controllers he would be interested to learn if the plain butt-contact switches which had been used to such a large extent had withstood arcing satisfactorily, and whether they required much more attention than the open-type carbon break switches, illustrated in Fig. 4 in the Paper. While the liquid controller gave a particularly smooth acceleration, serious objection appeared to be taken to the manual labour required to operate it. Had Mr. Rider had any experience with the type of liquid controller in which the dippers were lowered into the water by a float in a small chamber controlled by a gate valve which could be adjusted to give any depth of immersion in somewhat the same manner as that adopted in the standard liquid winding controller? Several of these controllers were already employed on small mine hoists in this country, and they would appear to have largely overcome the objection referred to, as the volume of water to be handled was much smaller than in the other case.

Mr. J. M. Walshe said that in referring to the tests of the motor-driven air compressors the author gave figures showing a discrepancy of 10 per cent. between the maker's guarantee and the results of a test on site. The larger part of the difference he considered to be due to the method of estimating the output of air. The efficiency stated was so much lower than was usually obtained with this class of compressor that he doubted very much whether the method used was reliable on those particular tests. The author used the expression "direct means," but any of the methods of measuring air were more or less indirect and depended for their accuracy on various corrections and assumptions. The instrument used on the test referred to was a "gate" or "weighted door" type of motor, the constant of which must be determined by calibration against a more direct method such as a reciprocating displacement meter. The conditions under which the calibration was carried out might differ considerably from those existing when the instrument was in use, and in consequence errors were likely to occur. He considered the sharp-edged orifice a much more reliable means of measuring air flow, but even this had to be used with caution. Corrections were necessary for contraction of jet, friction, ratio of orifice to pipe diameter, moisture, &c., and various assumptions such as uniform steady flow and constant density were made, any of which may be erroneous.

Dr. M. L. Kahn said that in view of the unique experience of Mr. Rider with three-phase induction motors used for main and tail haulage gears, he was particularly interested in his remarks about this point. These winders were compared with winders controlled on the Ward Leonard system. The Ward Leonard system required for each winder an induction motor direct-current generator and direct-current motor. The two latter machines introduced the element of two large commutators in the working of the system. The haulage gears as installed in most mines on the Rand only employed slip-ring type induction motors, which offered advantages in cost of installation and in maintenance, and reduced the possibility of trouble by decreasing the number of units required. In spite of this apparent simplicity, Mr. Rider seemed to favour the Ward Leonard system, apparently due to the fact that in the Ward Leonard system the whole speed control was effected by shunt regulators, while in

the single motor system large weirs of liquid starters had to be moved by hand.

Dr. KAPP said that the feeling of satisfaction at the great usefulness of the Paper was overshadowed with a feeling of uneasiness when we read of the failures recorded. These were not unavoidable failures, but failures due to dishonest work. That any firm should send out faulty work, patched up so as to hide the faults was bad enough, but that the work should be sent knowingly to a place where the lives of men depended on honest work was nothing short of scandalous. The author had not disclosed the makers' names, and he did not ask him to do so now; but he would be glad if he could in his reply give an assurance that these particular examples of commercial dishonesty did not come out of British workshops. When speaking of temperature limits, the author stated that a rise of only 35°C. was allowed, making the absolute temperature with an air temperature of 35°C. only 70. This was considerably lower than the Engineering Standards Committee allowed even for untreated cotton insulation. There may be a special reason why so low a temperature had been fixed for plant intended for Johannesburg, and it would be interesting to know this reason. The air-gap in asynchronous motors by the author's formula was smaller than generally allowed. He suggested that it would be safer to allow a larger air-gap and counteract its worsening effect on the power factor by using phase advancers. This would also have the incidental advantage of reducing the great variation in voltage mentioned in the Paper.

DISCUSSION AT MANCHESTER.

Mr. S. J. WATSON said that it was difficult to understand why the power plant load factor should be about 75 per cent. whilst the load factor of the air system was only 30 per cent. The 75 per cent. load factor indicated that some of the processes were working right through the 24 hours, and presumably the processes employing air compressors were only used part time. Further information on the compensating device for air meters would be of interest, also figures giving the efficiency of the air compressor system. The speaker was not aware of the distances over which the air at 100 lb. pressure was transmitted, but it appeared obvious from the author's remarks that, in the past at any rate, there had been very serious losses due to leakage.

Mr. A. E. MACKENZIE said that the author had addressed a word of warning, which some engineers present would perhaps have to take to heart during the next few years, in stating that it was only courting failure to attempt to give a permanent and reliable supply without a proper reserve of generating and transforming plant. Many central station engineers in this country would be pleased indeed to have the reserve of 25 per cent. which the author considered necessary for a supply like the Rand. It was difficult to understand why the power company stipulated in their agreement a possible frequency variation of 10 per cent. Such a variation would not be good enough for a Lancashire cotton mill owner, and considering a 75 per cent. load factor and the serious trouble encountered by the author with stamps and the speed of rotary mills, it appeared that this variation was frequently obtained. Mr. MacKenzie did not think there was a supply company in this country where such variations obtained at any time and desired the author's assurance that this guarantee or stipulation was quite unnecessary. Regarding the transformers, were these of the self cooling type?

Mr. RIDER said that they were oil-cooled.

Mr. MACKENZIE, continuing, asked whether oil-circulating or water-circulating systems were in use. The expense of three meters was warranted, especially in view of the immense power to be metered. It would appear advantageous to have each series of three composed of different types, preferably with different characteristics. The author stated, "It is a very common and erroneous practice to instal oil switches without considering the volts that they may be called upon to deal with." In justice to engineers in this country, the author should substitute "was" instead of "is," as this feature had been generally recognised in this country for a long time. Regarding a switchboard maker's guarantee, as to the maximum kilowatt which could be safely broken at normal voltage, the speaker would not place the slightest reliance upon such a guarantee.

Mr. ALCOCK was much impressed by the permissible pressure variation of 10 per cent. up or down, and it was astounding to know how the consumer handled his plant with this variation, especially having regard to the necessity of uniform speeds in certain operations. It would be interesting to consider how far this power supply in bulk would have been commercially feasible if, in the first place, the power company had been compelled to deliver energy under the rather restricted variations prescribed by the Board of Trade. Possibly the power company would never have come into being.

Mr. W. H. LEA, who returned from the Rand about nine years ago, expressed his surprise at the phenomenal change in plant which had taken place since he left. The weights of the stamps 10 years ago varied from 750 lb. to 1,250 lb., whereas to-day they were 2,000 lb. Again, the heaviest skip load encountered by the speaker was 4 tons against the [illegible]. [illegible] had been made some years ago to employ [illegible] of about 2 m. and bottom diameter [illegible]. Had they been adopted? The idea of placing the crushers at right angles to each other was quite novel and good.

[illegible] asked by both in the present Paper and that read [illegible] the whole of the [illegible] machinery appeared to [illegible] but in the country. If the motors, control [illegible] were better designed and better made [illegible] the reason why the [illegible] of the machinery being made here? It was clear that recently some of the switches had not been made abroad, and, whilst giving every due to our neighbours across the Channel of whatever nationality for excellence of design and detail, it was only fair to the English that the point should be emphasised in the Paper. If it were simply a question of price, that was another matter. Regarding the question of contracts, no reference was made to actual costs or prices charged. Did each group have its own separate contract? Further information on the cost of power and relative selling price, especially the sale of compressed air, would be very interesting to those engaged in supplying compressed air to coal mines in this country. The air unit referred in Mr. Hadley's Paper was interesting, but it was hoped that it would not be adopted as a standard. It often happened that a unit of this kind was simply put forward to overcome an immediate difficulty and turned up later to become universally adopted. In this case something more closely allied to the standard system would be, in the end, time saving, calculation-saving and trouble-saving. The speaker supported the use of three meters, and wished it to be made clear whether they were for balanced or unbalanced loads. The method of metering on the whole was very fair indeed to both parties, and very little difficulty was likely to occur. The short reference to air meters seemed very crude. The method of calibration would be of interest. Regarding the control of winding machinery, the cascade motor had not been mentioned, but, nevertheless, was worthy of consideration. Instead of wasting the energy absorbed in the rotor resistance, the intermediate system might be adopted whereby the rotary currents were led to a small polyphase motor which would make use of the energy so provided to drive additional machinery. This system had been successfully adopted in mining in this country. In any case it was more efficient than the plain polyphase system and actually was about a mean in cost and efficiency between the plain polyphase system and the Ward Leonard control. Referring to the use of compressed air, the speaker considered the present methods of measurement very rough. Any system of measurement by means of an orifice plate or other instrument which the author could put forward would be extremely useful, and no doubt adopted in this country sooner or later. It was necessary, however, to know how the measurement was to be made, how the formula was derived and how the system was checked or calibrated. The speaker had made tests with instruments dependent upon the same principle as the sharp-edged orifice plate and found them exceedingly unreliable. An interesting fact omitted from the Paper was that the compressors were rope driven. It would be interesting to know if these rope drives were entirely satisfactory, whether a heavy flywheel was used in connection with compressors, and whether from the tight state of the rope at the top or bottom any trouble had been experienced from ropes jumping out of the grooves. Great difficulty had been experienced in this country owing to loss of pressure in pipes conveying compressed air, and figures for comparison would be useful. The author's use of the term "root mean square" was not clear.

Mr. J. H. RIDER, in reply, expressed some disappointment with the discussion and in the absence of remarks regarding the problems encountered. The power side of the question had been dealt with very fully in Mr. Hadley's Paper, although, in reply to several speakers, it might be repeated that there was no secret about the price paid for power. The Rand Mines agreement with the power company was one under which the Rand Mines Group took the whole of the power. Steam plant was entirely scrapped. The price paid was 0·525d. per unit, but with certain discounts dependent upon the carriage on coal, &c., the net price came down in round figures to 0·5d. The air unit was paid for at the same figure and the decision as to the value of that unit was not the author's, as the contract was in existence when he journeyed to South Africa. Regarding the large difference between the load factor for electricity supply and air supply, obviously the reduction operations on the mines continued uninterruptedly, except for a few hours a month to clean up. The only variable electrical load was the winders; the pump and everything else was constant. If the winders were removed the load factor would increase from 75 to 98 per cent. The air load factor, on the other hand, was low on account of the drilling, which could not be a continuous operation. The drilling was done on a single shift, and generally finished about one or two o'clock in the day. The hole was then charged and blasted. Some mines had two drilling shifts, one day and one night, which improved the load factor, but it could never be as good as the electrical load factor, because of the time occupied in charging, blasting and clearing away the rock. Regarding the correction cams for air meters, Mr. Hadley had gone fully into this, and the results were certainly as stated. The gate meter was certainly better than the Venturi, and anyone interested in air meters should consult Mr. Hodgson, who was an expert on such matters. The author agreed with Mr. MacKenzie's condemnation of the frequency variations, and, as stated in the Paper, had to accept the facts. Contrary to Mr. Alcock's assertion, pressure variations did not affect the speed, this being governed by the frequency. The transformers used by the power company were oil-cooled with a natural air-draught coming in from outside. The recommendations in the Paper concerning the capacity of oil switches were calculated to be a step in the right direction. The question of taper ropes raised by Mr. Lea brought up an old story and an important point. The depth from which a winder could draw rock was dependent upon the rope, and if carried to extreme depth the rope alone would represent the full load without any addition. This point led to the suggestion and trial of the taper ropes referred to by Mr. Lea, but they were quickly given up. The author had no actual report of the reason of failure, but suggested that difficulties were experienced in working such ropes on the drums. The existing ropes were 2 m. diameter and the greatest depth of any winder was 1,141 ft. There was another reason besides that of the rope which determined whether

one or two winders should be used, one winder being at a lower stage. A deep shaft, say, 5,000 ft., using only one winder, would produce, say, 5, 6 or 8 tons at one operation, and with the winder going at 2,500 ft. per minute would take two minutes to get the rock to the top. If another winder were installed half-way down so as to wind in two stages, twice the amount of rock could be dealt with in the same time. This was the critical point determining whether to use one winder or two. Regarding remaining steam plant, as stated previously, the whole of the Rand Group was electrified, but there were other mines on the Rand which had not contracted for the whole of their supply, and retained steam particularly for winders, because unless they contracted for the whole supply they could not get a flat rate. They chose that type of load on their mines which gave the best load factor and thereby brought their rate down. In reply to Mr. Cramp, more than half the plant was ordered out of England, a good deal being bought from America. The author had pointed out to the owners that there were points other than price to be considered in placing orders, but nevertheless three-quarters of the plant was ordered almost entirely on a price basis. Lately, however, matters were changed and the price question had been largely eliminated in favour of quality. The author drew attention to the list of troubles in the Paper, and said that the product of British manufacturers was included. Reliability was the first demand, and efficiency to the purchaser meant something which would always run and give no trouble with ordinary attention. Each mining company in the Rand mines had its own contract, but all contracts were identical. The Rand Mines was acting trustee for these companies, and had an outstanding agreement dealing with matters. Balanced three-phase meters were used throughout, as the loads, except in the case of a few odd circuits, were balanced. There were no three-phase cascade motors on the Rand group, and the author did not feel disposed to go out of his way to adopt it. If a plain three-phase motor was unsuitable the Ward Leonard would be installed. The formula questioned by Mr. Cramp had been proved correct by the measurements of the displacement meter. The size of the orifice should be about $\frac{3}{4}$ in., which could be made within reasonable limits, say, $\frac{1}{8}$ in. up or down. It could be used without objection if it came within those limits. There were rope-driven compressors using three ropes from a motor, and no trouble had been experienced with the ropes. The flywheel effect was no greater than with the old steam compressor, because they were using what was practically the old flywheel. The turning movement was superior, using the motor instead of the reciprocating engine. There was no apparent reason why ropes should not be used other than the enormous amount of space occupied by the rope drive. It was much cheaper and better in every respect to instal high-speed compressors. The author had no figures regarding air losses in pipes, but emphasised the importance of maintaining a good air pressure at the drills. The definition "root mean square" was not, perhaps, a scientific expression, but its meaning was obvious. It was the true average horse-power which the plant was called upon to do. The term was in common use on the Rand, and if it were stated that a winder had a root mean square power of 2,000, it meant that in starting, the machine might have to develop over 4,000 H.P. for a short time

ON THE DIRECT MEASUREMENT OF POWER FACTOR.

BY R. D. GIFFORD, M.SC.

(*Concluded from p.* 86.)

Summary.—The author deals with the subject under the following headings: I. Description of the Dynamometer and Moving Iron Types of Power-Factor Indicator. II. Description of the Induction-Dynamometer Power-Factor Indicator. III. The Meaning of the Power-Factor of a Three-Phase Unbalanced Circuit. IV. The Theory of the Six Unit Power-Factor Meter. V. Results of Tests Substantiating Theory. VI. The Four Unit Power-Factor Meter on Three-Phase Unbalanced Circuits. VII. Frequency Tests on the Induction-Dynamometer Power-Factor Meter. VIII. Power-Factor Meters with Artificial Scales. IX. The Induction-Dynamometer Synchroscope.

V. Test on a Three-phase Unbalanced circuit Power-Factor Meter of the Induction-Dynamometer Type.

Power was obtained from a three-phase alternator supplying star-connected variable water resistances and choking coils, by means of which the line currents could be unbalanced as required. The voltage supply was taken from the star-connected secondary of a phase-shifting transformer, so that readings in any quadrant of the meter could be obtained. By suitable switching arrangements, the volts, current and power in each phase could be taken in succession without disturbing the conditions in the other two phases.

The measuring instruments used were also [illegible] standard class, and the power-factor meter under test was a six-unit induction-dynamometer pattern having [illegible] transformers, as shown in Fig. 11 and [illegible] was graduated in degrees from the position of [illegible]

A typical set of readings is given in Table I. :—

Table I

Phase.	Volts neutral to line.	Line amperes.	Phase watts.	Total power.	Pointer deflection. Degrees.
1	59·75	1·97	112·0	...	...
2	59·25	4·85	231·3	432·2	39·6
3	61·0	4·15	88·9	...	...

We shall proceed to compare this observed deflection with that calculated from equation (27), giving at the same time a

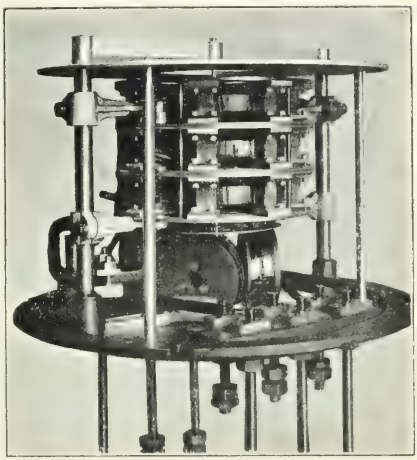


FIG. 11.

graphical representation of the theory developed above, as this serves to indicate more clearly what is actually taking place in the meter. From triangles of voltage and current, we find α_{12} 113 deg., α_{23}=116 deg., α_{31}=131 deg., and β_{12} 122 deg., β_{23}=156 deg., β_{31}=82 deg., also φ_1=18 deg. From these figures, and taking successive values of ωt, the values of F_V, θ_V, F_D and θ_i are found over a range of one cycle, by the

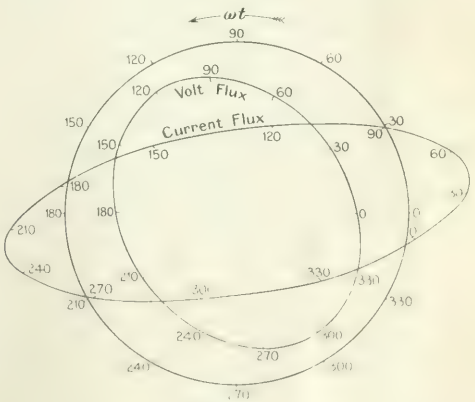


FIG. 12.

application of formulæ (10), (11), (12) and (15). These are plotted giving the ellipses in Fig. 12, which, therefore, show the manner in which the fields rotate in the meter. The values of ωt are marked round the circle, corresponding numbers on the ellipses indicating the positions of the voltage and current flux vectors respectively at a given instant. The relative posi-

tions of the ellipses are those produced when the moving system is held fixed in the position shown in Fig. 9.

Applying formulæ (32) and (33), it is found that the extremities of the major and minor axes of the current ellipse occur at ωt=48 deg., 228 deg., and 138 deg., 318 deg. respectively. Similarly these axes for the voltage ellipse occur at 118 deg., 298 deg., and 28 deg., 208 deg. This will be clear on reference to Fig. 12.

The instantaneous torque on the moving system, still assumed fixed, results, from equation 16, in the torque wave, curve (1) in Fig. 13. The whole of this curve being above the axis, means that the torque is in one direction throughout the cycle, although varying considerably in magnitude. That is to say, the current flux vector never overtakes the voltage vector. In the figure the ordinates of torque are given in arbitrary units, as the flux vectors are calculated, not in magnetic lines of force, but in terms of the E.M.F.s and currents. From the values of the α and β angles and φ_1 given above, the diagram of the circuit is set out as in Fig. 10, from which the values required in equation (27) are obtained. We then find for the angular deflection γ of the pointer

$$\tan\gamma=0{\cdot}838, \text{ i.e., } \gamma=40 \text{ deg., or } \cos\gamma=0{\cdot}766.$$

This result is in good agreement with the actual deflection (39·6), considering that nine instrument readings had to be taken to obtain the calculated deflection.

Now, if we assume the moving system, and, therefore, the volt ellipse of Fig. 12, to rotate clockwise through 39·6 deg. from the position shown in Fig. 9, and again calculate the instantaneous values of the torque, we obtain curve 2 in Fig. 13, from which it is clear that the torque has equal positive and negative values over the cycle. Its average value is, therefore, zero, and as its frequency is very high in comparison with the natural period of the moving system, the latter is in equilibrium.

It now only remains to calculate the power-factor of the circuit from the figures in Table I., first in the usual way—*i.e.*, by equation (3)—and, secondly, by the Campos method, equation (4).

The total volt-amperes of the circuit are 615, and the total watts are 432; hence, from equation (3),

$$\cos\varphi=0{\cdot}703, \text{ or } \varphi=45{\cdot}3 \text{ deg.}$$

The total reactive power is 351, and by (4),

$$\cos\varphi=0{\cdot}777, \text{ or } \varphi=39{\cdot}0 \text{ deg.}$$

The results of the tests are, therefore :—

Observed deflection	39·6 deg.	$=0{\cdot}77_2$ power factor.
Calculated ,, ...	40·0 deg.	$=0{\cdot}76_6$,, ,,
P.F. ,, by equation (4)	39·0 deg.	$=0{\cdot}77_7$,, ,,
,, ,, by equation (3)	45·3 deg.	$=0{\cdot}70_3$,, ,,

Hence, although the circuit was extensively unbalanced as regards both currents and E.M.F.s, it will be seen that the indication of the meter is practically identical with that given by the Campos method, which result is in agreement with that deduced from theoretical considerations in sec. IV.

Numerous other tests have been made, in all of which the observed and calculated deflections agree very closely, but these are not always in such good agreement with the calculated power-factor as in the above case. This discrepancy is, however, traceable to a large unbalancing of the E.M.F.s caused by a lack of symmetry in the windings of the phase-shifting transformer used in the tests, and would, therefore, not occur on an ordinary power circuit to so great an extent.

Although the power-factors above have been calculated to three significant figures, this has been done only to obtain the necessary comparisons. It is not suggested that such accuracy is required in practice.

VI. The Four-unit Power-factor Meter on Unbalanced Three-phase Circuits.

The most severe case in which a power-factor meter might be called upon to operate is where the three-phase circuit is so far unbalanced that the current in one line is zero. The argument following equation (30), however, shows that even under these conditions the six-unit meter would indicate the power-factor accurately so long as the E.M.F.s remain balanced, and would not be seriously affected if they were thrown considerably out of balance.

This is not so in the case of the four-unit meter, and it will now be seen why such an instrument, although accurate on balanced loads, is not satisfactory on unbalanced loads. The four-unit meter combines either one current with three pressure coils, or one pressure with three current coils. Let us, to fix our ideas, consider the latter combination, examples of which are the induction-dynamometer type shown in Figs. 5 and 6, and the moving iron meter already described. In these, the single pressure winding gives rise to an oscillatory flux, and the effect of reducing to zero the current in one line is to make the currents in the other two lines equal and in phase with each other. The two active current coils in the meter, therefore, together set up another oscillatory flux.

Hence, the moving system takes up a position in which these two fluxes fall into line, and, therefore, a change of power-factor does not affect the position of the pointer, but merely results in a decrease or increase of the mean torque. Since any unbalanced load tends more or less to approximate to this particular case, it follows that the readings of a four-unit meter on unbalanced circuits becomes more in error as the unbalancing increases.

The mode of operation of a four-unit meter on an unbalanced three-phase circuit has been investigated mathematically by a method similar to that employed in section IV. for the six-unit meter. The final results only need, therefore, be given.

Take first a four-unit meter having one pressure and three current coils, and let the pointer be so set that the meter indicates correctly on a balanced load, when the pressure coil is connected across phase one. If now the circuit be unbalanced, then, using the same notation as in section IV., the deflection of the pointer from the position of unity power-factor is γ, where

$$\tan\gamma=\frac{\sqrt{3}[\hat{I_2}\cos\hat{E_1I_2}-\hat{I_3}\cos\hat{E_1I_3}]}{2\hat{I_1}\cos\varphi_1-\hat{I_2}\cos\hat{E_1I_2}-\hat{I_3}\cos\hat{E_1I_3}} \quad . \quad (34)^*$$

Suppose the circuit to be that given in Table I. et seq., where the power-factor was found to be 0·77. Evaluating (34) we find γ=59·5 deg.—*i.e.*, the scale reading is $\cos\gamma=0{\cdot}51$., which

* This formula is deduced as follows :—

The instantaneous value of the flux from the three current coils, and its position with reference to the axis of coil 1, are given by

$$F_1=(A^2+B^2) \text{ and } \theta_1 \text{ are } \tan^{-1}\frac{B}{A}$$

where $A=I_1\sin\omega t-\varphi_1+\frac{I_2}{2}\sin\omega t+\beta_{12}-\varphi_1+\frac{I_3}{2}\sin\omega t+\beta_{31}-\varphi_1$

and $B=\frac{\sqrt{3}}{2}[I_2\sin\omega t+\beta_{12}-\varphi_1-I_3\sin\omega t+\beta_{31}-\varphi_1)$

The instantaneous value of the flux from the single pressure coil, assumed connected across phase one, and held with its plane parallel to that of current coil 1, is

$$F_V=E_1\sin\omega t.$$

The mean torque on the moving system at any moment is

$$\frac{1}{2\pi}\int_0^{2\pi}F_V F_1\sin\theta_1 d\omega t,$$

so that rotation through an angle γ to a position of equilibrium will take place, where

$$\frac{1}{2\pi}\int_0^{2\pi}F_V F_1\sin(\theta_1-\gamma)d\omega t=0;$$

or, $\left(\frac{1}{2\pi}\int_0^{2\pi}F_V F_1\sin\theta_1 d\omega t\right)\cos\gamma-\left(\frac{1}{2\pi}\int_0^{2\pi}F_V F_1\cos\theta_1 d\omega t\right)\sin\gamma=0$

or $\qquad Y\cos\gamma-Z\sin\gamma=0$

Putting $\quad F_1\sin\theta_1=B, F_1\cos\theta_1=A$, and $F_V=E_1\sin\omega t$.

$$Y \text{ reduces to } \frac{\sqrt{3}}{4}[E_1I_2\cos\beta_{12}-\varphi_1-E_1I_3\cos\beta_{31}-\varphi_1]$$

$$=\frac{\sqrt{3}}{4}E_1[\hat{I_2}\cos\hat{E_1I_2}-\hat{I_3}\cos\hat{E_1I_3}].$$

and Z becomes $\frac{1}{2}E_1[I_1\cos\varphi_1-\frac{1}{2}\hat{I_2}\cos\hat{E_1I_2}-\frac{1}{2}\hat{I_3}\cos\hat{E_1I_3}]$

whence $\tan\gamma=\frac{Y}{Z}=\frac{\sqrt{3}[\hat{I_2}\cos\hat{E_1I_2}-\hat{I_3}\cos\hat{E_1I_3}]}{2\hat{I_1}\cos\varphi_1-\hat{I_2}\cos\hat{E_1I_2}-\hat{I_3}\cos\hat{E_1I_3}}$

is greatly in error. Now, if the meter had been set for use with its pressure coil across phase two, and so connected to this same circuit, we find from an equation similar to (34),

$$\gamma = 28{\cdot}2 \text{ deg. and } \cos\gamma = 0{\cdot}88.$$

Similarly, with a meter set for use on phase three,

$$\gamma = 32{\cdot}25 \text{ deg. and } \cos\gamma = 0{\cdot}845.$$

On actual test, the readings found were practically identical with these calculated results, whose large disagreement disposes of the possibility of reliable readings being obtained with a four-unit meter on unbalanced circuits, although it is common practice to employ such meters in this way. Equally unsatisfactory results are, of course, given on unbalanced circuits by the use of a four-unit meter employing only one current and three pressure coils.

If such a meter be set for use with its current coil in line one of a balanced three-phase circuit, then the deflection on an unbalanced circuit may be determined from the formula,

$$\tan\gamma = \frac{\sqrt{3}[E_2\cos E_2\hat{I}_1 - E_3\cos E_3\hat{I}_1]}{2E_1\cos\varepsilon_1 - E_2\cos E_2\hat{I}_1 - E_3\cos E_3\hat{I}_1} \quad (34A)$$

Applying this to the unbalanced circuit given in Table I. the three power factor readings corresponding to those just obtained with a meter having one pressure and three-current coils are respectively 0·9, 0·85 and 0·48.

VII. The Frequency Error of Induction-Dynamometer Instruments.

A glance at the principle of operation of these instruments suggests that the indications are not independent of frequency, the reason being that the phase displacement between the

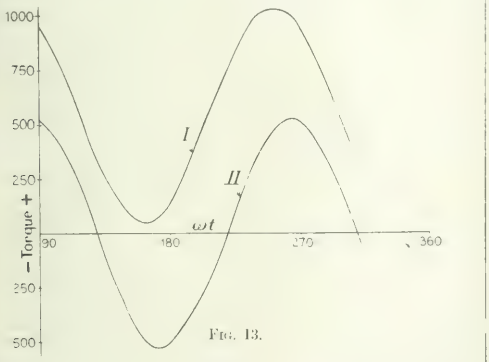


Fig. 13.

primary and secondary currents of the transformer system varies slightly with the frequency. It is not a difficult matter to show analytically that on lagging circuits, a rise of frequency has the effect of making the readings high, and vice versa on leading circuits. The amount of this error can also be calculated approximately. A more satisfactory method, however, is to take the results of actual tests, which show that for a rise of 10 per cent. in the frequency, the error is approximately 1 deg.—that is to say, a meter calibrated for a frequency of 50, if used on a 60-cycle circuit, of, say, 0·85 power-factor lagging, would read 0·866. Since, however, in ordinary supply systems, of all the variants the frequency is, perhaps, the most steady—as witness the modern call for frequency meters with reeds tuned for every quarter or half period in the region of the nominal value—it is apparent that for such changes of frequency as occur in practice, the error due to this source would be inappreciable and indeed unreadable

The above remarks apply to three-phase instruments. In the case of single phase meters (whether [illegible] moving iron or induction-dynamometer) there [illegible] frequency error attributable to the [illegible] since the approach to complete circularity of the rotary field is influenced by the frequency of the voltage applied to the choking coil or condenser, but, as in the above [illegible] with the conditions met with in practice, this error is negligible. Even on variable frequency circuits, by an [illegible] of a choking coil and condenser in the [illegible] Gilfillan,* these errors may be to a large extent rendered inappreciable.

VIII. Power-factor Meters with Artificial Scales.

It occasionally happens that a power-factor meter is required in a form other than the usual circular type; for instance, it may be that all the indicating instruments on a switchboard are of the edgewise type, with scales subtending an angle of about 80 deg., and that the power-factor meters are required to match these in appearance. In such cases the scale called for might be from unity to 0·5 power-factor leading and lagging.

The natural angle for 0·5 power-factor is 60 deg. from unity, that is to say, the total natural scale angle is 120 deg., and this has to be compressed into 80 deg. for accommodation in the edgewise case. The production of such artificial scales may be accomplished by (1) a manipulation of the mechanical angle between the phase windings, or (2) by introducing a dissimilarity in the ampere-turns of the phase windings, or (3) by a combination of these methods.

The alteration of the mechanical angle between the coils usually leads to difficulties in manufacture, so that if the required compression of the scale can be conveniently effected without resorting to this it is better to use the second method.

Suppose the meter is for a three-phase balanced load, and is provided with one current coil for connection in line 1, and three starred pressure coils. Then, instead of the effective ampere-turns of each of these pressure coils being equal, as is usually the case, we may wind coil number 1 so as to have n times the effective ampere-turns of coils 2 or 3. Adopting the notation of section IV., the components along and normal to the axis of coil 1, of the flux produced by the pressure windings, is given by

$$A = nE\sin\omega t - \tfrac{1}{2}E\sin(\omega t - 120) - \tfrac{1}{2}E\sin(\omega t + 120). \quad (35)$$

and

$$B = \frac{\sqrt{3}}{2}[E\sin(\omega t - 120) - E\sin(\omega t + 120)]. \quad (36)$$

We can write (35) in the form

$$A = \frac{2n+1}{2}E\sin\omega t.$$

and (36) can be written

$$B = \frac{3}{2}E\cos\omega t.$$

Hence, the angle θ_V, which the total pressure flux F_V makes at any moment to the axis of coil 1 is given by

$$\tan\theta_V = \frac{3}{2n+1}\cot\omega t. \quad (37)$$

Now, suppose the power-factor of the circuit is $\cos\varphi$, then the instantaneous current in the current coil is

$$i = I\sin(\omega t - \varphi) = F_I.$$

The moving system will find a position of equilibrium at some angle γ from its position at unity power-factor, where

$$\frac{1}{2\pi}\int_0^{\pi} F_I F_V \sin(\theta_V - \gamma)\,d\omega t = 0$$

This integral finally reduces to

$$\tfrac{3}{2}EI\sin\varphi\cos\gamma - \frac{2n+1}{2}EI\cos\varphi\sin\gamma = 0.$$

or

$$\tan\gamma = \frac{3}{2n+1}\tan\varphi. \quad (38)$$

From this result we can calculate the shape of the power-factor scale for any given value of n. In the particular and usual case in which the effective ampere-turns in the three pressure coils are equal, $n=1$, then $\gamma=\varphi$—that is to say, we get the natural scale. If we make the effective ampere-turns of coil 1 four times that of each of the other two coils, then, putting $n=4$ [illegible] $\tan\gamma = \frac{1}{3}\tan\varphi$

and by taking various values of φ from 0 deg. to 90 deg. [illegible] of $\cos\varphi$ from 1 to 0 and evaluating γ we get the scale shown on the right-hand side of Fig. 14. For comparison, the natural scale is shown on the left-hand side of the figure. With this arrangement it will be seen that a power-factor scale of some-

* The Electrician, Dec. 19, 1913, Vol. LXXII., pp. 455-6.

thing over 0·4 leading to 0·4 lagging could be obtained on an instrument whose scale subtends an angle of 80 deg. Fig. 15 shows a meter of the induction-dynamometer type with a power-factor scale of 0·5 leading to 0·5 lagging produced on the above principle and contained in an 80 deg. case.

IX. The Induction-Dynamometer Synchroscope.

It is clear that the principles employed in the induction-dynamometer instruments above described may be also used in the construction of a rotary synchroscope. In this, the current coils of the power-factor meter are replaced by pressure coils connected to the incoming machine, and the position of unity power-factor corresponds to synchronism between the 'bus-bar pressure and that of the incomer. The pointer, being free to rotate continuously, revolves in one direction or

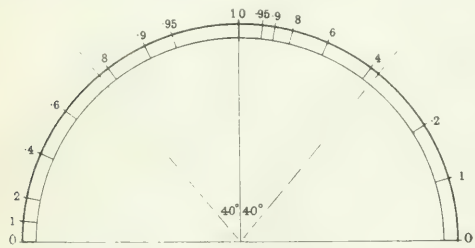


Fig. 14.

the other according as the incomer is running above or below synchronous speed.

This synchroscope has recently been improved by the addition of a signalling system. In cases where the instrument is some distance from the operator, the position of the pointer may not be sufficiently distinct to ensure accurate synchronising. This difficulty is overcome in the following way :—

A small glow lamp, similar to those used in pocket flash lamps, is carried from an arm attached to the spindle of the instrument, and is energised from a moving secondary coil similar to that used to supply the moving coil of the synchroscope. The primary of the lamp transformer is preferably connected to the 'bus bars, so that it is not liable to be either

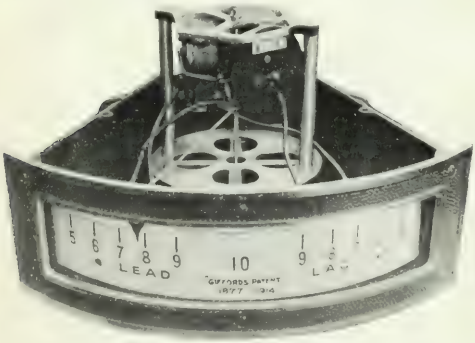


Fig. 15.

under or over-run, as it might be if connected to the incoming machine. The lamp moves directly beneath the dial of the synchroscope, which is of opalescent glass, thus producing a spot of light which is easily seen from a distance. At the position of synchronism, a circular hole, which may be fitted with a lens, is cut in the dial, and for a small space on each side of the hole, the back of the dial is coloured green, the remaining portion being coloured red.

Thus the position of the light-spot indicates the phase angle between the incomer and the 'bus bars, a red light being shown when out of phase, a green light when nearly in phase, and a white flash light at the correct moment for closing the switch.

In conclusion, the author must express his indebtedness to the directors of Messrs. Nalder Bros. & Thompson, Ltd., for the most excellent workshop and testing facilities placed at his disposal during the development of these instruments.

THE ENGLISH ELECTROTECHNICAL INDUSTRY AND THE RUSSIAN MARKET.

BY P. GUREWITSCH.

The Russian electrical industry has experienced an extraordinary development in the last 10 years, as is seen by comparing the imports of electrical products into Russia with the importation of other finished metal-products.

Years*	A.	B.	Years*	A.	B.
	Roubles.†	Roubles.†		Roubles.†	Roubles †
1904	4,472,000	96,167,000	1909	8,316,000	151 581 000
1905	4,562,000	106,276,000	1910	10,888,000	186,006,000
1906	5,567,000	106,969,000	1911	14,342,000	226,879,000
1907	5,759,000	117,908,000	1912	17,014,000	229,201,000
1908	7,073,000	129,616,000	1913	25,240,000	259,718,000

A. Imports of electrical products to Russia.
B. Total imports of finished metal-products to Russia.

No other group of finished products shows such a rising tendency, as those of the electrical industry. While the average yearly imports of electrical products to Russia amounted to only 5,500,000 roubles in the 5 years 1904–08, it increased to 15,200,000 roubles in the last 5 years 1909–13, or threefold.

In the last 10 years the imports of electrical products into Russia increased about 5½ times (from 4·5 to 25·2 millions roubles), whereas the imports of other finished goods of metal increased only 2½ times in the same period.

This rising tendency in electrical imports was observable also in the first six months of 1914, the value being 14,852,000 roubles against 12,142,000 roubles for the same months in 1913. As after the war a great increase in Russian industry is to be expected, development of the Russian electrical industry will certainly advance at a much more rapid rate than hitherto. Here one must take into consideration that, apart from the two capitals Petrograd and Moscow, as well as the chief industrial centres, in Russia's towns, and especially in the country districts, there are no electricity works, and consequently a great field of work for Russian electrical activity is sure to follow. Till now there have been established in Russia electricity works in only 225 towns (not taking into account electrical installations connected with factories).

More exact particulars for only half these works are to be had. Therefore it may be interesting to remark that four Russian towns (Petrograd, Moscow, Lodz and Baku), which possess the largest electricity works in Russia, delivered about 379,000,000 kilowatt-hours in 1913, while during 1905 Russian electricity works supplied only about 500,000,000 of kilowatt-hours. These figures indicate the rapid advance of the Russian electrical industry.

Electricity has in Russia especially good prospects, as there are only a few gasworks. While there is in the oldest European industrial country, England, 1,622 gasworks, in Germany 552, in Russia, the last to be transformed from agriculture industry, there are only 20 gasworks. At the same time, the output of the Russian gasworks is very small. For instance, the largest Russian gasworks in Warsaw (which belongs to the German Continental Gas Co. in Dessau) produced only 36,000,000 c.m., the gasworks in Petrograd 19,000,000 c.m. and the gasworks in Moscow only 13,000,000 c.m., while London consumed 900,000,000, Paris 500,000,000, Berlin 300,000,000 and Vienna 120,000,000 c.m.

Nearly all Russian towns are adopting electric light in place of petroleum lighting. Often in the clauses of the concession conditions are made that no gasworks shall be erected in addition to the electrical works.

Until now the founding of new electricity works in Russia has been bound up with many difficulties and particularly with great loss of time, on account of bureaucratic government. A long period elapses before concessions are ratified by the central authorities, or till town loans are granted. Through the great and useful work in caring for the wounded, the Russian Municipal Association, which was founded after the outbreak of the war, has won great influence. With the more liberal form of Government which must be introduced after peace has been made the freedom of action of Russian towns with regard to the erection of new electricity works will be extended.

* According to "Electrotechestwo," No. 10, 1914.
† Roughly, 10 roubles (actually 9·45) go to the pound sterling.

Against this the proposed tax on electrical energy, to be made by the Russian Government, will exercise a certain checking influence. With the other favourable conditions the Russian electrical industry will be able to bear this burden. The largest Russian electrical undertaking, "The Society for Electric Lighting," established 1886, in Petrograd, concerning whose liquidation much has been written on account of its being of German origin, was still able to pay last year a dividend of 8 per cent. on the original shares, and 11 per cent. on the preference shares on a capital of 50,000,000 roubles (=£5,263,000).

The electrification of various railway undertakings, decided upon by the Russian railway administration, as well as the utilisation of the water power in the Caucasus, and especially the utilisation of the celebrated Jmatra waterfalls in Finnland for supplying Petrograd and district with electrical energy, all of which have been postponed on account of the war, will also help towards a further advance.

Can Russia produce the necessary electrical plant, machinery and apparatus for such a vast increase?

This is a question one can certainly answer in the negative, as till now the Russian electrical industry has been more than in all other industrial branches in Russia dependent on imports from abroad.

Only the Russian cable industry could, protected by high tariff, proceed so far that it could meet the whole demands of the home market. At the head of this industry stand the United Cable Works in Petrograd, founded by Messrs. Siemens & Halske; the Russian General Electric Company, and the Carlswerk in Mülheim-on-Rhine of Felten & Guilleaume. Second place is taken by the Factorie Coltchugin at Moscow (works at Kelerowo). From 10 to 15 years ago the yearly imports of electric cables to Russia were 150,000 pouds (1 poud=36·11 lbs.), while the imports in 1913 amounted to only 8,000 pouds, value 155,000 roubles. The value of imported insulated wires in 1913 was 491,000 roubles. English cable manufactories cannot, therefore, reckon on exporting large quantities of electric cables to Russia. Russian cable factories may also come into consideration as good customers for English machines, fixtures and fittings for cable manufacturers, as these machines have, until now, been chiefly imported from Germany and the United States.

The manufacture of telephone and telegraph apparatus is also well developed in Russia, and she will be well able to cover her requirements in this regard, especially for telegraph apparatus, which is imported only in very small quantities. At the head of the Russian telephone and telegraph industry stand the Russian firm of L. M. Ericsson & Co. (share capital 4,000,000 roubles), and N. K. Heissler & Co., both in Petrograd. The imports of telephone and telegraph apparatus were in 1912 of about 240,000 roubles, whereof half came from Germany, about one-third from Sweden, and only about 1·2 per cent. from England. Five years ago, in 1908, Sweden delivered about half the whole Russian imports of telephone and telegraph apparatus, only 22 per cent. coming from Germany. In 1913 the imports increased to 363,000 roubles, of which Germany's share was larger than in 1912. England's exports of this apparatus in 1913 amounted to £290,279; England could, therefore, export more to Russia than has so far been the case, so soon as Germany's competition in Russia is weakened.

Russia's requirements for accumulators can be covered chiefly by Russian home industry, at the head of which stand the Russian Company "Tudor," of Petrograd. The value of imported accumulators in 1913 amounted to 58,000 roubles.

The conditions in regard to other electrical products are, however, quite different. Russian electrotechnical firms, including the Russian General Electric Co. (share capital 12,000,000 roubles, works at Riga), the Russian Siemens Schuckert Co. (share capital 15,000,000 roubles, works at Petrograd), and the Russian Electrical Co. "Dynamo," of Moscow, can by no means supply Russia's demands for electrical machines and apparatus. (The last-named company has, by the way, taken over the factories of the former Russian Electrical Society Westinghouse at Moscow, and is the sole agent for Russia of the British Westinghouse Electric & Manufacturing Co. of Manchester, and of the Westinghouse Electric & Manufacturing Co. of Pittsburg.) Consequently electrical products of a total value of 25½ millions of roubles had to be imported from abroad into Russia in 1913.

The chief place in these imports is taken by dynamos and motors. In 1906 the value of imported electrical machines was only 1·5 million roubles, in 1912 this increased to 6, and in 1913 to 9·6 million roubles. Of this, in 1912, according to Russian statistics, 86·6 per cent. came from Germany, 6 per cent. from England, and 1·8 per cent. from U.S.A.

In the export of electrical machines to Russia the English factories especially excel, by energy and efficiency, gain [illegible]. The more it may be of value to mention which machines [illegible] exported to Russia. According to "Monthly Reports of the Foreign Trade of Germany," the following dynamos [illegible] transformers were exported to Russia in 1913:

Dynamos and Motors.

	Average value in marks.	Average value in roubles.
(*a*) 182,300 kg., up to 25 kg. in weight	563,000	259,000
(*b*) 505,200 kg., weight from 25 kg. to 100 kg.	1,157,000	532,000
(*c*) 966,600 kg., weight 100 kg. to 500kg.	1,798,000	827,000
(*d*) 2,409,400 kg., weight over 500 kg.	3,012,000	1,385,000
(*e*) 663,900 kg., anchors, collectors, bobbins, &c.	1,135,000	522,000
	7,665,000	3,525,000

If we study the above table, we note the chief import, as well as value and weight, concerns heavy machines of over 500 kg., which are chiefly used by the electricity works. The imports of the small types of electrical machines are less, as these are manufactured in Russia. The exports of electrical machines to Russia in 1913 were divided among the chief exporting countries as follows:—

Exports to Russia.

	Total Exports.	Exports to Russia in per cent. of total exports.
Germany: Mks. 7,665,000=3,525,000 roubles (See Monthly Reports regarding the foreign trade of Germany)	Mks. 64,403,000 (=£3,220,100)	About 12·0%
England: £60,903=578,000 roubles. (See Annual Statement of Trade of the United Kingdom.)	£2,269,433	,, 2·7%
Switzerland: Fr. 3,278,000=1,229,000 roubles. (According to official Swiss Trade Statistics.)	Fr. 20,353,000 (=£814,120)	,, 16·1%
U.S.A. (Monthly Summary of Commerce and Finance.)	$7,261,000 (=£1,452,200)	,, 5·0%

If these figures are compared, we find that England's exports to Russia of the machines most suitable for export in comparison with Germany, and even with such a small country like Switzerland, is very small. The exports to Russia could, however, be, even with the present English production, easily increased.

Russian statistics regarding imports from foreign countries in 1913 have not yet been published. These statistics registered also extra parts of electrical machines and transformers, of which in 1913 the import (chiefly from Germany) amounted to 721,000 roubles. In 1912 these parts, to the value only of 365,000 roubles, were imported, so that here the imports doubled within one year.

The importation of transformers into Russia increased in 1913, according to Russian statistics, from 478,000 to 704,000 roubles, in 1912 90 per cent. came from Germany and only 9 per cent. from England.

While electrical machinery occupied first place in the Russian imports of electrical products the second place was taken by a group of goods belonging to the miscellaneous class of electrical articles, such as switches, fuses, rheostats, bells, signalling apparatus, &c. The imports of these goods had in 1912 a value of 3,849,000 roubles; 90 per cent. came from Germany, 2·8 per cent. from England, and 3·7 per cent. from Austria. In 1913 the imports amounted to 6,602,000 roubles (that is, increased about 71½ per cent.)—which enormous increase within a single year shows that Russia's requirements in electrical products of this kind rises extraordinarily, and that the home industry is quite unable to satisfy these demands.

English measuring instruments and electric meters could also find a good market in Russia. While in 1908 the total imports of these instruments to Russia only amounted in value to 354,000 roubles, in 1913 this advanced to 1,452,000 roubles (*i.e.*, increased fourfold within six years). Of the total imports of the instruments, value 1,183,000 roubles in 1912, 96 per cent. were of German origin, from England only 1·1 per cent. According to German official statistics, 615,700 kilos. of electric measuring instruments and meters, value about 4½ million marks, were exported in 1913 to Russia.

The exports of "unenumerated" electrical goods from England to Russia amounted, according to English official statistics, to only £16,007, slightly exceeding Russia's imports of these goods from Switzerland, in 1913 value [illegible] Fr. 557,000 (£14,280).

The imports of electric glow lamps to Russia in 1912 were valued at 3,803,000 roubles, 90 per cent. coming from Germany and 9 per cent. from Austria. In 1913 the import was value 4,619,000 roubles, an increase of 21·6 per cent. From England, which exported in 1913 electric glow lamps to the value of £152,456, hardly any found their way to Russia. In 1912 [illegible] were imported into Russia from Germany [illegible] Ivory 4.

(754 [illegible])

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In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY MORNING, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Advertisements of all kinds of which no proofs are required before first insertion can be accepted up to FIRST POST THURSDAY MORNING.

BATTERY BELL SIGNALLING IN MINES.

The subject of bell signalling was raised quite recently by Mr. C. P. Sparks in a Paper on "Electricity Applied to Mining" read before the Institution of Electrical Engineers, and our readers will remember that the information given, partly due to Mr. Sparks and partly due to Dr. R. V. Wheeler, was rather contradictory. A further report by Dr. R. V. Wheeler on this subject has now been issued by the Home Office, and the greater part of this will be found elsewhere in the present issue of The Electrician.

Upon going through this report our view is confirmed that consistent results by different investigators can be obtained only if great care is taken to see that the tests are carried out under identical conditions. We doubt if sufficient attention is always given to the conditions. For example, take the question of the inflammability of methane. It is found that when an electric circuit is broken in an atmosphere of methane an explosion takes place if the percentage of methane is within certain limits, and if the current exceeds a certain value. Mixtures of methane and air are most explosive between the limits of 7 per cent. and 10 per cent. In a Paper read by Dr. W. M. Thornton before the Institution of Mining Engineers in 1912, results were given showing that the lowest current causing ignition was about $3\frac{1}{4}$ amperes, and the percentage of methane was 7. In 1913, in dealing with the cause of certain explosions at Hebburn, Dr. Thornton gave in The Electrician some curves showing that the lowest current for methane was about 0·8 ampere, and the percentage of methane was 8. Now, in the present report by Dr. Wheeler, it is shown that the lowest current for ignition is about 0·2 ampere, the percentage of methane being between 7 and 9. It is noticeable, however, that Dr. Thornton used a break the quickness of which depended on the hand, and which, in any case, was comparatively slow. Dr. Wheeler, on the other hand, used a very much quicker break. It is not unlikely, therefore, that the divergence of these results would be explained by the difference in the quickness of the break that was used. In actual bell signalling as employed in mines, the break would be slow; therefore, we doubt if such small limiting currents would be obtained as those shown by Dr. Wheeler.

When we deal actually with electric bells as part of the experimental equipment the difficulties become still greater,

owing to the number of possible variables. It is well recognised that the greater the inductance in the circuit, the greater the effect of the sparking in causing ignition. For this reason Dr. WHEELER proposes to reduce the number of turns on the bobbins of the bells. A change of this kind will make a considerable difference in various directions. Thus, the inductance varies as the square of the number of turns. On the other hand, the igniting current appears to vary inversely as the square root of the inductance—that is, inversely as the number of turns. Apart from this, however, it is necessary to have a certain ringing force for proper operation, and this force will vary roughly as the square of the ampere-turns, or, for a given potential difference on the bell, as the number of turns. Dr. WHEELER experimented by removing a large number of turns, so that the resistance of the winding became reduced to about one-eighth or one-tenth of the original value. By so doing inductance was, of course, largely decreased; but, on the other hand, the current for operation was increased. In order to limit the current, series resistance was introduced, or cells were used with a high internal resistance; and the suggestion is made that the bobbins should be wound with metal having a higher specific resistance than that of copper.

We rather doubt whether this method will commend itself, although it is not unlikely that designs of electric bells are very crude; for it is certainly desirable to have what may be described as a large factor of safety in the working of a bell. The circuits are not always good, and the adjustment of the bell may be rather defective; consequently, it is undesirable to cut down the current very much, except by having a large number of turns. Further, there is always the possibility that the battery will supply less current as time goes on. Moreover, the larger the current taken by the bells the shorter will be the life of the battery.

Although the results obtained by Dr. WHEELER are distinctly interesting from the point of view of design, and although special methods of winding are considered which may be effective, we are surprised that no particular reference has been made to the possibilities of eliminating the difficulty by shunting the bell with resistance or capacity. It would have been useful to have had set out the results obtainable by such means as an alternative to the re-designing of bells, for it is improbable that re-designing will commend itself to manufacturers.

REVIEWS.

Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Graphical Methods. By C. RUNGE. (New York: Columbia University Press.) Pp. vii. + 148.

This work is based on a course of lectures delivered in Columbia University in 1909. It comprises the description and discussion of a variety of graphical methods of calculation, and introduces order and connectedness into the subject very successfully. Many, in fact nearly all, of the constructions discussed are already familiar to students of graphic statics and the theory of structures; but Prof. Runge has translated these familiar constructions into general terms, and has thus made them more readily applicable to problems other than those for which the constructions were originally invented, and for which they are usually used.

This process of formulation of typical graphical methods of calculation in their most generalised form frequently leads to results that should prove useful in less utilitarian fields than structural engineering. For example, students of various branches of applied mathematics will find much to interest them in the discussion of the equation

$$u = u_0 + u_1(x - p) + u_2(x - p)(x - q) + u_3(x - p)(x - q)(x - r)$$

in Chapter I. Chapter II. on the graphical representation of functions, and especially the section on the depiction of one plane on another, is very interesting and suggestive. The illustrations from spherical astronomy are handled in a comprehensive manner and these, so far as the reviewer can recall, have not appeared hitherto in any works in the English language. The last chapter deals primarily with the graphical integration of differential equations of the first order; and here the processes used so frequently in drawing offices where the theory of beams is taught, are dissected so as to exhibit their limitations as regards accuracy.

From this summary of the scope and aim of the work it will be seen that the book is one which every person interested in the pure spirit of graphics should possess and study. W. E.

Konstruktion, Bau und Betrieb von Funkeninduktoren und deren Anwendung mit Besonderer Berucksichtigung der Roentgenstrahlen-Technik. By ERNST RUHMER. Second, new and enlarged Edition. Part I.: Funkeninduktoren. Pp. ii. + 232 with 328 figures. Mk. 7·50. Part II.: Roentgenstrahlentechnik. Pp. iii. + 439 with 223 figures. Mk. 7·00. (Berlin: Administration der Fachenzeitschrift, "Der Mechaniker.")

This work is an enlarged, and largely rewritten, edition of a previous work by the author, which has been for some years out of print. The first part contains a very full account of the construction of different types of induction coils, together with a discussion of the theory of this instrument, and of the suitability of the various possible changes in design for different purposes. The relative advantages of the products of different makers are considered. Naturally the German manufacturers come in for the fullest treatment under this heading. From the list of makers which extends over the whole world we notice the omission of the firm of Newton & Wright, London. The suitability and design of various subsidiary appliances such as interrupters, sources of current, and current-measuring instruments are very fully considered. Amongst the important additions now included is a chapter dealing with the determination of the frequency, and of the current curve form in the primary and secondary circuits.

Part II. contains a full account of the different types of Röntgen ray tube, and the technique of their manipulation for radiographic purposes. The comparative advantages of various rectifiers and of devices for regulating the hardness of tubes are considered. There is a short chapter on the measurement of penetrating power and intensity of the rays, from the standpoint of the medical practitioner, rather than from that of the physical student of these interesting radiations. The different devices for screening and for cutting out soft rays are described very fully, as well as the various fluorescent screens and the technique of Röntgen-ray photography. Stereography and kinematography also come in for consideration. Amongst the omissions we notice the Coolidge tube, and some recent improvements in the Snook type of current generator.

The book is well got up, and the illustrations are very good, and not entirely taken from makers' catalogues. Those who are interested either in the manufacture of the apparatus described or in practical Röntgen ray technique, will find it a useful work of reference.

The Inventor's Adviser and Manufacturer's Handbook to Patents, Designs and Trade Marks. By RAY HADDAN. 9th edition. (London: Harrison & Sons.) Pp. v. + 170. 3s.

This useful practical handbook on patent law and procedure has reached its 9th edition, and it should prove helpful to inventors, engineers and others who are interested in patents and the commercial development of inventions. At the outset the author devotes nearly 200 pages to a good summary of British law relating to patents, including the latest developments in patent practice, while the effect of important recent decisions is noted. A special feature of the present edition is

the prominence given to the commercial development and working of patents. In Germany and the United States of America, our keenest commercial rivals, great importance is attached to the commercial development of inventions, and we are afraid sufficient attention has not been given to this aspect of the subject in this country. It has been alleged that if Great Britain had insisted upon a closer observance of the rules as to the compulsory working of alien enemy patents, certain branches of British chemical industry would not be in their present condition. Be this as it may, it is certain that there will have to be further legislation as to patents for inventions after the war, and the proper working and development of patents must be insisted upon. In a section of about 120 pages on Colonial and Foreign patent law, the author gives an outline of the necessary procedure, the period of protection granted, cost of securing patent, &c. Useful summaries are next given of the law relating to British and Foreign trade marks and designs, and the appendixes include forms of application, &c., suitable for every country or colony, the general rules as to size and materials for patent drawings, &c.

REPORT ON BATTERY-BELL SIGNALLING SYSTEMS.

We give below an abstract of the Report on battery-bell signalling systems as regards the danger of ignition of firedamp-air mixtures by the break-flash at the signal-wires, by Dr. R. V. Wheeler, of the Home Office Experimental Station at Eskmeals, which was noted in our last issue :—

In connection with the inquiry into the causes of the explosion at Senghenydd Colliery on October 14, 1913, experiments were undertaken to determine the limiting conditions under which the electrical ignition of firedamp-air mixtures could be effected when using a battery of dry cells connected through a bell of the pattern used at the colliery at the time of the explosion, so as to form a signalling circuit. The results of those experiments are recorded in the report on the explosion [Cd. 7,346]. Further experiments have been made with the result that it has been found possible to construct an adequate signalling system run off primary batteries, which cannot possibly ignite a firedamp mixture.

The Influence of Methane-content of the Atmosphere.—Experiments to illustrate the relative ease of ignition of different methane-air mixtures are recorded in the report already referred to (pp. 37 and 38). In those experiments the circuit was made through a bell of the pattern used at Senghenydd Colliery, and the current, obtained from a battery of dry cells, was maintained constant at 0·60 ampere. The differences in ease of ignition, by the break-flash at the signal wires, of the various mixtures, which ranged between 5·8 and 12·1 per cent. methane, were indicated by the differences in voltage of the current required. It was found that the most sensitive mixtures contained between 7·3 and 9·4 per cent. of methane. This conclusion has been confirmed by the present series of experiments, made in a somewhat different manner. The results for one set of experiments are given graphically in Fig. 1, in which percentages of methane in air are plotted against quantities of current (in amperes) required to cause ignition by the break-flash, the voltage of the current and the self-induction of the circuit being maintained constant. It will be seen from the curve (in thick line) that the most sensitive mixtures contain between 7·5 and 9·0 per cent. of methane, the current required for ignition of all mixtures lying between those percentages being practically the same. With mixtures containing less than 7·5 per cent. or more than 9·0 per cent. of methane the difficulty of ignition rapidly increases, more markedly as the higher limit of inflammability is approached. The limits of inflammability of methane-air mixtures under the conditions of the experiments are 5·6 (lower) and 14·8 per cent. (higher) and the mixture that has methane and oxygen in combining proportions, for complete combustion to form carbon dioxide and steam, contains 9·45 per cent. of methane.

The experiments just described were made with artificially prepared pure methane (99·8 per cent. methane) and pure air (containing 20·8 per cent. of oxygen). Since firedamp often contains a considerable proportion of nitrogen and the air of mines may contain less than 20 per cent. of oxygen, it seemed desirable to determine the sensitiveness of mixtures of methane and air to which nitrogen had been added. A mixture of oxygen and nitrogen containing 19 per cent. of oxygen was therefore prepared, and a series of determinations made of the currents required for ignition of various mixtures of methane with this "atmosphere." The voltage of the current and the self-inductance of the circuit were the same as in the series of experiments with methane-air mixtures. The results are plotted as a curve (in dotted lines) in Fig. 1.

All the mixtures with the 19 per cent. oxygen atmosphere require rather more current for ignition than the corresponding mixtures with air, the differences being more marked with the higher percentages of methane, presumably because of the defect of oxygen. The limits of inflammability for methane with a 19 per cent. oxygen atmosphere under the conditions of the experiments, are 5·8 (lower) and 12·5 per cent. (higher), while the mixture containing methane and oxygen in combining proportions contains 8·65 per cent. of methane.

The Influence of Self-induction of the Circuit.—In order to determine experimentally the effect of self-induction as might be expected to occur in signalling circuits a number of inductances of known magnitudes were made, consisting of coils of silk-covered copper wire wound in layers on cores of wood so as to be of constant value at all currents. These were introduced into the circuit from a battery of dry cells and the current, at 90, 60, 30 or 15 volts, required for ignition of different mixtures of methane and air by the break-flash determined. The results obtained with current at 90 volts were as follows :—

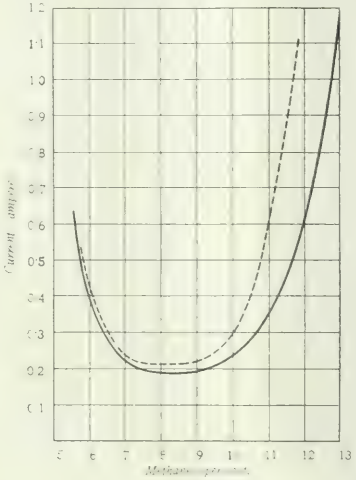


FIG. 1.

Table I.

Self-induction of circuit	Current required for ignition. 6 per cent. methane.	7 per cent. methane.	7·5 per cent. methane.	8 per cent. methane.
0·00815 henry	1·52 ampere	1·18 ampere	1·05 ampere	0·94 ampere
0·03175 ,,	0·84 ,,	0·52 ,,	0·46 ,,	0·42 ,,
0·06350 ,,	0·50 ,,	0·32 ,,	0·28 ,,	0·26 ,,
0·09510 ,,	0·40 ,,	0·23 ,,	0·20 ,,	0·19 ,,

These results are shown graphically in Fig. 2. It will be seen that the current required for the ignition of any of the mixtures increases rapidly so soon as the self-induction of the circuit falls below about 0·03 henry. Results of the same order were obtained with current at 60, 30 and 15 volts.

The Influence of Voltage and Amperage.—In general, it can be stated that the amount of current in a circuit is of far greater importance than the voltage as regards the igniting-power of the flash produced on breaking the circuit. Especially is this the case with highly self-inductive circuits. Thus, an 8 per cent. methane-air mixture is ignited by the break-flash with a current of from 0·24 to 0·25 ampere, at any voltage between 10 and 30, the self-induction of the circuit being 0·095 henry.

At 90 volts, which is well above the arcing potential, rather less current is required for ignition. On the other hand, at a given voltage, and with a given self-induction of the circuit, quite a small change in the amount of current is sufficient to determine whether the break-flash is capable or incapable of igniting a given mixture. Thus, with current at 90 volts, and with a self-induction of the circuit of 0·095 henry, 0·19 ampere is found to cause the ignition of

an 8 per cent. methane-air mixture under the conditions of the experiments. If the current is only 0·18 ampere hundreds of break-flashes can be made in the mixture without causing its ignition, whereas with 0·19 ampere ignition occurs at the first break-flash.

Experiments with Bells.—As a preliminary to a more extended study of different patterns of bells, experiments were made with a signalling bell of a common type procured locally. An 8 per cent. methane-air mixture was used throughout these and all subsequent experiments with bells, as being one of the mixtures most sensitive to ignition. The make and break of electric circuit, representing such as would occur on short-circuiting and releasing uncovered wires to give a signal, were arranged so as to produce the conditions most favourable to ignition by the flash (namely, a slow "make" and a quick "break"). The armature of the bell was fixed so that the platinum contacts just touched, the air-gap between the armature and the ends of the magnet being at about the minimum that could obtain if the bell were allowed to ring. All the bells subsequently experimented with were adjusted in the same manner. These conditions represented the worst possible from the point of view of danger of ignition by the break-flash, and were rather more stringent than those adopted for the experiments described in Cd. 7,346.

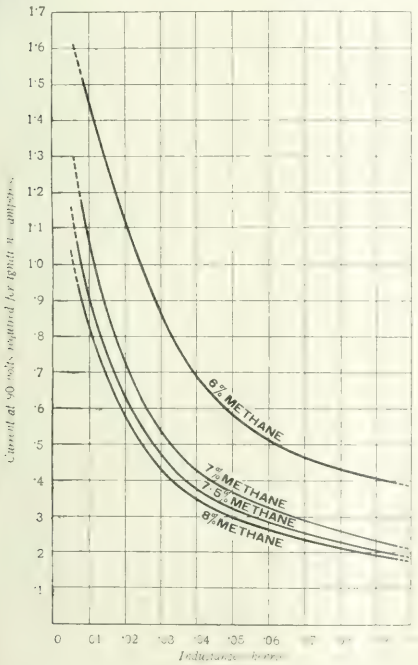


FIG. 2.

Using a battery of dry cells, and with only the resistance due to the magnet coils of the bell (10 ohms) in circuit, ignition of the 8 per cent. methane-air mixture was obtained by the break-flash with two cells, the voltage being 3·0 and the current on closed circuit 0·3 ampere. Ignition was also obtained when the current was reduced to 0·22 ampere by the introduction of 3·5 ohms (non-inductive) resistance, but not when the current was reduced below 0·21 ampere. One bobbin of the magnet was now removed, the resistance of the remaining bobbin being 5 ohms. Ignition was now obtained only when the current at 3 volts was increased to 0·34 ampere. The single-bobbin magnet was found to actuate the bell readily with two dry cells with an additional 8 ohms resistance in circuit, the current on closed circuit being 0·21 ampere—*i.e.*, well below the minimum igniting current. Six layers of wire were unwound from the bobbin, which then had a resistance of 3 ohms, and the minimum igniting current determined. This was found to be 0·61 ampere at 3 volts. The bell rang well with an additional 7 ohms resistance in circuit, the current then being 0·28 ampere. Six more layers of wire were removed, leaving three layers only (resistance, 0·5 ohm). No ignition could be obtained with the full current procurable from the two dry cells employed—namely, 2·4 amperes. The minimum igniting current was found to be 2·65 amperes.

These preliminary experiments show that it is possible to reduce the self-induction due to the magnet-coils (by removing one bobbin altogether and reducing the number of layers of wire on the remaining bobbin), thereby increasing the quantity of current required for ignition by the break-flash, without destroying the ringing power of the bell. By reducing the amount of wire in the bell, however, its resistance is reduced, so that the current passing round the circuit is greater. Thus, the full current obtainable on closed circuit from the two dry cells employed, with only the resistance due to the magnet coils of the bell, was: (*a*) Original bell with two bobbins each of 5 ohms resistance, 0·30 ampere; (*b*) bell with one bobbin having only three layers of wire, 2·40 amperes. Increased safety at the break-flash due to decreased self-induction is, therefore, to a certain extent negatived by increased danger due to the greater current available.

To overcome this objection the dry cells were replaced by wet Leclanché cells, quart size. A battery of two such cells, owing to high internal resistance, is incapable of giving a current of more than about 0·8 ampere at 3 volts when short-circuited across its terminals: while with 10 cells the current does not amount to more than about 1·4 amperes at 15 volts.* It was found that with a battery of 10 wet Leclanché cells no ignition could be obtained when the single-bobbin bell with diminished winding was included in the circuit. This result was to be expected, since the minimum igniting current at 3 volts had been found to be 2·65 amperes, and increase of voltage to 15 does not materially affect the igniting power of the spark. The bell rang well with the full current from 10 Leclanché cells, but very little additional resistance, such as would be given by about half a mile of signal wire, served to put it out of action.

Thus, with the bell as ordinarily arranged with two bobbins, and with a battery of 10 wet Leclanché cells, ringing just ceased when 220 ohms additional resistance was included in the circuit: while the minimum igniting current of 0·115 ampere was obtained when 80 ohms resistance was included. If, therefore, there were included as an integral part of the bell a non-inductive resistance of, say, 90 ohms, the break-flash would be incapable of igniting the most sensitive methane-air mixture—so long as not more than 10 wet Leclanché cells were employed as a battery—while resistance of about 130 ohms (or about 10 miles of No. 8 gauge galvanised iron wire) could be introduced before the bell would cease to ring. The single-bobbin bell was more efficient than the double-bobbin; for while about 60 ohms resistance had to be introduced to render the break-flash safe, the bell only ceased to ring with over 230 ohms resistance in circuit, thus giving a margin of about 160 ohms allowable for the resistance of the signal wires. A less cumbersome method of rendering the bell safe at the break-flash than that of attaching a non-inductively wound resistance to the bell-frame is obviously to wind the magnet with wire of higher resistance than the copper wire generally employed, which varied in the specimens of bells examined from 25 to 28 gauge.

Experiments with Different Bells.—Bells were obtained from eight different makers and subjected to tests. There was no wide variation in pattern between bells from different makers; all could be used as either "trembler" or "single-stroke" bells, and all were actuated by magnets consisting of two yoked soft iron cores wound with many layers of fine copper wire. The bells were adjusted to their best ringing positions and tested with a battery of 10 wet Leclanché cells in the manner already described. The main results obtained were as follows:—

Table II.

	Resistance of magnet. (1)	Current (bell only in circuit). (2)	Resistance required to prevent bell ringing. (3)	Current (bell and resistance in circuit). (4)	Minimum igniting current. (5)	Resistance req. to reduce cur. to min. igniting cur. (6)
A.	12 ohms.	0·63 amp.	175 ohms	0·07 amp.	0·12 amp.	50 ohms.
B.	13 ,,	0·59 ,,	80 ,,	0·13 ,,	0·13 ,,	80 ,,
C.	20 ,,	0·38 ,,	75 ,,	0·12 ,,	0·12 ,,	70 ,,
D.	12 ,,	0·63 ,,	225 ,,	0·05 ,,	0·20 ,,	45 ,,
E.	10 ,,	0·74 ,,	170 ,,	0·07 ,,	0·24 ,,	40 ,,
F.	14 ,,	0·58 ,,	65 ,,	0·15 ,,	0·15 ,,	65 ,,
G.	29 ,,	0·45 ,,	150 ,,	0·07 ,,	0·15 ,,	50 ,,
H.	37 ,,	0·29 ,,	250 ,,	0·04 ,,	0·12 ,,	65 ,,

Two points stand out clearly from an examination of this table. One is that all the bells tested are capable of giving a dangerous break-flash when used with a battery of 10 wet Leclanché cells (15 volts). The current available at the break-flash, supposing the signal

* A battery of two cells of this kind gave over 1 ampere and a battery of 10 over 12 amperes when short-circuited across the terminals.

wires to be short-circuited close to the bell so that only the resistance due to the magnet is included in the circuit, is in every case more than twice as great as the minimum igniting current, while in one instance (Bell B) it is four times as great. The other point is that in the majority of cases sufficient non-inductive resistance could be introduced into the circuit to reduce the current available at the break-flash below the minimum igniting current without seriously affecting the ringing power of the bell. Bells D and H in particular allow ample margin for bad connections on the signal wires

In many instruments involving the use of electro-magnets the sparking that takes place when the circuit is broken is objectionable, and several methods are ordinarily employed to minimise the sparking—usually to prevent the wear of platinum contacts. Of these methods two seemed to commend themselves for battery bell windings to prevent sparking at the signal wires.

Parallel Winding.—Two windings on the bobbins are carried in parallel throughout. Only one winding is used as the "exciting winding" for the magnet; the other is short-circuited on itself. The principle upon which this method of winding acts is that the current passing through the "exciting winding" induces a current in the short-circuited winding. When the main circuit is broken the E.M.F. of this induced current opposes the E.M.F. ordinarily due to self-induction of the "exciting winding," so that the intensity of the break-flash is greatly reduced. Two bobbins were wound with 28-gauge copper wire in this manner. Tests were made, using a battery of 10 wet Leclanché cells and with the experimental conditions as usual, as follows: (i.) Two bobbins, the additional winding being left open, the ends of the wire being free; (ii.) two bobbins, the additional winding being short-circuited; (iii.) one bobbin, additional winding as in (i.); (iv.) one bobbin, additional winding as in (ii.). The main data obtained were:—

Table III.

—	Resistance of magnet. (1)	Current (bell only in circuit). (2)	Resistance required to prevent bell ringing. (3)	Current (bell and resistance in circuit). (4)	Minimum igniting current. (5)	Resistance req. to reduce cur. to min. igniting cur. (6)
(i.)	20 ohms.	0·47 amp.	100 ohms.	0·10 amp.	0·30 amp.	17 ohms.
(ii.)	20 ,,	0·47 ,,	115 ,,	0·09 ,,	(Ignition at 1·55 amp., 38 volts, from 26 dry cells.)	
(iii.)	10 ,,	0·70 ,,	75 ,,	0·14 ,,	0·48 amp.	10 ohms.
(iv.)	10 ,,	0·70 ,,	95 ,,	0·12 ,,	(Ignition at 2·3 amp., 31 volts, from 21 dry cells.)	

It is interesting to find that, whether one or two bobbins were used, the bell rang better when the additional winding was short-circuited than when it was open, an effect probably due to eddy currents. Furthermore, it was found that more current was required for ignition by the break-flash when the additional winding was present but open, than if that winding had been absent altogether. This was probably also due to eddy currents in the copper contained in the additional winding, an effect upon which the second method of winding tried, that of placing tin-foil layers between the layers of copper wire, relies.

Tinfoil Layers.—Between the iron core and the first layer of copper wire winding a strip of tinfoil is interposed, and a similar strip is placed between each successive layer of winding. The mass of metal thus introduced produces eddy currents which absorb the energy of self-induction which would otherwise be expended at the break-flash. One bobbin was wound with 16 layers of 28-gauge copper wire in this manner, with a tinfoil strip between each layer, and tested in the usual manner with a battery of 10 wet Leclanché cells. The results were as follows: Resistance of magnet, 12 ohms; current, bell only in circuit, 0·78 amperes; resistance required to prevent bell ringing, 115 ohms; current, bell and resistance in circuit, 0·10 ampere. The minimum igniting current for the break-flash was found to be 2·30 amperes (at 27·5 volts), obtained from 19 dry cells. Several other methods of preventing sparking were tried, which were more or less effective, but not so simple of application as those described.

Conclusions.—The conclusions reached respecting battery bell systems, as a result of this investigation, can be stated briefly as follows:—

1. All the bells examined were capable of producing a highly-dangerous break-flash at the signal wires when used with a battery of 10 wet Leclanché cells, the current voltage being 15. The break-flash was still more dangerous when a battery of 10 dry cells was employed, since the current available from them is considerably greater than that obtainable from wet Leclanché cells. In general, the bells examined were "overpowered." A single bobbin with a reduced number of layers of wire was found in several cases, when fitted to the original bell-frame, to actuate the bell as efficiently as is required in practice. The use of only one bobbin (*i.e.*, a bar electro-magnet) with a small number of layers of winding reduces the self-induction of the circuit and thereby decreases the danger of the break-flash at the signal wires.

2. Inasmuch as the current voltage is relatively of little importance compared with that of the current strength, so far as the safety of the break-flash on the signal wires is concerned, it is desirable that attention should be directed towards not exceeding a certain maximum number of cells in the battery, rather than that care should be taken not to exceed a certain voltage. Moreover, it is desirable that a cell of comparatively high internal resistance, such as the wet Leclanché cell, should be employed, so as to avoid the possibility of obtaining large currents on short-circuiting the battery.

3. Taking as a standard battery 10 wet Leclanché cells, quart size, such as are commonly used for battery-bell signalling systems, giving a voltage of 15 and a maximum current on short-circuiting of about 1·5 amperes, it is possible so to modify the usual pattern of bell as to render the break-flash at the signal wires safe in the most sensitive methane-air mixture, without impairing the ringing power of the bell. This can be done in several ways, of which the simplest probably are: (i.) By the introduction of a non-inductively wound resistance coil in series with the magnet-coils such that it will reduce the current available at the break-flash below the minimum igniting current; (ii.) by increasing the resistance of the magnet windings of the bell by the use of wire of fairly high resistance, such as brass wire, for the same purpose as in (i.); (iii.) by the use of parallel winding; and (iv.) by the use of tinfoil strips between the layers of winding, in the manner and for the purpose already described. Of these four methods the third may be open to the objection that should the short-circuited winding be accidentally broken the bell might become unsafe.

No experiments were made as to the igniting power of the maintained spark at the trembler of the bell, for it was apparent from the bells examined that the provision of an adequate flame-tight casing, affording complete security against ignition of a firedamp-air mixture at the trembler of the bell, was not a difficult matter. Nor were any experiments made with relays such as are often introduced in battery bell-signalling systems, for all the considerations advanced in this report respecting bells apply, probably with equal force, to relays. A relay, if introduced into the signalling system, simply takes the place of the bell, and from the point of view of danger at the break-flash on the signal wires, can be regarded as a bell.

An appendix is given which shows the method and apparatus employed in making the experiments. These were carried out with a glass explosion vessel, which was filled with a mixture of methane and air (previously prepared in a gas-holder) by means of a mercury reservoir connected to it which could be raised or lowered. One terminal of the bell circuit was brought into the vessel by means of a horizontal brass rod, on which a short metal strip was carried. The other terminal was brought in through a vertical hollow glass rod which could be rotated. At the top of the rod and connected electrically to the mercury cup terminal at the base of the rod was mounted a short horizontal metal rod, which, when rotated, made contact with the metal strip of the other terminal. The rod was revolved so as to make contact every five seconds, the time of contact being about ½ second arranged so as to give a quick break.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Transactions" of the N. East Coast Institution of Engineers and Shipbuilders. Edited by E. W. Fraser Smith. (Newcastle-on-Tyne: The Institution.) Vol. XXX., Part 7. Pp. xxiv. + 111. 5s.

"American Journal of Science." Edited by E. S. Dana. (New Haven: Tuttle, Morehouse & Taylor Co.) Vol. XXXIX., No. 232. Pp. 159. $6.40 per year.

"Journal" of the Franklin Institute. (Philadelphia: Franklin Institute of the State of Pennsylvania.) Vol. CLXXIX., No. 4. Pp. 131. 50 c.

"Transactions" of the Institution of Engineers and Shipbuilders in Scotland. (Glasgow: The Institution.) Vol. LVIII., Part VI. Pp. 37.

"Canal Record." (Balboa Heights: Isthmian Canal Commission.) Vol. VII., with Index, August 27, 1913-August 19, 1914. Pp. 528.

"Journal" of the United States Artillery. (Virginia: Coast Artillery School Press.) Vol. XLIII., No. 2. Pp. 127. 80.55.

"Proceedings" of the American Institute of Electrical Engineers. (New York: American Institute of Electrical Engineers.) Vol. XXXIV., No. 4. Section 1, Institute Affairs, pp. 23; Section 2, Papers, Discussions, &c., pp. 239–81.

CORRESPONDENCE

DIRECT MEASUREMENT OF POWER FACTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am interested to find that Mr. Murphy has apparently been working on the same lines as myself with the object of overcoming the disadvantages of the ordinary forms of power factor meter. So far as I am aware he has not published any of his results, but appears to have been discouraged by the difficulties met with, which I also encountered in my preliminary attempts.

With reference to the well-known continuous-current method, due to Dr. Sumpner, of calibrating dynamometer power factor meters, it is not altogether obvious that the results are necessarily better than those obtained by calibrating on a circuit similar to that on which the meters must subsequently operate, especially when it is remembered that in accurately constructed instruments of the types under discussion, the calibrated scale obtained by either method agrees with the theoretical scale within the limits of observation error.

Dealing with the further point referred to, since unbalanced three-phase loads are usually due to a combination of lighting and power supply, it would merely be accidental if the power factor of each phase were the same, and it would certainly be incorrect to assume that such was the case; hence a balanced load meter should not be employed when intended for use on unbalanced circuits.

The "drag" torque of the moving iron meter is proportional to I^2 only when the strength of the rotating field is proportional to I. In the presence of the soft iron moving element in close proximity to the field coils, this cannot be assumed, for which reason I wrote "function I." I have, moreover, found that whereas the three-current-coil moving iron meter is practically independent of the load, the three-volt-coil type shows a considerable drag effect. However, if Mr. Murphy has satisfied himself that neither arrangement produces the desired result, this only tends to prove the superiority of the moving-coil meters.

I, of course, entirely agree that the dynamometer power factor meter is an inherently accurate instrument, like its near relative, the dynamometer wattmeter. It does, however, suffer from the disadvantages enumerated in my article, and whilst these have been removed, and other advantages gained, in the induction-dynamometer type, its chief dynamometer characteristics have been preserved. I have particularly noticed that in the attempt to make the control due to the ligaments as small as possible, they have been so much reduced in section as to be liable to injury and to burn-outs due to over-voltage.

Mr. Murphy will find that the question of frequency variation is discussed later in the article, as he might have perceived had he read the summary.—I am, &c.,

Chingford, April 23. R. D. GEORGE.

MATHEMATICAL SYMBOLS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In order to facilitate the composition [illegible] up of articles in which vector symbols occur, especially in concrete expression, where modulus and argument are both required, I suggest the use of the dagger "†" inverted for positive, erect for negative arguments, between modulus and argument. Thus $h \dagger \theta$ for $he^{i\theta}$ or $h \dagger \theta$ for positive values, and $\dagger h\theta$ for negative values of θ. A numerical example, $1{\cdot}72_{\dagger}15{\cdot}36$ illustrates the advantage. The point of the dagger follows the usual convention for + and − direction.

We have a very apposite precedent in $x+iy$ which for the purpose above mentioned replaces the original factorial symbol (x, y).—I am, &c.,

Woodwich, April 27. F. JACOB, M.Inst.C.E., F.P.S.L.

EFFICIENCY OF THE ELECTRIC ARC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to call attention to the particulars given in your Editorial Note of April 16th, with reference to Dr. Wedding's article published in "Elektrotechnische Zeitschrift," Jahrgang 35, p. 901. You have doubtless inadvertently given the impression that Dr. Wedding is the inventor of this wonderful improvement in searchlight practice. You will observe that in Dr. Wedding's own Paper he clearly states that the inventor is Mr. Beck.

In order to correct any misunderstanding, I should be obliged if you would kindly publish this letter in your next issue.—I am, &c.,

A. M. BILLINGTON,
Chairman, Beck Engineering Co., Ltd.

London, April 22.

THE PIZZUTI-FERRARI APPARATUS FOR PROTECTING ELECTRIC PLANTS AGAINST EXCESSIVE PRESSURES.*

BY E. PIZZUTI.

This apparatus, which forms the subject of Germ. pat. No. 199,112, fixes the point in the electric plant or system at which the peak of the excessive pressure must occur, *i.e.*, a loop in the stationary wave, so that by connecting the usual automatic earthing devices to this point, the efficient operation of such devices can be ensured.

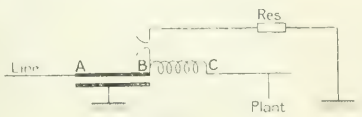


FIG. 1.

In Fig. 1 AB is a condenser, one electrode of which is connected to the line between the source of supply and the plant to be protected, whilst the other electrode is connected directly to earth. A coil, BC, having inductance is also connected in the line circuit. By this means a loop or point of reflexion of electric waves coming from the line is formed at B, to which the earthing device is connected. Even if a part of the wave passes beyond the point B towards C, the condenser AB and inductance BC are so proportioned that the time which the broken wave requires to pass from B to C is equal to or greater than the time which the reflected wave requires to pass from B to A, so that the earthing device connected to B will have earthed the excessive pressure when the broken wave has reached C. In [illegible] connected to protect [illegible] excessive pressure wave.

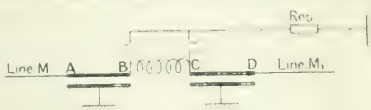


FIG. 2.

coming from both ends, the arrangement shown in Fig. 2 is employed. Here, waves coming from M are reflected at B, and waves from M' are reflected at C. The inductances BC are not greater than those which are usually employed in networks, and the capacities are equal to from 200 to 300 metres of line.

Quick Erection of Temporary Substation. The "Electrical World" reports the erection of a temporary substation, with a capacity of 2,000 kw., in the short time of 15 days. The Edison Electric Illuminating Co., of Detroit (U.S.A.), commenced the erection of this substation, which was to house two 2,000-kw. motor-generator units, on Jan. 12, and the operation of these units was begun before the end of the month. The motor generators, weighing 50 tons each, were skidded one at a time from their old position half a block away. Whilst one unit was moved the other had to be kept operating to supply the demand. With the machines the switchboard equipment had also to be moved.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Jahrgang XXXV., pp. 929-930.

LEGAL INTELLIGENCE.

British Vacuum Cleaner Co. (Ltd.) v. James Robertshaw & Sons.

On [illegible] the Lord Chancellor and Lords Shaw, [illegible] Parmoor and Wrenbury) reserved judgment at the conclusion of the hearing of an appeal by the British Vacuum Cleaner Co. against an order of the Court of Appeal in favour of respondents. The [illegible] brought by the appellants for an injunction to restrain respondents from infringing letters patent No. 17,433 of 1901 granted to Hubert C. Booth for an invention entitled "improvements relating to the extraction of dust from carpets and other materials," and for an inquiry and other relief. The patent had been held by the House of Lords in a previous action to have subject matter and to be valid. Plaintiffs complained of threats and of actual infringement by defendants' machine which had suction bellows instead of a cylinder pump. Defendants pleaded that the patent was invalid by reason of prior user of machines made under Harvey's specifications Nos. 546 of 1893 and 4,545 of 1894.

Mr. Justice Sargant decided in favour of plaintiffs but the Court of Appeal (Lord Justice Phillimore dissenting) considered that the term "a power-driven pump" could not be applied to a power-driven bellows, and that defendants had done no more than apply power to the old Harvey machine. Accordingly by the majority of the Court it was held that notwithstanding the prior user of Harvey's machine, the patent was on the construction placed on the specification by the House of Lords valid, but that defendants had not infringed and the appeal was allowed. Plaintiffs now appealed from that judgment.

Mr. Thos. Terrell, K.C., Mr. Colefax, K.C., and Mr. Courtney Terrel appeared in support of the appeal; Mr. Walter, K.C., and Mr. J. H. Gray for respondents, but on the hearing of the appeal respondents' counsel [illegible] and judgment was reserved.

National Freehold Land and Building Society v. Freeman.

Last week Mr. Justice Sargant gave his decision in this action, by which the society and a tenant (Battista Baraglia) claimed in respect of an alleged nuisance created by defendant by electrically driven machinery.

Mr. STROUD (for plaintiffs) said that defendant was the occupier, under a tenancy agreement, of the first floor of premises in Mitre-street, Aldgate, London, and an injunction was sought to restrain him from using, or permitting to be used, on his premises any machinery so as to cause a nuisance either to plaintiffs or the other occupiers of the premises. The society were the landlords and plaintiff Baraglia was a tenant of theirs who carried on a restaurant business there. Defendant became the occupier of the first floor of the premises under an agreement dated Jan. 15 last year, and he alleged that, before entering into the agreement, the society, through its agents, had warranted the premises to be adapted for motor power. That gave rise to the counterclaim, defendant contending that, in the event of the second plaintiff recovering any damages [illegible] being granted, he was entitled to claim against the society for breach of warranty. Prior to Jan. 12, defendant entered into negotiations with a firm of house and estate agents for premises suitable for his business of a button-hole maker. In these negotiations defendant explained that he required the premises for his business, and that he would be using machines, but no suggestion was made of introducing electric or other power on the premises. In a letter defendant said he had ascertained that there was no electric light, but he made no reference to electric power. Plaintiffs admitted that defendant had stated he would put in machines on the premises, but he was understood to mean treadle or hand machines, as nothing was said about power-driven machines. When the agreement was completed at the agents' office nothing was said about power-driven machines. The clause in the agreement upon which plaintiffs relied was that the tenant covenanted to do nothing that might cause nuisance or annoyance to the occupiers [illegible] property not [illegible] trade or business except that [illegible]

Mr. [illegible] SMITH: They could imply that it was not to be the purpose for [illegible] a button-hole maker [illegible] to be a nuisance, unless the nuisance was absolutely essential to the carrying on of a button-hole maker's business. Defendant would have to show that it was quite impossible to carry on his business without causing a nuisance.

COUNSEL said defendant was let into possession, and he proceeded to make arrangements with an electric lighting company to instal electric power without consulting the plaintiff society.

[illegible] the premises about repairs and saw an electrician at work there, but [illegible] society, complaining of the nuisance and loss of custom in consequence, [illegible] nuisance might be obviated by more firmly fixing the machines, the [illegible]

[illegible]

electrically-driven machines made little or no more noise than would hand or treadle machines. The machines he was now using stood on a bed about 3 ft. high, and were the best machines that could be got for his trade. There was no better method known in the trade of carrying on his business than the one he had adopted. As a button-hole maker, he did not think his business could be carried on with less noise. All the large firms used those machines.

Cross-examined, WITNESS said that when he asked whether electricity was laid on the premises he did not lead the agent to suppose that his inquiry referred only to electric light. He asked whether there were electric wires on the premises, and he did not think that anyone could suppose his inquiry was confined to wires for electric lighting.

In re-examination, WITNESS said that he made it clear to both Mr. Hilbury and Mr. Hawkins that he would be using motor-driven machines.

Other evidence for the defence was to the effect that there was very heavy machinery in the neighbourhood, the working of which could be heard in the street, and that defendant's electrically-driven machines would make less noise than treadle machines.

His LORDSHIP, in giving judgment, said that there had not been the slightest evidence put before him that the negotiations for the agreement of tenancy proceeded on the footing that defendant was to be entitled to use power-driven machinery on the premises, and he was satisfied that plaintiffs' agents never had it brought before them that it was the intention of using such machinery. The onus of showing that his business could not be carried on without causing a nuisance was on defendant, and he had not only not established that proposition, but had not attempted to do so. He had come to the conclusion that the working of these machines was a nuisance, though he thought it was just on the border line of what was a common law nuisance. He accordingly granted an injunction to restrain defendant from so working his machines as to cause a nuisance, and awarded plaintiff Baraglia £15 by way of damages.

Defendant was ordered to pay the costs, but the injunction was suspended for four weeks to enable defendant to get out of the premises.

O. Goodwin v. Avis.

At Ipswich County Court recently, Judge Eardley-Wilmot heard this action for a recovery of £46 13s. for [illegible] and goods supplied, and there was also a claim for damages for assault.

Mr. MARSHALL (for plaintiff) said that in October last defendant was reconstructing premises in Ipswich in order to turn it into a cinema, and Mr. Goodwin, as an electrical engineer, was asked to tender for the electrical work. Defendant considered plaintiff's price too high and plaintiff agreed to superintend the work for 50s. a week, defendant finding the materials. On one occasion defendant asked plaintiff to get materials from the General Electric Co. The order came to about £60, but the Company refused to send the goods without the money. Defendant was not in a position to pay and asked plaintiff to try and get the goods from some other firm. He did so and goods to the amount of £27 12s. were delivered for a cheque for £20. Further goods were required, but the firm would not send them without payment of the balance of the first account. Mr. Avis could not pay and an arrangement was entered into whereby plaintiff was to get the goods and allow defendant 25 per cent. of what percentage he secured, except on lamps on which 20 per cent. was to be allowed, the amount plaintiff received. The work continued, but the wages were not paid weekly. On Feb. 2nd last, plaintiff went to defendant's office, and there was some controversy about the accounts. Plaintiff asked for a further payment, and said that if he did not receive it he should not continue to work. Without warning, defendant struck plaintiff, knocking him on to the table. That was followed by several other blows on the face, plaintiff's teeth being knocked out.

For defendant, Mr. HAYWARD SMITH said the real dispute was whether plaintiff, as a servant, was entitled to make a profit on the accounts.

His HONOUR: Your client was not in a position to pay for the goods at that particular time, and plaintiff took [illegible] a risk, but which he was entitled to receive a reasonable percentage.

After hearing evidence for both sides, His HONOUR gave judgment for the amount claimed (£46 13s.) and £5 damages for the assault, with costs on the usual scale.

Osram Lamp Works (Ltd.) v. Secando Lamp Co. (Ltd.)

On Friday last Mr. Walter, K.C., mentioned to Mr. Justice Younger a motion in this action for an interim injunction to restrain until the trial an alleged passing off by defendants. Evidence had been filed on both sides and the conflict was such that he could not usefully ask his lordship [illegible] He had agreed with [illegible] that there should be no order except that the [illegible]

His Lordship [illegible]

Re Cunningham (Ltd.). In the Companies Winding-up Court last week Mr. Justice Astbury had before him the petition of W. T. Henley's Telegraph Works Co. for a compulsory order to wind up Cunningham (Ltd.). At first creditors for over £2,000 had agreed to an arrangement on the meeting, but creditors for about £400 [illegible] and the petition was allowed to proceed. On the second [illegible] counsel informed His Lordship that the whole of the creditors had come in and the petition was therefore, [illegible] dismissed without [illegible]

PARLIAMENTARY INTELLIGENCE.

YORKSHIRE ELECTRIC POWER BILL.

On the 22nd inst. the Select Committee of the House of Lords presided over by Lord Halton commenced the consideration of the Bill of the Yorkshire Electric Power Co., for further powers, including authority to supply electricity for lighting.

Mr. FREEMAN, K.C., who (with Mr. Tydesley Jones) appeared for the promoters, said the company was incorporated in 1901 for erecting generating stations and supplying electrical energy. Their area of supply comprised the greater part of the West Riding, but they were considerably trammelled because they had no power to supply electric light, being confined by sec. 48 of their 1901 Act to supplying electrical energy in bulk to authorised distributors or for power, though power users could use the current for lighting also. Counsel went on to give particulars of the limitations upon the company's power of supply and the clauses in their 1901 Act which protected municipal undertakers. He dwelt upon the difficulty of exploiting provisional orders for small areas, and said there were numerous instances of local authorities holding orders for years without exercising the powers conferred by them. In the company's area there were 84 districts in which no one was authorised to supply electricity for light, yet the company's mains were at hand, and there was a tolerably good demand for electric lighting in those districts. Consequently his clients were seeking powers to apply current for lighting to those districts set out in the schedule to the Bill. Originally many petitions were deposited against the Bill, but after a conference an agreement was arrived at which satisfied all those parties, a further result being the elimination from the schedule of all districts except 41, who desired to have the supply. He cited the Kent Power Co.'s Act of 1906 and the North Metropolitan Electric Power Co.'s Act of 1907 as precedents. The Yorkshire company had up to the end of 1914 expended £538,000, and had three generating stations with a total capacity of 21,300 kw. The opponents to the Bill consisted of the County Boroughs of Bradford, Barnsley, Brighouse, Halifax, Huddersfield, Leeds, Rotherham, Sheffield and Wakefield. No urban or rural district authorities (the people to which the Bill applied) opposed, and the Bill did not apply to the larger corporations because their area only could not go outside their area. He proceeded to analyse the reasons for the opposition of the local authorities. Certain gas and railway companies also opposed, but that was mainly on clauses. As to the Leeds opposition, that was on a different basis, because there was an agreement between that corporation and the company, that if they extended their borough boundaries the company should not oppose them, and should sell to them their plant and undertaking so far as it applied to the added area. The company were ready to extend that to the transference also of plant and apparatus for electric lighting, if Leeds would agree. He read and criticised the report of the Board of Trade on the Bill. The Board's chief complaints were that only about £500,000 of the £2,000,000 capital had been issued, that the company would be under no obligation to lay mains in any area within a specified time, that there was no purchase clause in the Bill, and that clauses 12 and 13 of the Bill should be omitted. Counsel pointed out that the facts had altered since the Board of Trade report, and if the clauses referred to were omitted the rest of the Bill might go as well.

Mr. ARTHUR G. LUPTON, chairman of the Yorkshire Electric Power Co., said the company was created in 1901, and it began with one generating station, but it had three now. He supplied full particulars of the progress made by the company, and he put in tables [illegible] ture, the demand for electrical energy, connections to the mains &c. They were also supplying electricity for lighting in 23 areas through authorised distributors. Under the Bill the boroughs would retain all their powers; the limit between the company and the [illegible] fairly clear, and there could be no competition [illegible] had had many demands for a supply for lighting [illegible] There were 64 districts in most of having such a supply. [illegible] was going to get a supply under the Bill were willing [illegible] of the Councils had passed resolutions in favour of the Bill. The people who objected were not really concerned. There were [illegible] among many of the local authorities whom we proposed to supply. [illegible] the company should obtain its powers. The origin of the Bill was the desire expressed in the different districts for a supply [illegible] for lighting. There were many collieries [illegible] especially in the Doncaster district, which [illegible] able to take the energy in bulk, but could not [illegible] lighting. However, in many of the districts [illegible] stated that it could not get a supply of electricity [illegible] company. In the area 18 provisional orders [illegible] been granted to some of the principal [illegible] rural undertakings, and in the case of 27 provisional orders the average [illegible] of inches per [illegible] worked out that in the districts with independent undertakings there was an average of 0·095 acre per head of population, in the districts supplied in bulk by the Yorkshire Company 0·236 acre per head, and in the area included in the company's present application 1·33 acre per head of population. In regard to the proposed [illegible] able put in showed that the price received for energy supplied for all purposes by the Yorkshire Electric Power Co. was 0·55d. per unit, while [illegible] price [illegible] Rotherham 1·12d., Rotherham 1·3d., Sheffield 1·13d. and Wakefield 1·45d. per unit. Another table showed that the average units per head of population in the non-county boroughs and urban districts with independent undertakings was 21·5 and the average price per unit 1·93d., while the average units per head of population in the Yorkshire Company's area was 90.

In cross-examination by Mr. Wedderburn, K.C. (for the gas companies), witness said the whole of the objections of the Board of Trade had been met by alterations as a result of negotiations which took place with the West Riding County Council on certain points raised by them; the modifications practically met the objections of the Board. He admitted that the Bill would do away with the necessity for applying for a provisional order, and to that extent the criticism of the Board had not been met.

In reply to Mr. Honoratus Lloyd, K.C. (for the Corporations of Leeds, Barnsley, &c.), Mr. LUPTON admitted that the Bill might affect cases of individual supply under sec. 6 of the Electric Lighting Act, 1909, which the Corporations could undertake. His company had not obtained provisional orders which they had not carried out. They had issued sufficient capital for their requirements and they could provide fresh capital as required.

Mr. W. B. WOODHOUSE, engineer and manager of the Yorkshire Electric Power Co., said that the original limited powers of power companies were rather hampering, and they required extending. They were supplying 40 collieries, and there were precedents for the present Bill. The area affected comprised new coalfields that were being developed. If the use of electric power was extended and modern methods of colliery development were adopted there would be a great reduction of the smoke nuisance. Although they might light the colliery and the yard, works, &c., they could not supply current to the houses of colliers; the same thing applied to textile mills and the houses round them. A colliery or mill owner, with an independent power plant could supply his cottagers with light, but the company could not. There was no engineering difficulty that would prevent the Yorkshire Company from supplying current for light in any part of their area. They found that when they extended the power mains to a district that a demand for lighting also arose, and he cited instances in support of the statement. The company was in an advantageous position for giving electric lighting supplies to the rural districts, and very little additional work would be necessary to do so. He gave particulars of the prices charged for electrical energy by the local authorities and by the company, the number of lapsed provisional orders, &c.; he estimated the cost of supplying electric light to the scheduled district to be £60,000. They could not apply for a provisional order for the whole of the area, nor for two districts which were not contiguous. The method suggested by the Board of Trade was costly, cumbersome and inapplicable. Sec. 49 of their Act gave the Board of Trade power to deal with special cases as they arose. No one would take up an order for some of the districts in the area if he were put under an obligation to lay down mains within two years; a rural district was hardly an appropriate one for that. In provisional orders the compulsory area was usually very small and only applied to the best part of the district. Applications under sec. 6 of the 1909 Act were made for individual cases, and the orders were granted under certain conditions, and the company's proposals would put the distribution in a more favourable position than the [illegible] order. Mr. Woodhouse gave detailed evidence about the position of the various opponents to the Bill. Such of the gas companies as were opposing the Bill appeared to be those who were charging a high price for their gas. The tracts in the boroughs would be subject to [illegible] breaking up than under their existing powers.

After hearing much local evidence in support of the Bill, Mr. HARRY BOOTH, of the Board of Trade, stated, in reply to a request by the Chairman as to the point raised in the Board of Trade report on the Bill, that the purchase clauses of [illegible] of the Electric Lighting Act of 1888 were different. Sec. 49 was permissive, but the 1888 Act was clear, and the local authority could purchase at the end of 42 years. He admitted that sec. 49 of the Yorkshire Company's Act of 1901 had escaped the attention of the Board when the report was drawn up. As to the [illegible] them, and he did not think they were in the public interest. The particular section which proposed to alter the general law was defective in two respects—because it gave no right of purchase, and because local authorities could only purchase works which were exclusively for the supply of their own district. The promoters were not [illegible] local authorities [illegible] to the company would [illegible]

The Committee, having considered the point raised, the CHAIRMAN announced that the Committee had decided that the Bill could not proceed as regards clauses 12, 13 and 13A, which related to powers to be exercised within the scheduled districts, the amendment of the 1901 Act and the prices for energy supplied for lighting purposes.

Mr. FREEMAN said that as the other portions of the Bill were of comparatively small importance and the promoters did not think they would [illegible]

RHONDDA URBAN DISTRICT COUNCIL BILL.

Last week the Local Legislation Committee considered this Bill for [illegible]

Mr. [illegible], K.C., [illegible] Rhondda Valley [illegible] Bill [illegible] [illegible] [illegible]

become a public danger. If their mineral trams "ran away" they might dash into the tramway and cause great damage. Counsel suggested there were crossing gates and practically there would be no danger.

The CLERK to the Council (Mr. W. P. Nicholas) said the district to be served by the proposed tramway, included the chief steam collieries supplying Admiralty coal. He stated (in cross-examination) that they had an undertaking with the local tramway company. If the company declined to construct the lines, the powers would not be exercised, as the Council did not want to construct the tramways.

Evidence was also given by Mr. E. HAZELDINE BARBER, engineer and surveyor to the Council, and by Mr. STANLEY, consulting engineer to the Rhondda Tramway Co. The latter said he would advise an alternative road if there were a contribution towards the cost.

After hearing evidence in opposition, the Committee consulted, and the CHAIRMAN announced that they were unanimously of opinion that it would be more desirable if a new road were made, rather than crossing the present level. The matter was, therefore, adjourned to enable the parties to confer.

Ultimately the tramway proposals were approved.

SOUTH SHIELDS CORPORATION BILL.

Last week a Select Committee of the House of Lords considered this Bill, which authorises the extension of the tramway service, the establishment of motor 'bus services, &c. Durham County Council and the North-Eastern Railway Co. opposed.

Ald. W. G. WYLIE, chairman of the Corporation Tramways Committee, said the proposed 'bus route from the boundary to Boldon Colliery, via the Farm, would be in the hands either of the Corporation or of the Rural Council. The route would be about 1½ miles in length, and the Corporation had agreed on terms with the Rural Council for running over their roads. The other route was from the boundary along Boldon-lane and then via a proposed new road to Hubert-street, a distance of 2¼ miles. The Council did not propose to run the 'buses along Boldon-lane until the new road was made, but the work could not be commenced until the end of the war.

Mr. C. W. BELL, chairman of South Shields Rural Council, said communication between Boldon Colliery and the surrounding district was very bad. His Council had been approached as to the provision of better means of communication with South Shields, and after consideration the Council decided to make the new road running from the colliery due east to Boldon-lane and giving access to Tyne Dock and South Shields.

Mr. WILLIAM T. ROBSON, tramways manager to South Shields Corporation, said it was proposed to run an average half-hourly service of 'buses. The service at slack times would be a 40 minutes' one, and in the evenings and at the week-ends one of 20 minutes.

Mr. LESLIE ROSEVEARE, borough engineer to the Corporation, considered that Boldon-lane was entirely satisfactory, both as to width and condition—as far as he could tell from the surface—for motor 'bus traffic.

Evidence was also given by Mr. J. B. Hamilton, manager of Leeds Corporation tramways, and Mr. W. J. Hadfield, city surveyor of Sheffield.

Mr. BROOKES, engineer for the county of Durham, who gave evidence in support of the opposition of the County Council, said the service of 'buses would practically destroy the surface of the road. Tar macadam would be essential if the bill passed, and the cost was estimated at £2,367. The capital charge cost of the maintenance would mean an expenditure of £600 per annum, and he estimated that the increase in the cost of the road to the County Council, owing to the motor omnibuses, would be 3d. per car-mile. His opinion was that ¾d. was quite insufficient to provide for that. Apart from the nature of the surface, the road was not suitable for motor 'bus traffic.

On Thursday the Committee decided to reject the Corporation's scheme for running motor omnibuses between Boldon Colliery village and the borough, but the tramway extensions, improvements and other proposals were approved.

THE ISSUE OF WAR BADGES TO ENGINEERS AND ELECTRICIANS.

In the House of Common on Tuesday, Mr. C. A. Lough asked the Under Secretary for War whether he was aware that many men formerly employed in the electrical services in the metropolis had joined the forces, that others were desiring to join, and, owing to the technical and expert training required, their places could not readily be filled, and there was some risk of the power stations, the output of which was largely used for Government purposes, becoming inefficiently manned; that representations had been made, at the instance of the general officer commanding the London district, of the importance of preserving the efficiency of electric and power services of the metropolis, but in the absence of some public service or other badge authorised by the Government, which could not be forged, to protect the men from reproach for not enlisting, it was difficult to persuade them to remain; was he aware that proposals submitted by the Association of Municipal and Electrical Engineers of Greater London had not resulted in any satisfactory solution of the difficulty; and would he consider the question of either authorising the issue of an officially recognised public works badge or of enlisting the men employed in approved public utility services in a special volunteer body authorised to wear uniform, as in the case of the Civil Service Corps?

In reply, Mr. TENNANT said recruiting officers had instructions not to enlist skilled employés of electrical services without the sanction of their employers. He was informed that several electrical companies, who had applied for War Office badges, had been offered such badges for issue to men of recruitable age who would be willing to enlist if called upon in the event of emergency, or of their ceasing to be urgently required in their present employment. These official badges were War Office badges.

Mr. TERRELL asked how the badges would differ from those given to persons engaged upon munitions of war.

Mr. TENNANT pointed out that the badges for makers of munitions of war exempted the wearer from all war service, inasmuch as he was helping to produce the munitions of war. The other badges would not in all cases exempt a man from military service, and in the case of emergency arising he would be called upon to serve, unless he were urgently required in his present employment.

Mr. TERRELL further asked if there were two classes of badges issued, and to whom was application to be made for those badges?

Mr. TENNANT replied that there were not two classes of badges. They were prepared to issue the badges, and application should be made to the Secretary to the War Office. It was a condition of the issue of the badge that the man who received it should give an undertaking to join the Colours if called upon to do so.

Bristol Tramways Bill.—The Corporation have withdrawn their petition against the Bristol Tramways and Carriage Co.'s Bill which extends the time for constructing six lengths of tramway authorised by the company's Act of 1904. The option of the Corporation to purchase the local tramways must be exercised within six months from May 1, and the Corporation contended that the company ought not to enter into any agreement for laying down new tramways before the expiry of the option. An arrangement has now been made by which the company will not, during the present year, construct or take any steps such as the letting of contracts preparatory to the construction of the tramways referred to, and therefore instructions have been given for the withdrawal of the petition.

Private Bill Legislation.—Application is intended to be made to Parliament this session for leave to bring in a bill giving power for various agreements (as to interchange of traffic, &c.) to be entered into between the City & South London, the Central London, London Electric and Metropolitan District Railway Co.s and the London General Omnibus Co.

Ormskirk Gas & Electricity Bill.—This bill is now proceeding as an unopposed measure in the House of Lords.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1413 S[illegible]

28,153 B[illegible]. Method of determining the [illegible] (7/12/13.)

Method of signalling from radio stations on lighthouses, &c., which renders it possible for an ordinary receiving station to determine the bearings of the station, wherein the emission of directed Hertzian waves, a certain number of which give the geographical direction of the plane in which they are emitted, is caused to take place [illegible] desired and distributed over the whole of the horizon, the transmitter remaining stationary during the actual transmission in any azimuth in order to facilitate the [illegible] ceived.

2[illegible]751 T[illegible]. E[illegible]

1[illegible]

624 ELLISON & MUELLER. Protective devices for dynamo-electric motors.

2,100 MARKS. (International Quadruplex Co.) Diplex and quadruplex telegraphy.

Method of diplex telegraphy employing a line relay which, when no signal is being transmitted, is caused to vibrate in quick sequence by means of pulses of alternating opposite polarity impressed on the line, and which rests in zero position when no pulses are impressed on the line, wherein, when a signal is being transmitted, the line relay is caused to deflect in one direction by means of current of a certain polarity remaining on the line, or in the opposite direction by means of current of the opposite [illegible]

[illegible]

1,141 Q[illegible]

1,384 BELLIS. Arrangement [illegible] telegraphy.

1,433 M[illegible]

motor cars and the like.

8,173 B.T.-H. Co., CLOUGH & WHITCHER. Protection of alternating current electric generators.

M[illegible]

the armature which consists in comparing the inductive effects of the currents in the parallel windings or the current in one winding with the sum of the currents in the parallel windings and utilising the resultant effect on the occurrence of a fault for the purpose of disconnecting said generator from the system.

8,717 B.T.-H. Co. & JEWITT. Electric regulating devices.

An automatic electric regulator comprising a mechanical contact breaker with a shaped contact for varying the "make" relative to "break" in which the relative position of the contacts is controlled by a pair of electromagnets, one or other of which is excited in accordance with changes from normal condition in the controlled appa[illegible]

1[illegible] A[illegible]

10,823 WELLS. Electromagnetic apparatus for controlling electric circuits. (9/7/13.)

12,721 HEYES & HEYES. Electrical signalling apparatus.

13,524 WESTERN ELECTRIC CO. Automatic switching mechanisms, more particularly for use in connection with telephone systems.

17,326 LANGMUIR. Electric incandescent lamps. (4/9/13.)

17,945 WEAVING, SMITH & FERRANTI LTD. Electric heaters.

18,106 SUMNER. Electric current graduating devices or resistances.

22,261 KOBERT. Apparatus for electric riveting and heading.

24,780 MILLER. Electrically-operated alarm apparatus.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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SPECIAL INDUSTRIAL HEATING.

The economic aspect of electric heating, both of rooms and water, is in great measure bound up with factors which are introduced by commercial expediency. The essence of economic production under present day conditions is made up from the elements of uniformity in design and quantity in production. Both America and Germany have set a fashion in this regard. The motto of the factory might well be, "Decide upon one product, specialise in it, and turn it out in gross lots." Such a policy is only possible where simplicity enters into the design of the product. Gas heating apparatus, which is at present hired and sold by the gas interests, owes its commercial success to this simple fact. We anticipate that it will be many years before manufacturers of electric heating appliances can undertake production upon a quantity basis, although they are making every effort to do so at the present time. These efforts are in every way commendable, and ultimately will bring about success. It is not surprising that, in view of these attempts at uniformity, present-day manufacturers of electric heating apparatus are disinclined to devote any attention to special applications of electricity for heating purposes. There is, however, abundant evidence of the existence of a great number of industries of a crying need for a simple method of heating which does not depend upon any process of combustion. The fact that the work is unsolved has checked any tendency of electrical men to investigate this important field. The few installations of special industrial electric heating which are to be met with have been put down more by chance than as the result of any special campaign by the manufacturers themselves. Almost in despair at the high factor of illness amongst his employés, the factory owner who uses gas for subsidiary heating purposes has come to hear that there is such a thing as electric heating, and upon making inquiries has adopted it with profit to himself and advantage to the health of his workers.

In the Supplement pages of The Electrician this week we give particulars of an interesting installation for which Mr. H. Tomlinson Lee, the electrical engineer of the borough of Wimbledon, has been responsible. He has undertaken the conversion of a number of presses in a box factory in his district from gas to electric heating, and has succeeded in doing this in an extremely simple manner. In addition, he has conclusively proved to the proprietors that the results have fully justified the change from the points of view of greater uniformity of production, economy of operation and improved health of the workers. It is surprising to find that factory rules and regulations, which require the fencing in of moving machinery and the protection of employés in certain works, in which chemical fumes or metallic dust may be deleterious to the health of the workers, suggest little or no precaution against the effects of fumes from open gas burners. As a rule, the heating of die blocks or other pieces of metal which are employed at fairly low temperature in certain gas-operated machine tools, is carried out with open bunsen flames, which play directly on to the mass of metal. The fact that the die occupies a position in the machine immediately in front of the operator makes the introduction of a hood to carry away the fumes a matter of extreme difficulty or impossibility. There is nothing for it, in these unpleasant circumstances, but to encourage the workers to carry on; also to allow a certain amount of leave in case of temporary sickness. Mr. Tomlinson Lee has shown that the introduction of an extremely simple form of low temperature heating element into the dies is a simple proposition. The maintenance of the heater is extremely low; its replacement can be undertaken at nominal cost, and the energy consumption at current rates is a mere bagatelle. The use of electricity in this manner is immediately reflected in the improved product, in consistent work on the part of the operators, and a clean and healthy atmosphere in the factory rooms. In view of the fact that makers of electric fires and other heating and cooking apparatus are either too busy or too disinclined to take up the work of their solution, it may with advantage be left in the hands of the manufacturers of the machine tools on which it is desirable to introduce some method of low temperature heating.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week April 19, 1915, *to April* 24, 1915

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* **note at foot of Exports.**)

IMPORTS.

[illegible] material, £48; unenumerated, £77. *U.S.A.:* Carbon candles, £377; elec. machinery, £5,621; elec. lamps, £294; telephone material, £44; wire and cable, £519; lamp parts, £170; unenumerated, £1,068. *Denmark:* Unenumerated, £129. *Holland:* Elec. lamps, £4,190—47 pkgs.; elec. machinery, £186. *Sweden:* Telephone apparatus, £89—33 pkgs.; elec. lamps, £25; lamp parts, £33; elec. machinery, £481. *France:* Carbon candles, £264; unenumerated, £297. *Italy:* Carbon candles, £20; elec. insulators, 32 pkgs. *Kobe:* Electro-copper ingots, 3,786. *Sydney:* Elec. meters, 81 pkgs. *N. Atlantic:* Quantity submarine telegraph cable.

MANCHESTER.—*Canada:* Elec. motors, 22 pkgs. *Italy:* Elec. motors, 6 pkgs.

[illegible]

EXPORTS.

T[illegible] £144; [illegible] £93. *Melbourne:* Elec. machinery, £2,973; wire and cable, £1,912; unenumerated, £2,621. *Sydney:* Elec. machinery, £173; wire and cable, £4,179; unenumerated, £3,231. *Wellington:* Wire and cable, £2,010; elec. machinery, £98; unenumerated, £239. *Adelaide:* unenumerated, £758. *Brisbane:* Elec. machinery, £61; unenumerated, £230. *Freemantle:* Wire and cable, £23; unenumerated, £36. *Dunedin:* Unenumerated, £100. *Christchurch:* Elec. machinery, £215; unenumerated, £34. *Perth:* Wire and cable, £11 *Lyttleton:* Unenumerated, £71. *Hobart:* Telephone material, £476.

SPAIN.—*Huelva:* Unenumerated, £17. *Bilbao:* Unenumerated, £61.

PORTUGAL.—*Lisbon:* Wire and cable, £174; unenumerated, £571.

CHINA.—*Hong Kong:* Unenumerated, £99. *Shanghai:* Unenumerated, £205.

INDIA, CEYLON AND INDO-CHINA.—*Bombay:* Elec. machinery, £75; unenumerated, £540. *Calcutta:* Elec. machinery, £1,349; wire and cable, £592; unenumerated, £1,631. *Madras:* Wire and cable, £285; elec. machinery, £88; unenumerated, £147. *Colombo:* Elec. machinery, £130; wire and cable, £463; unenumerated, £182. *Karachi:* Unenumerated, £11. *Port Swettenham:* Elec. machinery, £52; unenumerated, £469. *Kiindini:* Telegraph material, £108; telephone apparatus, £49. *Singapore:* Elec. machinery, £98; wire and cable, £1,226; unenumerated, £104. *Penang:* Wire and cable, £124; elec machinery, £299; unenumerated, £102.

CANADA.—*St. John's:* Unenumerated, £32. *Montreal:* Unenumerated, £40.

NORWAY.—*Christiana:* Wire and cable, £170.

SWEDEN.—*Stockholm:* Wire and cable, £150.

FRANCE.—*Dieppe:* Unenumerated, £210. *Treport:* Unenumerated, £29. *Havre:* Unenumerated, £2,324. *Bordeaux:* Wire and cable, £260; unenumerated, £80. *Boulogne:* Elec. machinery, £75; wire and cable, £3,382; unenumerated, £400.

SOUTH AMERICA.—*Buenos Ayres:* Wire and cable, £551; unenumerated, £5,692. *Rosario:* Elec. machinery, £76. *Rio de Janeiro:* Unenumerated, £53. *Monte Video:* Unenumerated, £89. *Santos:* Unenumerated, £30. *Puerto Mexico:* Unenumerated, £13. *Demerara:* Unenumerated, £25.

AFRICA.—*Durban:* Elec. wire and cable, £26; machinery, £286; elec. glow lamps, £275; elec. watertight bells, £333; telegraph material, £26; unenumerated, £502. *Port Elizabeth:* Wire and cable, £377; unenumerated, £149. *Cape Town:* Telegraph material, £68; unenumerated, £642. *East London:* Elec. machinery, £1,083; elec. glow lamps, £116; unenumerated, £12. *Alexandria:* Wire and cable, £23; elec. machinery, £630; unenumerated, £55. *Mauritius:* Unenumerated, £44. *Beira:* Wire and cable, £207. *Mombasa:* Elec. machinery, £1,819.

PORT SAID.—Wire and cable, £175; unenumerated, £29.

ITALY.—*Leghorn:* Unenumerated, £38. *Naples:* Unenumerated, £80. *Genoa:* Telegraph material, £47; telephone cable, £12,100; telephone parts, £174; unenumerated, £38.

[illegible]

H[illegible] Wire and cable, £11.

U.S.A.—*New York:* Elec. machinery, £452; unenumerated, £69. *Boston:* Wire and [illegible] £29.

JAPAN.—*Kobe:* Wire and cable, £113; unenumerated, £162. *Darien:* Elec. machinery, £46. *Fiji:* Wireless telegraph material, £169; wire and cable, £10; unenumerated, £34.

FOREIGN GOODS DUTY (paid and free).

Brisbane: Unenumerated, £82. *New York:* Unenumerated, £400. *Hong Kong:* Telephone material, £132; unenumerated, £45. *Amsterdam:* Unenumerated, £59 [illegible] Unenumerated, £59. [illegible] £41

NOTE.—**The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."**

BUSINESS NOTICES.

The Kingolite Co., of 19, 21 and 23, Oxford street, and Soho-square, W. (of which Mr. William J. Owen is managing director), have disposed of their business in electrical accessories and silk shades to the Edison & Swan United Electric Light Co. The Kingolite Co.'s works, together with practically the whole staff, have been transferred to Ponder's End, while Mr. Owen, having accepted a position with the Edison & Swan Co., continues to superintend the business he has been instrumental in establishing.

The Armordust Mfg. Co. ask us to announce that owing to certain rearrangements which are being made at their Watton Works, they have decided to relinquish the manufacture of Mr. Napier Prentice's Lighting Cooker, for which they held the sole license. Mr. Prentice will make arrangements for the manufacture of the cooker with some other responsible firm.

The British Electric Transformer Co. have closed their offices and showrooms at Charing Cross House, 29A, Charing Cross road, London, W.C., and communication should be sent to Hayes, Middlesex.

The title of Slaughter & Co. (Ltd.), electro-metallurgists, &c., has been altered to the Quasi-Arc Co. (Ltd.). The constitution and management of the company is unaltered and remains entirely British as heretofore.

Messrs. Wm. McLean & Co., electrical and mechanical engineers and machinery merchants and importers, of Elizabeth-street, Melbourne, notify that their general manager (Mr. O. L. Remington) and one of their engineers (Mr. H. P. McColl) have started on a visit to the United States and to Great Britain.

Messrs. Remington & McColl propose to make an extended trip through the principal industrial cities and districts of the Central and East American States, and provided war conditions permit they then propose to pay a visit of a few weeks' duration to this country in order to get into touch with electrical manufacturers, &c.

Patent Development. The proprietor of British patent No. 15,559/1911, relating to "Printing telegraphy," desires to make arrangements for working the invention in Great Britain. Particulars from Messrs. Dicker, Pollak & Derriman, Patent Agents, 20-23, Holborn, London, E.C.

The proprietor of patent No. 16,500 1907, for "Improvements relating to electric self-winding clocks," desires to make arrangements for the practical working of the invention in this country.

The proprietor of patent No. 16,638/1909, for "Improvements in clocks," also desires to make arrangements for exploiting the same in this country.

Applications in the two latter cases to Messrs. Haseltine, Lake & Co., Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

Plant for Sale.—Owing to the abandonment of an electric power scheme, an advertiser has some new plant for sale, including two 250-kw. three-phase 600-volt generators, two 400 H.P. Pelton wheels, two shunt-wound exciters, 650 galvanised steel transmission towers, and 3,600 h.v. insulators.

BANKRUPTCIES, LIQUIDATIONS, &c.

The liquidator of the Consolidated Diesel Engine Manufacturers, Ltd. (Sir W. B. Peat) announces that the company's works at Ipswich have been sold to Messrs. Vickers Ltd., at a price which will probably be sufficient to discharge the mortgage and pay the creditors and leave a small balance in hand.

A meeting to receive an account of the winding up of the Electromobile Co. (Ltd.), will take place at Sardinia House, Kingsway, London, W.C., on May 31.

A meeting to receive an account of the winding up of Molybdemun & Tungsten Traders (Ltd.) (in liq.), will be held at 638, Salisbury House, London Wall, London, E.C., on June 2.

A meeting to receive an account of the winding up of the Hove Electric Lighting Co. (Ltd.) will be held at Salisbury House, London Wall, London, E.C., on June 2.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aldershot. The Urban Council proposes to press for the loan of £8,500 for extensions of the electricity undertaking.

Barking.—An inquiry will shortly be held into the Council's application for sanction to borrow £18,000 for extensions of the electricity works.

Bolton.—An unopposed inquiry was held last week into the application of the Corporation for sanction to borrow £45,032 for the electricity undertaking.

The first part of the inquiry related to £23,032 for converter and other plant, and the electrical engineer (Mr. W. J. Wood) explained the plant was necessary so that full benefit might be obtained from the new works at Back o' th' Bank. It was necessary to make alterations in the system of distribution: at present they had four systems of supply at the Spa road works, requiring different plant for each, and the cost of generating would be substantially reduced if the whole supply could be generated by one plant, which the Committee proposed to do at Back o' th' Bank. By altering the system of distribution and transferring the whole supply to Back o' th' Bank the department would save £8,744 per annum.

The inspector (Mr. H. Shelford Bidwell) inquired as to the absolute necessity of the works as distinct from their desirability, and Mr. Wood said they were absolutely necessary for the financial success of the scheme. The Town Clerk also pointed out that the Corporation had suspended

other works on capital and revenue account to the extent of something like £275,000, showing they desired to comply with the requirements of the Board and the Treasury.

The other part of the enquiry related to £5,000 for the equipment of sub-stations on consumers' premises, and £17,000 for mains. The Town Clerk said they were quite prepared to place themselves in the hands of the Board, and accept sanctions as and when required.

Dover.—The L.G. Board propose to sanction a loan of £6,000 for additional generating plant, but the estimated value of the sets to be superseded (£1,000) must come out of revenue, the charge to be spread over three years.

It is proposed to give a supply of current to the Admiralty sheds in Guston-road.

Public service badges are to be given out to the members of the staff of the electricity works.

Hackney (London).—Mains are to be extended in order to supply several business premises in various parts of the borough.

Hawarden.—An inquiry will shortly be held by the L. G. Board into the Rural Council's application for sanction to a loan for the erection of electricity works to supply current in West Saltney, &c.

Mansfield. In order to give a supply of electric current to Clipstone Camp, the L. G. Board have sanctioned the application of the Council for a loan of £2,000 for transforming and converting plant, and orders for the plant and cables can be placed at once.

Stepney (London).—The Electric Supply Committee has decided to extend the supply mains in five streets.

Walthamstow. The Council has received sanction to borrow £6,986 for new plant at the electricity works.

GENERAL.

Boston.—The Board of Trade have granted a provisional order for this district, but it will not come into operation until after the war.

Cahirciveen (co. Kerry).—At a recent meeting of the leading ratepayers, it was reported that ten applications had been received for the position of consulting engineer, to prepare a report and advise upon the plans and specification submitted by the Ampere Electrical Co. for the electric lighting of the town.

Mr. W. J. U. Sowter, of Bray, was unanimously appointed. An application has been made to the Congested Districts Board for permission to build on the proposed site, and as soon as the required permission is granted, the Ampere Company can proceed with the work, provided the plans and specification are approved by Mr. Sowter.

Coventry. Last week the Corporation decided to obtain a spare stator and a spare rotor at a cost of £1,658, to be paid out of revenue.

A fourth turbo-alternator has been ordered from the British Thomson-Houston Co. as the L. G. Board have authorised the expenditure.

A site for a sub-station in Stoneleigh-terrace has been purchased.

Dalkey.—The Council have instructed a committee to report upon the question of taking a supply of current in bulk from the Kingstown Council.

Hull.—At last week's meeting of the Electricity Committee the deputy electrical engineer (Mr. J. F. Magoris) stated that in accordance with the instructions of the L.G. Board all capital expenditure on mains, services and the hire of motors ceased on March 31.

Mr. Magoris suggested that the hiring out of motors might now be temporarily stopped, but, for various reasons, he said it would be undesirable to cease connecting up all new services. He recommended that services be connected up and the cost of the service met out of revenue, the expenditure to be reported monthly for the Committee's approval. The services connected since April were estimated to return in revenue the cost of the service by the end of the year, so that the account would be balanced.

The Town Clerk submitted the sanction of the L.G. Board to the borrowing of £27,300 for new generating plant already installed at the electricity works.

Irlam. The Council's application for a provisional electric lighting order has been granted by the Board of Trade.

Kingstown.—The Dublin & Southern District Electric Supply Co. has now transferred the Kingstown Electric Lighting Order to the Council and the only outstanding question between the two bodies is the costs of the recent arbitration proceedings.

London County Council. At Tuesday's meeting the chairman of the Finance Committee (Sir Geo. Goldie) submitted the estimates of income and expenditure for the financial year 1915-16.

He said that the outstanding feature of the transactions was the growth (actual and prospective) of the traffic receipts. For several years they had watched with misgiving the falling off in receipts per car-mile, which reached their lowest point in 1913-14. There was a very substantial recovery in the earnings, due in part to the lessened competition of motor buses, but due also to certain new traffic facilities given by the Council. It was estimated that the traffic receipts would amount to £2,478,000, against £2,325,000 last year, the receipts per car-mile being 9·75d., against 9·47d. The number of car-miles to be run was estimated at 61,000,000, against nearly 59,000,000. The ordinary expenses of operation were on the increase, due mainly, but not entirely, to war conditions. In addition there were the special war service allowances (£81,000) and contingencies (£50,000), a large part of the latter being already earmarked to meet the special grant not exceeding 3s. per week recently made by the Council to its lower-paid employees to meet increased cost of living. The net result was a deficiency of £91,614 (to be met out of reserve), compared with a deficiency of £9,865 for the past year.

Manchester.—The Committees of the Corporation have now considered their estimates for the coming year.

The Electricity Committee propose to contribute the usual sum of £30,000 in the coming year towards the relief of the city rates. The surplus for the year ended March 31 was £35,850, against an estimate of £30,500. Compared with 1913-4 there was an increased volume of business. Among the expenses of the year were £6,015 for war allowances of 275 employees at the front, £3,267 for income tax and £2,964 for Parliamentary matters. For the coming year the Committee estimate that the sales will increase by about 9,000,000 kelvins. In view, however, of various causes, more particularly increased coal prices, a slight revision of charges for electricity will have to be considered.

The Gas Committee state that the gross profit for the year was £90,369, compared with an estimate of £119,571. The gross profit (together with £18,133 transferred from the reserve fund) has been appropriated as follows: For interest, £39,767; statutory sinking fund for liquidation of mortgage debt, £67,011; contribution to city fund in aid of rates, £50,000; certain capital expenditure not chargeable against borrowing powers, £10,091. The deficit thus caused (£58,367) has been carried to next year's account. The Committee adhere to their decision to increase the price of gas by 6d. per 1,000 ft.

The Tramways Committee has also decided to contribute £100,000 to the relief of the city rates.

Stafford. The Special Committee which was appointed to consider and report on the proposal to form separate committees for the management of the gas and electricity undertakings recently recommended the Council to continue the control of the two undertakings under one committee, as now; that Mr. W. H. Robins be appointed engineer and manager of the electricity works, presenting his reports direct to the Committee; and that Mr. W. M. Valon be appointed secretary for the electricity works and countersign all orders exceeding £10 in value.

In the discussion on the report, Ald. SWIFT moved an amendment that the two undertakings be placed under the control of separate committees. He pointed out that there was only one town in the kingdom where the dual control system existed, and that was at Alloa, in Scotland.

The amendment was lost after considerable debate, and the recommendations were agreed to.

Stoke-on-Trent. It was recently stated that the Corporation electricity department had filled the places of men who had enlisted by single men of military age.

Mr. C. H. Yeaman, Borough Electrical Engineer, has reported fully on the matter to the Electricity Committee. The Committee has instructed Mr. Yeaman to reply to the allegation, and to point out that the electricity department has sent a larger percentage of men than any other department of the Corporation—30 per cent. of its employees having enlisted, and 44 per cent. from the office staff. The allegation of taking on single men of military age is disputed, but it is stated that the greatest difficulty has been found in obtaining suitable men, and that a few more who would enlist are unable to do so because they cannot be spared, particularly as the War Office, the L.G. Board and local firms insist upon an adequate supply of electricity being maintained, especially by firms engaged in the production of munitions of war, &c.

West Ham.—The Electric Lighting Committee has adopted the proposals of the borough electrical engineer (Mr. J. W. Beauchamp) for increasing the charges for the supply of electric current.

Mr. Beauchamp recommended the following increases:—

Lighting.—Directly or indirectly, from 3d. to 3½d. per unit; in factories to extent of 10 per cent. of consumption for power, from 1d. to 1½d.; on maximum demand system, from 7d. and 2d. to 7d. and 2¾d.; for electrical showrooms, from 1½d. to 2d.; on household tariff, from £10 per kilowatt and ½d. per unit to £10 and 0·6d.

Power.—Directly or indirectly, including cell charging, from 1d. to 1½d., night and day tariff, from 1d. and ½d. to 1½d. and 0·85d.; *heating*, from 1d. to 1½d.; on household tariff from 10s. to 6s. 8d. per kilowatt and ½d. per unit to 10s. and 6s. 8d. and 0·6d. for large premises with fresh electricity factor, from ½d. to 0·85d. Discount on account over £10 per quarter, for payment within 14 days, are to be maintained as at present up to 7½ per cent. A minimum of 5/- per annum per service is to be charged for energy supplied, or such larger sum as may be necessary where special expenditure is incurred.

It is also recommended that an additional 5d. be made on the existing charges for hire and maintenance of arc lamps; and it is also proposed to advance the rate per quarter and per hour for 220 watt enclosed lamps from 1/- 6d. and 1¼ to 2/- 0d. and 1½d.

Woolwich (London). The charge for current for all classes of lighting (other than for factories) has been increased by ½d. per unit, and power consumers who have not a coal clause in their agreements must pay ½d. per unit extra, but they will get an option to accept a coal clause in substitution of the present clause.

LIGHTING, POWER & HEATING NOTES.

Electrical Equipment of Collieries.—In view of the increasing use of electricity in collieries, the Warwickshire Education Committee has instructed the mining lecturer to report as to the probable cost of suitable electrical equipment for instruction at the mining school.

Electricity in Mining. In the directors' report of the Rand Mines (Ltd.) for 1914 it is stated that the completion of further plant enabled the Rand Mines Power Supply Co. to give a full supply of both electricity and air to the mines of the group.

Lighting Restrictions.—The orders for lighting restrictions in many districts in West Yorkshire have been revoked. The districts include the boroughs of Bradford, Batley, Morley, Ossett, Keighley, Pudsey and a number of other districts.

TRACTION NOTES.

East Ham. The engineer and manager of the Corporation tramways, Mr. W. C. Tilbury, has reported on the rolling stock at his disposal.

The report draws attention to the necessity for modernising the equipment of the existing cars in order to reduce the excessive annual expenditure on maintenance, commercial speed, which has proved unequal to the demands made under present working conditions, and also to the need for purchasing additional cars to cope with the requirements. In submitting the report to the Council the Tramways Committee recommends that, as an experiment, one of the cars be fitted with a new type of equipment with 40 h.p. motors and new controllers at a cost of £275. The question of the purchase of additional cars has been deferred.

Glasgow. The extension of the tramways from Cochrane Terminus to Netherlee has been opened for traffic.

Newcastle-on-Tyne. The formal opening of the Corporation tramway route to Newburn and Throckley took place on the 22nd inst.

A large number of members of the Council accepted the invitation of the chairman, vice-chairman and members of the Tramways Committee, to traverse the new line by car from the Town Hall to the terminus. At Throckley the company was entertained to tea.

Wolverhampton. The Council have recently confirmed the recommendation of the Electricity Committee to purchase for £630 an electric vehicle to remove ashes from the Commercial-road generating station.

Women Tramcar Conductors.—Cardiff Corporation has followed the example of Glasgow, and has decided to engage women tramcar conductors. Four women started work on the 22nd inst., and it is stated that the experiment has proved successful.

Maidstone Tramways Committee experience great difficulty in securing suitable men for conductors, and it has been decided to appoint two women conductors as an experiment. The women are to be paid at the same rate as men.

The general manager of Glasgow tramways department (Mr. J. Dalrymple) has received a large number of applications for the position of conductor.

Among the applicants are a number of married women, whose husbands are at the front, and there are many applications from young women whose fathers or brothers are with the Colours. Only applicants over 25 years of age will be chosen. Many applications have been received from ladies desirous of filling the 300 or 400 vacancies, and it is stated that similar calls are being made in London, Newcastle, Perth, Derby, Berwick-on-Tweed, Manchester, Durham, Brechin, Newhaven and Wigan.

York. The Electricity and Tramways Committee have decided to appeal to the Treasury to allow the construction of the Hull-road tramways and the extension of the electric supply mains to Strensall, Poppleton and Naburn to proceed.

The work of constructing the Hull-road route was about to be commenced when the circular letter was issued. Large quantities of material had either been delivered or ordered, and contracts amounting to between £1,000 and £10,000 had been placed. The cost of the tramways is estimated at from £6,000 to £8,000, and the work is to be proceeded with at present at all events. The Corporation have, however, agreed to borrow no money borrowed to pay for materials already contracted for.

The question raised the number of horses the electric supply mains to Strensall, Poppleton and Naburn would travel. £10,000 has been [illegible]

EMPIRE NOTES.

Australasia. The Commonwealth Treasurer says the receipts of the Northern Territory for last financial year, ended Sept. 30, 1914, were £1,353, and the credit balance was £60 [illegible]

meters, coasting recorders or other devices for keeping a check on the expenditure of electrical energy in train operation, to submit particulars of appliances which are designed and applicable to railway trains operated on the multiple unit system by means of direct current at 1,500 volts. The particulars should include a technical description of the apparatus, details of its operation and the approximate cost of the equipment per car, and may be lodged at the office of the Secretary for Railways, Melbourne, or the Agent-General for Victoria in London.

Messrs. Gardner, Waern & Co., of Melbourne, have undertaken to equip the electricity supply works for Franklin and Port Cygnet.

The electricity supply works at Boort (Victoria) were officially opened on Feb. 3. Current is supplied at 230 volts from the local Butter and Ice Company's plant, which includes a 50 B.H.P. Hornsby suction gas engine and a dynamo supplied by Siemens Bros. Dynamo Works.

Kyneton (Victoria) Council proposes to borrow £15,000 for works, including an electric lighting plant.

An electric lighting scheme has been prepared by the Upper Yarra (Victoria) Shire Council for Warburton. It is expected to cost £4,000.

The engineer to the Shire Council has been instructed to take the preliminary steps towards carrying out the scheme.

Wynyard (Tasmania) Council has decided to instal a suction gas plant in connection with its electric light scheme. The Council proposes to borrow £6,000 for the undertaking.

Mr. W. J. S. Jones, consulting engineer, Brisbane, has recommended Ipswich (Queensland) Council to obtain tenders for an electric pumping scheme, which he estimates will effect a saving of from £1,000 to £2,000.

The Australian "Mining Standard" says Launceston (Tasmania) City Council were recently recommended by their Electric Light Committee to accept the tender of Siemens Brothers Dynamo Works for the supply of 41 electric motors (at £1,002. 12s.), but it was decided to refer the matter to the Council in committee.

Sydney Council have undertaken to supply current and h.t. feeders for public lighting in Lane Cove and Willoughby, the estimated cost being for Lane Cove £12,000 and for Willoughby £23,100.

India.—"Indian Engineering" says a public meeting was held in Lucknow on March 19 to discuss the formation of a company to take up the electrical schemes proposed for Lucknow and Allahabad. The capital required is 15½ lakhs, of which the promoters are to take 5½ lakhs, the balance to come from the public.

Pandit Jaggat Narayan explained that Messrs. Crompton & Co. (through their managing agents, Messrs. Martin & Co., Calcutta) had taken out a license for Lucknow and Allahabad. The company was putting in a big sum, and was offering the balance to the public in shares of Rs.100, one-fourth to be deposited on application. The municipalities guaranteed 4½ per cent. on the actual expended capital. The quantity of current for street lighting would practically cover the investors, and the latter could depend upon 5 per cent. on their money.

Mr. Jopling, who presided, announced that the Maharaja of Balrampur was putting in one lakh of rupees. A number of people present also took up shares.

MISCELLANEOUS NOTES.

Competition. Our contemporary "Electricity" during May will publish particulars of the next of the periodical electric light switching competitions founded on the contents of Messrs. Lundberg's booklet "Lektrik Lighting Connections." This competition is open to all. Substantial money prizes are to be awarded as well as book prizes and certificates.

Import and Export of Goods.—Notice is given that, with a view to preventing breaches of the Trading with the Enemy Proclamation, importers will be required to produce certificates of origin issued by British Consular officers and exporters, and to make declarations to Customs officials of the ultimate destination of their goods exported to any foreign place in Europe or on the Mediterranean Sea, except Russia and France.

Radiotelegraphy. The London "Daily Telegraph" New York correspondent states that the Germans have secretly trebled the strength of their radiotelegraphic plant at Sayville, Long Island, and hope to be in a position shortly to maintain a continuous service between America and Germany.

The B.E.A.M.A.—The following firms have recently been elected members of the B.E.A.M.A.: The Mirrlees Watson Co., John Musgrave & Sons (1913), Ltd., Newton Brothers (Derby) and Isaac Storey & Sons (Branch of United Brassfounders and Engineers, Ltd.).

Wireless Apparatus Prosecution. At Blyth on Tuesday Wm. Thompson, labourer, was sentenced to six months in the second division for having in his possession wireless telegraph apparatus without the consent of the Postmaster-General.

Evidence was given by Mr. Hope, Dunthorpe, Post Office expert, who said that the apparatus could transmit messages over a radius of 5 miles under favourable circumstances.

Defendant stated that he had made experimental experiments a hobby; he was not using the apparatus as a means of telegraph instrument. The greater part was used in relation to the boats and steamships at sea from there. He was experimenting on that subject with a model yacht on Ridley Park Lake.

A second charge of using [illegible] was also preferred against Thompson, and upon this he was fined one month's imprisonment in the second division, both terms to run concurrently.

TENDERS INVITED.

Transformers.

Tenders are invited for the supply of Four 250 k.v.a. Three-phase Transformers to the CITY OF MELBOURNE. Tender form, specification, &c., from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co., Ppty. (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by 11 a.m. May 18. *See advertisement.*

Lead-Covered Cable.

Tenders are invited for the supply of 9,680 yds. of 0·05 sq. in. Three-core Lead-covered Cable to the CITY OF MELBOURNE. Tender form, specification, &c., from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co., Ppty. (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by 11 a.m. May 18. *See advertisement.*

Steel Constructional Work.

ST. PANCRAS (London) Council require tenders by noon May 11 for Steel Constructional Work of extension to power house. Drawings may be seen at 57, Pratt-street, Camden Town N.W.

Wiring and Fittings.

SOUTHAMPTON Guardians require tenders by May 5 for the Electric Lighting of the Old Men's Home, at the Workhouse, Southampton. Specification, &c., from the Clerk.

Cables, Transformers, Switchgear, &c.

MELBOURNE (Victoria) City Council require tenders by 11 a.m. May 18, for supply of insulated copper cables, and three-phase transformers. Specifications from the City Electrical Engineer.

LAUNCESTON (Tasmania) Council want tenders by 4 p.m., July 26, for converter, switchgear, underground feeder cable, &c. Specifications, &c., from the City Electrical Engineer.

Turbo-Alternator.

SYDNEY (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

Telegraph and Telephone Instruments and Material.

The Deputy Postmaster-General, Sydney (N.S.W.), will receive tenders until 2:30 p.m. June 16 for the supply of 400 pony pattern Morse Sounders to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specification, &c., from the Deputy Postmaster-General.

The Deputy Postmaster-General, Perth (W. Australia) will receive tenders until 3 p.m. May 5 for the supply of 15 tons h.d. Copper Wire (schedule 426 W.A.), 3,000 Copper Binders, 31,000 Copper Sleeves and 13,000 Copper Tapes (schedule 428 W.A.), to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specifications from the Deputy Postmaster-General.

Track Transformers, Signals, Wheels and Axles, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. May 19 for 120 s.p. Track Transformers and 300 Electric Signals and Spare Parts; and by 11 a.m. June 2 for 300 Electric Train Stops (and in each case such further supplies of similar goods as may be required during five years), and for Bogie Trucks, Wheels and Axles for 10 Electric Street Railway Cars. Specifications from Railway Offices, Spencer-street, Melbourne.

Telephone Switchboard (Extension of Time).

The Commonwealth of Australia Postmaster-General's Dept. give notice that the date for the receipt of tenders for a Telephone Switchboard for Warwick (QUEENSLAND) is further extended from March 16 to June 1.

Railway Carriage Lighting, &c. (Extension of Time).

The time for the receipt of tenders by the VICTORIAN RAILWAY COMMISSIONERS for the supply of Material for Railway Car Lighting and Electric Lighting Material for Car Repair Shops is extended to June 2. Specifications from the Commissioners' Offices, Spencer-street, Melbourne.

Generators (Extension of Time).

The time for the receipt by the NEW ZEALAND PUBLIC WORKS Dept. of tenders for the supply of a Three-unit Exciter Set and a 1,500 kw. Generator in connection with the Lake Coleridge power scheme has been extended to noon May 21. Particulars from the Public Works Offices, Auckland, Wellington, Christchurch and Dunedin.

Electrical and General Stores, &c.

The Postmaster-General, ALEXANDRIA (Egypt), will receive tenders until noon May 15 for the supply of Lamps, Electric Fans, &c., for one year. Specifications, &c., from the Central Stores Department, G.P.O., Alexandria.

Circuit-Breakers.

JOHANNESBURG Municipal Council require tenders by noon June 1 for the supply of 24 Double-pole Automatic Oil-immersed Circuit-Breakers of 200 amperes capacity. Specifications from the Controller of Stores, Plein-square, Johannesburg.

Cable.

Tenders are invited by the NORWEGIAN STATE TELEGRAPH DEPARTMENT for the supply of Lead Cable. Particulars may be obtained by agents of the United Kingdom manufacturers on application to the Technical Department of the Telegraph Administration, Hasselgaarden, Christiania, to which address tenders are to be sent by noon May 15. Local representation by a resident is essential. In all Norwegian Government contracts a preference of from 10 to 15 per cent. (sometimes more) is given to Norwegian manufacturers.

TENDERS RECEIVED AND ACCEPTED.

POPLAR (LONDON).—The following tenders were received for the supply of two 1,000 kw. converters:—

General Electric Co. (*accepted*) (Brush transformer, 500 revs. per min.), £1,925, (Ferranti transformer, 500 revs. per min.) £1,900; Bruce Peebles & Co. (Westinghouse A type 375 revs. per min.), £2,265 (ditto C 375 revs.) £2,285, (ditto G 428 revs. per min.) £2,180 and (ditto E 428 revs. per min.) £2,150; British Thomson-Houston Co. (Brush, 500 revs. per min) £1,990, (British Electric, 500 revs. per min.) £2,117 and (Westinghouse, 500 revs. per min.), £2,122; British Westinghouse Co. (Westinghouse, 500 revs. per min.), £2,013; Siemens Bros. Dynamo Works (Ferranti transformer, 750 revs. per min.), £1,850, and (Brush transformer, 750 revs. per min.) £1,898.

Reporting upon the tenders the Electricity Committee states that the electrical engineer (Mr. J. H. Bowden) recommended the acceptance of the tender of the General Electric Co. for one rotary converter with Brush transformer for the main station at £1,925. As regards the Glengall substation Mr. Bowden pointed out that the building was not suitable for rotary machines, and that it was desirable to install a motor converter which would be in line with the existing machines, and therefore he recommended the installation of Messrs. Bruce Peebles & Co.'s type A, for £2,265. The Committee adopted Mr. Bowden's suggestions and recommend accordingly.

The tender of H. E. Keen & Co. (at £125) has been accepted for renewing the electric lighting and heating circuits at the Council offices, and the substitution of five 1,000 c.p. half-watt lamps in the Council Chamber. Duncan Watson & Co. tendered at £185 and Marler & Co. at £218.

WALTHAMSTOW.—The following tenders have been accepted by the Urban Council for annual supplies of electricity and tramway stores:

W. T. Henley's Telegraph Works Co., cables and pure rubber tape; General Electric Co., steel conduits and saddles; Edison & Swan United Electric Light Co., ceiling roses, lampholders, batten holders, adaptors, wall sockets and plugs, cut-outs, counterweight sets, &c.; Chamberlain & Hookham, meters; General Electric Co. and Cryselco (Ltd.), carbon filament lamps; Geo. Angus & Co., rubber insertion and rubber packing.

The following tenders are recommended for acceptance for the supply of switchgear and cables: British Thomson-Houston Co., h.t. switchgear (£391); General Electric Co., h.t. switchgear (£230); W. T. Henley's Telegraph Works Co., cables (schedule prices).

WIMBLEDON.—The following tenders have been accepted by the Corporation for the supply of annual electrical stores:—

Western Electric Company, paper cables (for three years); C. Macintosh & Co., rubber cables (for one year); British Insulated & Helsby Cables, workshop and talk flexible (for one year); W. Lacy & Co., Dussek Bitumen Co., Sykes & Sugden, and Callender's Cable & Construction Co., joint boxes and jointing materials; British Electric Transformer Co., transformers; Ferranti Ltd., meters; A. Dickinson & Co., cells.

BATTERSEA (LONDON).—The Electricity Committee has accepted the following tenders for the supply:

British Insulated Co., consumers' fuse boxes; Dussek & Co., box [illegible] Callender's Cable & Construction Co., troughing, bridges,

lutuners, &c.; Reason Mfg. Co., electrical meters; Brush Thomson-Houston Co., carbon lamps; Beldam & Co., packings; Pryke & Palmer, engine room stores, &c.; A. Duckham & Co., turbine oil; Prices Ltd., oils (except turbine).

LONDON COUNTY COUNCIL.—The Council received seven tenders for the roadwork in connection with construction of tramways in East-hill, Wandsworth, and that of J. Mowlem & Co. (at £5,415) has been accepted. The amount of the highest tender was £6,709, and the lowest £5,198, the Chief Engineer's estimate being £5,400.

The following tenders have also been accepted by the Council:—

Supplying Two 5,000 kw. Turbo-generators for Greenwich Station.—British Westinghouse Electric and Mfg. Co. (*accepted*), £62,003; Cole, Marchent & Morley (incomplete), £15,313. 10s.; British Thomson-Houston Co. (incomplete), £51,070; J. Howden & Co. (incomplete), £55,161 and £56,720; Maschinenfabrik Oerlikon, £57,600; Fraser & Chalmers, £58,012, £59,709, £63,816; Escher, Wyss & Co., £64,016 and £66,311; Willans & Robinson, £64,620, £66,795 and £67,442; Brush Electrical Engineering Co., £67,062; Dick, Kerr & Co., £68,100. (Estimate of the Chief Officer of Tramways, £54,532. With regard to the tenders submitted by Fraser & Chalmers, the Highways Committee were advised by Sir Alex. Kennedy that, although they were a firm of the highest standing, they had not constructed any turbines of a larger capacity than 3,000 kw., and that their experience of large sets was, therefore, limited. In view of this fact the Committee felt bound to take into serious consideration the experience which the different firms tendering had had of machines of the type and size in question, and they accepted that of the British Westinghouse Co., who have supplied three of the five turbo-generators at the generating station, and have since completed a further machine for the station.)

Supply and Laying of Cables required in connection with Additional Supply of Power.—Western Electric Co. (*accepted*), £6,214; British Insulated & Helsby Cables, £6,298; W. T. Henley's Telegraph Works Co., £6,407. 13s. 4d.; Johnson & Phillips, £6,636. 3s. 4d.; W. T. Glover & Co., £6,742. 18s. 4d.; Siemens Brothers & Co., £6,798. 17s. 6d.; Callender's Cable & Construction Co., £6,833. 2s. 6d. (Estimate of the Chief Officer of Tramways, £6,214.)

Supply of 20,245 yds. Trolley Wire.—From Smith & Co. incorporated in London Electric Wire Co. & Smiths) (*accepted*), £65. 19s. 6d. per ton; Edward le Bas & Co., £62. 10s.; Fernand Espir, £66. 10s. (less 2½ per cent.); British Insulated & Helsby Cables, £68. 5s. (less 2½ per cent.); Watlington & Co., £68; T. Bolton & Sons, £68. 5s.

For Track Bolts and Fastenings.—Walter Scott (Ltd.), Glasgow, £28,340; Bolckow, Vaughan & Co., £29,575. 10s. (Chief Engineer's estimate, £26,580.)

For Conductor Rails.—Frodingham Iron & Steel Co. (*accepted*), £17,150. (Chief Engineer's estimate, £15,650.)

Supply of 3,000 (or 6,000) *Driving and* 2,000 (or 4,000) *Trailing Wheel Tapes per Tramcar.*—The prices quoted per tyre:—

	3,000 dr. wh. tyres.	2,000 tr. wh. tyres.	6,000 dr. wh. tyres.	4,000 tr. wh. tyres.
John Brown & Co. (Ltd.)	£1 6 6	£1 6 6	£1 6 0	£1 6 0
H. Bessemer & Co.	1 10 6	1 5 0	1 10 6	1 5 0
Cammell, Laird & Co.	1 12 0	1 11 0	..	..
Brown Bayley's Steel Works	1 17 6	1 10 0	1 17 6	1 10 0
Steel, Peech & Tozer	1 18 7	1 11 11	..	..
Vickers (Ltd.)	2 0 0	1 10 0	2 0 0	1 10 0
Patent Shaft & Axletree Co.	1 18 0	1 15 0	1 18 0	1 15 0
Baldwin Locc Wks. Co. (plus freight from New York)	£12 13 3 17 8		£24,267 15 4	

DEWSBURY.—The Corporation recently placed an order for a mile of electric cable, with the Macintosh Cable Co., at £151

SUNDERLAND.—The Electricity Committee recently accepted the following tenders for stores:—

British Insulated and Helsby Cables, bifurcating boxes; Ferranti Ltd., e.h.t. switchgear cabinet and two e.h.t. switch panels; India Rubber, Gutta Percha and Telegraph Works Co., cable; Sanders Rehders & Co., CO_2 recorder; General Electric Co., metal-filament lamps and d.c. switchboard; Brunner, Mond & Co., alkali.

EAST HAM.—The tenders of Farmer & Co., Pryke & Palmer, Engineering Supplies (Ltd.), Middleton Bros., M. G. Davis & Co. and Docker Bros. have been accepted for engineers' sundries to the electric lighting and tramways departments for 12 months.

WOOLWICH (LONDON).—The tender of Babcock & Wilcox (at £255. 15s.) has been accepted by the Council for the supply of steam piping, and that of Seagers Ltd. (at £260) for the supply of a c.i. rain-water tank for Globe-lane station.

BELFAST.—The tender of Siemens Brothers Dynamo Works has been accepted for the supply of carbon filament lamps to the Corporation tramways department for the ensuing 12 months.

MARYLEBONE (LONDON).—The Electricity Supply Committee has accepted the tenders of J. Bird & Co., Middleton Bros. and F. Tyzack & Son for annual supplies of tools and ironmongery.

BRIGHTON.—The Corporation are recommended to accept the tender of Richardsons, Westgarth & Co. for the supply and erection at Southwick power station of a surface condenser at £1,925.

BASINGSTOKE.—For the supply of three and five ampere meters for the next 12 months, the Corporation have accepted the tender of the Electrical Apparatus Co.

PRAHRAN MALVERN (VICTORIA).—The Tramways Trust have accepted the tender of Elder, Smith & Co., for a Tudor buffer battery.

SYDNEY (N.S.W.).—The Council, having entered into an agreement to supply electrical energy to North Melbourne Municipality, have accepted the tender of Noyes Bros. for the supply of the necessary submarine cable at £2,389, subject to variation in the price of copper.

Meter Contracts.—Messrs. Chamberlain & Hookham have received contracts for the supply of meters to Cardiff, Grimsby and Hornsey Councils.

Annual Supplies Contracts.—Messrs. J. H. Tucker & Co., of Birmingham, have recently received contracts for annual supplies of service fuse boxes from Blackburn and Bolton Corporations and from Ilford Urban Council. The firm have also secured contracts for the supply of lampholders from Swindon Corporation and for iron-clad switches from Dundalk Urban Council.

Tool Steel Gears and Pinions.—Messrs. Scholey & Co. (Ltd.) have secured contracts for the supply of tool steel gears and pinions from the Croydon Corporation and tramway departments.

The firm have also obtained large orders recently from the Oerlikon Co. (for the L. & N.W. Railway electrification), the L.B. & S.C. Railway Co., East Ham Corporation tramways, Johannesburg and Pretoria Municipal Councils, the Colombo Electric Tramways & Lighting and the Auckland Electric Tramways Co.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Direct United States Cable Co. (Ltd.)

The seventy-second ordinary general meeting of the Company was held on Tuesday, Sir JAMES PENDER presiding.

The SECRETARY, Mr. William Mollan, read the notice calling the meeting and the auditors' report.

The CHAIRMAN said they had been exceptionally fortunate during the year 1914 and to the end of November, the receipts [illegible] the expenditure [illegible] £42,000 and in the following year of [illegible] £100,000. The effect of [illegible] would be materially [illegible] the expenditure [illegible] cable, [illegible] recommended to [illegible] accumulations during the past year. The reserve fund had been increased from £31,496 to £40,000, in addition to £25,000 to the Cable renewal account in the balance sheet of 1913. In view of the fact that the cable encountered which occurred in 1913 and 1914, the board consider it necessary to keep sufficient cable in stock to ensure the successful carrying through of any similar repair. The present value of the cable is very largely in excess of the figure at which it appears in the accounts. Heavy depreciation in all classes of securities since the war has reduced the present value of the Company's investments to such a figure that the provision of £50,000 is insufficient, but the Directors think it unnecessary to increase that sum, hoping that when the war is concluded and business conditions resume the normal, investments will recover to their original value. Relations with the Western Union Company continued to be most friendly, notwithstanding the war, cable traffic being more than maintained. He then moved the adoption of the report and accounts, and the payment of the dividend set out therein.

Mr. JOHN VARLEY seconded the motion, which was carried unanimously.

Sir James Pender, Bart., and Mr. John Varley having been reelected Directors, and Messrs. Deloitte, Plender, Griffiths & Co. reappointed auditors, a vote of thanks to the chairman and directors terminated the proceedings.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The chairman (Mr. H. Allen) stated at the meeting last week that notwithstanding the exceptional circumstances of the past year, they were making the usual distribution of 8 per cent. In their new exchange in the north of Lisbon they expected a considerable accretion of business during the current year, with but a moderate addition to the expenses. The completion of the North Exchange was the most important work of the year and accounted for £19,542 of the capital expenditure of £27,229. It was already fitted for 1,800 subscribers, and had an ultimate capacity of 6,000. Although political and commercial conditions in Portugal at present were very unsettled, they were not reflected in the business of the company, which was continually expanding; there was no falling off in the demand for telephone facilities.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The Directors' report for the year 1914 states that the total receipts were £38,244. 13s. 10d., while the expenses amounted to £16,702. 3s. 4d., leaving £21,542. 10s. 6d., to which has to be added £7,848. 14s. 8d. from 1913, giving a total of £29,391. 5s. 2d. The sum of £3,000 has been placed to reserve against loss on investments, £2,500 to pension fund and £2,000 added to general reserve fund, which now stands at £100,000. Interim dividends were paid on Oct. 22, 1914—viz., at the rate of 10 per cent. per annum (less tax) on the preference shares and at the rate of 5 per cent. per annum (tax free) on the ordinary shares. These dividends absorbed £7,000, leaving £14,891. 5s. 2d., out of which the directors recommend the payment of final dividends at the same rates, making total dividends for the year of 10 per cent. on the preference shares (less tax) and 5 per cent. on the ordinary shares (tax free), the balance (£7,891. 5s. 2d.) being carried forward. Mr. John Pitman Hooper has been appointed a director in place of the late Mr. Robert Kaye Gray.

DUDLEY, STOURBRIDGE & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The revenue for 1914 was £50,780, compared with £52,843 for 1913. After payment of expenses and debenture interest and placing £1,500 to renewals fund, the surplus (including £75 brought forward) is £7,351. It is proposed to pay a dividend on the ordinary shares of 1 per cent. for the year, leaving to be carried forward £851.

O. C. HAWKES (LTD.)—The net profit for 1914 (after allowing for bad and doubtful debts and charging cost of replacement and repairs to revenue account) was £7,714. 12s. 3d., including balance brought forward. Deducting managing director and directors' fees, income tax and national health insurance, the balance is £5,957. The directors have paid a year's dividend on the 5 per cent. preference capital to Dec. 31, which absorbs £4,255, and they recommend that the balance (£1,702) be carried forward.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.)—At the meeting last week the chairman (Mr. J. G. B. Stone) said that the net revenue had risen from £10,161 to £12,724, and the balance carried forward was £7,365 against £5,226 in 1913. The street lighting contract had augmented the income last year, and considerable extensions were being put in hand. The progress of the undertaking had not been materially affected by the war. There was no material change in the tramway position, but the supply side continued to grow. Generating costs had fallen from 1d. to 0·83d. per unit, and the revenue per unit was 1·86d. They were paying a dividend of 5 per cent. for the year.

KIDDERMINSTER & DISTRICT ELECTRIC LIGHTING & TRACTION CO (LTD.)—The report for 1914, states that the net receipts of the lighting department were £4,260. Adding dividends receivable (£1,955) and amount brought forward (£204) the total is £6,420. After deducting administration and general expenses, reserve for doubtful debts, debenture interest, &c., the balance is £2,468. The directors propose to place £750 to reserve, and to pay the cumulative preference shares dividend for the year, leaving £218 to be carried forward.

LAUNCESTON & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the chairman (Mr. R. B. Rogers) said the business had grown satisfactorily, and the number of customers at the end of 1914 was 188, and the 8 c.p. lamps connected were equal to 5,020. The receipts were £1,130 and the working expenses £685, leaving £445. The town lighting had been approved by the Corporation, and the question of [illegible] the mains was under consideration. The report was adopted and a dividend of 2½ per cent. was agreed to.

NORTH OF SCOTLAND ELECTRIC LIGHT & POWER CO. (LTD.)—At the [illegible] meeting it was reported that the company had made [illegible] during the first half of 1914, but the war had occasioned a serious falling off during the latter half. The gross profits (including £1,859 brought forward) were £8,795. 7s. 2d., and after meeting interest on debentures and loans (£2,819), and writing off £57 from suspense account, the net total was £5,920. A dividend at rate of 3 per cent. [illegible] was declared, £2,000 was placed to renewal reserve account, [illegible] £2,420) carried forward. The connections in Montrose increased from 9,192 to 33,750 equivalent 8-c.p. lamps; in Buchan from 21,466 to 23,360; and in Inverness from 35,872 to 38,969, making a total of 5,079 8 c.p. for the three towns.

WILLANS & ROBINSON (LTD.)—The net profit for 1914 was £17,058. 6s. 3d., after payment of debenture interest, [illegible] depreciation and the proper upkeep of Queen's Ferry Works. The latter have been utilised by the Government in connection with war requirements since August. A dividend at rate of 10 per cent. is recommended on the ordinary shares, leaving £9,108. 6s. 3d., out of which it is proposed to carry £7,431. 4s. 7d. to reserve, and to distribute the balance (£1,677. 1s. 8d.) among the holders of 15 preference stock units. [illegible] common with those engaged in engineering work the company had been [illegible] seriously disturbed by the war, but the directors had pleasure in stating that they were able to be of [illegible] ment and are now largely engaged in that direction. The latter work, though partly undertaken towards the end of 1914, is not reflected in the accounts submitted. A large number of the company's staff (both from works and offices) having joined H.M. forces, arrangements were made for substantially assisting their dependents and for re-employment after the war. The number serving represents over 20 per cent. of the total male employees. During the year the directors accepted, with regret, the resignation of Mr. Leslie Robertson, and subsequently appointed Major P. M. Peters to the vacancy. Mr. G. W. Anderson has intimated that he proposes to retire at the annual meeting, and the shareholders will be asked to leave to the directors the question of filling the vacancy.

CITY NOTES.

MEMORANDA (April 28).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 66⅝. Consols Pay Days May 5 and June 1. Stocks and Shares Ticket Days May 12 and 27. Pay Days May 13 and 28. Price of silver, 23⅞d.

EASTERN TELEGRAPH CO. (LTD.)—It is announced that (subject to final audit) the accounts for the year ended Dec. 31, 1914, show that after making a contribution to the general reserve fund, payment of interest on the 4 per cent. mortgage debenture stock, dividend on the 3½ per cent. preference stock and three interim dividends of £1. 5s. per cent. each on the ordinary stock to Sept. 30 last, there is a balance available, out of which the directors recommend payment of a final dividend of £1. 5s. per cent., and a bonus of £2 per cent. (both tax free, and payable on May 12), making with previous payments on account a total distribution of 7 per cent. on the ordinary stock for the year 1914. The transfer books of the ordinary stock will be closed from the 5th to the 12th May, inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) Subject to confirmation by the shareholders on the 11th prox. the directors have declared a dividend for the quarter ended Dec. 31 last of 2s. 6d. per share, together with a bonus of 4s. per share, payable (tax free) on May 12, making with the three interim dividends already paid a total distribution of 7 per cent. for the year 1914. The share register will be closed from the 4th to the 11th prox. inclusive.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—The directors recommend a final dividend of 1s. 6d. per share on the ordinary shares for 1914, making 2s. 6d. per share (or 12½ per cent.) for the year, the same as for 1913, carrying forward £334,000, against £323,716 a year ago. Mr. J. M. Falkner has been appointed vice-chairman of the company.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors have decided to recommend to the shareholders at the approaching meeting payment of the following dividends: 6s. per share on the first and second preference shares (for six months to Dec. 31, 1914), and 9d. per share on the ordinary shares (tax free).

Sir Alexander Freeman King, K.C.B., recently secretary to the Post Office, has been elected a director of this company in the place of the late Sir John C. Lamb, C.B., C.M.G.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, April 28. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Last Dividend.	Name.	Price, Wed., April 28.	Rate per cent Yielded.	Dividend Due.
	Electricity Supply.		£ s. d.	
[illegible] 7	[illegible] & Peebles Ord.	[illegible]	7 2 8	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
5 10%	[illegible] & Kent [illegible]	[illegible]	5 19 1	Mar, Sept
[illegible]	Central Elec. Supp. C. Deb. St	[illegible]	[illegible]	[illegible]
[illegible]	Charing Cross West End & City Debs.	[illegible]	4 7 11	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	Mar, July
St. 5%	[illegible]	[illegible]	[illegible]	Jun, Dec
10 6%	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	Do. 2nd Deb.	[illegible]	4 12 1	My, Nov
[illegible]	Edmundson's Elec. Supp. 4½% Debs.	[illegible]	5 13 2	July
[illegible]	Kensington and Knightsbridge Ord.	[illegible]	6 4 2	Feb, Aug
5 3/0	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	4 12 3	[illegible]
[illegible]	Metropolitan E. Supp. Ord.	[illegible]	5 9 10	Mar, Aug.
[illegible]	[illegible]	[illegible]	4 15 3	Jan, July
[illegible]	Newcastle & Dist. E.L. 6% 2nd Dbs.	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	Apl, Oct
[illegible]	South London E.S. 1st Mort. Debs.	[illegible]	[illegible]	Jan, July.
[illegible]	[illegible]	[illegible]	[illegible]	Apl, Oct
[illegible]	[illegible]	[illegible]	[illegible]	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	Jan, July.
	Electric Railways & Tramways.			
[illegible]	British Elec. Traction 5% Debs.	[illegible]	[illegible]	Apl, Oct
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
St. 4%	Central London Guar. Assented Ord.	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

† Ex [illegible] † Ex rights.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

SHARE	LAST DIVIDEND	NAME.	Price, Wed., April 28.	RATE PER CENT. YIELDED	DIVIDEND DUE.
		Electric Railways and Tramways —*cont.*	£ s. d.		
9	1½	Metropolitan R. Co. Ord.	[illegible]	[illegible]	Feb. Aug.
5	3½	Do. 5% Pref.	[illegible]	4 13 -	Feb. Aug.
5	3½	Do. 5% Pref.	74½	4 13 -	Feb, Aug
10	7	Do. 4% Pref.	83	4 3 4	Jan, July
5	3½	Do. 3½% Pref.	82½	4 3 1	Jan, July
10	..	Metropolitan Dist. Ry. Ord.	12	.. ..	Feb, Aug
4	2	Do. 4% Pref.	84	4 15 -	Feb, Aug
4	4½	Do. 4½% First Pref.	102	4 8 4	Feb, Aug
4	2	Do. 4% Pref.	104	4 13 3	Jan, July
4	2	Do. 4% Pref.	104	4 6 -	Jan, July
4	2	Do. 4% Def. Stock	104	4 13 -	Jan, July
4	2	Do. 4% Def. Stock	104	.. ..	Mar, Sept
10	..	Underground E. Rys. of London Shares.	12	.. ..	.. ..
1	..	E. A. Pref.	..	.. ..	.. ..
1	..	E. A. Def.	..	.. ..	.. ..
5	6%	D. Def.	113½	5 6 11	Mar, Sept
5	6%	D. 6% Income Bonds	..	5 6 11	Mar, Sept
4	4½%	D. 4½% Bds.	110	4 5 -	Jan, July
1	..	Yorkshire W. Rys. Ord.	..	.. ..	March
		Electric Manufacturing, &c.			
1	1/0	Bullers & Wilkinson Ord.	2½	8 3 10	Apl, Oct
1	1/0	Brit. Aluminium Ord.	..	5 11 4	Mar
100	5%	Do. Prior Lien Debs.	..	.. ..	Jan, July.
1	7½	Do. 6% Pref.	12	6 12 11	Jan, July
1	7½	Brit. Insulated & Helsby Ord.	11½	6 17 -	Apl, Oct
5	3/0	Do. 6% Pref.	5	5 - -	Jan, July
1	6½	British L.M.Ericsson Mfg. Cm.6% Pref	1½	6 11 11	Mar, Sep
1	7½	Brit. Westinghouse Pref.	1	7 11 1	Apl,
5	5/0	Callender's Cable, &c., Co. Ord.	12	6 4 -	Jan, July
2	2/6	Do. 5% Pref.	5	5 - -	Feb, Aug
1	15%	Cambrian Kesterson	3½	4 13 -	May, Nov
1	6%	Dick, Kerr & Co. Pref.	..	7 14 10	Sept
1	..	Electric & Gen. Use Exhaust	..	.. ..	Feb, Aug
1	6%	Elec. Construction Ord.	9	6 - 11	May
81	4%	Do. 4% Debs.	87	5 15 11	Jan, July
10	6	General Electric 6% Pref.	12	6 - -	Jun, Dec
10	20%	W. T. Henley's Teleg. Wks. Co. Ord.	15½	6 12 11	Feb, Aug
	2.5	Do. 4½% Cum. Pref.	4	4 10 -	.. ..
	2.5	Do. 4½% Do.	5	4 13 -	Jun, Dec
St.	4½	India Rubber, G. P. &c., Ord.	11	6 - -	Feb, Aug
10	5%	Do. Pref.	12	6 1 -	Apl, Oct
10	4%	Do. 4% Def.	37	4 - -	Apl, Oct
1	36/0	Telegraph Construction & Maintenance	31½	6 - -	Mar, July
10	4½	Do. 4½% Def.	93	4 4 3	Jan, July
1	12½	Vickers Ord.	13	6 11 7	May, Aug
1	6d.	Do. 5% Pref.	1	4 11 1	May, Aug
St.	4%	Do. 1st Debs.	93½	4 5 7	July, Dec
100	4½%	Do. 4½% Def.	114	4 - -	Jun, Dec
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	10½	5 12 10	F. M. Aug. N
St.	30/0	Do. Def. Ord.	23	6 5 3	Fb.My.Aug.N
St.	4%	Commercial Cable 4% Debs.	87	5 3 11	Ja.Ap.Jly.O
10	..	Cuba Submarine Ord.	7	5 - 1	May. Nov.
10	10/0	Do. Pref.	16	6 3 1	.. ..
5	2%	Direct Spanish 10% Pref.	7½	6 13 4	.. ..
1	4%	Direct United 5% Pref.	5	5 - -	Ja.Ap.Jly.O
St.	2%	Eastern Tel. Co. Ord.	13½	5 - -	Ja.My. Jly.O
St.	4%	Do. 3½% Pref.	74½	4 14 -	Ja.My. Jly.O
St.	4%	Do. 4% Debs.	92	4 7 -	May. Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	92	4 7 -	Feb, Aug
1	2/6	Do. Ord.	12½	6 7 -	Ja, Ap, Jly.O
1	..	Gt. Northern Tel. Co. with Coup. 6	7½	7 13 1	Ja, My, Jly
1	..	Marconi's Wireless Tel. Co.	1½	1 - 4	April
1	1/0	Do. 7% Pref.	1½	7 - -	July
1	1/3	Western & Brazilian Ord.	1½	6 - -	May, Nov
1	1/3	Do. 1st Pref.	1½	6 - -	May, Nov
St.	4%	Western Teleph. Co.	93	4 5 11	Mr. Jly.O.Dec
		Do. 4% Deb. St.	93	4 5 11	Jun, Dec
		Telephones.			
	$2	American Telephn. & Telgh. $100 Cap	124	6 - -	Ja.Ap.Jn.O
		Do. 6% Bds.	104	5 15 -	Jan, July
		Monte Video Telephn. Ord.	5½	5 - -	Nov.
1	7½	New York Telephone 4½% Bds.	103½	4 7 4	May, Nov
	4½%	Pacific Telephone Ord.	94	4 15 1	Jan, Oct
1	6	Do. 6% Pref.	97	4 13 4	Jan, July
St.	4%	Telephn. Co. of Egypt Db. St.	88½	4 1 -	Jan, July
St.	4½%	United River Plate Ord.	84	5 7 -	Apl, Oct
		Do. 5% Cum. Pref.	97	5 3 -	.. ..
		Financial and Investment.			
1	..	Globe Telegh. & Trust.	1½	.. ..	Jan, July
1	..	Do. 6% Pf.	1½	.. ..	Sp.Dc.Mr.Jn
1	..	Do. 6% Pf.	1½	.. ..	Sn.Dc.Mr.Jn
1	..	Mexican Telegh. Ord.	1½	.. ..	Ja. Apl. Jly.O
		Do. 6% Pref.	1½	.. ..	Ja.Ap.Jly.C
	4	Do. 6% Pref.	1½	5 14 -	Apl, Oct
100	4	Do. 4% Deb. St.	92	4 14 -	.. ..
		Colonial and Foreign Railways, Tramways, &c.			
		Anglo Argentine Trams. 5% Debs.	94½	5 1 -	Jun, Dec
		Do. 5% Pref.	97½	5 3 0	Jan, July
	4½	Do. Ord.	84½	4 16 3	Jan, July
	4%	Do. 4% Pref.	82	.. ..	Jan, July
	2/9	Do. Def.	42	.. ..	Jan, July
	2/9	Do. Def.	42	.. ..	Jan, July
1	3	Brazilian Traction Ord.	12½	6 - -	Fb.M.Aug.N
	3	Do. 5% Pref.	74½	6 14 -	Ja.Apl.Jly.O
	4/0	Brisbane Trams Ord.	8	Mkt.	.. ..
	2/6	Do. 5% Cum. Pref.	4½	6 - -	May, Nov
		Buenos Ayres Tramways Ord.	12½	.. ..	.. ..
St.	4½	Calcutta Elec. Trams. Ord.	94	4 15 -	.. ..
		Havana Elec. Ry. 5% Bds.	94½	5 6 -	Mr., ..
		Madras Elec. Trams 6% Cum. Pref.	9½	6 - -	Feb, Aug
		Do.	9½	6 - -	Jly. July.
100	5%	Mexico Trams Common St.	14½	.. ..	Fb.M.Aug.N,
		Do.	14½	.. ..	Mar, Sep
	4½	Montreal Street Ry. 4½% Debs. (1922).	94½	4 15 -	Feb, Aug
1	4½	Rio de Janeiro Tram, L. & P. 50 yr. Bds	94½	4 14 -	Jun, Dec
1	4½	Do.	94½	4 14 -	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
		Adelaide Elec. Supply 6% Pref.	14½	6 13 -	Mar, Sept
		Brompton & Piccadilly Ord.	2½	4 16 -	Jan, July
		Do. 6% Pref.	11½	5 4 -	Jan, July
		Buenos Ayres Electric Ord.	12½	.. ..	Apl, Oct
		Do. 6% Pref.	12½	6 - -	.. ..

THE ELECTRICIAN:

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NOTES.

ıe Arc v. The Spark.

AMONG those interested in wireless telegraphy, there has g been intense interest and a certain amount of disagreent regarding the carrying powers of spark waves and ntinuous waves. Apart from the academic importance the question, great commercial interests have been, and . involved, and this has sharpened controversy, and haps influenced some of the views that have been exssed. On all these accounts, a Paper which we abstract another page, and which describes a long series of urate measurements with arc waves, must be regarded of the greatest scientific and practical importance. Mr. C. FULLER, the chief electrical engineer of the Federal lsen Co. of America, has had the opportunity of making long series of measurements under almost ideal conons over a range of 2,100 nautical miles, by aid of two the most powerful arc plants in existence; and his Com- have had sufficient breadth of view and public spirit encourage the performance of the experiments and to mit the publication of the results. The Paper contains r points of interest beyond those connected with the pagation of waves, such as the description of the large arc plant at the San Francisco and Honolulu stations. So far as theory had been applied before these experiments were made, it would seem that undamped waves ought to be better than damped waves in two respects: First, the available modes of detecting seem to favour undamped waves; and, second, better resonance can be attained. But as regards the mere act of propagation of the waves from one place to another, there are really no obvious physical reasons for supposing that the undamped waves would have, say, a 10 per cent. advantage over the damped—a negligible matter commercially. Moreover, it can be shown that the advantage accruing from better resonance is not a great one when the damped waves are not excessively damped. Thus, we fall back into expecting that the difference, if any, will arise mainly from the difference in the methods of detection used in arc and spark telegraphy. Experimenters in this matter have done their best to eliminate the influence of the detector by endeavouring to reduce the readings obtained from various instruments to an energy basis; but strong doubt exists as to the adequacy of the processes used in the reduction, and it seems preferable to think of AUSTIN'S experiments as having been made with a spark and crystal detector combination, while the recent ones under notice have been made with the arc and ticker combination.

WITH this in mind, it is interesting to compare the results of the arc and the spark experiments with each other and also with theory. The whole matter is summed up in the various formulæ, empirical and theoretical, now available. The most important term is the exponential one, involving the wave-length. The diffraction formula of MACDONALD, which has been discussed and confirmed by LOVE, and also NICHOLSON'S formula, give the index $\frac{1}{2}$ to the wave-length. The formulæ of MARCH and RYBCZYNSKI, students of SOMMERFELD, give this same index, it may be mentioned; but, as has been demonstrated by LOVE, a fundamental blunder exists in their work. The index found by AUSTIN and COHEN for the spark is $\frac{1}{2}$, and that now found by FULLER for the arc is 1·4. Strictly, the theoretical formulæ are properly compared only with the arc results, since continuous waves are assumed in the deduction; and here FULLER'S result suggests that diffraction cannot account fully for the facts. While on comparing the arc and spark results we arrive at a conclusion that may be of great practical importance—namely, that for the distances covered by these experiments the arc and ticker combina-

tion is superior to the spark and crystal detector combination for wave-lengths over 3,000 metres, though inferior for shorter wave-lengths.

The Russian Market.

Elsewhere in our present issue we publish the conclusion of an article by Mr. P. Gurewitsch, a Russian engineer, in which a great deal of interesting information is given in regard to the Russian market. There is no doubt that much remains to be done in the electrical development of Russia, and it is equally certain that the Russian manufacturers are not in a position to supply anything like the whole needs of their home market. A great deal of machinery must therefore be imported, and it will be our own fault if British manufacturers do not benefit by the new conditions, and do not export largely in order to supply Russian needs in the near future. The cost of production in Russia is high for a variety of reasons, one of which, oddly enough, is that there is a high tariff on raw materials. For example, the import duty on raw iron amounts to 100 per cent. *ad val.* Consequently, although there are import duties on all classes of electrical machinery, the tariff on raw materials is a great handicap on the home producer, and affords some compensation to engineering firms wishing to import plant into Russia. It may, however, be well to assume that the tariff on raw materials will be considerably reduced after the war, provided that the mine owners and iron and steel producers cannot bring sufficient pressure upon the Government to prevent such a step. In considering this market there are, of course, local conditions which must be taken into account, and in this direction we fear that we have a national weakness for disregarding such matters. For example, prices for the importer should preferably include carriage and duty, and firms who are not accustomed to charges of this kind may find it difficult to arrive at proper figures. It is essential, however, if a trade is to be done in foreign markets, that the local conditions should be realised, and that prices should be given on a basis which is easily understood. These, and many other points, are discussed by Mr. Gurewitsch.

Industrial Prosperity.

A good many annual meetings of manufacturing companies are now being held, and although the results cannot be taken as a complete indication of the effect of existing conditions, the reports generally refer to some marked effects of the present conflict. When the percentage joining the Colours rises to 20 per cent. of the staff and employees of a works the efforts of those remaining behind are rendered none too easy if the desired output is to be maintained. In this connection it must not be forgotten that overtime beyond a certain proportion leads to a lowering of the standard of work, and therefore a point is soon reached beyond which the overtime cannot be increased with advantage. Among the firms who have made satisfactory progress during the past year, we are glad to note Messrs. Willans & Robinson, who are paying a dividend of 10 per cent. on the ordinary shares. Messrs. Johnson & Phillips also are paying 5 per cent. on their ordinary shares, and we gather that this would have been increased under normal conditions. Again, the report of the British Thomson-Houston Company shows a net profit some £10,000 greater than in the previous year, and further debentures have been redeemed. These results are typical of those firms who are more or less engaged on Government work.

Gift to Sheffield University.—Sir Joseph Jonas, chairman of the Applied Science Committee of the University of Sheffield, has given the University £5,000 to found, endow and equip a testing laboratory in connection with the Applied Science Department.

British Industries Fair.—The British Industries Fair, which has been organised by the Board of Trade, will open on Monday next at the Royal Agricultural Hall, Islington, N., and will continue till the 21st inst. Buyers from the Continent, Canada, America and other places have notified their intention of attending and inspecting the exhibits of the 600 firms, who have been allotted space. There will be special enquiry offices for each of the trade sections, as well as interpreters, and an office of Commercial Intelligence Branch of the Board of Trade in order that every possible facility will be available to buyers and exhibitors.

Electrolysis in Reinforced Concrete Poles.—Experiences as regards electrolytic action on 1,500 reinforced concrete poles on the Utica–Syracuse lines of the New York State railways during the last five years are related in the "Electric Railway Journal." Of these poles only three developed defects, which, upon investigation, proved to be directly traceable to leakage of the 600-volt trolley current through the reinforcing rods to earth. The evident remedy for this is to insulate the pole completely by placing in the spans the proper strain insulators. In every case ample warning of the failure was given by the gradual cracking of the concrete long before the pole was liable to fail altogether.

Coal Supplies.—We have pleasure in noting that a conference was held yesterday of representatives of the electrical and gas undertakings at the Institution of Electrical Engineers, for the purpose of considering the best course to adopt for bringing the far-reaching issues evolved under the attention of the Government with a view to some immediate measures of relief being obtained.

The chair was taken by Sir Corbet Woodall (president of the British Commercial Gas Association), and the lecture theatre was crowded to overflowing. The chairman dealt with the importance of the subject, expressing the view that the desire for some alteration of existing conditions was not due to the greed of traders in gas and electricity. The country was now faced with a coal famine, due partly to miners joining the Colours, and partly due to the men who remain not making an effort to maintain the output. Coal owners were to blame to some extent for seeking to make profits through the present special circumstances. The opening remarks of the chairman were supported by Sir John Snell (president of the Institution of Electrical Engineers). The chairman then called on Alderman Kay (Manchester) to propose a resolution. This resolution, while congratulating the Government on the action they had taken in appointing a Committee to deal with the export of coal, and hoping that this might be effective in limiting exports, viewed with the deepest concern the depletion of stocks and difficulty of renewing them, and urged the Government to take steps to expedite the output of coal at the pits and increase the facilities of transport by rail and water. Mr. Frank Bailey seconded the resolution. Mr. Bond (president of the Institution of Gas Engineers) briefly supported the resolution, as did also Mr. R. A. Chattock (representing the I.M.E.A.). Mr. R. Neville, M.P., urged the desirability of putting some definite course before the Government rather than an indefinite resolution. Bailie Irwin, of Glasgow, spoke in support of the resolution, and stated that the stock of coal in Glasgow had been largely depleted, but had been somewhat renewed by buying at high prices. Sir Alexander Kennedy stated that in London no blame was to be attached to the suppliers of coal, who, he was sure, were not making undue profits. After some other remarks, the resolution was put to the meeting and was unanimously carried. Ald. Phillips (of Salford) moved that the Government be asked to take such steps as will reduce the price of coal to within reasonable limits. After some discussion, the resolution was carried practically unanimously. Lastly, a resolution was proposed that a representative deputation be appointed to place the matter before the Government, and the names of the proposed members were read out. This resolution was carried unanimously and the membership was adopted. The proceedings closed with resolutions of thanks to those chiefly concerned.

In our next issue we shall give a full account of the meeting.

Petrol-Electric Automobile.—An automobile which is equipped with a 5 kw. petrol engine-driven generator, a series-wound motor and a storage battery has recently been developed by the Galt Motor Co. A water-cooled two-cylinder, two-stroke engine, directly connected to the generator, furnishes the power. This engine embodies several novel features of design. The generator operates at 50 volts. The battery is divided into two groups, and is carried on each side of the chassis outside of the frame. The motor is directly connected to the rear axle through a double universal-jointed shaft and 4 to 1 reduction gear. The engine is only 12 in. in over-all length and weighs 250 lb. The total weight of the car is approximately 5,000 lb., but the Company is also expecting to build automobiles of 2,800 lb. and 3,000 lb. The battery is of sufficient rating to operate the car for 20 miles over ordinary roads without the assistance of the engine. The car is geared for speeds up to 40 miles per hour. Tests with the car have shown a fuel consumption of 58·5 ton-miles per gallon of fuel. The fuel consumption of the power plant alone is claimed to be $\frac{7}{8}$ pint per kilowatt-hour

Electric Cooking Exhibit at the Horticultural Hall.—In connection with the Women's Exhibition, which has been open during the past week at the Horticultural Hall, and which closes to-morrow, the Westminster Electric Supply Corpn. have arranged an extensive exhibit of electric cooking, heating and subsidiary apparatus in the annexe. A large working kitchen has been in operation under the charge of Mrs. Annie Cross, who is giving practical demonstrations at intervals during the day and evening. The equipment comprises a Carron 5 kw.-6 kw. cooker, an E.O.A. 6 kw. range, a complete Plexsim kitchen outfit, a Belling grill and several Belling hot-plates; a standard Ferranti cooking range is also included. A number of Belling 2½ kw.-3 kw. fires are on view, and the subsidiary appliances includes a selection of separately heated utensils supplied by Messrs. Benson & Co., and other makers. Various patterns of electric irons are also exhibited. The whole of the display is in charge of one of the selling engineers of the Westminster Electric Supply Corpn. On Tuesday afternoon Mrs. Maud Lancaster gave a lecture on the domestic uses of electricity for cooking, heating, cleaning and ventilating purposes. This lecture was attended by a small gathering of ladies, who appeared to take considerable interest in the subject. The apparatus, of which Mrs. Lancaster explained the various uses from the platform, was kindly supplied by the Westminster Electric Supply Corpn. The gas interests are represented at the exhibition by a comparatively small and inanimate exhibit of modern gas fires, so it may be presumed that the special activities shown by the electricity supply people will have an important educative effect upon the ladies who have, we understand, visited in great numbers during the course of the week.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Dr. C. V. Drysdale contributes an article on the "Alternate-current Potentiometer as a Standard Instrument" (p. 157).

We publish an article by Mr. R. D. Gifford on "A Method of Determining the Phase Angle of Current and Potential Transformers" (p. 166).

We conclude an article, by Mr. P. Gurewitsch, on the "English Electrotechnical Industry and the Russian Market" (p. 160).

An abstract of a Paper on "Continuous Waves in Long-distance Radio-telegraphy," by Mr. L. F. Fuller, appears on p. 154.

We reproduce in abstract an article on "Recording Currents," by Dr. E. G. Merrick (p. 151).

A Paper on "Protective Devices against Lightning and Surges," by Messrs. E. Kilburn Scott and L. F. Fogarty, is abstracted (p. 162).

We give an account of the discussion which took place before the Institution of Electrical Engineers in London and Manchester on Dr. A. Dickinson's Paper on the "Bombay Hydro-Electric Scheme" (p. 167).

Companies' Meetings and Reports.—Meeting of the Anglo-European Telegraph Co., Cuba Submarine Telegraph Co., Eastern & Associated Telegraph Companies, Wilcox, Calcutta Tramways Co., Johnson & Phillips, Oriental Telephone & Electric Co. and Richardsons, Westgarth & Co., are reported; and the directors' reports abstracted include those of the Anglo-American Telegraph Co., British Thomson-Houston Co., Calcutta Electric Supply Corpn., City of Santos Improvements Co., Craigpark Electric Cable Co., Eastern Telegraph Co., Eastern Extension, Australasia & China Telegraph Co., Evered & Co., General Electric Co. (U.S.A.), Lisbon Electric Tramways, Paignton Electric Light Co., South Wales Electrical Power Distribution Co., Southport Tramways Co., Submarine Cables Trust, West African Telegraph Co., West Coast of America Telegraph Co., West India & Panama Telegraph Co., Western Canada Power Co., Wolverhampton District Electric Tramways and Yorkshire (Woollen District) Electric Tramways (pp. 179-182).

OBITUARY.

LIEUT. D. H. FIELD.—We regret to record the death of Lieut. Dare Hamilton Field, who was recently killed in action. The deceased officer was assistant works manager of the British Aluminium Co., Milton, Staffordshire.

LIEUT. E. DARWIN.—We also regret to record the death of Lieut. Erasmus Darwin, who was killed in action. Deceased, who was a director of the Cambridge Scientific Instrument Co., had a distinguished career at the University, and gained an exhibition in mathematics at Trinity College, Cambridge. On the outbreak of war the deceased lieutenant held an important appointment with Messrs. Bolckow, Vaughan & Co., of Middlesbrough.

PERSONAL.

Prof. E. W. Marchant, of Liverpool University, has been elected chairman of the Liverpool Engineering Society for the ensuing year.

Mr. J. Shepherd, assistant electrical engineer to the tramways department of the London County Council, has resigned in order to engage in practice as a consulting engineer as from July 1, 1915. Mr. Shepherd has held the position of assistant electrical engineer to the L.C.C. tramways department since Nov. 1, 1910, and his resignation will take effect as from Sept. 30, 1915.

We regret to notice that Second Lieutenant John Chamberlain, of the South Wales Borderers, was wounded in action in Flanders. Mr. Chamberlain, who is a son of the late Mr. Arthur Chamberlain, is chairman of Tubes (Ltd.), and a director of Credenda Conduits, Chamberlain & Hookham and other companies. During the recent fighting he was rather seriously wounded in the stomach. He was treated at the Base Hospital and on the 28th ult. he returned to London. We understand that the patient is progressing satisfactorily.

One of the two companies of the Dundee Territorial Engineers, under the command of Capt. Harry Richardson, the city electrical engineer, left Dundee on Tuesday.

On Monday last week Mr. Charles Bright, F.R.S.E., gave a lecture at Tonbridge on various aspects of the war, taking as his title: "Nothing as Usual."

APPOINTMENTS VACANT AND FILLED.

An assistant electrical engineer is required by the Government of Malta for service in the electric lighting department. Salary £150 per annum. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, S.W. *See an advertisement.*

The Commissioners for the Port of Calcutta require an assistant to the superintendent of machinery. Candidates must have had thorough mechanical and electrical training. Salary Rs.450 per month, rising by increments of Rs. 50, to Rs. 600, with free quarters, &c. Applications to the consulting engineer and London agent (Mr. J. Angus, M.I.C.E.), 17, Victoria-street, Westminster, S.W., by May 28. *See also an advertisement.*

A first-class turbine mechanic is required for the operation of a large turbine-driven a.c. plant. *See advertisement.*

A chief of the mains department is required for the Gemeente-Electriciteitswerken, Amsterdam. Applications by May 13 to the Directie der Gemeente-Electriciteitswerken, Hoogte Hadijk 200, Amsterdam.

Two assistant storekeepers are required by the Government of Nigeria for the Posts and Telegraphs Department. Commencing salary £250, rising to £300. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W.

Applications are invited for the position of principal of the Wigan and District Mining and Technical College. Forms of application from Mr. A. M. Lamb, chairman, General Purposes Committee, to whom applications by May 12.

Mr. G. H. Hayes has been appointed assistant mains superintendent in place of Mr. W. R. Poole resigned.

INSTITUTIONS AND SOCIETIES.

Scottish Section of the Institution of Electrical Engineers.—The fifteenth annual report of the Committee was presented at the annual general meeting held on the 13th ult. Six meetings were held during the session, and the average attendance thereat, although not satisfactory, was much the same as last year. The total membership at the end of the session was 370, a reduction of 5 per cent. on the previous year. The office-bearers for the ensuing session were elected as follows: *Chairman*, Mr. David A. Starr; *Vice-Chairman*, Mr. J. K. Stothert; *Past Chairmen*, Messrs. W. M'Whirter, S. Mavor and J. Lowson; *Chairman of Students' Section*, Mr. A. Page: *Ordinary Members of Committee*, Messrs. J. S. Nicholson, E. T. Goslin, G. Stevenson, J. E. Sayers, A. S. Hampton, J. D. Cormack, F. H. Whysall, W. W. Lackie, Magnus Maclean, Alex. Lindsay, A. Wilson; *Hon. Sec. and Treas.*, Mr. J. Taylor; *Assist. Hon. Sec.*, Mr. W. F. Mitchell.

Junior Institution of Engineers.—An interesting Paper on the "Interlocking of Points and Signals" was recently given before this Institution by Mr. T. S. Lascelles, who traced the development of railway signalling from the early days of railways to the present time. Interlocking was applied extensively from 1860 onwards, and in 1889, after the Railway Regulation Act, following the terrible Armagh disaster, its use became compulsory. The locking frames adopted fell into two classes, those in which the locking was actuated by the movement of the lever itself, and those in which it was operated through the lifting of the trigger or catch handle of the lever. The tappet principle was now universally adopted for interlocking the levers. After dealing with the different types of signals, the author went on to discuss the use of points. Points were worked by a system of rods, which had to be compensated for changes in temperature, and, in the case of facing points, arrangements made for securely locking them during the passage of a train and before a governing signal could be lowered. All points over which an important move was made were also fitted with detectors to ensure their being in the correct position in obedience to the lever before a signal was lowered. Electricity was now extensively used for this purpose, and also for repeating the position of signals out of sight of the signalman and for controlling levers, &c., through the track circuit. Many things, such as controlling outlying points and slotted signals—*i.e.*, signals controlled from more than one cabin—were now done electrically instead of mechanically.

Royal Institution.—The annual meeting was held on Saturday afternoon last, Sir J. Crichton Browne, in the chair, when the following gentlemen were unanimously elected as Officers for the ensuing year: *President*, the Duke of Northumberland; *Treasurer*, Sir J. Crichton-Browne; *Secretary*, Col. E. H. Hills; *Managers*, Sir Thomas Barlow, Bart., Dr. H. T. Brown, Dr. J. H. Balfour Browne, Dr. A. Carnegie, Mr. C. E. Groves, Sir Robt. Hadfield, Mr. C. Hawksley, The Hon. R. C. Parsons, Mr. E. Pollock, Sir James Reid, Bart., The Right Hon. Lord Rothschild, Messrs. A. Siemens, A. A. Campbell Swinton, H. Swithinbank, The Right Hon. Lord Wrenbury. *Visitors*. Rev. E. S. Dewick, Lieut-Col. H. E. Gaulter, Mr. J. G. Gordon, Dr. W. J. Gow, Dr. J. Dundas Grant, Messrs. J. W. Jarvis, James Y. Johnson, H. R. Kempe, F. Legge, F.-K. McClean, E. R. Moon, R. Pearce, H. G. Plimmer, A. J. Walter, and Sir Henry J. Wood. At a general meeting held on Monday it was announced that the President had nominated the following as Vice-Presidents for the ensuing year: Sir Thomas Barlow, Bart., Dr. J. H. Balfour Browne, Mr. C. Hawksley, Mr. E. Pollock, Sir James Reid, Bart., The Right Hon. Lord Wrenbury, Sir J. Crichton-Browne, and Col. E. H. Hills.

Institute of Metals.—Sir J. J. Thomson, O.M., F.R.S., will deliver this year's Institute of Metals May Lecture, his subject being "The Passage of Electricity Through Metals." The lecture will be given, at the Institution of Electrical Engineers on Wednesday, May 12 at 8.30 p.m. The Council have appointed Mr. W. E. Gibbs as acting honorary investigator to the Corrosion Committee, owing to the absence of Dr. G. D. Bengough, on active service.

British Science Guild.—A report has been issued by a committee of the British Science Guild on the supply of glass for optical instruments generally since the outbreak of war. As to the supply of glass for telescopes, binoculars, range-finders and other service instruments, the committee report that the supply is sufficient for the purpose, but that the supply of English glass has not always been adequate in quantity, and delays have been experienced in obtaining quick delivery. The position with regard to glass for photographic and optical purposes is not so good, and generally a sufficient variety of English glasses is not available. Provision for the authoritative testing of glass is not sufficient and the Committee suggest that the National Physical Laboratory could do something in this direction. It is also suggested that a research on a refractory material for lining the melting "pot" might be carried out. As regards the future, the Committee recommend that these latter two points should be given immediate attention. It is further recommended that facilities for systematic, scientific and manual training in technical optics should be provided, and as educational training takes time, the organisation of optical training should be taken in hand at once.

Institute of Chemistry.—The results of the examinations recently held in London have been published.

Of 5 candidates who presented themselves for the intermediate examination, 2 passed: T. L. McEwan, B.Sc., and E. Mendoza. Of 10 candidates who presented themselves for the Final (A.I.C.) examination, 4 passed:—In the Branch of Physical Chemistry: E. K. Rideal, B.A., Ph.D. in Organic Chemistry: W. S. Allen and Gilbert Harding; in Chemistry (and Microscopy) of Food and Drugs, Fertilisers and Feeding Stuffs, Soils and Water: A. S. Carlos, B.Sc.; R. H. Hopkins, B.Sc., D. A. Legg, A. R. Pearson, B.Sc., A.R.C.S., and G. A. Stokes.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 7th (to-day).

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Discourse on "Electrons and Heat," by Prof. O. W. Richardson, F.R.S.

SATURDAY, May 8th.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Lecture on "Photo-Electricity," by Prof. J. A. Fleming, F.R.S. (Tyndall Lecture II.)

NOTTS AND DERBYSHIRE BRANCH OF THE ASSOCIATION OF MINING ELECTRICAL ENGINEERS.

3:30 p.m. Meeting at University College, Nottingham. Paper on "Protective Devices," by Messrs. E. Kilburn Scott and L. F. Fogarty.

TUESDAY, May 11th.

SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C. Paper on "Some Future Developments in Heating and Ventilation," by Mr. A. H. Barker.

WEDNESDAY, May 12th.

YORKSHIRE SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Annual General Meeting at the Philosophical Hall, Leeds. Paper on the "Power Supply of the Central Mining-Rand Mines Group," by Mr. J. H. Rider.

BIRMINGHAM SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Annual General Meeting at the University, Edmund-street, Birmingham.

ROYAL SOCIETY OF ARTS.

8 p.m. Meeting at 18, John-street, Adelphi, London, W. Paper on "Recent Progress in Pyrometry," by Mr. C. R. Darling.

FRIDAY, May 14th.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at 39, Victoria-street, London, S.W. Paper on the "Production of Sound from Wind Vibrations," by Mr. G. G. Simonds.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Meeting at the Institution of Civil Engineers, Great George-street, London, S.W. Paper on the "Distribution of Heat in the Cylinder of a Gas-Engine," by Prof. A. H. Gibson and Mr. W. J. Walker.

THE NATIONAL RELIEF FUND.

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BEARING CURRENTS.*

BY E. G. MERRICK.

Summary.—The author explains the general theory of currents in the bearings of electrical machinery, records tests on the value of these currents and mentions the means adopted for preventing them.

Trouble is frequently experienced with rotative electrical machinery due to the destructive effect of currents in the bearings. The theory of the production of these currents is not generally understood, and comparatively little data on this subject has been published.

Consider, first, the case of a four-pole revolving-field alternator as indicated in Fig. 1. Since the flux = magnetomotive force/magnetic resistance, we have

$$\varphi_1 = \frac{\frac{4}{10}\Sigma NI}{\Sigma \frac{l_1}{\mu_1 q_1}} \text{ and } \varphi_2 = \frac{\frac{4}{10}\Sigma NI}{\Sigma \frac{l}{\mu q}},$$

where NI is the ampere-turns, l is the length, μ the permeability, and q the cross-section of the various parts of each circuit.

If the reluctances of the two circuits are equal, then $\varphi_1 = \varphi_2$; but these reluctances may be different, due to peculiarities in the design, by variations in the permeability of the iron, or even by faulty machining or assembly of the parts. Referring to Fig. 2, if the reluctance of the joints between the two halves of the stator frame is appreciable, the total reluctances of the two circuits will be different, and φ_1 will be greater than φ_2 by an amount which we may represent by X—*i.e.*, $\varphi_2 = \varphi_1 - X$. The result of this new condition will be more clearly understood if the flux lines are rearranged as shown in Fig. 3, the total flux, of course, remaining unchanged. Each of these fluxes encircle the shaft; at the instant shown, the flux represented by the dotted line φ_1 is turning in a clockwise direction, and that represented by the full line φ_2 is turning in a counter-clockwise direction. When the rotor revolves by an amount equal to one pole-pitch, it is evident that the direction of both fluxes reverse; each flux has then gone through a half cycle, and the resultant field around the shaft, whose intensity equals X, has therefore the same frequency as that of the machine. Such a condition will, of course, give rise to an E.M.F. along the shaft.

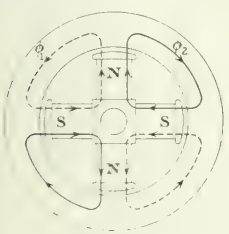


Fig. 1.

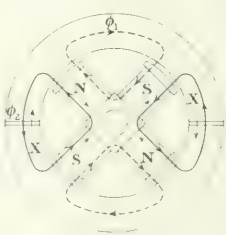


Fig. 2.

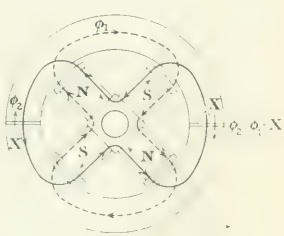


Fig. 3.

In the case of a six-pole machine, the flux φ_2 cuts the joint on one side, while the flux φ_2 cuts the joint diametrically opposite. If the reluctances of the two joints are equal, there will be no difference in the values of the fluxes and no E.M.F. will be induced in the shaft. For an eight-pole machine with two joints the same condition exists as that indicated in Fig. 3.

An analysis of these conditions shows that (*a*) where the number of poles is a multiple of twice the number of joints an E.M.F. may be expected to occur in the shaft. (*b*) If the number of poles is not a multiple of twice the number of joints, the joints will be evenly distributed between the two flux circuits; therefore there will be no variation in flux around the shaft, and consequently no E.M.F. induced in it. The conclusions under (*a*) and (*b*) are based on a symmetrical distribution of the frame joints. Mechanical considerations, however, sometimes require an unsymmetrical arrangement of the joints, and this, under certain conditions, may be such as to reverse the rules just stated.

This explanation covers the general cases where dissymmetry in the magnetic circuits originates from actual mechanical joints in the stator, which is the principal cause of induced voltage in the shaft. It is evident, however, that a more or less unsymmetrical condition may be produced in other ways; for instance, by inequalities in the permeability of the magnetic material constituting the two flux paths, or by a difference in the effective lengths of these paths. The result is the same, however, regardless of what is the cause of the dissymmetry. It is evident that, in the case of direct-current machines, the conditions are exactly analogous to those given above.

Where the magnetic fields are produced by alternating currents the results are again the same as already described. The arrangement of the stator coils in an asynchronous machine is such that, for each pair of coils, a circuit is formed similar to that of two consecutive poles of the synchronous machine.

In a three-phase machine one phase is usually symmetrically placed with respect to the joints, and the other phases produce the shaft E.M.F. In the case of a two-phase motor, the coils of one phase will be symmetrically placed with respect to the joints, and the shaft E.M.F. will be due to the other phase only.

As regards the generation of shaft currents, the only difference between machines in which the field is produced by direct current and those in which the field is produced by alternating current lies in the fact that in the former type a shaft E.M.F. can be generated only when the machine is running, whereas in the latter type an E.M.F. is present whether the machine is running or at rest, its magnitude depending on the relative values of the stator fluxes for the standing and running conditions. Due to the fact that the oil film between the shaft and bearing is maintained only when the machine is running, the standing current of a synchronous machine will be greater than the running current on account of the lower bearing resistance offered when the machine is at rest.

If R is the reluctance of one of the main flux paths and r that of the joint, or any other cause producing dissymmetry, then

$$\varphi_1 = \frac{\frac{4}{10}\Sigma NI}{R} \text{ and } \varphi_2 = \frac{\frac{4}{10}\Sigma NI}{R + r}.$$

Therefore,

$$X = \varphi_2 \cdot \frac{\frac{4}{10}\Sigma NI}{R + r},$$

which shows the importance of the ratio r/R and permits of the following conclusions: (1) As the diameter of the air gap or the number of poles increases R becomes greater and r/R smaller, and the unbalancing effect due to joints or other causes for dissymmetry therefore diminishes. (2) The ratio r/R decreases as the ratio of air-gap ampere-turns to total ampere-turns increases. As the air gap of an induction motor is small in comparison with that usually found in a synchronous machine, it is evident from (2) that induction motors are especially susceptible to the effect of unsymmetrical conditions in their magnetic circuits.

Although in general it is possible to predetermine the cases in which shaft currents may be expected to occur, it is absolutely impossible to calculate the magnitude of these currents. This is due to the fact that the bases for calculating either the induced voltage in the shaft or the resistance of the circuit formed by the shaft, bearings, pedestals, base, &c., are indeterminate quantities. As an illustration of the impossibility of predetermining these factors, the shaft current in an 860 kw. alternator cited by Adler was reduced from 200 amperes to 35 amperes simply by scraping the bearing lining so as to obtain a more perfect oil film over the entire surface of contact. The writer has also found variations of several hundred per cent. in the value of these currents as measured on machines of exactly identical design operating in parallel. This is shown by the curves of Fig. 4, which give the shaft currents of two 62-pole 4,000 k.v.a. 116 revs. per min. 13,200-volt three-phase alternators and the shaft currents in the two machines at normal speed and variable voltage. At normal voltage the shaft currents of machines "A" and "B" were 170 amperes and 60 amperes respectively. Fig. 5 shows the variation of shaft current in machine "A" when running at constant excitation, and therefore at practically

* Abstract of an article in the "General Electric Review."

constant flux, but at different speeds. The actual observed values are shown by the full-line curve "X." It is interesting here to note again the effect of the oil film between shaft and bearing; the resistance of this film decreases with decreasing speed of the machine, which explains the higher proportionate values of current at low speeds. If this film resistance had remained constant, the shaft current would have decreased in direct proportion to the frequency, and would have given a curve approximately as indicated by the dotted line "Y."

Extended tests made by the Allgemeine Elecktrizitäts Gesellschaft-Union Elecktrizitäts Gesellschaft of Stadlau showed that, when the current density in the bearing exceeds about 1 ampere per square

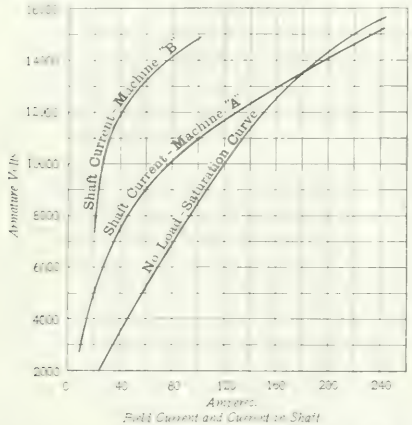


FIG. 4.—NO-LOAD SATURATION AND BEARING CURVES OF 62 POLE, 4,000 K.V.A., 116 R.P.M., 13,200 VOLT THREE-PHASE ALTERNATOR AT CONSTANT FREQUENCY VARIABLE FLUX.

inch of contact, appreciable pitting of the journal takes place: for lower values of current density the pitting is limited to the bearing babbitt. Of the means adopted by different manufacturers to protect shafts and bearings against the destructive effects of these currents, only two methods are of practical interest, viz.:—

Method (A).—Brushes are placed on both ends of the shaft, and are either earthed on the bearing pedestals or connected together by a heavy copper conductor. The result in either case is to shunt more or less of the shaft current through this path, and thus reduce the amount passing between the shaft and bearings. As the resistance of this latter path varies greatly, depending on whether the oil film

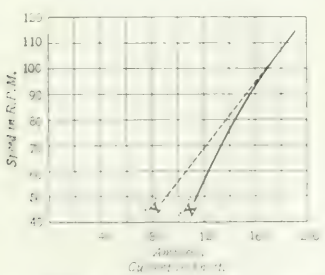


FIG. 5.—VARIATION IN SHAFT CURRENT OF A 62 POLE, 4,000 K.V.A., 116 R.P.M., 13,200 VOLT THREE-PHASE ALTERNATOR AT CONSTANT FLUX AND VARIABLE FREQUENCY.

is more or less perfect, and may be very low as compared with the contact resistance of the brushes, the amount of current shunted by the brushes is indeterminate, and the protection afforded is, therefore, uncertain.

Method (B).—In the case of horizontal machines, insulation is inserted between one or more of the bearing pedestals and the machine base, the number of points at which the circuit is to be broken depending on the number of bearings and the number and type of machines mounted on the same shaft. This method, applied to vertical machines, necessitates the placing of insulation between the upper bearing bracket and the armature spider and the insulating of holding-down bolts. In addition, it is, of course, necessary to insulate all piping, stairs, handrails, &c., which would otherwise complete the electrical circuit. Method (B) does not, of course, reduce the induced voltage in the shaft; but, as this varies from a fraction of a volt to a maximum of possibly 10 volts, it is of no consequence, providing the insulation described above remains intact. This method, if properly applied, therefore provides an absolute protection to journals and bearings against the destructive effects of the induced currents which have been discussed.

REPRESENTATION OF THE TOTAL LOSSES IN IRON, DUE TO ALTERNATING MAGNETISATION, BY AN EXPRESSION OF THE FORM $W=\sigma B^n$.*

BY N. W. McLACHLAN.

The following experiments were carried out on different brands of iron by means of an Epstein tester used in conjunction with an alternator, the wave-form of which differed from a sine curve by less than 5 per cent. The object of the experiments was to ascertain whether the total number of watts lost per kilogram could be expressed in the form $W=\sigma B^n$, as an alternative to the usual expression $W=aB^{1\cdot6}+bB^2$, in which the hysteresis and eddy-current losses are considered separately.

Fig. 1 shows diagrammatically the apparatus used in all the tests. In each case the supply frequency was kept constant and a series of readings of voltage-drop in the test coils (*i.e.*, the back E.M.F.), total number of watts lost (including I^2R and instrument losses which were deducted), and current, were taken. The voltage was adjusted so that the maximum flux density in the iron varied between 4,000 and 10,000 lines per square centimetre. Special care was exercised when readings were taken in the vicinity of these limits so that the values of a and b could be obtained as accurately as possible.

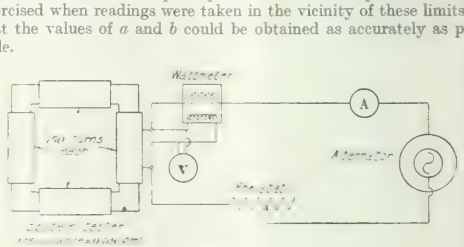


FIG. 1.

Fig. 2 shows, for various frequencies, the total iron loss in watts per kilogramme of stallory plotted against the maximum flux density. In determining the values of a and b (hysteresis and eddy-current constants) the curves were drawn to a large scale and the values of W corresponding to $B_{max.}=10,000$ and 4,000 were read off and substituted in the formulæ:—

$$b=\left(\frac{W_1-4\cdot33W_2}{10\cdot305}\right)10^{-7}, \qquad a=\left(\frac{W_1-10^4b}{2\cdot512}\right)10^{-6}.$$

The equation to the curve in Fig. 2 is

$$W=6\cdot38\times10^{-7}B^{1\cdot6}+10\cdot57\times10^{-8}B^2. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Fig. 3 shows log (10W)† plotted against log $B_{max.}$ for the same curve. The equation to the line is

$$\log(10W)=n\log B_m+\log C.$$

Choosing two points on the line (indicated by crosses) and allowing for the multiplier 10,

$$n=1\cdot75 \text{ and } C=2\cdot66\times10^{-7}.$$

Hence, the equation to the curve is

$$W=2\cdot66\times10^{-7}B^{1\cdot75}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

To test the accuracy of the above equations, we may take $B_{max.}=5,000$ and 8,000 lines per square centimetre, calculate the corresponding values of W, and compare them with the values from the curve. These are given in Table 1.

In this case equation (2) is a little more accurate than equation (1), and the error in both cases is less than 1 per cent. (It does not follow that equation (2) will always be more accurate than equation (1).

It appears that in none of the three brands of iron tested is the

* Abstract of a Paper published in the "Journal" of the Institution of Electrical Engineers.

† Log (10W) has been taken to avoid the use of negative quantities.

Table I.

$B_{max.}$	W from equation (1).	W from equation (2).	W from curve.	Percentage error of equation (2).
5,000	0·795	0·795	0·79	0·63
8,000	1·80	1·796	1·79	0·34

hysteresis constant proportional to the frequency, for the loss seems to increase more rapidly than the frequency.* This may be due to the skin effect produced by eddy currents altering the distribution of the magnetic lines of force across the section in such a way that $B_{max.}$ is really greater than that given by calculation. The eddy-current constant b for each brand of iron does not increase as rapidly as f^2, and this decrease may be due to an increased resistance brought about by skin effect.

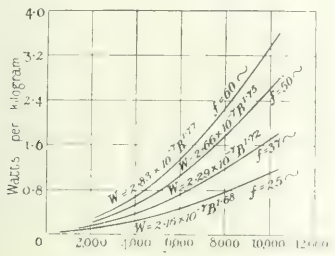


FIG. 2.

The values of C and n both increase with the frequency, the increase in n being practically the same in each case, although the plate thicknesses were different.† On plotting log n and log f it was found that the points were almost collinear, so that n and f are connected by a law of the form $n=c_1 f^{n_1}$. Fig. 4 shows the values of log n plotted against log f.

Using the experimental values of n, the corresponding values of $k(=a/b)$ have been calculated and a hypothetical curve constructed for stalloy as follows :—

$$k \left(\frac{2-n}{n-1{\cdot}6}\right)B^{0{\cdot}4} \text{ approximately.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Now, when $n=1{\cdot}68$, k may be taken as 145 approximately, and when $n=1{\cdot}77$, k may be taken as 50 approximately.

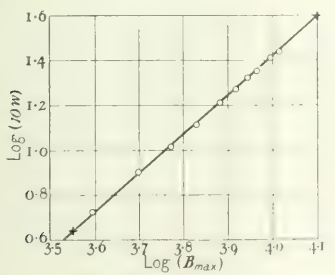


FIG. 3.

For these respective values of n and k the values of B are 7,780 and 8,280, giving an average value of 8,030.

* The values of a for Stalloy when $f=25$ and 60, and for Lohys when $f=25$ are possibly in error.

† Although the variation of n is a small percentage, it makes a great difference in a calculation when used as an index ... 10,000 ... 5·25 ... 10⁸, while 10,000⁻⁸ ... 12 ... 10⁸ ; so that an increase of about 1 per cent. in the index has caused an increase of about 230 per cent. in the absolute value. However, it must not be assumed that a small error in the determination of n will cause a large error in the value ... W is calculated from the formula W = cB^n, because an error in ... is proportionately compensated for in the corresponding value of c. Taking a case in point, suppose n in equation (2) was 1·74, the corresponding value of c would be 2·92. Using these values, W=0·8 when B=5,000, and this differs from the curve by only 1·3 per cent. For larger values ... B ... ess, and is of the order of one-fifth of 1 per cent. ... B=10,000

Table II.

f.	Stalloy. n.		Lohys. n.		Ordinary iron. n.	
	Experiment.	Calculation.	Experiment.	Calculation.	Experiment.	Calculation.
25	1·68	1·68	1·73	1·74	1·75	1·76
37	1·72	1·72	1·77	1·77	1·78	1·80
50	1·75	1·75	1·8	1·79	1·81	1·81
60	1·77	1·76	1·82	1·81	1·83	1·83

Table III.

—	Stalloy. $c \times 10^7$.		Lohys. $c \times 10^7$.		Ordinary iron. $c \times 10^7$.	
	Experiment.	Calculation.	Experiment.	Calculation.	Experiment.	Calculation.
25	2·16	2·17	1·76	1·78	2·92	2·89
37	2·29	2·29	2·04	2·05	3·78	3·77
50	2·66	2·65	2·32	2·32	4·64	4·61
60	2·83	2·83	2·49	2·47	4·98	4·97

Thus, $k \left(\frac{2-n}{n-1{\cdot}6}\right)8{,}030^{0{\cdot}4}$,

$$36{\cdot}5\left(\frac{2-n}{n-1{\cdot}6}\right) \text{ approximately.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Fig. 6 shows the curve obtained by plotting k and n. The experimental values are indicated and agree very closely with the curve.

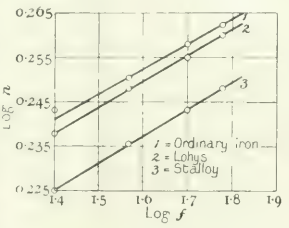


FIG. 4.

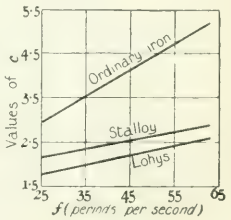


FIG. 5.

Curves of a similar nature were obtained for lohys and ordinary iron. From an equation given by the author we have

$$n = 2\frac{B^{0{\cdot}4} + 1{\cdot}6k}{B^{0{\cdot}4} + k}$$

By substituting the value 8,030 for B, the equation becomes

$$n = \frac{73 + 1{\cdot}6k}{36{\cdot}5 + k}$$

The various values of n for stalloy were found by inserting values of k in this equation, and the values for other brands of iron were

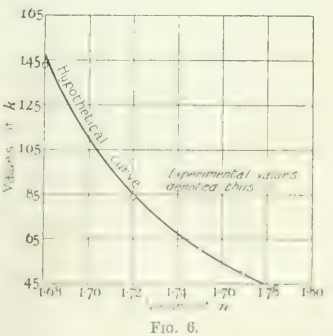


FIG. 6.

determined in a similar way. Table II. shows the experimental and calculated values of n for the three brands.

Using the formula $c=aB^{1{\cdot}6-n}+bB^{2-n}$, by inserting the value of B used above and the experimental values of a, b and n, the correspond-

ing values of the constant c can be calculated. Table III. shows these values, the experimental results being given for comparison.

In calculating the values of n and c for lohys the value of B used was 20,000, which is considerably beyond the range; it will be advisable, therefore, to take these values with reserve.

Conclusions.

1. That for flux densities between 4,000 and 10,000 lines per square centimetre, and frequencies between 25 and 60 periods per second, the combined hysteresis and eddy-current losses in stalloy (0·5 mm. plates) or in ordinary iron (1 mm. plates) subjected to an alternating magnetisation can be represented within 1·5 per cent. by an expression of the form $W=cB^n$, n varying from 1·68 to 1·77 for stalloy and 1·75 to 1·83 for ordinary iron.

2. That for flux densities between 5,000 and 10,000, and frequencies between 25 and 60, the combined hysteresis and eddy-current losses in lohys (0·37 mm. plates) subjected to an alternating magnetisation can be represented within 2·5 per cent. by an expression of the form $W=cB_n$, n varying from 1·73 to 1·82.

3. That in the expression $W=cB_n$, c varies directly as the frequency, but the relation which exists between n and f is of the form $n = cf^{0.1}$.

CONTINUOUS WAVES IN LONG-DISTANCE RADIO-TELEGRAPHY.*

by L. F. Fuller.

Summary.—Experiments are described with continuous waves over a period of six months between San Francisco and Honolulu, a distance of 2,100 nautical miles (3,880 km.), and the equipment is illustrated.

Theoretical Features.

The comparative transmission efficiency of continuous and damped waves has been the subject of much discussion. Most experimental attempts to study the question have been over moderate distances, and no difference has been observed until recently. Austin states that experiments of the United States Navy Department from the Arlington station, using a Poulsen arc for the generation of continuous waves and a 500-cycle spark transmitter for the production of damped waves, have shown that at distances of the order of 2,000 nautical miles (3,700 km.), or above, continuous waves are, on an

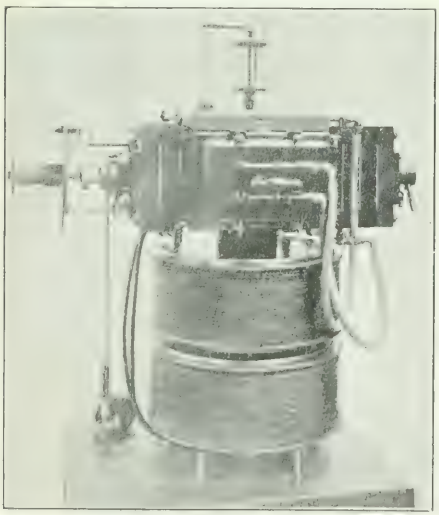


Fig. 1.—Thirty kw. Poulsen Federal Arc Transmitter.

average, superior. A theoretic analysis of the transmission of electromagnetic waves, either continuous or damped, over a perfect conducting sheet was given by Somerfeld in 1909. Further treatment of the subject has been given by Poincaire, Nicholson, March, [illegible] and Zenneck. Certain experimental data over short distances have also been given by Duddell, Taylor and Tissot. In 1912 Eccles gave a theoretical discussion of the propagation of electromagnetic waves in long-distance transmission around the curvature of the earth. His conclusions are strengthened by the United States Navy Department's tests of 1910 and 1913, recorded by Austin and by the Federal Telegraph Co. Poulsen arc, San Francisco–Honolulu tests of 1914, to be described herein.

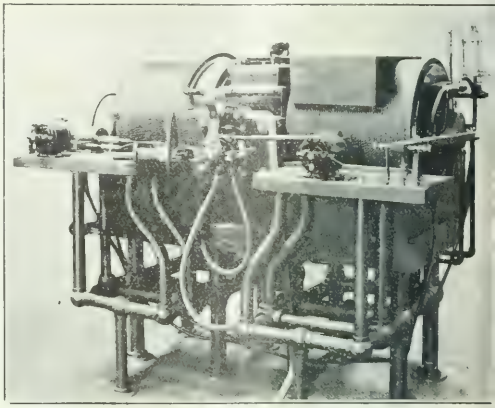


Fig. 2.—Front View 100 kw. Poulsen-Federal Arc Transmitter used at San Francisco and Honolulu during Tests.

The author then deals with Somerfeld's treatment of the problem.

Description of Plants.

The data presented herein were taken during the period of six months, extending from January to June, 1914, inclusive. The range of wave-lengths was from 3,000 to 11,800 metres, and the distance of transmission 2,100 nautical miles (3,880 km.). The stations were the San Francisco and Honolulu plants of the Federal Telegraph Co. Both were equipped with 100 kw. Poulsen-Federal arc transmitters rated on continuous direct-current input, although

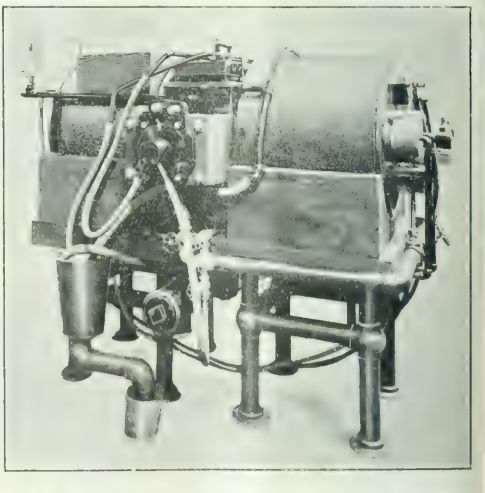


Fig. 3.—Back View 100 kw. Poulsen Federal Arc Transmitter.

40-50 kw. is the usual power employed. Each had three guyed wooden towers, two 440 ft. and one 608 ft. in height, giving triangular flat top antennas of 0·010 mf. capacity. At San Francisco the 440 ft. towers were 600 ft. between centres. The 608 ft. tower was 900 ft. from one, 1,095 ft. from the other 440 ft. tower.

At Honolulu all towers were on 600 ft. centres, forming an equilateral triangle, and there was, in addition, the arc of approximately

* Abstract of a Paper read before the American Institute of Electrical Engineers.

135 deg. of an umbrella antenna, strung from the back side of the 608 ft. tower over shallow tide water. This accounts for the capacity of this antenna with the close tower spacing being the same as that at San Francisco. The centre of capacity at Honolulu was very close to 394 ft. (120 m.), while at San Francisco, due to greater sags, it was approximately 380 ft. (116 m.).

Methods of Taking Data.

Antenna currents were measured by hot-wire ammeters calibrated from a 100-ampere Hartmann-Braun unshunted hot band instrument used as a standard.

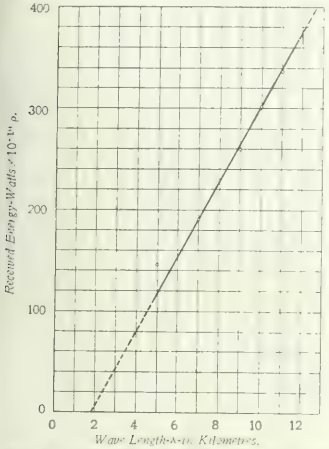


Fig. 4.—Honolulu to San Francisco, January 25, 1914. San Francisco Time: 1:05 p.m.–2:55 p.m. I_s=35 amperes.

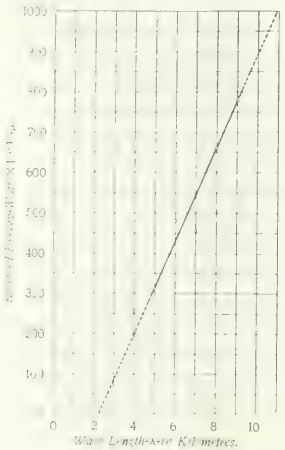


Fig. 5.—Honolulu to San Francisco, March 8, 1914. San Francisco Time: 11:44 a.m.–12:03 p.m. I_s=35 amperes.

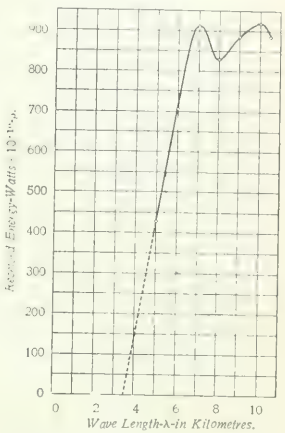


Fig. 6.—Honolulu to San Francisco, March 8, 1914. San Francisco Time: 3:08 p.m.–3:54 p.m. I_s=35 amperes.

Wave-lengths were measured by a standard wave meter employing a tikker and phones to indicate resonance.

Centres of capacity were determined by mapping the triangular network of the antennas giving the height above the earth for various areas, and assuming a low capacity for the down leads.

Received watts were determined by the shunted telephone method. The general procedure was identical with that used in the U.S. Navy

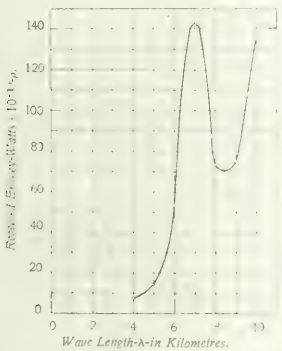


Fig. 7.—Honolulu to San Francisco, March 15, 1914. San Francisco Time: 10:30 a.m.–12 m. I_s=35 amperes.

Department tests of 1910 and 1913, described by Austin, and was briefly as follows:

If the receiving telephones be shunted by a variable resistance, the incoming signal has an audibility of one when the shunting resistance is so adjusted that the dots and dashes can just be differentiated. The following relation then exists:

$$A_f = \frac{R + S}{S} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where A_f = audibility factor or number of times audible,
R = impedance of telephones in ohms
and S = impedance of resistance shunting telephones in ohms.

For the purpose of determining the received watts for a given value of resistance shunting the phones, or for a given audibility factor, another Poulsen-Federal arc station near by was used as a transmitter, and a thermo-couple and galvanometer were inserted in the antenna of the receiving station. These had previously been calibrated on direct current and indicated the received antenna current. Measurements of the resistance of the antenna circuit, with the secondary of the receiver adjusted to resonance, were made throughout a range of wave-lengths extending from 3,000 to 10,000 metres, and the received watts for a known audibility factor were calculated by RI_2. These values of received energy were reduced to received watts for unit audibility. Using a rotary tikker and sensitive telephone receivers, these results gave the relation

$$P = 3{\cdot}2 \times 10^{-10} A_f \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where P = received energy in watts and
A_f = audibility factor as defined above.

General Notes.

Reference to the tabulated data shows the general average of signal strength obtained with the antenna current at the transmitter reduced to 35 amperes. It was kept below 50 amperes in order that a minimum error might be introduced in correcting received current for a constant transmitting antenna current for all wave-lengths. Preliminary investigation of this point showed that for transmitting antenna currents somewhat above 50 amperes the received current did not vary directly as the transmitting current, but fell off somewhat. In order to eliminate as far as possible factors tending to cause questionable results, the antenna current in all tests was kept at such a value as to make it possible to correct received current with certainty to the values which would have been obtained had it been convenient to hold the transmitting antenna current constant for all wave-lengths.

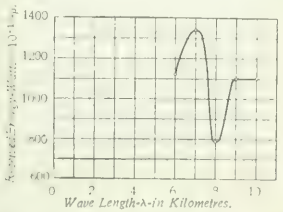


Fig. 8.—Honolulu to San Francisco, April 1, 1914. San Francisco Time: 3 a.m.–4 a.m. I_s=35 amperes.

All data are for transmission with daylight over the entire path, except on a certain few night tests. With the exception of 10 miles of bare hills approximately 1,200 ft. in height at the San Francisco end, the path of transmission lies entirely over sea.

Discussion of Curves.

Figs. 4 and 5 show received energy as a straight line function of the wave-length. It is possible that during these tests the waves were subjected to refraction only, and that the amount of energy received by reflection from the upper atmosphere was small, probably indicating stable day conditions.

The data in Fig. 6 show a constant gain in received energy up to 7,000 metres, with a second peak at 10,000 metres. Fig. 7 is some-

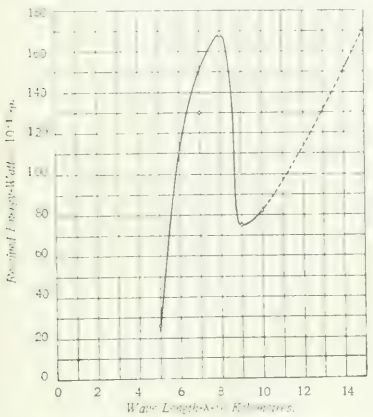


Fig. 9.—Honolulu to San Francisco, May 24, 1914. San Francisco Time: 10:25 a.m.–11:25 a.m. I_s=35 amperes.

what similar, again showing a maximum at 7,000 metres, a minimum between 8,000 and 9,000, and a rise again at 10,000 metres. These are of this same general type, and indicate a combination of day and night conditions, with possibly partial interference on certain wave-lengths and addition on others, due to a combination of reflection and refraction phenomena. Fig. 8 is a typical night curve, showing a marked reduction in signal strength on certain wave-lengths, probably due to reflection phenomenon.

Fig. 9 shows a maximum at 8,000 metres, a minimum at 9,000 metres and a decided rise at 10,000 metres. It is thought quite pro-

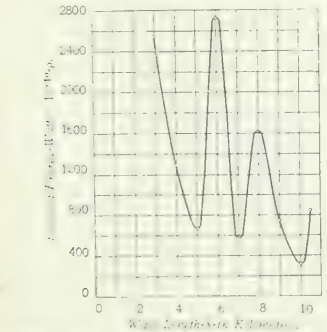


Fig. 10.—Honolulu to San Francisco, June 13, 1914. San Francisco Time: 2:45 a.m.–3:30 a.m. I_s=35 amperes.

Typical night curve showing marked reduction in signal strength on certain waves.

bable that at 14,000 and 16,000 metres, the double of 7,000 and 8,000 metres, other maxima might be noted. Fig. 10 is another typical night curve, similar to Fig. 8, showing a marked reduction in signal strength on certain waves. It is interesting to note that the average of these points gives a curve which follows the radiation resistance curve of the transmitting station, showing a falling off of the received energy in proportion to the reduction in the radiation resistance of the transmitter. For reasons given in the discussion of Fig. 8, the efficiency of transmission must have been very high and reflection phenomenon marked at the time Fig. 10 was taken. Figs. 11 and 12 are typical examples of the unstable daylight class, probably representing refraction and in addition reflection, and a resulting interference upon certain wave-lengths.

From half an hour to two hours elapsed during the taking of each set of observations. During this period the conditions of absorption for various wave-lengths could have changed materially. However, many sets of observations are the results of two sets of readings, giving identical curves, although separated by one-half to three-quarters of an hour. It may be assumed with reasonable accuracy, therefore, that, as a whole, the observations for any given date recorded herein present conditions existing simultaneously on all the wave-lengths. This is undoubtedly true of the data showing stable day conditions, and this is the only data from which deductions and calculations have been made. It is probably not true, however, of the pure night curves, Figs. 8 and 10. At night, conditions of apparent absorption may vary by several hundred per cent. within a few minutes. The fact that the mean values of Fig. 10 follow the radiation resistance curve, however, would tend to show that conditions were fairly uniform throughout the period during which its observations were made.

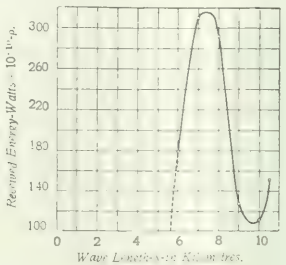


Fig. 11.—Honolulu to San Francisco, June 22, 1914. San Francisco Time: 10:30 a.m.–11:15 a.m. I_s=35 amperes.

From the curves (such as those here reproduced) a modified transmission formula is derived.* This is believed to be accurate within 20 per cent., but the large variations of conditions from day to day must be borne in mind.

It is concluded that (1) under normal day conditions the comparative transmission efficiency of continuous waves is somewhat

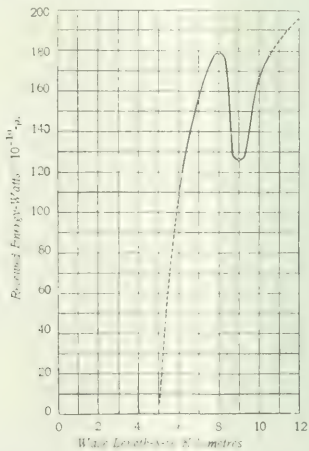


Fig. 12.—Honolulu to San Francisco, June 28, 1914. San Francisco Time: 10:45 a.m.–10:30 a.m. I_s=35 amperes.

higher than that of damped waves on wave-lengths above 3,000 metres.

(2) The transmission efficiency of continuous waves generated

* This formula (for continuous waves over sea water) is

$$I_E = 377 \frac{h_1 h_2 I_s}{\lambda R} \sqrt{\frac{}{\sin \theta}} \cdot e^{-\alpha d/\lambda^2}$$

in which I_E, I_s are the received and sending currents respectively in amperes, h_1, h_2 the heights of the antennæ in kilometres, λ the wave-length in kilometres, d the distance in kilometres, R the resistance of the receiving antenna in ohms, and θ the angle at the centre of the earth subtended by d. The formula used by Austin differs from this in the numerical constants and in that λ^2 is replaced by $\sqrt{\lambda}$.

either by a Goldschmidt reflection alternator or a Poulsen-Federal arc would seem to be the same.

(3) In transmission over distances in the order of 4,000 nautical miles, intervening land appears to be the equivalent of sea water at least during the winter months. This may be due to the greater part of the received energy traversing the upper strata of the atmosphere.

(4) From the curves much evidence is found adding weight to the theories of refraction, reflection and interference upon certain wave-lengths. These are further borne out by observations made at the Beach station of the Federal Telegraph Co., 9 miles from the high-power plant described herein. Very frequently a wave-length is used which is excellent at one station but useless at the other, and as atmospheric conditions change conditions are reversed. This plainly shows interference bands not over 18 miles in width. Such phenomena are most apparent at night, when reflection is pronounced.

(5) Ability to change wave-lengths rapidly is of the greatest value in long-distance radiotelegraphy. Fig. 7 shows this to good advantage.

THE ALTERNATE-CURRENT POTENTIOMETER AS A STANDARD INSTRUMENT.

BY CHARLES V. DRYSDALE, D.SC.

In previous articles describing investigations made with the alternate-current potentiometer * stress has been laid rather upon its capabilities as an instrument for research than on its suitability for standardising purposes. This was due to the fact that in principle the instrument does not profess to be a standard, in that it does not measure the effective or R.M.S. value of a P.D. or current having other than an approximately sinusoidal wave-form. Nevertheless, even when the potentiometer was first described,† theory and preliminary measurements were given which indicated that, with reasonable precautions as to wave-form, it would be satisfactory for all ordinary standardising operations; and subsequent experience has justified this expectation and showed that the accuracy to be attained in practice was often superior to that of instruments of more correct principle.

Apart from the question of principle, the extreme convenience of the potentiometer as a standard instrument need not be insisted on. Besides its availability for all continuous-current P.D. and current measurements, the instrument, in combination with the ordinary volt box and resistances used for continuous-current work, is capable of measuring alternating voltages and currents from a few millivolts or microamperes to 1,000 volts or amperes, or even more. As the instrument also indicates the phase or power-factor directly, the power on an alternating or polyphase circuit can be obtained by successive measurement of P.D. and current. When one considers the enormous battery of balances or dynamometers, of voltmeters and wattmeters, which would be required to make the same measurements, the economy and advantage of the potentiometer are abundantly manifest, and the following theoretical and practical considerations will show that as regards accuracy the potentiometer does not suffer greatly by comparison with other standards.

In order to compare the theoretical accuracy of the potentiometer with that of other devices, its principle must first be briefly recalled. Fig. 1 shows the skeleton diagram of connections of the instrument, which consists of an ordinary potentiometer fed with alternating current from the secondary of a phase-shifting transformer, through a dynamometer ammeter, A. The phase-shifting transformer is in principle like a two-phase induction motor with wound rotor, and a uniformly rotating field is produced from the single-phase supply by the aid of a condenser, K, and resistance, R, in series with one of the stator windings. In consequence, a current of fixed value, indicated by the dynamometer A, passes through the potentiometer coils, and the magnitude and phase of the P.D. v between the sliding contacts of the potentiometer are varied by sliding the contacts and by turning the secondary of the phase-shifting transformer. It is, therefore, possible to obtain a P.D. from the potentiometer which can be brought into exact coincidence as regards magnitude and phase with any P.D. to be measured which is derived from the same source of supply, and this coincidence is determined by a vibration galvanometer, G.

In dealing with the question of accuracy of measurement three matters have to be considered: (*a*) The accuracy of the dynamometer A at various frequencies, (*b*) the freedom of the potentiometer resistances from inductive or capacity effects, and (*c*) the principle of the instrument in relation to non-sinusoidal wave-forms. As regards the two former, it may be said that the dynamometer, which is a Weston pivoted instrument, is wound with fine wire on split bobbins, so that there is no reason to suspect eddy currents, which are the only source of error in this case. The absence of any appreciable frequency errors in the measurements on electrostatic instruments given below confirms this. The resistance coils, also, are of the gauge of wire and wound in the manner which has been found by the Washington Bureau of Standards to equalise the inductive and capacity time constants, and thus to produce no resultant error. As regards perfectly sinusoidal wave forms, therefore, it may be claimed that there is no theoretical source of error, and we have only to consider the question of non-sinusoidal waves.

The vibration galvanometer, being a tuned instrument, is practically only sensitive to the fundamental wave, and disregards the harmonics. When balance is secured with non-

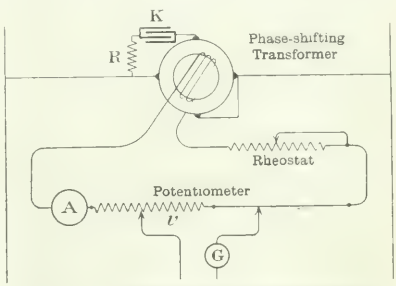


FIG. 1.—PRINCIPLE OF A.C. POTENTIOMETER.

sinusoidal wave-forms, therefore, it means that the fundamental waves of the P.D.s are coincident. If V_1, V_2, V_3, &c., are the magnitudes of the fundamental and successive harmonics of the P.D. to be measured, then the effective value

$$V = \sqrt{V_1^2 + V_2^2 + V_3^2, \text{ \&c.}} = V_1\sqrt{1 + \left(\frac{V_2}{V_1}\right)^2 + \left(\frac{V_3}{V_1}\right)^2 + \text{, \&c.}}$$

Similarly, if v_1, v_2, v_3, &c., are the magnitudes of the fundamental and successive harmonics of the P.D. derived from the potentiometer, the effective value of this P.D.

$$v = \sqrt{v_1^2 + v_2^2 + v_3^2, \text{ \&c.}} = v_1\sqrt{1 + \left(\frac{v_2}{v_1}\right)^2 + \left(\frac{v_3}{v_1}\right)^2 + \text{, \&c.}}$$

When balance is secured, $V_1 = v_1$, and, consequently,

$$V = v\sqrt{\frac{1 + \left(\frac{V_2}{V_1}\right)^2 + \left(\frac{V_3}{V_1}\right)^2 + \text{, \&c.}}{1 + \left(\frac{v_2}{v_1}\right)^2 + \left(\frac{v_3}{v_1}\right)^2 + \text{, \&c.}}}$$

If the harmonics are small compared with the fundamental,

$$V = v\left\{1 + \frac{1}{2v^2}(V_2^2 + V_3^2 - v_2^2 - v_3^2 \text{, \&c.})\right\}.$$

This shows that the potentiometer reads correctly when the wave-forms of the potentiometer and measured P.D. are both sinusoidal, or both similar as regards the magnitude of the successive harmonics, without reference to their phase.

D

* "A Remarkable Vector Diagram," THE ELECTRICIAN, November 18, 1910. "The Propagation of Magnetic Waves in an Iron Rod," THE ELECTRICIAN, April 28, 1911. "The Use of the Alternate-current Potentiometer for Measurements on Telegraph and Telephone Circuits," THE ELECTRICIAN, August 1, 1913.

† "Phil. Mag.," March, 1909.

If the potentiometer current is sinusoidal,

$$V = r\left\{1 - \frac{1}{2r^2}(V_2^2 - V_3^2 - \&c.)\right\}.$$

This shows that a single 14 per cent. harmonic or two of 10 per cent. would produce a 1 per cent. error. A single harmonic of 4·5 per cent. would produce an error of only 0·1 per cent., while each 1·4 per cent. harmonic would cause an error of 1 part in 10,000.

By using an alternator or rotary converter with well-designed poles or windings there is no difficulty in getting a wave-form with less than a 2 per cent. harmonic, and in this case the potentiometer measurements may be regarded as free from error, provided that the machine is not so loaded as to distort the wave seriously.

To show that the phase-shifting transformer, with its phase-splitting device, produces no sensible distortion of wave-form, Fig. 2 gives a typical set of ondograph curves taken from the secondary of the phase-shifting transformer at intervals of

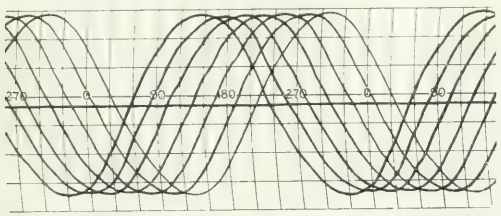


Fig. 2.—Ondograph Curves from Secondary of Potentiometer Phase Shifting Transformer.

27·5 deg. of phase angle. The maxima of these curves do not differ more than 2 per cent., which is presumptive evidence that no harmonic of a greater value than 1 per cent. is anywhere present.

In current measurements at high frequencies, care must be taken that the resistance or "shunt" across which the P.D. is measured has no appreciable inductive drop. In 1910 the author described a form of low resistance standard in which the inductance and external magnetic field was reduced to a very low value by the employment of a number of bent strips in parallel,* and Mr. Tinsley has since modified this constructionally, while maintaining the same principle, by making the resistance in the form of concentric manganin tubes. The inductance and capacity of this form can easily be calculated, with the result that as ordinarily made the time constant works

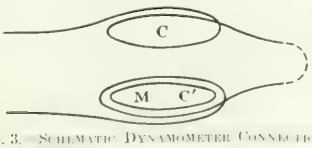


Fig. 3.—Schematic Dynamometer Connections.

out at $1{\cdot}3\times10^{-6}$ second. This means that on 50 ~ supply the phase displacement is only 0·023 deg., and the error due to impedance 1 in 12,000,000, while at 1,000 ~, these amounts are only increased to 0·47 deg., and to 1 in 30,000 respectively. A more detailed description of these resistances, including a correcting device for this small residual inductive effect, will be given later.

Errors of Dynamometer Instruments.

In heavy current instruments of the dynamometer type, errors are liable to be caused by eddy currents induced in the coils or metal work. Although the amount of these errors cannot be calculated generally, their variation with frequency can easily be ascertained. Fig. 3 shows schematically the circuits of a dynamometer in which there are two coils in series acting on one another, and a third coil representing the closed circuits in the metal parts. The main current, C, induces a secondary current in the metal parts of the value $C' = -\frac{jM\rho C}{r + jL\rho}$, where M is the coefficient of mutual induction between the coils and the eddy-current circuit, L the inductance of the latter, r its resistance, $\rho = 2\pi \cdot$ frequency, and $j = \sqrt{-1}$. Rationalising the denominator,

$$C' = -j\frac{M\rho C}{r^2 - L^2\rho^2} \quad \frac{ML\rho^2 C}{r^2 - L^2\rho^2}.$$

The first term is a quadrature or "cross-magnetising" component, and has no effect on the deflection, while the second is a demagnetising component reducing the force between the main coils. Hence, we have—

$$\text{Deflection } D \propto C\left\{C - K\frac{ML\rho^2}{r^2 - L^2\rho^2}C\right\} \propto \left\{1 - \frac{a\rho^2}{b - c\rho^2}\right\}C^2.$$

If the effect is small, as in practice, this may be expressed in the form $K = K_0 + \frac{m\rho^2}{1 - n\rho^2}$, where K_0 is the constant of the dynamometer for continuous currents, and K that for alternating currents, m and n being constants. It will be seen from this that the variation of the "constant" with the frequency will be of the form shown in Fig. 4, where $K = K_0$ at low frequencies, rising first according to a parabolic law when $n\rho^2$ is small compared with unity, then inflecting and approximating to a new constant value $K_0 + \frac{m}{n}$, when $n\rho^2$ is large compared with unity. This will be readily understood, as at high frequencies the E.M.F. inducing the eddy currents is proportional to the frequency, and the reactance of the metal parts becomes large compared with the resistance and proportional

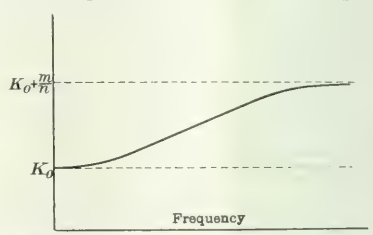


Fig. 4.—Change of Dynamometer Constant with Frequency.

to the frequency, so that the eddy currents are opposite in phase, and bear a constant ratio to the main current.

As regards electrostatic standards of voltage, there is little to be said as regards any theoretical error, except that, as Mr. Duddell has pointed out, at very high frequencies the capacity taken by them may be sufficient to cause an appreciable resistance drop in the suspension. Their freedom from inductive errors has led them to be very widely advocated, but their sluggish action and limited range render them only serviceable when they can be installed with large reflecting scales and be calibrated point by point with extreme care. Although the potentiometer needs the supply to be kept very constant for the best work, it is more easy to get accurate results with a slightly unsteady circuit than with an electrostatic instrument, while it needs, of course, no special calibration or preparation. Most of these measurements were made within an hour of setting up a new instrument.

Measurements.

The following are examples of P.D., current, and power measurements made on various occasions by Mr. Tinsley and the author in Mr. Tinsley's laboratory at Eldon Park Works, South Norwood, employing the potentiometer in comparison with ordinary standard instruments, with both continuous current and alternating current of ordinary frequencies derived from an inverted rotary converter of very closely sinusoidal E.M.F. wave. Some of the measurements were also repeated with frequencies of from 500 ~ to 1,200 ~ per second, derived

* A non-inductive low-resistance standard of shunt. (The Electrician, Dec. 9, 1910.)

from a Duddell high-frequency alternator, which according to Mr. Duddell's own tests, gives a good sinusoidal E.M.F. For the low frequency measurements a Drysdale-Tinsley magnetic-control vibration galvanometer was used, and a Duddell instrument for the high-frequency ones. The frequency was measured and controlled by the author's stroboscopic tuning fork and disc.

P.D. Measurements.—In order to check the behaviour of the potentiometer at different frequencies, the most simple device was to compare it with a Kelvin electrostatic voltmeter, very kindly lent us by Mr. Rennic from the Board of Trade Electrical Laboratory. The following table summarises the tests :—

Table I.—*Calibration of Kelvin Electrostatic Voltmeter by Direct-current and Alternating-current Potentiometer.*

Reading on electrostatic voltmeter.	D.C. Readings.			A.C. readings.	
	+ to needle.	− to needle.	Mean.	60 ∼.	1,000 ∼.
60	59·35	59·42	59·38	59·6	59·25
80	79·67	79·80	79·74	79·95	79·6
100	100·10	100·08	100·09	100·02	99·9
120	119·95	119·99	119·97	119·8	119·8
140	140·65	140·75	140·70	140·85	140·5

On comparing the results in the last three columns, it will be seen that although their consistency is not as perfect as could be desired, there is very little evidence of definite difference between the direct-current and alternate-current readings, except that the high-frequency readings appear on an average to be about 0·15 per cent. lower, which may be caused by imperfections of wave-form. In criticising the irregularities of readings it should be remembered that at the most open part of the scale (100-120 volts) the electrostatic voltmeter only indicated 1 mm. per volt, while at 60 and 140 volts the scale was much closer. The periodic time of the voltmeter was about 12·5 seconds, and there was also a tendency to creep of zero to the extent of 0·2 to 0·3 volt, so that as the steadiness of running of the machines was not perfect, it was hardly possible to expect greater consistency than that shown.

As an example of tests at higher voltages a 2,000-volt Ayrton-Mather electrostatic voltmeter was also calibrated. Inthis case alternating readings only could be taken, as no sufficiently high continuous voltage was available. A 100,000-ohm volt box was employed.

Table II.—*Calibration of 2,000-volt Electrostatic Voltmeter.*

Voltmeter reading.	Potentiometer readings.	
	50 ∼ per second.	900 ∼ per second.
740	733	736
1,020	1,025	1,025
1,362	1,386	1,383
1,555	1,569	1,566
1,730	1,750	1,742

These readings, in combination with the former ones are sufficient to show that there is no reason to apprehend an error of more than 0·1 per cent., so far as frequency or wave-form is concerned with fairly well-designed alternators, while if the supply is kept constant, there is no difficulty in obtaining consistent readings to within a few parts in 10,000.

Current Measurements.—A considerable number of measurements made with the potentiometer and the special form of non-inductive "shunt" devised by Mr. Tinsley and the author, in comparison with a Kelvin deka-ampere balance, has given results in very close agreement, certainly within two or three parts in 10,000, at ordinary supply frequencies. The following tests will be of interest as showing the comparison between this balance and the potentiometer readings at different frequencies. In these tests the Kelvin balance was set to 20 amperes, and the current regulated to balance it at each frequency, the corresponding potentiometer reading being noted in each case. The shunt employed was of 0·005ω resistance, so that the drop was approximately 0·1 volt.

The curves showing the change of constant of the Kelvin balance with frequency, taking the potentiometer as being correct, is given in Fig. 4, which may be compared with the lower portion of Fig. 3. Although the readings are not perfectly consistent, it will be seen that they do not depart from the line as a rule by more than 0·1 per cent., and it should be mentioned that at this range the zero of the Kelvin balance was found to change by as much as three divisions in 400 between successive readings, corresponding to an error in the current of nearly 0·4 per cent., and this in combination with its sluggishness made it less easy to read than the potentiometer. It was unfortunately impossible to get higher currents at the high frequencies, or the readings would no doubt have been more consistent; and it is to be regretted that no readings could be obtained between 50∼ and 750∼ per second, as the high-frequency alternator would not give sufficient output at low speeds. The potentiometer itself worked equally well without any modification over the whole range of the tests. The absence of any appreciable frequency error in the potentiometer, as indicated by the P.D. measurements, makes it practically certain that this curve represents very closely the actual effect of eddy currents in the Kelvin balance.* When the writer visited the Charlottenburg Technisele Hochschule about ten years ago he was informed that they had discarded Kelvin balances as being unreliable on alternating currents, errors of 1 per cent. or more being spoken of. It is interesting to notice from this curve that the probable error of the balance is less than 0·1 per cent. at 100∼, or 0·025 per cent. at 50∼, so that although it is as much as 3 or 4 per cent. out at telephonic frequencies, it is practically correct under ordinary conditions. The results, however, also show the value of the potentiometer even at ordinary frequencies, while at high frequencies there is probably no other instrument which would give such accurate results.

Table III.—*Comparison of Kelvin Deka-Ampere Balance with Potentiometer.*

Frequency, ∼ per second.	Kelvin balance reading.	P.D. by potentiometer.	Current by potentiometer. Amperes.
0 (D.C.)	20	0·09998	19·996
50	20	0·10002	20·004
600	20	0·1018	20·36
750	20	0·10245	20·49
900	20	0·10275	20·55
1,000	20	0·10315	20·63
1,200	20	0·1043	20·86

In this connection it may be of interest to give the results of a current test at 1,000∼ made by the National Physical Laboratory in October, 1912 :—

Table IV —*Current Test at* 1,000 ∼.

Frequency, ∼ per sec.	Current ampere.	Potentiometer.		Error per cent.
		Multiplier.	Reading.	
1,000	$1{\cdot}00_0$	1	$0{\cdot}99_7$	$0{\cdot}_3$
1,000	$0{\cdot}100_0$	1	$0{\cdot}99_4$	$0{\cdot}_6$
1,000	$0{\cdot}100_0$	0·1	$0{\cdot}100_0$	0·0
1,000	$0{\cdot}0100_0$	1	$0{\cdot}0099_1$	$-0{\cdot}_9$
1,000	$0{\cdot}0100_0$	0·1	$0{\cdot}099_3$	$0{\cdot}$

"The accuracy of the current measurements in the second column of the above table is probably not closer than two parts in 1,000."—(Note by National Physical Laboratory.)

At first sight the accuracy shown by these tests is not high, but it must be remembered that in the latter readings the greatest error corresponds to less than one division on the slide wire or to less than 0·0001 volt in the P.D. across the "shunt." In measurements at high frequencies also error is liable to be caused by capacity currents between the primary and secondary of the phase-shifting transformer, which were eliminated in

* It might be claimed that the increase in the potentiometer reading with increase of frequency was due to inductance in the shunt. But apart from the calculations showing the negligible effect of the latter, the curve would not have become straight as it is had the increase been due to inductance of the shunt. Since this was written an actual test has been made on the inductance of the shunt by a special method employing the potentiometer, which showed the inductance to be even smaller than the exceedingly small value found by calculation).

our own tests by feeding it from a transformer with low capacity between the windings. This was not probably the case in the measurements taken at the National Physical Laboratory.

Power Measurements.—The accuracy of power measurement depends, of course, not only upon that of the P.D. and current measurements, but upon those of phase difference. In testing each potentiometer this point is investigated by the simple process of measuring the primary current and secondary E.M.F. of a pair of coils forming an ironless mutual inductance. These quantities are in perfect quadrature, and by altering the phase of the current the accuracy of the phase shifting can be checked at various parts of the range. The following is a typical series of such readings as given on the certificate of the instrument :—

Table V.—*Mutual Inductance Checks.*

Primary current phase	74·1	15·8	27·0	9·8	\33°	\62·8°
Secondary E.M.F. ..	15·9	14·2	63·0	99·8	\123·1°	152·8
Difference	90·0	90·0	90·0	90·0°	90·1°	90·0°

These readings show that the accuracy of phase reading is, as a rule, within 0·1 deg. Similar results have been obtained at frequencies of 1,000 ∼ or more, and the following is the report of tests made at a frequency of 1,000 ∼ by the National Physical Laboratory, using a somewhat different method :—

Table VI. —*Phase Angle Tests at* 1,000 ∼.

Frequency, ∼ per second.	Actual phase difference.	Potentiometer, angular reading.
1,000	18·1	18·2
1,000	39·2	39·2
1,000	58·5	58·5
1,000	90·0	90·0
1,000	131·4	131·4
1,000	162·1	161·9

"It will be seen that the agreement is almost as close as the possible accuracy of the reading."—(Note by National Physical Laboratory.)

As regards wave form, the true power is, of course, given by the relation,

$$w = V_1C_1 \cos \varphi_1 + V_2C_2 \cos \varphi_2 + V_3C_3 \cos \varphi_3 + \text{&c.},$$

where V_1, C_1 and φ_1 are the effective values of the fundamental waves of P.D. and current, and their phase difference, respectively, and similarly for the harmonics. So long as the P.D. wave is closely sinusoidal, therefore, distortion of the current wave produces no error in measuring the power by the potentiometer.

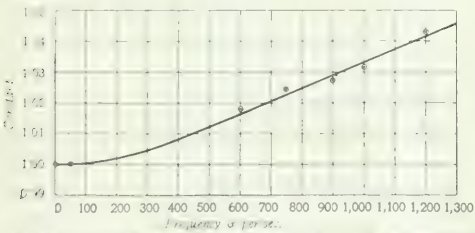


Fig. 5.—Constant of Kelvin Balance at Various Frequencies.

The following table gives the results of a series of power tests made by the potentiometer in comparison with a standard dynamometer wattmeter of the author's form. The current and P.D. were measured by a Kelvin balance and Weston standard dynamometer voltmeter, so that the table summarises the behaviour of the potentiometer :—

Summary.—Although the observations given in the foregoing tables are obviously not examples of good standardising work, it must be remembered that they have all been made in a works' test-room as instruments became available, and with little opportunity for preparation. The alternator for the high-frequency tests was motor-driven from supply mains on which a number of other motors were being continually started and stopped, and some of the low-frequency tests were made directly on these mains. Each test was made with a different potentiometer, and the instrument was simply placed in position and used for the measurement without any of the adjustment or calibration usually necessary with electrostatic instruments. With an alternator of moderate power run from a secondary battery there should be no difficulty in obtaining consistent results to within three parts in 10,000 (which is as close as the dynamometer A can be read), and the above theory and observations indicate that on reasonably sinusoidal wave-forms no intrinsic error of more than this amount need be feared. Already about twenty of these instruments have been put into service in various Government testing laboratories, central stations, works and testing institutions, and, so far as any reports have been received, with nothing but satisfactory results.

The above tests have been given as covering the principal measurements of an ordinary meter or other test-room, but the potentiometer is equally applicable for all inductance and capacity tests, and examples of such tests will be given later.

Table VII.—*Comparison of Potentiometer with Standard Wattmeter.*

P.D. Weston V.	Current Kelvin C.	Potentiometer readings. V.	C.	φ.	Cos φ.	$w = VC \cos \varphi$.	w by wattmeter.	Errors. Per cent.	Phase angle.
		Current lagging.							
58·9	15·12	59·07	15·16	35·5°	0·815	730	730	0	0
60·4	15·12	60·40	15·16	61·3°	0·481	440·5	441·5	0·2	0·06°
60·6	15·20	60·61	15·20	84·4°	0·098	90·2	90·0	0·2	0·01°
		Current leading.							
61	15·21	60·95	15·21	4°	0·997	924	922·5	0·16	...
62·4	15·17	62·37	15·17	31·6°	0·852	806	805	0·15	0·17°

The figures given in the last column are the errors in the phase angle which would be sufficient to produce the discrepancies in the values of the power obtained from the wattmeter and potentiometer readings respectively.

THE ENGLISH ELECTROTECHNICAL INDUSTRY AND THE RUSSIAN MARKET.

BY P. GUREWITSCH.

(*Concluded from page* 129.)

From the figures previously given, the study of which I recommend to English manufacturers, it follows that Germany has till now been the chief provider of all kinds of electrical goods to Russia, who in 1913 took of the total German exports (330,000,000 marks) of electrical goods 6·93 per cent., against in 1912 36·1 per cent. The increase in German exports to England of electrical products was, in the same period, only 24·2 per cent.

In imports of German-made incandescent lamps, electric machines, measuring instruments and high current apparatus Russia takes first place among all countries.

Further, it may be mentioned that most Russian electrotechnical factories have been chiefly founded with German capital. While in the last few years Germany has withdrawn its capital from the Russian mining and bank branches, since by her great industrial growth she has required all her capital for use in Germany, she has always invested increasingly in the Russian electrotechnical industry.

From January 1, 1911, to January 1, 1914, the capital of Russian electrical companies, in which the Germans were chiefly interested, increased from 20,600,000 roubles to 41,000,000 roubles. The names of the companies and their respective capital are as follows :—

	Capital in roubles. Jan. 1, 1911.	Jan. 1, 1914.
Siemens & Halske	5,600,000 ...	5,600,000
United Cable Works	4,800,000 ...	6,000,000
Russian General Electric Co.	7,000,000 ...	12,000,000
Siemens Schuckert.....	2,000,000 ...	15,000,000
Tudor (accumulator factory)	1,200,000 ...	2 400,000

With regard to the increase of capital of Siemens-Schuckert, it may be noted that 11,000,000 roubles were taken up by Siemens & Halske in return for property made over by them to Siemens-Schuckert. Of these 11,000,000 roubles 10,000,000 roubles were taken over from the Russian Company by Siemens & Halske in Berlin.

During the financial year 1913 the Russian General Electric Co. showed a turnover 25 per cent. greater than in 1912, the net profit

being 1,751,479 roubles, against 1,295,618 roubles in 1912. A dividend of 23·50 roubles was declared, as compared with 22·50 for the previous year, while the capital was increased during 1913 from 8,000,000 roubles to 12,000,000 roubles.

Also, of 100,000 shares of the previously-mentioned Society for Electric Lighting (established in 1886) in Petrograd, 38,000 shares belong to Germans, representing a value of 19,000,000 roubles, while about 60,000 shares, value 30,000,000 roubles, belong to Swiss investors.

The purpose of the groups of figures set out in the first part of this review concerning the Russian electrical industry is to show what quantities and which kinds of various electrical goods Russia has required to be imported in the past. In the following review I shall endeavour to give a few practical hints, which may be of special interest to those English manufacturers who desire to profit by the present situation to increase their exports to Russia, which may soon be of great importance to the English electrical industry.

As a consequence of the decreased exporting possibilities for the German electrical industry to countries at present at war with Germany, a keener competition of German electrical industry against England in the neutral countries, especially in South America, will inevitably follow. It was in these countries that the English electrical industry had, excepting the English colonies, their best customers. England exported in 1913 electrical products—

To Brazil	Value	£360,102
,, Argentina	,,	594,170
,, Chili	,,	107,959
Total		£1,062,231

As the demands of the Russian market, as already mentioned, after the war will be very great, English manufacturers, with a total export of £7,656,000 in 1913, can cover the decreases which may occur elsewhere by increased exports to Russia. Further particulars about Russian conditions will, therefore, be of interest to English manufacturers.

Before all else, it is necessary to note that Russia, until now, has been one of the most pronounced protectionist countries, with very high protective tariffs. So far as we know, Russia will not alter its tariff policy after the war. As Russian factors often ask for offers "including carriage and duty," it will be necessary to consider the tariffs on the most important categories of machinery, and this all the more as by these figures the English manufacturers will ascertain at what price their machines can be delivered in Russia.

In making offers it is also sometimes advantageous to quote prices "including carriage and duty," especially for orders from factories, municipalities and other large regular users, as there is then more chance of the offers being considered. While the importers and traders who are constantly occupied with the importation of machinery can easily calculate the duty and carriage, it is not always an easy matter for a manufacturer who only occasionally requires to place such orders. German firms meet the wishes of their Russian customers by quoting prices carriage and duty paid. It is necessary in making such offers to have a good knowledge of Russian conditions and tariffs, as in the event of a faulty declaration, machines may be dutied under a higher classification, and the manufacturer and exporter suffer loss. The English Board of Trade should be of assistance in this matter by collecting all details concerning Russian tariffs and conditions of import.

Machines and apparatus of cast and wrought iron, besides those specially mentioned, are generally taxed with a duty of 2·10 roubles per poud (= 16·38 kg., say 24s. per 100 kg.). This tariff holds good also where machines are partly of copper, but the weight of copper must not be more than 25 per cent. of the total weight of a machine. If the weight of copper exceeds this limit, the duty is nearly four times higher, as such machines are then dutied at 8 roubles per poud (106s. per 100 kg.). For machines which contain copper in large quantity this is, of course, of great importance.

Steam boilers and saws are taxed at 2·10 roubles per poud (say, 24s. per 100 kg.), while for other machines used in the wood-working industry, steam-engines, pumps, refrigerators, the duty is 3·20 roubles per poud (say, 43s. per 100 kg.), and machine tools at 4·65 roubles per poud (say, 61s. per 100 kg.). As stated, machinery and apparatus containing copper are taxed at the highest rate.

Dynamos and electric motors are taxed at 8·50 roubles per poud (112s. per 100 kg. (or, 30–36 per cent. of their value); mathematical and geodetical instruments, and all apparatus for electrotechnical industry (such as switches, fuses, bells, &c.) at 9 roubles per poud (about 118·5s. per 100 kg., or 28–33 per cent. of their value); electrical measuring instruments and meters at 12 roubles per poud (say, 160s. per 100 kg., or 26–28 per cent. of the value).

In spite of these heavy tariffs, the import of machinery and apparatus from abroad to Russia increases every year, as the manufacture of special machines and apparatus in Russia is only slightly developed; even simple machines can only be produced by the home industry of Russia at extraordinarily high prices. With this high cost of production, Russian manufacturers, protected by high tariffs, are not satisfied with the small profits, with which manufacturers in countries where industry is more fully developed are satisfied, on account of the much larger output.

With regard to cost of production, the report of a Commission for the preparation of new tariffs, called together by the Manufacturers' Society of the Moscow district, is interesting. According to the report, the cost of producing 1 poud of machinery is 15·5 roubles, against 10·95 roubles in Germany. The cost of production in Russia is 4·45 roubles per poud higher than in Germany. If we transform these results into shillings and 100 kg., in order to get a clearer view, we find that every 100 kg. of machinery produced in Russia costs 58½s. more than in Germany. Of this higher cost of production the half (2·19 roubles) is for fuel and raw materials, higher insurance rates, dearer credit, smaller capabilities of the lower trained Russian workman (owing to low wages), old-fashioned methods of manufacture, absence of skilled technical personnel, &c., and this notwithstanding the rich coal and iron mines of Southern Russia (the governments of Ekaterinoslaw, Cherson, Tawrien and Don Province), comprising 335,000 sq. kilometres (England and Ireland together have only 317,664 sq. kilometres), and in spite of the richest naphtha springs and manganese deposits in the Caucasus, and in spite of the immeasurable and for the most part unexploited mineral deposits, &c., of Siberia. Prices of fuel and raw materials increase in Russia every year, until in 1914 the question of fuel supplies became acute, and from 8,000,000 to 10,000,000 tons of coal were imported, and the price for naptha (used by many Russian factories, steamship companies and railways for fuel) was forced to a very high figure by the Trust of the naptha spring owners.

The unwise tariff policy exercised a very important influence in causing the enormous rise in cost of raw materials. In no other western European State does a protective tariff for raw materials exist (even in Germany the tariff for raw materials is only 3 per cent.); generally in Russia the tariff amounts to 22 per cent. The import duty on raw iron amounts to 100 per cent., ad val. The heavy kinds of iron and steel bear a tariff amounting to 70–125 per cent., and lighter sorts to 108–125 per cent., ad val. Thus the half-finished articles enjoy a higher protection than the finished article, which on an average is taxed at 30 per cent., ad val.

The most important material for the electrical industry, namely copper, is taxed in Russia at 5 roubles per poud; consequently the Russian prices of bar copper are one and a-half times higher than in Germany or England. As long as this high protective tariff on raw materials and half-finished articles exists, successful competition of the Russian home machine-making industry with foreign manufacturers is impossible, notwithstanding the high price of the finished article.

One may assume that the tariffs for raw materials will be considerably reduced after the war, although the Government will be in a difficult position with regard to the mine owners and the iron and steel producers, with the cry of "Russian products must be made from Russian raw materials." The tariffs for finished products will, however, hardly be reduced. It is quite probable that the tariff on certain categories of machines which are manufactured in great quantities in Russia will be increased. If the import of simpler machines in the same categories is thereby decreased, the import of complicated special machines and machine tools will not be greatly influenced by the increase, as the manufacture of such machines in Russia is very little developed. Only after the more general development of Russian machine construction will the production of special and machine tools of home manufacture obtain a sure footing.

The machine imports to Russia will only experience an alteration in the categories of such machines. The timely adaptation to the expected altered situation in Russian machine imports may, therefore, be of great importance to English exporting firms.

We will now turn to the important question of credit in Russia. When exporting to Russia great care in giving credit is generally necessary. However, and especially in the machinery and electrical branches, the conditions are particularly favourable. Firstly, in the machinery branch short credit is usual, while in the textile trade some times as much as one year's credit is given. Consequently the risks for the creditor are smaller, as the financial situation of the customer cannot change unfavourably in so short a time, if the information obtained beforehand as to his financial position is reliable.

A difference must be made between giving credit to a manufacturer and to a dealer. Great profits in trading operations are usually combined with increased risk, and this is especially so in Russia. But in Russia the number of bankruptcies of manufacturers is very small, and of these the greatest number is in the textile trades. The

conditions prevailing in Russia for foreign suppliers of machinery is favourable, as in Russia there are chiefly large and medium sized factories, employing hundreds and even thousands of workers. There were in Russia in 1914 about 1,100 factories with over 500 employees, about 2,300 factories with 100 to 500 hands, and about 2,150 factories with 50 to 100 workers. The number of Russian factories with more than 100 workmen outnumbered the factories with 50 to 100 workmen by 55 per cent. The explanation is, that Russian industries having only had a short period of development, and most enterprises for the machinery and iron working industries were chiefly founded for State requirements.

Small factories, as they exist in Western Europe, are comparatively seldom found in Russia. It is for this reason that credit can be given to most of the large Russian factories. A wholesale or retail trading firm can receive goods on credit shortly before declaring itself bankrupt; a factory, on the contrary, will seldom order new machines when business is bad. In the question of credit to the railway workshops, municipal electrical works, &c., the risks as to credit are almost nil. Of the 222 Russian electricity works of which particulars are available 89 belong to municipalities.

The conditions are, of course, different if the manufacturer does not deliver direct to the Russian factories, but on credit to factors and merchants. In this case the risks are certainly greater, but even then not so great as in some other branches, as the English supplying house can demand bills of exchange from the Russian factories to whom the trader delivers the machinery, &c., and so the risk is reduced. German manufacturers have taken due note of this situation, and have always endeavoured to deliver direct to the Russian factories. Of course, for this direct trading great energy and enterprise must prevail, and an accurate knowledge of Russian tariffs, transport facilities and all other conditions is necessary.

An important part is played in connection with this direct supply to the Russian factories and other users of machines, apparatus, &c., by written offers, printed catalogues, &c., in the Russian language. Often the view is held that catalogues in French are sufficient for Russian business transactions. This is certainly not the case. If the upper classes of Russia can read and understand the French language, in the technical, manufacturing and trading classes, which are the most important in regard to the question I am discussing, the German language is far more wide spread. Nearly the whole trading operations of Russia, especially the imports section, was confined to Germany. Tens of thousands of Russian engineers and technical officials have, during the last 10 to 15 years, studied in German technical and commercial universities, and have done much to spread the German language in Russia. It has, however, been the more recent policy of Germany, by the framing of rules restricting the entrance of Russian students to the German universities, and so the number of Russian students has greatly decreased. The reason given for these rules is that the Russian students, trained to be engineers in German universities, subsequently became competitors to the many thousands of German engineers employed in Russian factories. Besides, these German-trained Russian engineers, by founding new factories in Russia, has led to a decrease in the imports of German products.

In "The Times" Russian Supplement of 15th January last an article appeared entitled: "Need for interchange of men between England and Russia." In this regard I would remark, that this would be best effected by an interchange of students. If easy means of admittance to English technical schools could be arranged for Russian students it would help to spread the knowledge of the English language in Russian technical circles, and also bring the Russian commercial and industrial classes into touch with English firms, machines, apparatus, materials and methods.

After this digression I will resume. As already mentioned, the knowledge of French in Russian technical circles is small. In sending French catalogues to Russia one must take into consideration also that the technical heads of factories may perhaps understand a letter in French fairly well, but they are seldom able to master the technicalities of a catalogue with many little understood expressions. The success of the German exporting industries is, I say, founded in great measure upon the fact that they have made their offers and catalogues in the mother tongue of the customer.

For the English industry it is absolutely necessary to work up the Russian customers in the Russian language if a sound footing is to be gained. A few of the large Russian importing firms employ English correspondents, but such firms are but a drop in the ocean of Russian business people. In England also, knowledge of the Russian language, owing to the small exchange of merchandise and correspondence between the two countries, is even less, and it is hardly to be expected that this will soon change. To wait until Russian schools teach the English language*, besides German and French, or until there are more English people who understand the Russian language, would mean losing the golden opportunity afforded by the changed conditions of the present time.

This language question is, however, really not, in my opinion, so acute, as it appears at first glance. In Germany the Russian language is not well known. Certainly many German commercial travellers work Russia and speak Russian, but in order to translate Russian technical catalogues or to make a perfect tender in writing their knowledge is not sufficient. German firms have found a way out of this difficulty. Most large German firms have one or more young Russian engineers in their employ, and these have been employed to conduct the business relations between their customers and their principals, or if a Russian customer visited the factory, these employees have conducted the conversation in the Russian language. Should English factories wish to follow this effective example, a certain number of suitable young Russian engineers would be at disposal who wish to complete their knowledge of English conditions and English language. Such engineers, after having acquired this knowledge, have returned to Russia as heads of branches or representatives of the English firm by whom they are employed, and thereby have served to draw closer the trade relations between the two countries.

With regard to the medium-sized English factories and exporting firms, with only a few employees, and therefore unable to keep Russian engineers or correspondents, they could make use of certain translation bureaus employing persons of various nationalities. The costs of these translations in Germany amount, at the most, to 1s. per 100 words.

There can be no doubt that an important part is played in the influencing of the Russian buyers by advertisements in suitable Russian technical and other papers. While in England the existence of Russian technical journals is hardly known, German firms during the past few years have recognised the importance of this class of publicity. If one peruses the Russian technical journals published before the war one is struck by the great number of German advertisements, almost equaling in number the Russian. Some Swiss, French, American and Italian advertisements were to be found, but scarcely any English. In some technical journals the number of German advertisements even exceeded the Russian. That most of these advertisements appeared for many years proves that they had fulfilled their mission of impressing the name of the German firms in the minds of Russian buyers.

The Russian electrical market, with its import of 25,000,000 roubles, is an object worthy the trouble of securing, especially if one takes into consideration that the imports from Germany, which amounted to 90 per cent., has already been broken off for eight months, and that all reserve stocks are therefore exhausted. One requires for this work energy and initiative. Before all, the iron must be hit while it is hot, as time is not only money, but everything. The English electrotechnical industry must keep in view also that in the supply of electrical machinery and apparatus to Russia it has a very capable competitor in the Swiss electrotechnical industry, and that in the supply of electrical accessories of all kinds the competition of Sweden must be reckoned with. In consequence of its favourable geographical situation to Russia, as well as its wealth in water power for manufacturing purposes, Sweden is a potent factor in this connection. Shortly after the outbreak of war large orders for machines, formerly given to the German firms, were transferred to the Swedish factories by Russian electricity works. Progress is not at a standstill, and Russian trade seeks the easiest and most advantageous source of supply. If the conquest of new markets is difficult, the pushing out of a competitor from an already conquered market is a hundred times more difficult, and demands, as I have said, energy and initiative.

* In a few Russian commercial schools English is already taught.

PROTECTIVE DEVICES AGAINST LIGHTNING AND SURGES.*

BY E. KILBURN SCOTT AND L. F. FOGARTY.

This Paper has been written with the object of describing various pieces of apparatus used for the protection of electric power systems against lightning and surges. The first types of protective device dealt with are the various kinds of air-gap arresters, both the spark-gap and horn-type arresters being considered. Details of horn-type arresters are also given. Another type of arrester which is considerably used is the electrolytic type, which depends for its action on a film of aluminium hydroxide deposited on aluminium plates when immersed in a suitable electrolyte. These arresters are built up of cone-shaped trays stacked one above the other, and kept apart

* Abstract of a Paper read before the Association of Mining Electrical Engineers.

by porcelain spacers. The exact amount of electrolyte required is poured into each cup, and the whole immersed in a vessel filled with oil. The number of trays is determined by the normal voltage of the system, the usual allowance being 275 effective volts per tray for alternating current, and 350 volts per tray for direct current. The action of these arresters is as follows: The film of aluminium hydroxide has an exceedingly high resistance when moderate voltages are impressed upon it; but, if the pressure reaches a certain critical value, this resistance breaks down almost entirely and permits the flow of current. When the excess pressure is relieved the normal resistance is restored. With this type of arrester a horn gap has to be inserted between the line and the arrester, as the film will automatically discharge any abnormal frequencies, such as those of lightning, without any rise in voltage. If allowed to remain for some time without any E.M.F. being impressed upon them, the cells have a tendency to lose their resistant properties, and, consequently, arrangements have to be made with this type of arrester to impress a suitable E.M.F. upon them periodically. The film of aluminium hydroxide really acts as the dielectric of a condenser, and this idea has been utilised by Messrs. Isenthal for apparatus to protect low-voltage direct-current circuits. Water jet arresters, or water leaks as they are sometimes called, are used for conducting static charges continuously to earth where the working pressures exceed 5,000 volts. Their action is merely that of a resistance.

In spark-gap circuits resistances are connected to dissipate the energy of the excess pressure and limit the energy current which follows it. A common form of these resistances consists in an earthenware slab with a zigzag groove cut on its surface, the groove being filled with carbon dust. The current is brought in through carbon plugs with the flexible copper leads embedded in them, and the resistance can be altered by varying the depth and quality of the powder. For lightning discharges a single straight groove is used, since the path to earth must be as straight as possible. Where discharges do not often occur, a carborundum rod can be used. The

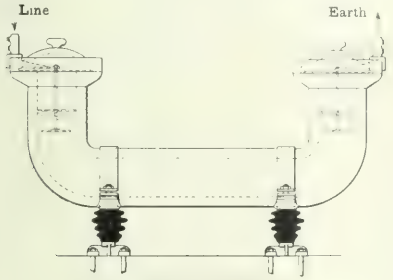


FIG. 1.—WATER RESISTANCE.

rod is usually about 150 mms. long and the resistance when cold about 500 ohms. This resistance goes down to about half when the rod becomes warm. The objection to this type of resistance is the liability of the rod to become broken. Another form of resistance for use with a horn spark gap is the water resistance shown in Fig. 1. This consists of a U-shaped earthenware vessel mounted on insulators. The electrodes are 10 cms. below the water surface, and the latter 5 cms. below the tube edge. A layer of 1 cm. of oil is poured into each side of the tube.

If continuous loss of energy in the mains is permissible, resistance arresters can be adopted. In this type no spark gaps are inserted between the mains or between the mains and earth. The need for resistance arresters is reduced in the case of cable systems. They are most suitable for low-voltage mains in which the spark gaps of the arresters provided are always non-sensitive.

The authors also devote a brief section to the use of choke coils in protecting apparatus against discharges, and then pass on to the subject of charging switches. These are useful for starting large three-phase motors. The closing of the stator switch may cause excess voltages, which may not only damage the motor in use, but other machines on the same mains. A protection against this is to switch in the machine slowly through a resistance, and for this purpose a special contact is required on the switch, so that the resistance is connected in series on the first step and short-circuited on the second or main circuit. It is now possible to obtain motor stator switches which are fitted with charging contacts and have suitably graded resistances. The extra charge is not great, and it is certainly well worth incurring, as it may be the means of preventing a very serious breakdown.

It is useful to connect an arrester between the neutral point of the motor winding and earth. It usually consists of a number of roller type gaps in series with a high-tension fuse and a carborundum rod. These arresters serve to reduce the unequal pressure on the windings resulting from a badly-operated switch which, for instance, closes two phases before the third connection is made. This device prevents the insulation from being pierced, and can in many cases be used instead of special charging devices on the primary oil switch.

The question of earth plates is also dealt with, and the authors consider the general features of these for different cases. An interesting apparatus described is the Giles electric valve. This apparatus, shown diagrammatically in Fig. 2, consists of a first spark gap, e e_1, in series with a resistance, R, and a number of spark gaps, e_2, e_3 to e_5. The gaps e_2 to e_5 are indirectly connected to earth through small condensers shown on the right, whilst the last electrode, e_6, is directly connected to earth. The action of the apparatus can be best explained by taking figures. Assume, for example, that the line has a normal potential of 10,000 volts and that the first spark gap is regulated to come into action at 12,000 volts. Then the first knob e_1 is at a potential of 12,000, and all the other knobs, e_2, e_3 to e_5, are maintained at zero or earth potential by reason of the small condensers. When a surge comes along, the pressure of 12,000 volts produces a small spark between e and e_1, so that the knob e_1, which just previously was at zero potential, will now be at a potential of 12,000 volts, less the potential drop in the spark gap. As the current which actually passes in such a spark is small, being only of that magnitude which can pass through the small condenser, it follows that the potential drop in the spark will be relatively small. If we assume it as 500 volts, then the knobs e_1, e_2 will have a potential of $12,000-500=11,500$ volts. The knob e_3 is still at zero potential, and the spark will now jump between e_2 and e_3, bringing the potential of e_3 to $11,500-500=11,000$ volts.

This action goes on through the whole series of knobs, the sparks passing, as it were, in cascade until they reach the last knob, which is metallically connected to earth. As soon as the last spark gap from e_5 to this last earthed knob is in operation a discharge can pass direct from the line to earth, following the path e_1, e_2, R, e_3, &c., to earth.

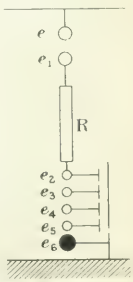


FIG. 2.—DIAGRAM OF GILES' ELECTRIC VALVE.

The resistance R is made sufficiently great to avoid the production of high-frequency oscillations, and therefore the apparatus may be insufficient to deal with the surge tension produced in a large distribution system. In such a case the output of the valve can be increased by placing several columns parallel. In practice it is found that each column operates independently of the others, and since no combinations of columns can be regulated to mathematical uniformity, they will not start working at the same instant. If the tension rises at a certain point, any one of the valve columns will come into action, and if its output is insufficient the voltage will continue to rise, and will possibly arrive at a higher point, where a second valve will operate, and possibly a third valve will come into operation. If three columns are sufficient to deal with the surge tension, then the pressure cannot increase beyond a certain value, and from this point onward it will drop again. Supposing that it had been shown that a resistance of 10,000 ohms was sufficient to avoid the production of high-frequency phenomena, and that we had 10 columns in parallel, then we would have only 1,000 ohms equivalent resistance between the conductors and earth, and yet from the point of view of high-frequency generation the result would not be the same as if we had put a single column with 1,000 ohms resistance in series. In fact, since the valves come into operation one after the other, the aggregate of valves does not produce an oscillatory phenomenon which one would otherwise certainly have obtained with a single column having a resistance of 1,000 ohms only. This point has been verified experimentally. It is found that the terminal pressure at the valve sinks very little below that voltage for which the spark gap e e_1 (Fig. 2) is adjusted; the sparks cease spontaneously without having recourse to any blow-out arrangement. The valve thus does not act during the whole period, but only during that time in which the surge tension occurs, and its effect is to cut off from the voltage curve all the peaks which are beyond the value for which the gap is regulated. The Giles valve not only serves to suppress the peaks of the voltage curve due to resonance phenomenon produced in the line by changes in the load, but it also carries away the energy stored in the alternators or transformers at the moment when a short-circuit is broken, either by a switch or fuse.

The remainder of the Paper is devoted to the consideration of the causes of electrical surges, both high and low tension, and the use of protective condensers.

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THE USE OF PROFITS IN RELIEVING THE RATES.

We have, on more than one occasion, dealt with the policy of relieving the rates by using the profits of municipal undertakings for this purpose, and we have expressed our disapproval of such a policy. It has always seemed to us that if there is any considerable profit from an electricity undertaking, after adequate provision is made for the maintenance of reserve and contingency funds, the tariff should be lowered so as to give the consumers the advantage; otherwise, consumers are made to pay an unnecessarily high price for their energy for the benefit of the ratepayers in general.

We should not refer to this question again at the present time, but for the fact that the conditions under which such undertakings are now being carried on are abnormal. The Government has expressed itself as being averse to expenditure on extensions, and many of the extensions that had already been planned in various parts of the country by municipal authorities are thus in abeyance because the Local Government Board is unwilling to give permission to raise the necessary loans. This action naturally places such undertakings in a somewhat difficult position. Under ordinary conditions a certain growth takes place from year to year, and it is well that this should be provided for fairly in advance of the time when the plant will be actually required. Apart from normal growth, however, there is at present a large demand for power on the part of those firms which are carrying out Government contracts. It is obviously desirable that power for such purposes should be provided as far as possible. Apart from the question of extensions, and the difficulties caused by their restriction, the costs of production have risen considerably, due more particularly to the increased cost of coal, and to some extent to the higher cost of labour. Although we hope that this may be only a temporary difficulty, this increase in cost has now become so marked that prices are being raised by a large number of undertakings.

Taking these facts into consideration, it seems to us most

important at the present time that municipal undertakings should keep a tight hand on any profits. We fear, however, that in some cases this policy is not being followed. We notice, for example, that the Manchester Electricity Committee propose to contribute in the coming year the usual sum of £30,000 towards the relief of the rates. In this case the surplus for the year ended March 31 was £35,850, against an estimate of £30,500, so that there was an increase in the estimated profit; but we note that there will probably be a slight revision of charges for electricity in the present year to counterbalance the increase in cost. In the case of the gas undertaking at Manchester, on the other hand, the state of affairs is by no means so satisfactory, as the gross profit for the year was £90,369, compared with an estimate of £119,571. Nevertheless, a contribution to the City fund in aid of the rates is to be made to the extent of £50,000, with the result that there will be a deficit of £58,367, which is to be carried to next year's account. Further, the price of gas is to be increased by 6d. per 1,000 cubic ft. Lastly, we notice that the Manchester Tramways Committee have decided to contribute £100,000 to the relief of the rates. The case of Manchester is not by any means an isolated one, for nearly all the large local authorities who control electricity supply, gas and other public services have also allocated large sums to the relief of the rates. It is very questionable whether this policy is wise or whether it is economically sound; at all events, the heads of Government Departments seem to have changed their views upon the question in recent years, and the present tendency in private bill legislation is to fix a limit upon the sum which any local authority may devote to the relief of the rates out of the profits of a productive undertaking. At the present time Manchester Corporation and other local authorities have important and urgent schemes of electricity supply extensions and other public works in abeyance on account of the Government policy of restricting loans, and it seems to us that municipal authorities would be better advised to avoid relieving the rates in this way—at all events for the present—and to keep all the profits in hand as a reserve against contingencies.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Questions and Solutions in Telegraphy and Telephony. By H. P. FEW. Pp. 230. (London: S. Rentell & Co., Ltd.) 2s. 6d. net.

Books of this nature serve two extremely useful purposes. They form a primer of the very best nature for the student at the end of his course, prior to his entry into the examination room, and they show to him at the beginning of, and throughout his course, the essential principles underlying his study.

In the answers to examination questions covering a number of years will be found, concisely put, the whole fundamentals of a subject, and Mr. Few's book, taking, as it does, the highly specialised subjects of telegraphy and telephony, may well be reckoned as invaluable to the students of those subjects.

The fourth edition now published includes answers to the questions set in the City and Guilds examinations in the first grade in these allied sciences for the years 1904 to 1914 inclusive. Covering this period the questions set touch upon practically every phase of the two subjects, and the student who is able to answer all, will be able to assure himself that he has little else to learn.

Many of the questions are answered more fully than is required, or is possible, in the examination room, but this adds to the usefulness of the book rather than detracts therefrom. It may be suggested, however, that a better way of meeting this want, would be to give a model answer, and to amplify by means of footnotes, or distinctive print.

It is a pity that the opportunity has not been taken in issuing this new edition, to revise the answers given to questions in the earlier years, so that the book may fully meet the needs of the modern student—the telephone illustrated on page 60, for instance, is now quite obsolete.

Very great care is required in a book of this nature to avoid errors that may prove to be serious stumbling blocks to students, and it is to the credit of the author that but few appear. On page 85, however, the Wheatstone Bridge test given for locating an earth fault in a cable is only true if the fault has no resistance, and if the conductor is of uniform gauge and material throughout, but these important limitations are not mentioned. Heat coils of the form shown on page 83 are never used in *modern* telephone exchanges, as is stated on page 193, and a condenser appears to be omitted in Fig. 146.

Perhaps Mr. Few, in future editions, will make his excellent handbook even more useful by including answers to the Honours grade questions. As it stands, however, the book has a great value and no student should neglect the opportunity it gives to test his progress in the learning of these fascinating subjects. W. A.

A School Electricity. By C. J. L. WAGSTAFF, M.A. Pp. xi + 250. (Cambridge: The University Press.) 5s. net.

It is a pleasure to note the excellence of this volume. This branch of physics is one which is by some regarded as difficult for a school subject. Unquestionably, however, it places at the command of the teacher an inexhaustible fund of experimental illustration and measurement. In the hands of an enthusiastic and imaginative teacher its value as a mental training is bound to appear, whilst for its place from the point of view of importance of subject-matter there is nowadays no need to plead.

The present book is full of suggestiveness in every chapter. In a very short time—probably his second week—the boy is engaged in the construction of a simple motor to run from a single cell. In quick succession he is introduced to important apparatus and mechanism, such as secondary cells, ammeters and voltmeters, dynamos, &c. Experimental illustrations for the class room are described, as well as experiments to be performed in the laboratory.

This attention to the experimental side is fully supplemented by accuracy in the statement of laws, and a mathematical treatment which assumes here and there a knowledge of the calculus. This side of the book is not the least interesting. There is plenty of opportunity and stimulus for the most capable boy and downwards. In all, close on 500 examples are included, some surprisingly daring (*e.g.*, No. 12 on p. 139). But all is justifiable, given the right sort of teacher.

In regard to illustrations and letterpress the book could hardly be improved. The only errors that have been observed are in the equations on p. 133, and in the rule of direction quoted as Fleming's Rule on p. 119, which is *not* Fleming's Rule.

In concluding this notice, one would express the hope that in a subsequent edition room will be found by the author for a chapter on the conduction of electricity through gases, and perhaps for one on the telephone. D. O.

American Handbook for Electrical Engineers: A Reference Book for Practising Engineers and Students of Engineering. Edited by HAROLD PENDER. Pp. xviii + 2023. (New York: John Wiley & Sons, Inc.) $5.

We have been editorially admonished for sending in a tardy review of this 2000-page book, and a denial of our ability to review such a book either on the day of publication or a few days after publication, as some men are able to review works of fiction in the lay Press, constitutes our sole defence.

In our opinion, the Editor should feel flattered that we have devoted some weeks to the study of his book. When several

years are spent on the preparation of a big book, we hold that it is the duty of a reviewer to give the book his most careful attention, despite the fact that his sole reward, apart from the usual column rates, is either an occasional signed copy from a delighted author, or a letter of abuse from the author or his publisher. As we have nothing but praise for this book, we shall be spared the pain induced by such abuse.

As existing engineers' handbooks in our possession require 28 in. of shelving for their accommodation, we decided that it would be a good plan to use the book under review in our everyday work for some time. The result of the experiment is that, on practically every occasion the work has been consulted, the information sought has been obtained.

The numerous articles are characterised by their thorough adaptability to practical engineering and by the careful statement of their scientific foundation. Of the many features of interest two stand out prominently. These are the encyclopædic arrangement and the consistent plan followed in the treatment of all the articles. Experience has shown that the alphabetical arrangement is eminently fitted for an encyclopædia of general information; a like arrangement is equally applicable to a reference book dealing only with engineering topics, and credit is due to the editor-in-charge for the adoption of the arrangement in this book. The plan consistently followed in all the articles is praiseworthy to a degree. This plan comprises a general description and definitions, a brief statement of application and a discussion of the principles of operation. Then follow sections on design, testing, performance, specifications, installation, weights and costs, and at the end of each article a bibliography is given. The latter is intended to direct the reader to more extended information in treatises and current periodicals. It is stated that the references are usually those with which the writer of the article in question is most familiar and which he has found most useful. They are, therefore, in no sense complete, but they will be found a useful guide in the search for additional information. In many instances a blank space is left after the bibliography, and this space can be used for the insertion of further references.

Although the book deals primarily with electrotechnical matters, a large amount of space is, very properly, given to those branches of engineering which are closely allied to electrical engineering practice. The collection of mathematical tables and formulæ is unique, and the book is in every respect worthy of a place on the same shelf as "Molesworth."

Aircraft in the German War. By H. Massac Buist. Pp. ix. + 116. (London: Methuen & Co.) 1s. net.

This little volume is of topical interest at the present time, but is not technical in character, except for a brief account of the types of aeroplanes and airships at present in use by the Allies and by the enemy. Three chapters are devoted to British equipment, to that of our Allies and that of Germany and Austria. A general description is also given of the very important work undertaken by air services in war.

A METHOD OF DETERMINING THE PHASE ANGLE OF CURRENT AND POTENTIAL TRANSFORMERS.

BY R. D. GIFFORD, M.Sc.

The phase angles of modern instrument transformers are so small that their measurement usually requires elaborate and special apparatus, and unless the characteristics of this apparatus are very accurately known, the results obtained are at least doubtful. The author has used the following simple and direct method of phase angle measurement.

If we take an ordinary four-element power-factor meter, having one current and three pressure coils, then by switching its current coil first into the primary and then into the secondary of a, preferably, one to one ratio current transformer, whilst its pressure coils are supplied from a steady source, a deflection of the pointer will take place equal to the phase angle of the transformer.

As the angle to be measured is of the order of only 1 deg., it is apparent that the deflection on an instrument of ordinary construction would be too small to be read accurately. The deflection might be magnified by employing a reflecting instrument, but this entails additional apparatus and a darkened room, which may not always be convenient.

The required magnification was actually obtained by suitably adjusting the effective ampere-turns of the three pressure coils. Suppose the effective ampere-turns of the coil connected to phase 1 to be n times those on each of the other two coils, then it has been shown in a previous article* that the flux at any moment due to the three coils, along the axis of coil 1 is proportional to

$$A \frac{2n-1}{2} E \sin \omega t \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and the cross flux is proportional to

$$B \frac{3}{2} E \cos \omega t \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

It was also shown that if the primary current I_p in the current coil of the meter lags φ deg. behind the phase E.M.F. E_1, a deflection γ_p of the pointer from its position at unity power factor takes place, where

$$\tan \gamma_p = \frac{3}{2n-1} \tan \varphi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If the phase angle of the current transformer be α, then on switching the current coil of the meter into its secondary circuit, we have

$$\tan \gamma_s = \frac{3}{2n-1} \tan (\varphi + \alpha) = k \tan (\varphi - \alpha) \quad . \quad . \quad . \quad (4)$$

The deflection of the pointer on switching over is, therefore,

$$\beta = \gamma_p - \gamma_s \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

If E_1 and I_p are in quadrature, *i.e.*, $\varphi = \frac{\pi}{2}$, then from (3) $\gamma_p = \frac{\pi}{2}$

Hence, from (4) and (5)

$$\tan \gamma_s = \tan (\gamma_p - \beta) = \cot \beta,$$

and

$$\tan \gamma_s = k \tan (\varphi - \alpha) = k \cot \alpha.$$

Since α and β are small, we may write $\cot \beta = \frac{1}{\beta}$ and $\cot \alpha = \frac{1}{\alpha}$

Hence

$$\beta = \frac{\alpha}{k}$$

If n be greater than unity, then k is less than unity, and, therefore, β, the angular deflection on switching over is $\frac{1}{k}$ times greater than the phase angle α of the transformer. For example, if $n=4$, $k=\frac{1}{3}$, from which it follows that in the region of the scale over which the pointer moves when $\varphi = \frac{\pi}{2}$, a magnification of 3 will be obtained.

It will be observed that to produce this result I_p must be in quadrature with E_1. This involves the use of some such device as a phase shifter which may not always be available. Moreover, the number of magnification does not increase very rapidly with an increase of n.

It will usually be more convenient to obtain the magnification when I_p is in phase with E_1.

This may be effected by making n less than unity. Then at $\varphi=0$ we get in a manner similar to that given above $\beta = k\alpha$

For $n = \frac{1}{4}$, $\beta = 2\alpha$, and at $n = 0$, $\beta = 3\alpha$.

To obtain greater magnification than this the instantaneous currents in coil one must be reversed when n assumes negative values.

The magnification factor k then increases rapidly for small increases of n, for example,

at	$n = \frac{1}{6}$	$k = 4{\cdot}5$
	$n = \frac{1}{9}$	$k = 6{\cdot}0$
	$n = \frac{1}{3}$	$k = 9{\cdot}0$

For these higher values, β is no longer small, when the exact formula, $\tan \beta = k \tan \alpha = kd$ (at $\varphi=0$) should be used.

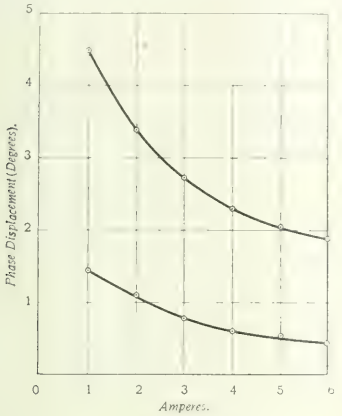
* The Electrician, Vol. LXXV., p. 167.

In reality, all that is being done by varying the ampere-turns on the coils is to produce a rotating flux vector, the extremity of whose path is an ellipse, one of whose principle axes coincides with the axis of coil 1. The angular magnification, discussed above, is in fact the ratio of the major to the minor axis of the ellipse.

The author has not had an opportunity of fully investigating the practicability of this method, but it would seem to be free from much of the tediousness of the usual methods.

As regards precision, assuming a pointer 4 in. long, and using a magnification of 5, the deflection corresponding to 1 deg. of phase displacement is 0·35 in. If the pointer has a fine knife-edge tip and the instrument be fitted with a mirror scale to avoid parallax, the deflection may be easily read to less than 0·01 in., which, under the above conditions, corresponds to less than two minutes of phase angle.

Some preliminary results obtained by this method on a small 5 to 5 ampere current transformer are shown in the accompanying figure, the lower curve being obtained when the transformer had its full rated secondary load, and the upper curve when the load was several times the rated amount. It is noteworthy that these results were obtained in a few minutes.



The same method is, of course, applicable to potential transformers, the phase meter in this case being one with one pressure and three current coils.

THE BOMBAY HYDRO-ELECTRIC SCHEME.

We give below an account of the discussions which took place before the Institution of Electrical Engineers in London and Manchester on Mr. A. Dickinson's Paper on this subject. An abstract of this Paper appeared on p. 117 of our last issue.

Mr. Robert Hammond, in opening the discussion, said that he was appalled at the size of the undertaking which Mr. Dickinson had so successfully carried through. He congratulated the author on his choice of 50 ∼ as the generating periodicity. They were using on the Rand when they took a periodicity of 25, and they were using in the States when they used 60 ∼. Mr. Dickinson had adopted a line voltage of 100,000. There were cable makers in the room who would have been appalled 20 years ago if they talked of 10,000 volts, and now they took on 100,000. Mr. Dickinson would probably let them know why he put it quite so high. From Vereeniging to the Rand—almost the same distance, 43 miles—the voltage was 80,000, and there were numerous transmission schemes in the States where they carried energy from 40 to 80 miles with pressures of 40,000 up to 70,000 volts. He knew of no scheme except Mr. Dickinson's where they used 100,000 volts for so short a distance. It would be useful to have Mr. Dickinson's figures showing to what extent the saving of copper balanced the more expensive equipment for 100,000 as compared with, say, 70,000 or 80,000 volts. In the water supply scheme for Birmingham, Portland cement was used for the reservoirs, but Mr. Dickinson was making his with lime mortar. Perhaps he would inform them why? Also he would like to know how the joints of the pipes (which were of 82 in. internal diameter) were made secure, and what means were adopted in a climate like that of India for preventing corrosion. The generators were driven by horizontal impulse turbines. Pelton wheels were more usually employed with very high heads for horizontal shafts. He noticed Mr. Dickinson had adopted suspension insulators, and he would like to know why he did so. One of the Niagara companies had had considerable trouble with the excessive swinging of suspension insulators, with the result that special means had to be taken to prevent it. He believed Dr. Pearson advocated pin insulators even for higher voltages than 100,000. The transmission towers, 160 ft. high, were no doubt the tallest in existence, and it would be interesting to know whether they were galvanised or painted.

Mr. T. O. Callender said that Mr. Dickinson had been identified with the scheme from the beginning. The difficulties he had had at the lakes were immense, and shifting a lot of mud by native labour was very different from having a gang of English navvies. The work Mr. Dickinson was carrying out was going to make one of the most wonderful industrial developments that have ever existed in the East and probably in the world.

Mr. J. H. Rider said that Mr. Hammond was in error in saying the Rand took 25 cycles. The Rand supply was 50 ∼. He thought they should be proud that such a magnificent piece of work as the Bombay scheme was being carried out by a British engineer. The only regret was that so much of the plant had not come from Britain. He also would like to ask why a line pressure of 100,000 volts was adopted? He did not think the line would be less, or materially less, economical had a lower pressure been adopted for a line only 43 miles in length. Mr. Dickinson referred to what he called the line efficiency, and he gave the efficiency of each of the circuits when carrying 15,000 kw. as 93 per cent., by which it appeared that there was a drop of 7 per cent. in the transmission; but Mr. Dickinson also said the receiving transformers were made to take a pressure of 85,800 volts. That was a drop of 14·2 per cent., and he did not quite know how that was accomplished if the efficiency of the line was 93 per cent. They were not told how the governors for the turbines were driven. The turbines were built by one firm and the governors usually made by another firm. He thought the governors should be direct driven, and turbine makers should put the proper extensions to their bedplates for them. With regard to the transmission system, Mr. Dickinson was using star-wound generators with the neutral not earthed, and then delta step-up transformers and delta-delta step-down transformers. Apparently there was no earth connection on any part of the system. He did not know whether they suffered from lightning, but it was found on the Rand that earthing the system in several places had been necessary to reduce the risks from lightning. He would like to know why Mr. Dickinson used the star-delta step-up and delta-delta step-down, why he did not have a neutral point on his high-tension line and why he did not earth it? Figs. 8 and 14 gave some indication of the arrangements made for lightning protection. He noticed only one horn arrester in series with an aluminium lightning arrester, and he would like to ask whether one horn arrester had been found sufficient to protect a line of that nature? Mr. Dickinson told them that the electrically-operated switches in the station were operated at 220 volts from a small battery with a motor-generator, and his exciting pressure was 250 volts. Would it not have been better to have taken his current for operating the switchgear from his exciting circuit, only 30 volts higher, and put the battery in parallel with his exciters? Had Mr. Dickinson had any trouble with the pipe supports for his slate panels? The line was a seven-strand wire. What was the reason for adopting a seven-strand wire rather than a solid conductor? Did Mr. Dickinson have, or expect to have, any trouble due to corrosion of the wire, because it would be a larger surface, and there would be more space for moisture than on a round conductor? He thought the suspension type the right type of insulator to adopt. He found on the Rand that no trouble was caused by swinging. He would question whether six insulators in series would have been sufficient for a 100,000-volt line. On the Rand they used six of the same pattern in series for 80,000 volts, and on a 22-mile line with 20,000-volts transmission they had to put two in series. They would be glad to have the author's figures as to capital and operating costs, and also whether he had any trouble with the electrical work or the electrical plant, and if so what they were.

Mr. E. Doelly (Escher, Wyss & Co.) said the governors in the Bombay power house were belt driven. It was the usual way to drive them. His company had tried rigid-driven governors. The pendulum was usually driven separately, and when they tried the rigid drive it had given trouble, and in several places they had to replace the rigid drive, which they supplied on the special request of customers, by the belt drive. There were shocks in transmission which led to trouble when the governor was direct driven. In the joints in the pipe line there was a round rubber ring inserted in a cavity between the two flanges, and the water pressure itself made it tighten. It had proved quite satisfactory.

Gen. B. Lovett referred to the difficulties caused by evaporation and percolation of the water, and said that an earth tremor might cause a fissure which might wreck the whole project. He would like to know what was the daily discharge in the discharge flumes, and also the cost of the work in each of the 10 heads into which the Paper was divided?

Mr. G. V. Twiss said it was stated that the towers were designed with a factor of safety of 4, and also that they were successfully tested at four times their working load. He thought they would have done very well if tested at three times the working load, as it was impossible to allow for bolt clearances, &c., in the calculations. Although towers had been designed with the delta form of suspension of the insulators, it was something of a departure from the usual practice of putting cross arms

one above the other. He believed, however, it had been quite justified by the practical results. He thought the pin insulators used by Dr. Pearson were not really pin insulators, but suspension insulators cemented one above the other, making what might be called a rigid suspension insulator.

Sir JOHN MCCALL said that he was not qualified to criticise the Paper in a technical sense, but he might refer to the hydro-electric works in his own State—Tasmania. They had the good fortune to have their water conserved for them and placed on the tops of mountains. He believed the same amount of water was obtained there by the erection of a wall about 100 yds. long. He gave particulars of several of the hydro-electric schemes there, and stated that they looked forward to making that State probably the principal one of the Australian Commonwealth. They had companies ready to establish woollen factories when the power was ready.

Dr. A. H. RAILING said they had heard so much about the diversity factors of consumption, but in this scheme they had a diversity factor of generation : in three months of the year—the time of the monsoons—sufficient power was stored to supply 80,000 H.P. for 12 months. The diversity factor was such an immense one that he did not know of any other water-power scheme where the case was similar. If they had the same diversity factor in England, it would make such a scheme uncommercial. He would like to ask what was the cost of labour out there. He assumed that the low cost of labour had a good deal to do with the practicability of the scheme. With regard to the pipe line, had special precautions been taken to prevent collapse of the pipes in view of the pressure variations of the water ? The limit of speed variation of the generators was stated to be about 12 per cent. if the load was suddenly thrown off. If the voltage variations that had been mentioned were added, there would be pressure rises amounting to 36 to 40 per cent. of the voltage. Were there any special surge protection devices in the line ? Mr. Dickinson mentioned spark-gaps, but it was not clear whether the spark-gaps were for static discharges or for station pressure rises. With regard to temperature rises in machinery, on the generators 60 deg. rise was specified for each and 20 per cent. overload for 10 hours without injury. He took it that meant roughly 90 deg. rise. Therefore about 200° F. seemed to be the temperature which was permissible. On page 20 of the Paper Mr. Dickinson said he allowed 60 deg. rise for the armature and 80 deg. for the field of the receiving motors. Allowing 80 deg. rise for the field, with the 20 per cent. overload would bring his temperature up to about 240 deg., or about 240 deg. inside the field bars, which seemed a high temperature for rotating field bars. Perhaps the 20 per cent. overload was only for cases of emergency ? He also would like to know Mr. Dickinson's reason for adopting the stranded wire for the line, and he would like some idea of the power factors under certain load conditions.

Mr. G. F. SILLS asked whether there was any difficulty as to right of way for the line. In reference to Mr. Hammond's comment on the use of 100,000 volts for such a short line, he might mention that there had been in operation for two or three years in Germany a line 45 to 50 miles in length, on which the same voltage was used. He mentioned that the Hydro-electric Power Commission of Ontario erected their towers in the water because of the difficulty of getting the right of way on shore. The transformers used in the Bombay scheme were single phase. The European practice had been to use three phase and the American single phase. On the 110,000-volt line of the Hydro-electric Commission in Canada the insulators were six in series, and in four years they had only one shut down of the system for five hours, and that was on a 400-miles line. Had Mr. Dickinson had any trouble with the aluminium lightning arresters, especially when they were charged ?

Mr. DICKINSON said that he proposed to answer most of the questions in the "Journal." He said the success of the Bombay scheme was largely due to his colleagues, especially Mr. Moore and Mr. Joyner. Dr. Railing had touched the main point of the scheme. The scheme would not have been commercially possible in this country owing to the cost of labour. The masonry dams would have cost about three times as much, and the rainfall in this country, or practically any other country but India, was not sufficient to provide the water on the catchments that they had. They had this year 540 in. of rain in 90 days. With regard to the water-tightness of the lakes, one of the factors which made them decide upon those particular valleys for the lakes was that they were full of land-crab holes, and, as land-crabs must have water every day, it demonstrated that there was always water on the top of the rock. They used lime mortar instead of cement simply because it was cheaper, as they had the lime there. He was not going to give the financial figures. When the scheme was in full working order—he hoped within two years—he was sanguine that the ordinary shareholders would receive 30 per cent. dividend.

DISCUSSION AT MANCHESTER.

Mr. J. S. PECK said that the Paper dealt with one of the largest undertakings in the world, and in view of the enormous expenditure involved in preparing dams and making the surrounding country sufficiently tight to hold the water, none but the most daring financiers and engineers would have made the attempt. The power station presented many interesting features owing to the large size of the generators and the [illegible] head of water. The transmission voltage, viz., 100,000 volts, appeared very high for such a comparatively short length of line. Regarding the regulation of the generators, 22 per cent. at 0·8 power factor seems rather large, especially in view of the fact that automatic regulators were used. A regulation of about 30 per cent. of the total load would appear to be more satisfactory. Were both Tirrell and Brown Boveri regulators installed ? Comparatively few manufacturers in this country had experience of such large generators, and more information concerning the mechanical details would be of value. The bearings were said to be water-cooled, but it was not stated whether the oil was cooled in a separate cooler or the water forced through the bearing pedestal itself. The cooling water was taken from the main pipe line, and it would seem more economical in view of the horse-power value of such water to instal a small pump to circulate the cooling water at lower pressure. The transformers were connected delta to delta, whereas the usual practice was delta to star. The latter arrangement gave a safer construction and permitted the neutral point to be earthed if desired.

Mr. S. L. PEARCE referred to the very striking fact that the whole of the water was collected during the monsoon period. Whilst the monsoon season occurred with appalling regularity, the amount of water could not be ensured, and it might appear possible for an exceptionally dry season to produce a shortage. The speaker suggested that much value would have been attached to figures giving the cost of the installation, particularly to figures giving the cost of the hydraulic works and generator end. A Canadian engineer had remarked that whilst people thought power would cost next to nothing if derived through the agency of a hydro-electric company, the Britishers with large steam turbines were far ahead. The remark was a very striking one, and supported the point of view that large hydro-electric schemes could not compete with the large steam turbines in this country as regards turning out power cheaply. The speaker asked why the unearthed neutral system had been employed. The use of the transfer 'bus bar, while usual at the present day, could be dispensed with by treating the step-up transformer and generator as one unit. A scheme eliminating the transfer 'bus bar would certainly be cheaper, less complicated, and on the whole more reliable, and it was probable that the future development of large high-tension schemes would be along these lines. Regarding the supply of energy to the mills, it seemed most striking that whilst energy was sold at 0·5 anna to the customer's own motor equipment, the additional price in the case of equipment supplied by the company was only 0·05 anna. Calculations showed that the figure of 0·05 was little more than half what it should be if the cost of the mill equipment had to be written down in 10 years. Did the Company write down the equipment within 10 years, or did they assume that after the agreement had come to an end the motors could be taken into stock and transferred to some other mill ?

Mr. BRISTOW dealt upon the romantic details of the scheme and stated that during the three months' monsoon season the rainfall in the district, which was 40 miles from the coast, was between 24 ft. and 30 ft. The monsoon season up country failed much more frequently than near the coast, but it was possible even where this scheme was situated that a total failure might occur one year and be followed by a partial failure in the succeeding year. The monsoon varied sometimes to the extent of 50 or 60 per cent. in consecutive years, but when the scheme was laid out allowance was made for a complete failure succeeded by a partial failure. There was great difference with regard to the scheme at the commencement owing to the variable monsoon conditions, fissures in the rocks, and lack of electrical knowledge amongst people who were expected to be the chief customers. The chief thing which popularised the scheme was letting the mills have motors with the current. Roughly there were 13 mills supplied, and in practically every case it meant scrapping the entire steam plant. It was very doubtful whether anyone of the mills would have done this and laid out fresh capital for new motor equipment. The price, 0·55 anna, was fixed for current and motor equipment, and when some enterprising mill owner came along and asked what reduction would be allowed if he supplied his own motor equipment the company fixed 0·05 anna. Motor equipment salesmen were soon on the spot to convince native proprietors that a saving could be effected by putting in their own motors and buying energy at 0·5 anna.

Dr. F. H. BOWMAN asked what allowance was made for evaporation during the dry season. A case had occurred in Yorkshire where a dam which covered about an acre and was absolutely free from leakage showed a difference of level of 4 in. during one week-end due entirely to evaporation.

Mr. C. C. ATCHISON referred to the difficulty of governing turbines working with so much head, and it was supposed that after trying to govern by shutting off the supply of water, the by-pass system had been adopted. In view of the remark concerning the horse-power value of cooling water, this would be very small compared with the horse-power value of the by-pass.

Mr. H. C. CREWES asked what proportion of the 0·5 anna represented what was understood in this country as capital charges.

Mr. ALCOCK asked for comparative figures of conductivity and mechanical strength of the twisted sleeve mechanical joint as compared with an equal length of unbroken conductor.

Mr. W. FENNELL said that in an installation of this kind the greater part of the charge for energy would represent standing charge, and it was of interest to know whether the promoters had considered the question of charging on the Hopkinson basis having a fixed amount per horse-power to cover standing charges plus a small charge to cover running expenses. Periods of bad trade were sure to arise when the financial position of this scheme might be jeopardised.

Mr. E. S. W. MOORE (who read the Paper in the absence of the author), in reply to Mr. Peck, said that the 22 per cent. regulation at 0·8 power factor had been adopted as a middle course in the calculations, and so far there had been no reason to regret the decision. Concerning the present state of the scheme, one of the pipe lines was through and working on one or two turbines. The operations commenced during the past month, so that it was quite too soon to give operating experiences, although it might

be said that in starting up the 100,000 volt plant nothing abnormal had occurred, which was very gratifying. Regarding the question of regulation, experience was somewhat limited and complexity was introduced by the number of banks of transformers in circuit. Ultimately it was decided to regulate up to the high-tension bus bars automatically, using a Tirrell regulator for the purpose. A stand-by was considered desirable and for that reason the Tirrell was placed on one side of the system and a Brown-Boveri on the other side. The two regulators were not operated together. The construction of the generators was a very practical development of ordinary practice and was comparatively simple. The question of ventilation of the large flywheel generators presented a problem which was ultimately solved by putting in a large air duct from end to end of the building with inlet and outlet to vers well to ensure a good air. Automatic gates were used controlled simultaneously with the excitation field, so that when the field was excited the air was put in, and vice versa. The question of cooling water from the pipe line was very carefully considered, having in view the economy of using a motor pump, but it was decided to start with a static supply from a ball valve tank. The oil was passed through coils and water was also circulated from tanks through the bearings. The delta connection of the transformers was also decided after lengthy consideration. Regarding the question of rainfall raised by Mr. Pearce, the scheme was based upon that and data carefully accumulated for many years. It was interesting to note that the large area of water had the effect of increasing the rainfall over the catchment area. The elimination of the transfer bus bars was very attractive and simple if it could always be carried out, but in this particular case it was desirable to have means of transferring transformers rapidly. Mr. Bristow had referred to the difference between 0·5 and 0·5 anna, although Mr. Pearce's suggestion that the amount was insufficient was not to be regarded as borne out by the author's experience. Standardisation of the methods adopted had showed 0·05 anna to be exceedingly reasonable for the costs of a mill installation. The effect of evaporation had been allowed for, and although figures were not accessible the allowance was enormous. The governing of the turbines by deflecting nozzles as referred to in the Paper had proved successful so far. The installation was not sufficiently advanced to permit the allocation of charge for energy between capital and running expenses. In reply to Mr. Alcock, the twisted sleeve joint had proved very satisfactory both mechanically and electrically. Even if the resistance were twice that of an equivalent length of conductor the effect would be immaterial and the operation would not be affected. Regrading the suggestion of fixed charge per horse-power to provide for a slack season, the Indian financiers had certainly protected themselves from any failure from that source.

CORRESPONDENCE

THE HEAVISIDE LAYER

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Many of us in America who are at all familiar with radio-transmission from arc or undamped wave generators have read with amazed amusement the series of letters appearing from time to time in your columns under title "The Heaviside Layer."

It is rather difficult to understand just what it is all about and the doubt at times arises that the writers of some of these letters themselves know what they are driving at—"Self-induction"—"hopeless mix between the molecular and the gross"; theoretical discussions as to whether or not under certain assumptions refraction or reflection might or might not conceivably exist! Why all this fanning in the dark when a rich mass of actual data can be had by those who really need it? Why not look at facts in hand and base subsequent theories thereon?

In your columns in 1911 I called attention to the almost daily recurring and indisputable evidence of interference phenomena observed at the Pacific Coast stations of the Federal Telegraph Co. (Poulsen system) and to the fact that reflection layers, or curtains, were there demonstrated as clearly as any other phenomenon in radio-transmission. Every day since its first discovery has added proof of the existence of the reflecting layer, and yet we read to-day in your columns letters which would indicate that many radio speculators are utterly unaware of these facts.

For the benefit of such I trust you will find space to print the exceedingly interesting Paper on "Conditions Which Influence Wave Transmission," recently presented before the A.I.E.E. by Mr. L. F. Fuller, of San Francisco.

Some of the curves accompanying this Paper [illegible] be conclusive and graphic evidence of interference [illegible] 18 miles wide, possess, in my opinion, a live interest unequalled by any recent observations of radio phenomena.—I am, &c.,

New York, April 20. LEE DE FOREST.

[An abstract of Mr. Fuller's Paper appears on p. 154 of the present issue.—ED. E.]

DIRECT MEASUREMENT OF POWER FACTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am obliged to Mr. Gifford for his reply to my criticisms of his article on the above subject, but he has not apparently grasped the fact that far from being "discouraged by the difficulties met with" in phase meters with floating transformer secondaries, I distinctly stated that for unbalanced circuits when a complete circular scale is desired, the scheme offers some advantages.

For this reason *my instrument was developed to meet this one condition*, and particular care was taken to reduce the disadvantages of the increased movement-weight and complication to a minimum. I did not consider the matter of sufficient general interest for publication, though, of course, a natural publicity always attends the sale of instruments.

With regard to calibration, as the result of experience gained in the calibration of several hundred power-factor meters by both continuous and alternating-current methods, I unhesitatingly prefer the former. Alternating-current calibration may be *essential as a final standard of reference*, but this by no means implies that it is the more accurate or suitable method for a commercial test room.

With reference to the burning out of ligaments on excess voltage, I have never experienced any difficulty, but in order to test the point the fusing current of a piece of ligament was measured and found to be approximately 2 amperes. This corresponds to an excess voltage equal to 40 times normal, which is probably sufficient margin for most practical purposes. Perhaps Mr. Gifford was thinking of damage caused by careless connection of instruments without their resistance boxes, in which case the ligament certainly does burn out before the rotor winding. Personally, I regard this as an advantage, as the winding is protected by the comparatively inexpensive ligament.

The application of the "induction-dynamometer" scheme to instruments with short scales, such as the edgewise instrument illustrated in Fig. 15, certainly seems an example of how to make a simple and accurate instrument as complicated as possible without any added advantages.

I note that Mr. Gifford agrees that the "induction-dynamometer" type is not independent of frequency, and is therefore not suitable for work of the highest accuracy, such as is required in standard testing instruments.—I am, &c.,

Edgware, May 2. LEONARD MURPHY.

MATHEMATICAL SYMBOLS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I sent to Prof. A. E. Kennelly, of Harvard University, a fore copy of my proposal which appeared in last week's issue, and he writes that he is the more interested in the suggestion, as he believes that he was the introducer of the notation $r/0$ about the year 1893. He welcomes the suggestion as a very good one, saving a good deal of work in "composition," and hopes it will be earnestly advanced with a view of winning its ultimate adoption. His notation is, of course, self-explanatory, but it would, I deem, not take long for all who are interested in the subject to accept the dagger with its simple *memoria technica* for positive and negative angles.—I am, &c.,

Woodwich, May 3. F. JACOB.

Pennsylvania Locomotive at the Panama-Pacific Exposition. One of the principal exhibits at the Panama Pacific Exposition will be one of the Pennsylvania Railroad electric locomotives mounted on a track turntable. The locomotive is said to be the largest in the world in passenger service. It consists of two main and two [illegible] 136 tons and is the first [illegible] geared locomotive ever placed in service. It has two motors having a total capacity of 1,000 H.P.

A 100,000-VOLT PORTABLE SUB-STATION.*

BY CHARLES I. BURKHOLDER AND NICHOLAS STAHL.

Synopsis.—The authors describe a portable sub-station, capable of operating at voltages of from 100,000 to 13,200 on the primary side and 2,200 to 13,200 on the secondary, and designed for operation on a big American power system, where the railway facilities are such that any part of the system can be reached by rail.

In July, 1914, a portable transformer sub-station of 4,000 k.v.a. capacity and adapted for operating with voltages as high as 100,000, was put into service on the system of the Southern Power Company. The idea originated from the growth of the Southern Power Company, the need for some means of extending, at will, the connections of the system, and the somewhat unusual transportation facilities along its transmission lines.

Such a station must be capable of supplying adequate transformer relays for the following uses: (1) Spare capacity for even the largest stations. (2) Temporary replacement of a distributing or tie-in sub-

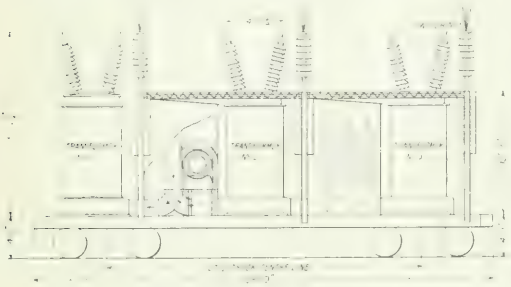


FIG. 1.—SUB-STATION, ELEVATION.

station being enlarged or rebuilt. (3) Break-down replacement of a sub-station. (4) Emergency stand-by service to or from neighbouring transmission companies, central stations or isolated plants (5) "Pioneer service" at town or mill, pending the determination of the proper permanent sub-station equipment. (6) Tentative service for mill or other prospective customer. (7) "Power solicitor service" with those needing power immediately. (8) Miscellaneous emergencies.

To perform these functions satisfactorily, the equipment must admit of transport over standard steam and electric railways, and be adaptable to work with different voltages, both high tension and distribution according to the requirements of the district in which it is operating.

DESCRIPTION OF EQUIPMENT.

General Arrangement.—Three 1,000 k.v.a. transformers, three high-voltage horn gap switches, and two enclosed cabs, are arranged



FIG. 2.—SUB-STATION, PLAN.

alternately along the length of the car, and occupy the entire floor space except for a raised walkway for trainmen at each side. Each transformer weighs 29,000 lb., and one is located over each truck, with the third placed near the centre. Six built-up steel columns, with latticed struts, guy rods and cross bracing provide supports for the high-voltage switches, and also form a rigid framework to which the cab sheathing, the oil switches and the switchboard are attached (see Figs. 1 and 2). The trucks are of steel truss type, M.C.B. standards, capacity rating 120,000 lb. exclusive of car.

High-tension Switches.—Three double-break horn gap switches, specially designed for 100,000-volt service, are arranged transversely on the car, each being carried on a steel base which, to secure proper clearance height for the horns, slides vertically inside the main columns, and can be raised or lowered by means of two small windlasses, operated by men stationed at each side of the car. Simultaneous service operation of the switches is obtained by means of a pipe rod connected to a crank on each switch. The switch bases slide up and down in guides made of one 7 in. and two 4 in. channels, and each switch has four insulators of the post type, comprising six 14 in. porcelain discs. The blade is of special brass tee, pivotally mounted on the two central insulators, thus giving a break between a pair of horns at each end of the blade. The total clearance between the terminals of an open switch is 6 ft. Each insulator weighs 175 lb., the total weight of each unit raised or lowered being 950 lb.

The passage-way for trainmen and operators limited the distance the switches might be lowered, and hence it was necessary to make the horns detachable by simply bolting each horn in position.

High-tension Delta.—To establish the high-tension delta with sufficient clearance for 100,000-volt operation, the second and third transformer terminals shown in Fig. 3 (counting from the left) are connected directly to the inboard end of the middle switch, while the fourth and fifth terminals similarly connect with the right-hand switch, the first terminal joining the left-hand switch directly, and the delta is closed by bringing to this switch a lead from the sixth terminal by means of two post-type insulators with special bases which hook over the latticed strut so that the insulators lean outwardly at an angle of about 45 deg., and require no bolts for proper support.

Transformers.—For obvious reasons, oil-insulated, self-cooled transformers were the only admissible type. Space limitations were imposed by tunnel and bridge clearances, and by the necessity for symmetrical truck loading and for a passage-way for trainmen. Thus arose the necessity for provision of additional cooling arrangements, which were secured by a 20 H.P. motor-driven blower having



FIG. 3.—VIEW OF SUB STATION IN OPERATION ON 44,000 VOLT CIRCUIT.

capacity for 20,000 cubic ft. of air per minute at 1 oz. pressure, forcing air from the cab, shown on the right in Fig. 3, through suitable ducts surrounding the base of each transformer, and up along the corrugations. To allow transport through tunnels and under bridges, it is necessary to house the transformer terminals, and to lower the lower tension switches. In the case of the transformer terminals, this is accomplished by rigging from the latticed strut structure, forming the top of the framework above the car, a wooden derrick, the parts of which are carried as car equipment. With this derrick the terminals are lowered through openings in the tops of the cabs, where special steel racks are provided for these terminals, including sheet steel cylinders, which cover the ends of the terminals normally under oil, and prevent the entry of moisture to the condenser type bushings.

Flexibility of Connections.—It is possible to secure 42 high-tension voltages, ranging from 100,000 volts to 13,200 volts. The current-carrying capacity of the windings is such that 28 out of these 42 possible high-tension arrangements can be used with rated capacity output from the transformer (1,000 k.v.a.) without exceeding, in continuous operation, a temperature rise of 40° C. Low-tension windings provide for full capacity output at 2,200, 4,400, 6,600 and 13,200 volts. Therefore, out of the 168 possible ratios of transformation 112 of these combinations can be secured with full capacity of the transformer.

Insulating Transformer Windings.—Small lead covered leads are also brought out from the low-tension sides of the transformers from separate single-phase windings for 110 volts and of 10 k.v.a. capacity each, which provide, first, current for the blower motor, regardless of what may be the high-tension or low-tension voltages

* Abstract of a Paper read before the American Institute of Electrical Engineers.

of the main windings; second, lighting for the car; third, source of voltage for the instruments.

Wiring and Switchgear. High-tension wiring is bare copper. All low-tension wiring is lead-covered cable, the main leads being insulated for 13,200-volt operation, and of sufficient capacity to carry full transformer output when operated at 2,200 volts. Suitable voltmeters, ammeters and watthour meters are mounted on an appropriate panel, also containing the operating handles for the low-tension oil switches. In order to provide proper metering equipment for the lowest voltage (2,200), as well as the highest (13,200), of the low-tension arrangement, two sets of series transformers are used and so operated from a pallet-switch, mounted on one of the oil switches, that when one of these switches is opened, the corresponding series transformers are short-circuited, and the series transformers for the other oil switch are connected to the metering devices. It was mainly to make "fool-proof" this part of the equipment that two interlocked low-tension switches were provided, both insulated for 13,200-volt operation, and one with adequate current-carrying capacity for full output at 2,200 volts.

The total weight of the installation, including car, is approximately 135,000 lb., and the cost of such an installation, complete and ready to run, is approximately £4,200, or £1·4 per rated kilovolt-ampere.

Operation.

Although the main transformers are nominally rated at 1,000 k.v.a. each, test results show heat dissipation such that the station may have an output of 4,000 k.v.a. without exceeding standard temperature rise. On the same basis the permissible station capacity, without the blower, is easily 2,000 k.v.a. The station has been in operation several times since July, 1914, when it was first put into commission. It has replaced sub-stations damaged by lightning and fire, and given absolute satisfaction. It has also been used to replace an existing sub-station during the time it was rewired and enlarged.

PARLIAMENTARY INTELLIGENCE.

POST OFFICE TELEGRAPHS AND TELEPHONES.

On the 28th ult. the House of Commons went into Committee of Supply on the Civil Service Estimates, and on the vote of £15,336,380 to complete the sum required for the expenses of the Post Office (including telegraphs and telephones), the Postmaster-General (Mr. Hobhouse) said that last year he estimated for a revenue of £31,700,000 and an expenditure of £26,181,000. On the outbreak of war there was a shrinkage, and they dropped in the course of the year a revenue of £2,100,000. Of that sum £800,000 came off postal services, £80,000 off telegraphs and £280,000 off telephones. On the other hand, expenditure went up by a great sum. The department sent a large number of men to the Colours, and the provision of substitutes cost £750,000. The net increase of expenditure came to £280,000. The actual realised revenue was £29,650,000, and the expenditure £26,430,000, so that the estimated surplus had shrunk to £3,250,000. This year he put the revenue at £30,400,000 and the expenditure at £26,836,000, or a surplus of £3,500,000, which would be reduced by outgoings to £1,500,000. The Department had sent 35,000 men to the front, and had had to recruit in their places 20,000 men and 5,000 women. At Manchester no less than half the male telegraph staff had enlisted. Had it not been for the loyal action of the pensioned telegraph clerks and other pensioned men it would not have been possible to get through the congested business which had to be dealt with.

The vote was agreed to.

ABERDARE URBAN DISTRICT COUNCIL BILL.

Last week this bill was considered by a Select Committee of the House of Lords.

Mr. Clode, K.C. (for the promoters), outlined the objects of the bill. He said powers were sought to construct certain tramways, the equipment of some trolley and motor-omnibus routes, &c. In 1911 Parliament sanctioned the construction of tramways. The tramway service as opened in October, 1913, and the expectations of the promoters had been fully realised. The trolley omnibus routes had not shown a profit. He proposed tramway extensions would be from Treecynon to Hirwain, from Aberaman to Cwmaman and to Aberpwmbon, and the trolley routes extending the existing route from Treecynon to Cwmdare, from Abernant-road to Cwmbach, and from Treecynon to Llwydcoed. The council sought power to borrow £49,751 for the construction and equipment of the tramways and for the installation of trolley omnibuses, and £5,500 for motor omnibuses. Power-driven motor omnibuses had not been granted up till now, but they desired to have them for testing purposes. The gross earnings of the projected routes were estimated at £5,504, the working expenses at £9,543, interest and sinking fund £,051, and the surplus was £1,910.

Mr. H. T. Goldworthy, accountant to the Council, submitted figures to show that the tramway undertaking had been successful; and Mr. O. Williams, surveyor, gave evidence that the railway travelling facilities in the district were not good.

Other local evidence in favour of the bill was given, and Mr. S. Sellon supplied technical details of the proposed extensions. The latter said he had known Aberdare for many years, and he had come to the conclusion that the proposed tramways would greatly benefit the whole district. It would be a great convenience to the public if the tramways carried goods.

Mr. J. B. Hamilton, general manager of Leeds city tramways, also gave evidence for the bill, and the promoters' case closed.

Evidence in support of the opposition of the Powell Duffryn Co. and of the Taff Vale Railway Co. was given.

Mr. Robert Hammond, M.Inst.C.E., who gave evidence for the Taff Vale company, contended that the population of the district would not justify the making of the tramways, and that all the routes would show a loss. In cross-examination, he said that it was true that in the Mountain Ash case he said that tramways in a colliery district would be a greater success than in any other part of the country, and that provision of means of transit created traffic.

The Great Western Railway Co. opposed the Hirwain extension, and Sir John Snell gave evidence for them.

Ultimately, the Committee, after consulting in private, announced that the bill might proceed, but the extension to Hirwain struck out. The clauses were adjusted on the following day (Thursday).

HALIFAX CORPORATION BILL.

Last week the Select Committee of the House of Lords, presided over by Lord Newton, considered this Bill, which sought powers to construct additional tramways, to provide and run trolley vehicles and motor omnibuses, &c.

Mr. Lloyd, K.C. (for the Corporation) explained the proposals of the Bill, and said the Elland extension was opposed by Huddersfield Corporation and by the West Riding County Council.

Evidence in support of the Bill was given by the chairman of the Tramways Committee (Ald. Spencer), the borough engineer (Mr. Jas. Lord), Mr. J. B. Hamilton (of Leeds) and several others. Mr. Hamilton said that the Corporation tramways department was able to give a most satisfactory service. One third of the Corporation tramways were outside the borough, and the proposed route to Elland would be the nearest from Halifax. He did not think it would be possible to have through running from Halifax to Huddersfield, at any rate not by the Huddersfield cars, as their gauge was 4 ft. 7¾ in., whilst the Halifax gauge was 3 ft. 6 in. There was through running between Bradford and Leeds, but the gauges were not as narrow as 3 ft. 6 in. About 90 per cent. of lines in this country were 4 ft. 8½ in. The extensions would be beneficial to Huddersfield, as additional facilities always increased traffic. If Huddersfield and Halifax tramways were one system, and he was manager, he would not have the slightest hesitation in recommending the construction of the extensions proposed. The trams to Stainland would be self-supporting, and as to the Elland extension, diversion of traffic was desirable from Salterhebble. The motor omnibus routes were quite suitable. As to the power for running omnibuses generally, with the consent of the Board of Trade, the same power had been granted in Walsall. The County Council ought not to have an absolute veto re motor 'buses on roads over which they were neither the road nor the local authority.

After Mr. A. R. Fearnley, general manager of Sheffield Corporation tramways, had also given evidence in support of the Bill.

The Committee decided to reject the proposed Elland tramway and also to modify a clause to enable the Corporation to enter into agreements for or in relation to the construction, leasing, working, &c., of neighbouring lines. The omnibus powers were granted, but Huddersfield and Brighouse obtained protective clauses against competition.

Bristol Tramways Bill.—This Bill, which is now unopposed, passed the Committee stage in the House of Lords on Tuesday. The measure extends the time for the acquisition of lands to extend the tramway construction of the Bristol Tramways & Carriage Co., &c.

LEGAL INTELLIGENCE.

Patent Revocation.

On April 29 the Court of Appeal (the Master of the Rolls, Lord Justice Phillimore and Mr. Justice Joyce) delivered judgment upon the appeal of Witcarbonising (Ltd.) from a judgment of Mr. Justice (now Lord Justice) Warrington dismissing their petition for revocation of letters patent No. 10,370 of 1912 granted to John E. Jameson, Oliver H. Valpy and Edmund A. Buckle for "improvements in the treatment of peat and the like." One of the claims of the patent was as follows: "In a process for the extraction of water from peat and like substances passing an electric current through a pulp of the same heated to a temperature of 100°C. under a pressure such that no steam is produced substantially as described." Appellants applied for revocation of the patent on the grounds that it was invalid for want of utility and insufficiency of directions, but the application was dismissed with costs, and hence the appeal. The facts and legal arguments were given in our issue for April 2, and judgment was reserved.

Mr. Walter, K.C., Mr. Colefax, K.C., and Mr. Frost appeared in support of the appeal; and Mr. Bousfield, K.C., and Mr. J. Hunter Gray for respondents.

The Master of the Rolls, in the course of his judgment, said he did not consider the experiments which had been made by both sides were

either satisfactory or equitable, but, on the whole, he thought the petitioners had failed to prove that respondents' patent was bad for want of utility. While feeling more difficulty upon the other point as to the directions in respondents' specification being insufficient, as alleged by petitioners, he was not, on the whole, prepared to differ from the conclusion arrived at by Mr. Justice Warrington upon that issue. The result was that in his opinion the appeal should be dismissed, with costs.

Lord Justice Phillimore and Mr. Justice Joyce delivered judgment to the same effect.

Underwood v. British Uralite Co.

Last week a Divisional Court (Mr. Justice Bailhache and Mr. Justice Shearman) heard this appeal by defendants from a verdict and judgment in this action, heard in January last by Judge Rentoul in the City of London Court, when the jury awarded plaintiff £71 damages for breach of contract. Defendant company had an electric engine and dynamo for which they had no further use and desired to sell. With that object in view they got into communication with Mr. Underwood, a dealer in second-hand machinery, who obtained an option to purchase within seven days for £250. He got into communication with a Mr. Martin, who in turn introduced a firm as probable purchasers. Plaintiff did not purchase, but in order to bring about the sale he went to defendants' works and cleaned up the engine. Subsequently, however, the engine was sold direct to the firm introduced for £340. Upon that plaintiff claimed commission on the ground that the sale was the outcome of his introduction. He contended that the work he had done had been adopted by defendants and ought to be paid for. He further said that there was a custom with dealers in second-hand machinery which prevented vendors from dealing directly with purchasers who had been introduced by the dealer. For defendants it was argued that there was no contract with plaintiff by which defendants were precluded from selling to Messrs. Kynoch, and that there was no custom with regard to dealers which would prevent them from dealing direct after the dealer had failed to purchase.

Mr. Justice BAILHACHE found that the work done by plaintiff had been done for his own benefit in order that he might sell during the period of his option. The circumstances of the case did not support the arguments of plaintiff in regard to custom. If it were so, defendants would have been unable to dispose of their machinery without incurring a liability to pay the dealer. The Judge in the court below had wrongly directed the jury and the appeal would be allowed.

Mr. Justice SHEARMAN concurred, and the appeal was accordingly allowed with costs.

An application by plaintiff for a stay with a view to appeal was granted.

Thomas Piggott & Co. v. Hicks & Co.

In the Marylebone (London) County Court last week plaintiffs claimed the return of £13 for a second-hand electric motor and also for damages. In February plaintiffs got into communication with defendants as to the purchase of an electric motor for driving a lathe, the power being wanted in the turning out of steam pipes for the Admiralty. The motor was warranted a good as new, and to be of 7½ H.P. A bargain was struck, the price (£13) being paid by cheque, and the machine despatched to plaintiffs at Birmingham. When tested it was found that the coils were worn out, and that it did not develop anything near 7½ H.P.

His Honour: You could not expect a powerful new motor for £13.

Mr. DYSON, plaintiffs' works manager, said that the motor was found to be useless for the purpose for which it was procured, and they had to dismantle one of their tried motors and move it to the lathe for the pipes. In reply to his Honour, Witness said that at that time a new motor would have cost £25, and could have been delivered within a month. The out of pocket expenses in labour in dismantling and re-erecting the motor was £7. [illegible] and their work was delayed about a month, by which they lost over £7.

His Honour gave judgment for plaintiffs for £20 [illegible] and costs, and the return of the rejected motor.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract [illegible] the specifications recently published have been specially [illegible] by Messrs. MARKS, CLERK & PEAKE, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

Whenever the title [illegible] differs from the date on which the application was lodged at the Patent Office the latter is given in brackets after the title.

[illegible]

packing being of material which will become consumed when the carbon is in use.

[illegible]

14,577 B.T.-H. Co. (G.E.Co. of America.) Systems of electric distribution.

[illegible] system, and in restricting the supply of this wattless current to any desired value by compensating for voltage drop in transmission by introducing an independently controllable source of potential in said system.

14,841 CHAMBERLAIN & HOOKHAM (LTD.) & SPRAGUE. Electricity meters of the mercury motor type.

[illegible]

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date of application, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

April 6, 1915.

[illegible] vehicles and the like engines.

5,184 BOSCH. Electric light systems more particularly adapted for vehicles. (24 [illegible]

5,191 SHULTZ. Train-stopping apparatus.*

5,192 AUTOMETROGRAPH AKT.-GES. Printing-mechanism for counting apparatus meters. (14/4/14, Hungary.)*

5,193 AUTOMETROGRAPH AKT.-GES. Meters. (24/4/14, Hungary.)*

5,200 MURRAY & SHOTTER. Electromagnetically-operated devices.

5,201 MURRAY & SHOTTER. Circuit-breakers, current limiters, excessive current indicators and the like for electric circuits.

April 7, 1915.

5,224 ROBERTSON & LENNOX. Electrically-operated reversing mechanism for planing machines and the like.

5,240 JOEL, SEN. Joints of pipes and couplings, applicable to electrical conduit fittings and like purposes.

5,260 B.T.-H. Co., SHUTTLEWORTH & BROWN. Dynamo electric machines.

5,261 LYON. Testing the actual available working current in electric batteries or cells.

April 8, 1915.

5,292 WHEELER. Cord grips for electric lampholders or other electrical fittings.

5,307 B.T.-H. Co. (G.E. Co., U.S.) Electromagnetic switches.

5,319 BLATHY. Adjusting electricity meters. (9/4/14, Germany.)*

5,323 PATTERSON. Miners' electric safety lamps.

April 9, 1915.

5,342 GES. FUR DRAHTLOSE TELEGRAPHIE M.B.H. Receiving arrangement for wireless telegraphy. (9/4/14, Germany.)

5,371 MARCONI'S WIRELESS TELEGRAPH CO. & MITCHELL. Manufacture of electrical condensers.

5,373 B.T.-H. Co. (G.E. Co., U.S.) Amplifying electric potential variations.

5,385 INTERNATIONAL ELECTRIC CO., LE NOIR & FUNCCIUS. Intercommunication telephone systems.*

5,388 JONES. Attaching or supporting electric cables and other wires and the like.

5,395 THOFEHRN. Electric batteries.*

April 10, 1915.

5,412 SMITH. Electric lamps and holders for the same.

5,426 ZEISS. Adjustment of uniocular telemeters. (19/4/14, Germany.)*

April 12, 1915.

5,486 B.T.-H. Co. (G.E. Co., U.S.) Controlling alternating currents.

5,489 ROSENBERG. Dynamo-electric machines.

5,498 MEIROWSKY & Co. AKT.-GES. Manufacture of electric condensers. (23/7/14, Germany.)*

5,511 AKT.-GES. BROWN, BOVERI ET CIE. Insulators. (25/4/14, Germany.)*

5,512 BEHM. Measuring or recording oscillations, impulses and the like. (29/4/14; Germany.)*

5,513 OLDHAM. Miners' electric safety lamps.

April 13, 1915.

[illegible] circuit endurance.

5,554 BRITISH WESTINGHOUSE ELECTRIC MFG. CO. Electrical measuring instruments. (15/4/14, U.S.)*

5,556 MCGREGOR. Sparking plugs and the like.

5,557 B.T.-H. Co. (G.E. Co., U.S.) Electric rectifiers and methods of operating the same.

5,578 BREEZER & SHORT. Cable supports.*

[illegible]

April 14, 1915.

5,591 BENITEZ. System for the generation of electric currents. (Addition to 17,811, 14.)*

5,594 DOD. Field telephone or telegraph wire reel.

5,596 SAVIN & AUTOMATIC TELEPHONE MFG. CO. Electrical relays.

6,602 DEARLE & DAVIS & SON (DERBY). Electric signal systems and apparatus for use in mines and the like.

5,623 SIEMENS & HALSKE AKT.-GES. Electrical alarm systems. (16/4/14, Germany.)*

5,627 B.T.-H. Co. (G.E. Co., U.S.) Brazing material.

5,628 RUDD. Electric lamp [illegible]

[illegible]

5,630 JACKSON. (Submarine Signal Co., U.S.) Mounting of electric oscillators for submarine signalling.

5,639 LEWIS. Electrodes for arc lamps.

April 15, 1915.

5,657 WALSHAW. Trolley-setting guide for use on tramways.

5,664 COLLIN. Metal trays or supports for carrying electric wires.

5,672 SIMPSON. Brushes or connections for magneto-electric machines. (Divided application on 19,784 14. Sept. 15.)

5,673 SIMPSON. Contact-breakers for magneto-electric machines. (Divided application on 19,784/14. Sept. 15.)

5,676 DRANSFIELD. Alternating-current voltmeters

5,684 B.T.-H. Co. (G.E. Co., U.S.) Electric discharge controlling devices and methods of operating same.

5,696 SAVOYE. Automatic switching apparatus for electrically-illuminated signs and the like. (Addition to 823/15. 30/4/14, France.)*

5,697 LAMKIN. Apparatus for recording phonetic sounds transmitted by means of a telephone.

April 16, 1915.

5,708 FARMILOE. Electromagnetic solenoids.

5,713 BOWRING. Construction of side guard for tramcars and the like.

5,717 TUCKER & CRABTREE. Electric switches. (Divided application on 21,175/14. Oct. 19.)

5,723 BENTLEY. Magneto-electric machines.

5,725 & 5,726 WARD. Electrical apparatus for therapeutic and like purposes.

[illegible] like.

5,731 ELLIOT. Portable primary batteries or cells.

5,741 B.T.-H. Co. (G.E. Co., U.S.) Electrical discharge devices and methods of [illegible]

April 17, 1915.

5,753 TILNEY & JENSEN. Constructing electrical measuring instruments.

[illegible] the like

THE ELECTRICIAN
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LEGISLATIVE OBSTACLES TO ELECTRICAL PROGRESS.

At present we hear and read much about the capture of foreign trade from alien enemies. It is, no doubt, a very desirable thing to get control of markets which have hitherto been supplied by Germany and Austria-Hungary. THE ELECTRICIAN has done, and will continue to do, everything in its power to achieve this object. There is, however, a risk that, while we are paying attention to the expansion of our export business, we may overlook obstacles to the development of home trade and industry, which is, after all, the backbone of the great majority of the trades of this country; and in this manner we may lose more at home than we gain abroad. In the last issue of THE ELECTRICIAN two cases were reported which illustrate this point. The first of these is the report of the proceedings before the Select Committee of the House of Lords on the Yorkshire Electric Power Bill. On many occasions we have pointed out the injurious effects of legislation upon the progress and development of British electrical industries. The Yorkshire Company, having statutory authority to supply electricity for power and also in bulk to what are known as "authorised distributors," and being in a position to give a cheap supply for lighting also, applies to Parliament for the necessary power to give such a supply to a number of Urban and Rural Districts in its area. It was proved before the Committee which considered the Bill that 64 such districts were anxious to get a supply, and over 40 of the Councils passed resolutions in support of the measure. Practically the only hope of getting a cheap supply of electrical energy in the great majority of these districts is by arrangement with a big power company or from one of the larger boroughs, and the Yorkshire Company is in a better position to supply the manifest demand for current than anyone else. When making their application to Parliament the promoters do not appear to have allowed for the vigilance of the officials of that Department of the Government—the Board of Trade—which is supposed to exist for the purpose of fostering and developing British trade and commerce. The official of the Board of Trade who gave evidence before the Parliamentary Committee appears to have made two examinations of the Company's Bill, and as a result of the first examination considerable modifications of the clauses were made, but the final result was that the official expressed himself as not being satisfied with the terms under which the local authorities could purchase the undertakings in their districts, and for this reason—and for this reason alone—the Committee straightaway rejected the lighting clauses, and so destroyed the Bill—and the only chance many of the local authorities who supported it will have of getting public and private electric lighting introduced into their districts. We think that the terms and conditions of purchase laid down in the Electric Lighting Acts of 1882 and 1888 are inapplicable to the Yorkshire Bill, and we should have thought that a business-like Committee, even if it thought a purchase clause necessary, would have devised some equitable arrangement to meet the case, instead of destroying a useful measure. It is true that a number of neighbouring councils may combine among themselves for the purpose of establishing a joint electric supply undertaking, but this method has its disadvantages, and it is certainly not so economical or so expeditious as the Yorkshire Company's scheme.

We write in no hostile spirit towards municipal enterprise, because we believe that important public services, such as electricity and gas supply in large towns and urban areas, should either be in the hands of, or be controlled by, the local authorities of the districts; but the existing purchase clauses of the Electric Lighting Acts of 1882 and 1888 are inapplicable to small urban and rural areas. In these places power and lighting are interdependent services, and very often, as in colliery and industrial districts, lighting is made possible because of the power demands. The local authorities of these districts, with a population of from 2,000 to 10,000 or 12,000, are not in a position to put down and maintain independent generating plants. Even in the case of bulk supply we believe it would pay all these small local authorities to contract with a big power company for the maintenance of the public lamps and distribution system. To show how absurd our law relating to electricity supply is it is only necessary to point out that if a colliery company

has an independent generating plant, it can—in addition to supplying its own needs—supply electric current to the houses of its workmen in the neighbourhood of the colliery, but if the Yorkshire Company supplies energy to the colliery for power and lighting it could not supply the colliers' houses!

The other case to which we wish to refer is a decision of a Judge of the Chancery Court in an action for a nuisance by electrically-driven machinery. A man took a floor in a building in Aldgate for button hole making. It was admitted by the landlords that the tenant had stated that he would be using machinery in his business, and that he inquired if "electric wires were on the premises," but the landlords alleged that they thought "hand or treadle machinery" was meant, and that the reference to electric wires only related to electric lighting. We thought it was common knowledge nowadays that nearly every up-to-date business, particularly those connected with the clothing trades, employ electric motors. In fact, the defendant stated that there was no better method known in his business, and evidence was given that electrically-driven machinery made less noise than hand or treadle-operated machines. This part of the case does not seem to have been very well put before the Judge, who appears to have been somewhat reluctant to grant an injunction against defendant, for he was allowed a month to get out of the premises. We think the defendant has a distinct grievance, for, although he might have made his tenancy agreement in more definite terms, it is clear that he would be allowed to use the more archaic and noisier and less efficient hand-power machinery, while the up-to-date efficient electric motor is barred. The removal of these and similar obstacles to the natural progress and development of the electrical industry in this country should be insisted upon as soon as the war is over.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week April 26, 1915, to May 1, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

LONDON.—*Switzerland:* Elec. machinery, £23; unenumerated, £17. *U.S.A.:* £975; wire and cable, £2,710; elec. carbons, 20 pkgs.; unenumerated, £393. *Canada:* ratus, 26 pkgs.; unenumerated, £70. *France:* Carbon candle:, £1,407; elec. lamps, £5; unenumerated, £555—18 pkgs.; *Denmark:* Unenumerated, £330. *Spain:* Unenu- unenumerated, 184 pkgs. copper bars, 977 no.

EXPORTS.

unenumerated, £491. *Melbourne:* Elec. machinery, £598; wire and cable, £3,651; unenumerated, £977. *Sydney:* Wire and cable, £733; elec. machinery, £969; un- , £114.

JAPAN.—*Yokohama:* Elec. machinery, £857; unenumerated, £300. £332. *Calcutta:* Wire and cable, £334; elec. machinery, £33; unenumerated, £1,001. *Madras:* Unenumerated, £142. *Colombo:* Wire and cable, £902; unenumerated, £142. *Karachi:* Unenumerated, £14. *Shanghai:* Unenumerated, £1,145. *Port Swettenham:* Elec. machinery, £167; unenumerated, £28. *Karachi:* Unenumerated, £14. *Singapore:* Elec. machinery, £300; wire and cable, £42; unenumerated, £742. *Kingston:* Unenumerated, £121. *Rangoon:* Wire and cable, £160; unenumerated, £19. *Penang:* Wire and cable, £51; unenumerated, £111.

CANADA.—*Montreal:* Elec. machinery, £269; unenumerated, £706. *Vancouver:* Unenumerated, £26. *Toronto:* Unenumerated, £764. *Halifax:* Unenumerated, £118. *Ottawa:* Unenumerated, £304.

NORWAY.—*Christiana:* Wire and cable, £1,302; elec. machinery, £53; unenumerated, £241.

FRANCE.—*Dieppe:* Elec. motor, £187; unenumerated, £650. *Boulogne:* Unenumerated, £670. *Marseilles:* Unenumerated, £45.

SOUTH AMERICA.—*Buenos Ayres:* Elec. machinery, £164; wire and cable, £10,084; unenumerated, £2,004. *Antofagasta:* Unenumerated, £23. *Barbados:* Wire and cable, £45; unenumerated, £25. *Monte Video:* Submarine cable, £1,400. *Talcahuano:* Elec. cable, £122. *Rosario:* Elec. lighting material, £3,502.

HOLLAND.—*Amsterdam:* Wire and cable, £534; unenumerated, £123. *Rotterdam:* Wire and cable, £283; unenumerated, £65.

U.S.A.—*New York:* Unenumerated, £26.

PERSIA.—*Busreh:* Wire and cable, £45.

MALTA: Unenumerated, £45.

FOREIGN GOODS DUTY (paid and free).

INTRANSIT Elec. T £21; W Unenumerated, £120 23 cwts.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 11½d. is payable at Bankruptcy-buildings, London, W.C., to creditors of Granville Burgess (trading as Granville Burgess & Co.), electrical engineer, 27, Museum-street, Bury-street, London, W.C.

A meeting to receive an account of the winding up of the Rapid Light Controlling Synd. (Ltd.) (in liq.) will be held at 7, Victoria-street, London, S.W., on May 31.

The Electric Railway Signalling Synd. (Ltd.) is being wound up voluntarily, and Mr. C. F. Palmer, 1, Broad-street-avenue, London, E.C., has been appointed liquidator.

BUSINESS NOTICES.

We are informed that, after eight years' active work in connection with the "Tricity" cookers, Mr. F. S. Grogan will very shortly sever his connection with the British Electric Transformer Co. in order to take up an appointment as manager of a new concern (the name of which will be announced later) for the manufacture and sale of electric fires and cookers. Personal communications for Mr. Grogan should be addressed to him at 14, Argyll-mansions, Beaufort-st., Chelsea, S.W.

Patent Development.—The proprietor of patent No. 16,500 1907, for "Improvements relating to electric self-winding clocks," desires to make arrangements for the practical working of the invention in this country.

The proprietor of patent No. 16,638 1909, for "Improvements in clocks," also desires to make arrangements for exploiting the same in this country.

Applications in both cases to Messrs. Haseltine, Lake & Co., Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Battersea (London). On Tuesday the London County Council sanctioned a loan of £9,000 for electricity supply purposes.

Bermondsey (London).—The electrical engineer (Mr. W. E. J. Heeran) suggests an alteration of the stokers of the three Howden boilers at the electricity works.

Mr. Heeran proposes to take out the existing underfeed stokers and replace them by three of the chain grate type, which will, in addition to saving coal, increase the capacity of the three Howden boilers by 33 per cent. The following proposals have been received from manufacturers of stokers: Underfeed Stoker Co. installing two stokers in place of existing stoker, subject made each boiler, increasing grate area to 91 sq. ft., £254 per boiler. Erith Engineering Co. installing three chain grate stokers, £320 per boiler, or installing an Erith Ridge stoker without changing boiler, £430 per boiler. H. Brown & Co., installing patent improved [illegible] stokers in chain grate stoker, [illegible] per boiler, total [illegible] 112 sq. ft., £385 per boiler, if further grates are ordered, £20 per boiler less. To all these quotations £45 per boiler must be added for alterations to brickwork, &c. According to Mr. Heeran's report, the Underfeed Stoker Co. and the Erith Engineering Co

will accept half payment when stokers are installed and the remainder one year afterwards. Ed. Bennis Co. will accept payment of one-third when installed, one-third one year after and the remainder the following year. In Mr. Heenan's opinion the chain-grate stoker is the best scheme, and he recommends Messrs. Bennis's scheme.

During the winter Mr. Heenan was authorised to make some inquiries in regard to bulk supply, so as to meet next winter's demand, but he believes that with increased boiler power they will be justified in postponing the question for at least another year. The Electricity Committee has approved the proposals of the engineer.

Derby. The Corporation have applied for sanction to the borrowing of the following amounts, viz.: £3,488 already expended on mains and £569 for motors. For additional expenditure on mains and motors to give supplies for war purposes £1,000 is required.

Hammersmith (London).—Electric supply mains are to be extended at a cost of about £240.

Last month the Council accepted the tender of Johnson & Phillips for the supply of box frames, covers, boxes, &c., during the current year. The firm now state that they have received a number of Government orders, and that in consequence of a large number of their men being specially allocated for that work, deliveries of the Council's order would be much impeded, and in the circumstances they ask to be allowed to withdraw their tender. The Electricity Committee considers the explanation satisfactory, and has instructed the engineer (Mr. G. G. Bell) to communicate with the next lowest tenderers (Messrs. W. Lucy & Co.) to ascertain if they are prepared to enter into a contract.

Salford. The Electricity Committee has applied for sanction to borrow £5,466 to cover capital expenditure incurred in connection with the undertaking since March 12 last.

Stepney (London).—The Treasury has agreed to raise no objection to a loan of £15,000 by the London County Council to the Borough Council (repayable in 25 years) for mains, but the Borough Council must undertake to limit expenditure on the provision of mains for the duration of the war, to the laying of mains to supply electrical energy to consumers engaged on work for the War Office or the Admiralty.

Willesden.—As the result of an interview which the clerk (Mr. S. W. Ball) and the electrical engineer (Mr. A. W. Blake) have had with an official of the L.G. Board with reference to extending the electric supply mains to factories engaged in manufacturing munitions of war in West Willesden, the Board has sanctioned the work being carried out at once.

GENERAL.

Aberdeen.—At a meeting of the Electricity Committee last week, the city electrical engineer (Mr. J. Alex. Bell) submitted a statement as to the effects of the war on the department.

Mr. Bell stated that there were 166 men on the department's books at the outbreak of the war, and the number of men on the books at April 16 was 87. The men with the colours numbered 27, of which four were in the 157th Brigade of Artillery. Seven men had been allowed to join the colours since the winter's load was over, and to prepare for next winter and to keep the works running it had been necessary to use the clerical department and train them up as switchboard attendants. The number of power consumers since the opening of the war had increased by 17, and over half a million more units were generated during the first seven months of the war, compared with the corresponding period of the previous year.

Bristol.—Fifty-two of the workmen and staff of the Corporation electricity department are serving with H.M. Forces, the percentage of the staff being 36 and of the workmen being 15.

Chelmsford.—The Council are entitled to purchase the local electricity supply works next year, but notice of intention to acquire them must be given by Jan. 29, 1916. The question of the advisability of doing so is being considered by the Lighting Committee.

Coventry.—On Tuesday the City Council considered the annual report of the electricity department.

During the year ended March 31 the consumers increased from 3,174 to 3,889, an increase of 715, compared with an increase in 1913-4 of 658. The units sold advanced from 16,508,338 to 20,249,018, an increase of 3,740,680. The income from sale of current, meter rents, &c., was £77,913, against £71,207; and the net profit on the year's working was £22,829, against £21,749. The Committee recommended that £6,000 be paid to the general district fund in aid of rates, compared with £5,000.

The Electric Light Committee also recommended that the salary of the engineer and manager of the electricity works (Mr. G. Tough) be increased from £650 to £750 per annum.

At the meeting of the Council on Tuesday the Chairman of the Electric Lighting Committee (Councillor F. Lee) said nearly all the local manufacturers were taking power from the Corporation, and the firm engaged largely in the manufacture of munitions of war it was essential that the plant should keep busy. The report showed a record profit, a record number of consumers, and a record low cost of production.

Mr. Quennell, Chairman of the Gas Committee, suggested that small consumers should have more consideration, as they had been turned down in such as large consumers.

Councillor Lee replied that the small consumers took only 6 per cent. of the output.

The report and accounts were adopted, and recommendation to increase the salary of the electrical engineer (Mr. Tough) was also agreed to.

Croydon.—We regret to notice that Ald. D. B. Miller has been compelled to resign the chairmanship of the Electric Lighting Committee owing to ill-health.

Ald. Miller was chairman of the General Purposes Committee when it reported in favour of obtaining a provisional electric lighting order; he has been chairman of the Electric Lighting Committee since 1897 and from the outset he has been closely identified with the progress and development of the electricity undertaking.

Dundee.—Seventy employees of the electricity supply department have enlisted.

The military allowances to these amount to £1,100 and the war bonus to £700, making £1,800 per annum. There are also nearly a score of enlistments from the central staff of the department, bringing up the extra charges to £3,500 per annum. The coal difficulty has led to abnormal prices at present, and though the expected Government action may cause a slump, the electricity charges will probably have to be increased.

Eccles.—The Council are recommended to make a charge of 2d. per unit for current supplied to photographers for printing purposes and 4d. per unit for studio lighting and other purposes.

Edinburgh.—The draft estimates of the Electric Light Committee for the year 1915-16 show a deficit of over £5,000.

The deficit is due to the increased cost of coal, which has gone up by £10,000. The Committee is considering whether the estimated deficit was to be made up by increasing the charges or otherwise.

Kingston-on-Thames.—A new scale of charges for current for consumers whose special arrangements have expired has been adopted.

For Kingston Empire, £6. 10s. per kilowatt and 2½d. (instead of 2d.) per unit, the charge for current for motor generator not included in the kilowatt demand to be 2¾d. per unit and the charge for current for power and heating to be 1⅔d. per unit. For picture palaces, lighting 3½d. per unit, current for motor generators 2¾d., power and heating 1⅔d. per unit, G.P.O. and Telephone exchange, 7½d. and 3d. (instead of 7d. and 2½d.) per unit, and 1½d. (instead of 1¾d.) per unit for power.

In view of the recent decision of the Council not to accept the Lighting Committee's recommendation to make no alteration in the charge for current for heating, cooking and fixed motors, the charge for such purposes will now be 1⅓d. per unit.

The L.G. Board has asked for particulars of the excess expenditure (£5,792) over loans already sanctioned for the electric supply department.

London County Council.—Subject to the approval of the Treasury, the London County Council have sanctioned the following arrangements in regard to the capital expenditure involved by the substitution of turbines for reciprocating engines at the Greenwich generating station:—

Expenditure on river works, foundations for new machinery, and alterations to buildings (added value as distinct from cost of substitution of new work for work destroyed) to be repaid within 60 years. Expenditure on new plant and machinery (other than additional steam, exhaust, feed condenser, &c., pipes) to be repaid within 15 years, on the understanding that, in the event of payments on the agreed basis being made into the renewals fund at any future date, the question of the period for repayment shall be reviewed. Expenditure on additional steam, exhaust feed condenser, &c., pipes to be repaid within 25 years. Cost (recurring every five or seven years) of reblading turbines and re-winding generators to be charged to revenue or renewals fund. Obsolete capital expenditure to be repaid within three years from the time that the whole of old plant is displaced.

Manchester.—On Wednesday the Electricity Committee recommended the City Council to increase the charges for electricity, both for lighting and power.

The proposed increase was 10 per cent. on the lighting, 15 per cent. on the industrial power, and 10 per cent. on the domestic charges. The reasons for the advance in price are attributed to the increased price of coal and other materials, increased wages, &c. The Committee think that the increased price is inevitable if they are to fulfil their promise of making their usual contribution of £30,000 to relief of rates. The advance will not apply to about 75 per cent. of the department's volume of business, as the large consumers are charged according to a sliding scale according to the price of coal and other materials. The sliding scale is in operation for general power users for unrestricted supplies. Users of electricity charged on the "Norwich" system at 12½ per cent. on the net assessable value will be charged 15 per cent. plus ½d. per unit for current used. The proposed increase in charges would bring another £20,767 per annum.

The Committee's balance-sheet for the past year shows that, compared with the previous year, the actual results in volume of business proved to be large, but the net surplus was £9,840 on a capital expenditure of £20,500. The gross income from all sources was £113,849 as against £103,509. The net surplus after meeting certain abnormal expenses (£12,266) was £25,840, against £36,006.

Selby.—The Urban Council have withdrawn their opposition to the application of the Electrical Distribution of Yorkshire, Ltd.)

for a provisional electric lighting order, as they have now got the option to purchase their proposed undertaking in the district as a going concern at the end of 21 years, or 28 or 35 years.

Stoke-on-Trent.—Last week the Corporation confirmed the recommendation of the Electricity Committee to increase the charge for current by 10 per cent. in order to make up for increased cost of fuel, increased wages, &c.

Waterford.—An inquiry was held last week into the Council's application for sanction to borrow £30,000 for electricity supply works.

Evidence in support of the application was given by the town clerk (Mr. J. J. Feely), the borough surveyor (Mr. J. J. Fleming) and the borough treasurer (Mr. P. Kent). It was stated that the gas, which was 3s. 4d. a thousand, was unsatisfactory, and Mr. Fleming stated that in his opinion electricity supply was a long-felt want in Waterford. There was a clause in the contract under which the gas company incurred a fine for defective light, and during the past three months the company incurred fines amounting to about £26.

Ald. Dr. O'Sullivan, J.P., stated that there were general complaints about the quality and supply of gas in the city and its cost. The Chamber of Commerce, which was a conservative body, had asked them to go on with the electric supply project. He felt confident that if electricity supply were available in the city it would be largely used both for power and lighting. The Asylum Board recently considered the question of putting in an installation of their own, and everybody admitted that it would be the proper light for an institution of the kind, but the cost of the plant had caused opposition. Their scheme provided for a main as far as the asylum, and in the same vicinity they had the Bishop's Palace, St. John's College, the Union, the County and City Infirmary and the Ursuline Convent. He had installed a petrol plant in his house, as he found that owing to the poor pressure at night from the gas it was necessary to light candles when reading. He was sure that De La Salle College would take in electric light the moment it passed their door. They delayed their scheme at the College for a year in the hope that the Corporation would proceed. The Corporation not proceeding they had to put in their own installation. There was provision for laying mains across the river, but the area was not included in the present list of scheduled streets. Waterford was a great shipping centre, and the Board of Agriculture required that cattle for shipment should be examined in daylight, and should be also under inspection for two hours in daylight. That was a serious matter because cattle coming into town at two o'clock on a winter's day could not be inspected by daylight. The Board of Agriculture was satisfied with electric light, provided it was sufficiently powerful, and he understood that a scheme was in hand for at least one cattle yard to be lit by electricity.

Technical evidence was then given by the consulting engineer (Mr. E. M. Lacey, M.Inst.C.E.), and the inquiry concluded.

Woolwich. At the meeting of the London County Council on Tuesday the Finance Committee presented a long report on the Borough Council's application for sanction to a loan for extensions of the electricity undertaking, &c.

The Committee recommended that the borrowing by Woolwich Borough Council of an amount not exceeding £35,000 for its electricity undertaking be sanctioned, such sum to be repaid by yearly, half-yearly or quarterly instalments of principal, or of principal and interest combined, of as nearly equal amounts as may be, as to £9,000 for buildings within 30 years, and as to £26,000 for plant (turbo-generators, condensing plant, boilers, transformers, switchgear, &c.) within 15 years, in each case from the date of borrowing. The seal of the County Council is to be affixed to an order sanctioning the borrowing, but the order is not to be issued until the Borough Council has agreed to repay the outstanding balance (£80) of so much of a loan of £16,391 granted on July 12, 1907) as is in respect of building work destroyed in connection with the extension of its electricity undertaking; to repay the amount of loan included for plant and machinery as specified against five loans (particularised in the report) within reduced periods, equivalent in each case to one-half the period for repayment unexpired at April 1, 1920, according to the original terms of the mortgage deeds securing the same.

LIGHTING, POWER & HEATING NOTES.

Bourton-on-the Water.—At the last meeting of Gloucester County Council it was reported that the tender of the local electric light company had been accepted for the public lighting for three years.

Electric Power in Schools.—The London Education Committee proposes to instal electric power at a cost of £150 at the Aristotle-road metal work centre for driving the machinery.

Electric Pumping in Mines.—At the recent meeting of the Sons of Gwalia (Ltd.) the chairman, Mr. C. Wanklyn, stated that in June they had to contend with a breakdown of the Cornish pump, and operations on the 20th level were interrupted by floods. They had either to substitute an electrically driven pump or to repair the Cornish pump at a cost of £500.

As an exceptionally heavy programme of capital expenditure was then in full swing, and, in spite, therefore, of the fact that an electrically driven pump would have been more economical in the end, they decided on repairing the Cornish pump. The question of an electrically driven pump would undoubtedly have to be considered before long.

Electric Pumping at Sewage Works.—Uxbridge Urban Council have approved the agreement with the Uxbridge Electric Supply Co. for the supply of electric current to the sewage works. The agreement is for three years certain, and from year to year after that, with three months' notice on either side.

Erith.—The Urban Council were recently asked by the West Kent Electric Co. to submit terms for giving a bulk supply of electric current for lighting 200 cottages to be erected in Colyer's-lane.

At the last Council meeting the clerk reported on the legal position with regard to the supply of electrical energy outside the Council's area, and the matter was left in the hands of the chairman, clerk and electrical engineer to take such steps as they deemed necessary.

TRACTION NOTES.

Eccles. An agreement was come to at the recent conference of the special sub-committee of the Council and the Salford Tramways Committee on the tramway dispute.

Salford Tramways Committee is to put the whole of the overhead equipment in a thorough state of repair on payment by Eccles of £800, and the Committee will undertake full responsibility for the maintenance of the overhead equipment for 10 years from April 1 last on payment by Eccles of £35 per mile of single trolley wire per annum, in addition to cost of new material provided, but less value of scrap recovered. The Committee will also undertake the responsibility of cleaning and painting the poles, brackets, &c., as and when required on payment of the cost of labour and materials thereof by Eccles.

Edinburgh.—The Electric Lighting Committee recently considered an inquiry from a firm as to the probable cost of current for charging electric motor vehicles.

The firm proposed to use electric motor cars for their business. The Committee was impressed by the value of such a load, and it was unanimously proposed to recommend that the rate should be 1d. per unit.

Ilford.—In a report by the electrical engineer (Mr. A. H. Shaw) on the provision of a mechanical wagon for the cartage of coal, the purchase of an electric vehicle is recommended, but before adopting this recommendation the Lighting Committee has arranged for an inspection.

The department's showroom in High-road has been closed and since adapted for use as a sub-office for inquiries.

Longbenton.—The Urban Council have agreed to allow Newcastle-on-Tyne Corporation to postpone until after the war the construction of the projectd tramways in this district.

Southampton.—The price for charging electric vehicles has been fixed at 1½d. per unit.

The mains in the northern district are to be increased at a cost of £500.

Women Tramcar Conductors.—Many tramway undertakings have decided to follow Glasgow's lead in the employment of women conductors, including Brighton, Maidstone, Newcastle-on-Tyne, Salford and South Shields Corporations. Some tramway companies have also decided to employ women, while Southend-on-Sea Council propose to employ women conductors for motor omnibuses. On the other hand, Liverpool Corporation have rejected a recommendation to engage women conductors.

TELEGRAPH AND TELEPHONE NOTES.

Spanish Submarine Cable.—The "Gaceta" (Madrid) of April 16 publishes a Royal Decree authorising the Ministerio de la Gobernacion to contract, by public tender, for the laying of a submarine telegraph cable from Cadiz to Laraiche (Morocco). The credit allotted is 1,000,000 pesetas (about £41,700), and if the whole of this amount is not required for the purpose mentioned the Minister is authorised to devote the remainder of the credit to the renewal of the cable between Tangier and Tarifa, the laying of a new cable between Majorca and Minorca, and the extension to Malaga of the cable from Ceuta to Estepona.

A further decree in the same "Gaceta," authorises the Minister to contract, by public tender, for the repair of the following cables: Melilla to Almeria, Alhucemas to Penon de la Gomera (Africa); Iviza to Majorca; and Cadiz to Teneriffe. Should the credit of 500,000 pesetas (about £20,800) assigned for these works not be absorbed, the remainder will be devoted to the repair of the cables between Ceuta and Estepona, between Chafarinas and Cabo de Agua, &c.

EMPIRE NOTES.

Australasia.—Blayney (N.S.W.) Council recently invited proposals for lighting the streets by means of electricity or gas.

Application has been made by the Queenscliff (Victoria) Council for an Order in Council authorising the adoption of electric lighting in the borough.

A deputation from Hawthorn and Camberwell (Victoria) Councils recently asked the Minister of Public Works (Mr. Hagelthorn) to re-

consider the question of issuing an Order in Council to enable the Councils to construct an electric tramway from Power-street to Burke-road.

Brisbane City Electric Light Co. (Ltd.) has declared a dividend at the rate of 15 per cent. per annum on its ordinary shares for the past half-year.

A claim is to be made for damages at the rate of 4d. per car-mile for every car-mile lost by the Prahran-Malvern (Victoria) Tramway Trust through the recent breakdown of the supply of energy to the Trust by the Melbourne Electric Supply Co. It is admitted that the feeder cable was overloaded, but as it was done to oblige the Trust the point to be determined is whether the recent interruption comes under the provisions in the agreement relating to penalties.

MISCELLANEOUS NOTES.

British Firms in Germany. It is announced that the Commercial Intelligence Department of the Board of Trade have notified over 70 British firms with branches in Germany that the German Government have requestrated or taken over of their business and property.

The central provincial authorities have been empowered, with the assent of the Imperial German Chancellor, to place under absolute control undertakings which belong entirely or partly to British, French or Russian subjects. The administrator who is appointed may continue the business wholly or partly, or confine himself to completing current contracts. It is also provided that any surpluses realised are to be deposited to the account of the enemy aliens at the Reichsbank. The object appears to be to take care that during the war no money or other assets of the controlled undertakings shall reach any enemy alien, and in this respect the procedure is somewhat similar to that under the Trading with the Enemy (Amendment) Act, 1914, with a view to arrangements to be made at the conclusion of peace. The Imperial Chancellor may, however, "by way of retaliation," declare permissible the liquidation of any business belonging to an enemy alien.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade have issued lists 17 and 18 of articles which enquirers desire to purchase, and whose sources of supply or markets have been interfered with by the war. United Kingdom manufacturers and traders may obtain copies at 73, Basinghall-street, London, E.C.

Customs Tariffs.—A gold Coast Customs Tariff Ordinance, dated March 16, states the import duties in force throughout the Colony which have been fixed instead of the different rates hitherto in force for the ports of the Colony east and west of the river Volta respectively.

The following are exempt from duty:—Apparatus and structural material for telegraphs, telephones and electric lighting, instruments and appliances for scientific purposes and research, electrical mining and pumping machinery and appliances, models of inventions, &c., railway and tramway plant, material and rolling stock, vehicles of all descriptions, steam and other launches and scientific apparatus and appliances brought by professional persons for their use.

According to a recent decision, electric igniters for gas or oil engines imported into New Zealand are subject to import duty of 20 per cent. ad val. if of foreign manufacture, but are duty free if of British manufacture. Amongst the articles which can be imported duty free under the new Commercial Tax Law of Panama (which comes into operation on May 24, 1915) are machinery and primary materials for the "manufacture" of electric light, apparatus of iron, steel and other metals for lightning conductors, electric meters, lamps and other apparatus for public lighting.

"Keep Going."—This phrase appeals to Mr. Charles Bright as preferable to that of "Business as Usual." In an instructive lecture to the Tonbridge (Kent) Chamber of Trade on the subject of the war and its lessons, Mr. Bright reviewed the general situation, and pointed out how completely the present campaign had resolved itself into one of organisation.

It must be remembered, he said, that our enemies have been making a continuously close study of warfare over a considerable period, far more scientific and thorough than our own. With us of late years war had been a very incidental consideration, whereas with Germany it had become a sort of second faith. The Germans, too, were past masters in the art of organisation, developed on strictly scientific lines. He considered we had been backward in our Intelligence Department, and were very heavily handicapped in fighting a country of cultured savages with whom chivalry was a thing forgotten. He advocated, when we get into Germany, as we should, the "flattening out," not of German women and cathedrals, but of every German dockyard, arsenal and Government factory. There must be a complete job made now, or matters would be worse than they were before the war. Mr. Bright proceeded to condemn sport and pleasure at such a time, and to note with satisfaction the fact that domestic party politics had been dropped for a time and that a more national spirit prevailed.

Mr. Bright received a hearty vote of thanks for his lecture.

Lecture. At the exhibition entitled "Woman and their Work," which has been held this week at the Royal Horticultural Hall, Westminster (closing to-day, Friday), Mrs. Maud Lancaster on Tuesday delivered an interesting lecture on "Electricity in the Service of the Home." Although only a short discourse, it was most instructive and convincing, and the audience evidently accepted with favour Mrs. Lancaster's description of the many merits of the electric service. Such lectures are calculated to do a great deal of good and to bring home to the housewife the advantages which will follow the installation of electrical apparatus for various uses in the home.

A number of exhibits were made of particular interest in connection with the exhibition and with Mrs. Lancaster's lecture. The Westminster Electric Supply Corpn. gave practical demonstrations of electric cooking, and these attracted much attention. A good show was made of Belling electric fires, and the complete exhibit and demonstration of the Dowsing Radiant Heat Co. were, as usual at these shows, well patronised.

Skilled Labour and the War.—A conference of local authorities was held at Manchester last week to consider the proposals of the Government to enlist skilled and unskilled labour for increasing the output of munitions of war.

The conference was attended by Mr. R. H. Bicknell, engineering inspector of the L.G. Board, and by representatives of a number of local authorities in the neighbourhood of Manchester. Mr. Bicknell read a letter from Lord Kitchener to the President of the Board, in which he referred to the effort being made to augment the supply of fitters, millwrights, machine hands and skilled and unskilled labourers for increasing the output of munitions. Mr. Bicknell said that the results so far had shown that the authorities had done magnificently, for 20,000 men who were employed by local authorities had been sent to the War Office, and a further 7,000 or 8,000 men would be added in a few days. He asked them to include in their lists of available men every man in their employ who was ablebodied whether skilled or unskilled. For every skilled man four unskilled were necessary in munitions factories. He stated that 2,100 men were unnecessarily killed at the front each week for the want of munitions, and he appealed to them to see to it that labour was forthcoming at the earliest moment.

Several authorities produced lists of names giving the names of available employés, but it was decided to take the lists back for augmenting the number of men to be liberated for the munition factories.

Many local authorities in other parts of the country are also co-operating with the War Office in providing workmen for the manufacture of munitions of war.

The Leyton Lighting Committee has approved a scheme whereby the mechanics at the electricity works will be enabled, in their own time, to assist in the manufacture of spare parts for transport motors for war purposes, the material being supplied by the Associated Equipment Co., who will pay the men for work done.

TENDERS INVITED.

Armoured Cable and Induction Motors.

Shanghai Municipal Council invite tenders for the supply and delivery f.o.b. at British port of 2,600 yds. Three-core c.h.t. Armoured Cable and 79 Three-phase Induction Motors in various sizes between 5 B.H.P. and 80 B.H.P., complete with slide rails and foundation bolts. Specifications, general conditions and forms of tender from Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, Westminster, S.W. [illegible] to be delivered by noon Thursday, May 20. [illegible] *Assessment.*

Coal Handling Plant.

Manchester Electricity Committee want tenders (by noon June 2) for coal unloading crane, conveying plant, &c., at their Barton power station.

Steam Feed and Water Pipes, &c.

Leeds City Council invite tenders for the supply and erection of Steam Feed and Water Pipes, &c., in connection with an extension of works, involving the addition of 18,000 kw. of plant. Copies of general conditions, specification and forms of tender from the manager of the Electricity Dept., Mr. C. Nelson Hefford, 1, Whitehall-road, Leeds, and tenders to the town clerk, Sir Robert E. Fox, Town Hall, Leeds, by 10 a.m. May 26. [illegible]

Boiler, Rotary Converter or Motor Converter, &c.

[illegible] Corporation want tenders by noon May 21 for supply of Vertical Tube Boiler, 250 k.w. Rotary Converter or Motor Converter and Switch Panel. Specification from Borough Electrical Engineer.

Wiring and Fittings.

EDMONTON Corporation require tenders by May 12 for an Electric Lighting Installation for Water Power Buildings, Powderhall, Broughton-road, Edinburgh. Specification, &c., from the Engineer, Dewar-place, Edinburgh.

LONDON County Council require tenders by 11 a.m. May 12 for Wiring and Fitting Sebbon-street elementary school, Islington (about 210 wiring points). Specification, &c., from the Chief Engineer, Spring-gardens, S.W.

Motors.

THE VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 30 for supply of Four Electric Motors, varying from 7 H.P. to ½ H.P. (Contract 28.771). Particulars from the Commissioners' Offices, Spencer-street, Melbourne.

Cables, Transformers, Switchgear, &c.

Tenders are invited for the supply of Four 250 k.v.a. Three-phase Transformers and for the supply of 9,680 yds. of 0·05 sq. in. Three-core Lead-covered Cable to the CITY OF MELBOURNE. Tender forms, &c., from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co., Ppty. (Ltd.), Billiter square buildings, London, E.C., to whom tenders by 11 a.m., May 18.

LAUNCESTON (Tasmania) Council want tenders by 4 p.m., July 26, for converter, switchgear, underground feeder cable, &c. Specifications, &c., from the City Electrical Engineer.

Turbo-Alternator.

SYDNEY (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

Telegraph and Telephone Instruments and Material, &c.

The Deputy Postmaster-General, Sydney (N.S.W.), will receive tenders until 2:30 p.m. June 16 for the supply of 400 pony pattern Morse Sounders to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specification, &c., from the Deputy Postmaster-General.

The Commonwealth of Australia Postmaster-General's Dept. give notice that the date for the receipt of tenders for a Telephone Switchboard for Warwick (QUEENSLAND) has been further extended from June 1.

Tenders are invited by the NORWEGIAN STATE TELEGRAPH DEPARTMENT for the supply of Lead Cable. Particulars may be obtained by agents of the United Kingdom manufacturers on application to the Technical Department of the Telegraph Administration, Hasselgaarden, Christiania, to which address tenders are to be sent by noon May 15. Local representation by a resident is essential. In all Norwegian Government contracts a preference of from 10 to 15 per cent. (sometimes more) is given to Norwegian manufacturers.

Generators (Extension of Time).

The time for the receipt by the NEW ZEALAND PUBLIC WORKS Dept. of tenders for the supply of a Three-unit Exciter Set and a 1,500 kw. Generator for Lake Coleridge power scheme has been extended to noon May 21. Particulars from the Public Works Offices, Auckland, Wellington, Christchurch and Dunedin.

Electrical and General Stores, &c.

The Postmaster-General, ALEXANDRIA (Egypt), will receive tenders until noon May 15 for the supply of Lamps, Electric Fans, &c., for one year. Specifications, &c., from the Central Stores Department, G.P.O., Alexandria.

TENDERS RECEIVED AND ACCEPTED.

LONDON COUNTY COUNCIL.—In our last issue (p. 144) we gave Particulars of the tenders received for the supply of two 8,000 kw. turbo-generators for the Greenwich generating station, and announced that the contract had been placed with the British Westinghouse Co.

In their report the Highways Committee pointed out that the lowest complete tender was that submitted by Messrs. Brown, Boveri, of Switzerland, but in view of the difficulties which would be likely to arise during the war in the transport of raw material and of the imported work, and also in the improvement of the machinery during manufacture, they decided to recommend that tender.

We are informed by the Manager and Chief Engineer of the Manchester Local Committee of the company that they are able to submit a reply to the Committee's proposals as recently announced, and that, subject to the acceptance of our counter-offer and the final conditions, they greatly prefer their tender to that which the company are at the present moment executing in this country, though, of course, owing entirely interfered with by the war, have nevertheless been quite effectively and successfully handled, and all transport difficulties have been overcome. In the early stages of the war consignments via Genoa were rather irregular in coming through, and required sometimes from four to six and eight weeks. Transit consignments through France (Treport, Bordeaux, Havre, Dieppe, &c.) are much more regular, and in some cases consignments have reached this country within two to three weeks from the date they left the Oerlikon works in Switzerland, even if they are dispatched by ordinary goods, and in case of great urgency these latter transport periods can even be improved upon.

The London County Council have accepted the tender of the Lilleshall Co. for the supply of rolled steel bar for magnetic brake shoes at £8. 10s. per ton. The Frodingham Iron & Steel Co. tendered at £8. 16s. 3d. delivered at central car repair depot or within 20 miles of Leicester), and £8. 11s. 3d. on truck to siding at depots. Earl of Dudley's Round Oak Works at £8. 17s. 6d. and £9. 10s. H. Bessemer & Co. at £9. 7s. 6d. and Goodwin & Co. at £14. 10s.

The County Council have also accepted the following tenders for the supply of annual tramway stores, &c.:

London Electric Wire Co. and Smiths, 2 tons of triple cotton-covered copper wire, £79 a ton; Edison & Swan United Elec. Lt. Co., drawn wire filament lamps, £2,800; British Westinghouse Co., Dick, Kerr & Co., A. Clare & Co. (£513 8s. 6d.) and Manchester Armature Repair Co. (£261. 5s.), electrical equipment (motor generator) spares; British Westinghouse Electric & Mfg. Co., Dick, Kerr & Co., electrical equipment (controller, circuit breaker and other switch, &c., details and magnetic brake) spares; British Westinghouse Co. (£61. 4s. 3d.), Dick, Kerr & Co. (£6), Dyer & Young (£188. 0s. 9d.), E. Showell & Sons (£122. 8s.) and Tramway Supplies (Ltd.) (£1,194. 17s. 6d.), contact fingers and parts, segments, &c.; British Insulated & Helsby Cables (£820. 16s.), Hooper's Telegraph & India Rubber Works (£400), Liverpool Electric Cable Co. (£410. 8s.), Midland Electric Wire Co. (£53. 1s. 8d.) and Saxonia Electrical Wire Co. (£120), electric cable, fuse wire and cotton-covered copper wire; British Insulated & Helsby Cables, copper bonds, £1,033. 10s.; British Westinghouse Co. (£87. 11s. 8d.), Crystalate Mfg. Co. (£12), Ebonestos Mfg. Co. and Litholite (Ltd.) (£308. 19s.), moulded insulators (other than rubber); Bullers (Ltd.) (£4,462. 10s.), Gaskell & Grocott (£201. 13s. 4d.), Doulton & Co. (£103. 2s. 6d.), and Taylor, Tunnicliff & Co. (£103. 2s. 6d.), track insulators; Anti-Attrition Metal Co. (£3,924. 6s.), machined bronze bearings; E. Showell & Sons (£161. 2s. 11d.), Gabriel & Co. (£7. 14s. 6d.), Anti-Attrition Metal Co. (£180. 18s.) and Brecknell, Munro & Rogers (£292. 10s.), machine finished articles (brass, gunmetal, &c.); Bayliss, Jones & Bayliss (£682. 18s. 3d.), British Westinghouse Co. (£103. 15s.), F. W. Cotterill (Ltd.) (£39. 14s.), J. Holroyd & Co. (£133. 10s.), Ibbotson Bros. & Co. (£170. 15s. 6d.), C. Richards & Sons (£54. 2s.), W. J. Ritchie & Co. (£70. 19s. 4d.), F. W. Rowlands & Co. (£16. 4s.) and Wilkes (Ltd.) (£323. 7s.), machine-finished articles (wrought iron and mild steel); F. W. Rowlands & Co. (£1,255. 16s.) and J. Holroyd & Co. (£30), gear and pinion wheels, ratchets, worms, &c.; British Westinghouse Co. (£51 5s.), drop forged stampings; Bayliss, Jones & Bayliss (£182 12s.), Bush Electrical Co. (£69. 12s.), East Ferry-road Engineering Works Co. (£21. 15s.), Male & Jordan (£204. 2s. 6d.), W. J. Ritchie & Co. (£79. 4s.), Warren & Sons (£15. 12s.) and Hadfields (Ltd.) (£47. 16s.), iron and steel forgings; Crown Spring Co. (£134. 9s. 8d.), West Bromwich Spring Co. (£320. 1s. 6d.), Joseph Steel & Sons (£14. 17s.), springs; Carron Co. (£1,501. 15s.), A. Clare & Co. (£19. 10s.), J. Holroyd & Co. (£137. 10s.), H. Newton Knights & Co. (£360) and T. Summerson & Son (£585), machined iron castings; Pease & Partners (£3,416. 17s. 6d.), brake shoes; Bullers (Ltd.) (£753. 19s.), Leys Malleable Castings Co. (£448. 19s.) and Brecknell, Munro & Rogers (£36), machined malleable iron castings; Hadfield's (Ltd.) (£539. 17s. 6d.), M. & G. Truck & Eng. Co. (£200. 17s.), E. Allen & Co. (£264. 17s. 6d.), S. Peace & Sons (indefinite quantities required), and H. R. Marsden (Ltd.) (£22. 1s.), steel castings; Morgan Crucible Co. (£296. 10s. 7d.), foundry crucibles.

AYLESBURY.—Tenders were recently received by the Council for the supply of Diesel engine oil.

The Anglo-Mexican Petroleum Products Co. offered to supply 20 tons fuel oil at 70s. per ton net, carriage paid to Aylesbury in tank barges, or 65s. per ton in railway trucks, and the Anglo American Oil Co. at 78s. 6d. per ton, delivered by the Canal at the Council's Wharf. It was decided to order two tons of the Anglo American oil, the tender for the bulk to remain in abeyance.

GRIMSBY.—The Lighting Committee has directed that half the meters required for two years be purchased from the British Thomson Houston Co. and the remainder from Chamberlain & Hookham and Ferranti Limited in equal quantities.

WANDSWORTH SCHOOL LIGHTING.—Seven tenders were received by the London Education Committee for wiring the Derinton-road school, and the lowest, that of the Alpha Mfg. Co. (at £357. 15s.) has been accepted. The amount of the highest tender was £804. 10s.

SHOREDITCH (LONDON).—The tender of the Stirling Boiler Co. (at £414. 15s.) has been accepted by the Lighting Committee for supplying and fixing a pair of chain-grate stokers.

LIVERPOOL.—The City Council is recommended to accept the tender of Ferranti Ltd., for 12 months' supply of meters.

BERMONDSEY (LONDON).—The Council are recommended to accept the tenders of Hy. Clark & Sons, W. B. Dick & Co. and the Silvertown Lubricants (Ltd.) for 12 months' supply of enemic oils.

CROYDON.—The Corporation recently placed an order with E. Green & Sons for the renewal of the economiser tubes at £831.

SYDNEY (N.S.W.) The City Council have accepted the following tenders :—

E. A. Machin & Co. (agents for R. W. Paul, London), potentiometer, £135 ; Lawrence & Hanson, 500 15 amperes, 500 25 amperes and 200 50 amperes house service line boxes £136. 5s. ; 500 public lighting fittings, less shades, 2s. 10d. each ; Willans & Robinson, two impellers, with impeller shafts, for Orten Boving pumps, £214 each ; Australian General Electric Co., 6 50 k.v.a. 33,000/415 volt three-phase transformers, six sets expulsion fuses, and six three-pole disconnecting switches, in connection with supply to Kurnig gai municipality, £2,064 ; Noyes Bros., 5,000 yds. 0·05 three-core 5,000 volt cable, 500 yds. 0·15 three-core h.s. cable, and 2,000 yds. 0·15 three-core l.t. cable, £1,823. 10s. 4d., subject to copper market ; Siemens Bros. & Co., 2,000 yds. 7/16 twin h.s. cable, 1,000 yds. 7/16 three-core h.s. cable, 1,000 yds. 7/16 four-core h.s. cable, 3,000 yds. 0·1 four-core h.s. cable, 5,000 yds. 7/16 twin arc, 1,000 yds. 0·05 three-core l.t. cable, 5,000 yds. 0·05 four-core l.t. cable, 8,000 yds. 0·1 four-core l.t. cable, 3,000 yds. 0·3 three-core l.t. cable, and 3,000 yds. 0·3 four-core l.t. cable, £9,060. 10s. 3d., subject to copper market ; British Insulated & Helsby Cables, 5,000 yds. 0·15 four-core l.t. and h.s. cable, £212. 10s., subject to copper market, and 50 miles of 7/18 bare copper cable, £4,580. 18s. ; Australian General Electric Co., 4,000 10,000-volt straight pins, insulators, and 5,000 10,000-volt disc-type insulators, £1,005. 4s. 2d. ; Edison & Swan United E.L. Co., 600 5 amperes and 25 100-amperes 240-volt two-wire a.c. meters ; W. G. Watson & Co., 50 5-amperes, 25 15-amperes, 50 25-amperes, 50 50-amperes, 10 100-amperes, 6 200-amperes and 6 300-amperes m.d. indicators ; Standard Waygood Hercules (Ltd.), 14 50 k.v.a. outdoor-type transformers, £1,383. 18s.

Meter Contracts.—Messrs. Ferranti Limited have recently secured many annual contracts for the supply of meters, including the following :—

Belfast Corporation, c.c. house service meters, 250 500 amperes sizes only, for 12 months ending March 31, 1916 ; Halifax Corporation, c.c. house service meters, for 12 months ; Heston and Isleworth Urban Council, c.c. house service meters for 12 months ; Swindon Corporation, c.c. house service meters for 12 months ; Wimbledon Corporation, a.c. house service meters for 12 months ; Gray's Urban District Council, c.c. house service meters for 12 months ; Grimsby Corporation, portion c.c. house service meters for 12 months ; Birkenhead Corporation, c.c. house service meters for 12 months ; Alloa Town Council, c.c. house service meters (10/100 amperes inclusive) for 12 months to May 14, 1916 ; Liverpool Corporation, c.c. house service meters for 12 months ; Borough of Kilmarnock, c.c. house service meters for 12 months to May 15, 1916 ; Bradford Corporation, c.c. and a.c. house service meters for 12 months.

Messrs. Chamberlain & Hookham have secured contracts for 12 months' supply of d.c. meters to Maidenhead, a.c. meters to South Shields and d.c. meters to Bradford Corporation.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :

Postmaster General's Dept., Brisbane.—Western Electric Co., fuse, £281. 5s. ; India Rubber, Gutta Percha & Telegraph Works Co., corks and tubes for Meidinger cells, £50 ; Jas. Paton & Co., telephones, £3,532. 10s. ; R. Allen, glass cells, £143. 15s., porous cups, £37. 10s. ; British Insulated & Helsby Cables, cable, £3,570, and zincs for batteries, £880 ; Siemens Bros. Dynamo Works, bridge megger as per schedule No. 292, Wheatstone bridges £2. 3s. 6d., detectors £6. 1s., galvano meters, and megger as per schedule (item 11) ; W. T. Henley's Telegraph Works Co., cable, £2,637 ; Fred S. Lee, insulators, £143.19s.2d., porcelain tubes £16. 13s. 4d. ; Commonwealth Art Pottery, &c., Co., insulators £187. 1s.

Postmaster General's Dept., Perth.—Unbehaun & Johnstone, power board, &c., £151. 6s. 5d., micrometers £11. 2s. 6d., mirrors £1. 6s., shunt £3

Postmaster-General's Dept., Melbourne.—A. J. Todd & Co., protectors, £229. 3s. 4d. ; J. Bartram & Co., protectors, £628. 15s. ; Australian Porcelain Works, insulators, £1,428. 2s. 6d.

Postmaster-General's Dept., Sydney.—Western Electric Co., cable, £34. 2s. ; Victor Motor Co., manhole covers and frames, £254. 12s. 6d. ; Wm. Adams & Co., accumulators, £211. 11s.

Metropolitan Board of Water Supply, &c., Sydney.—Zoodmer (Ltd.), pumps and motors, £2,074 ; Simpson Bros., duplicate pumping unit, £2,489 ; Babcock & Wilcox, boilers for boosting plant, £2,242.

New Zealand Government Contracts.—The Public Service Store-Tender Board, Wellington, have accepted the following tenders :

S. Brown (Ltd.), copper wire £9. 7s. 9d., gal. steel wire £135. 9s. ; Lawrence & Hanson Co., rings for clamping ear pieces, £75 ; Williams & Proctor, refrigerating plant, £390 ; A. & T. Burt, insulator cups, £2,224. 8s., ear pieces £17. 2s. 6d., cable £4,080, gal. bolts with leather washer and cups £312. 12s. 6d. ; Riley & Co., calculagraph clocks £348, cable £1,465 ; Richardson, McCabe & Co., cable, £6,400 ; P. R. Baillie & Co., cable, £4,498. 2s. ; Hughes & Cossar, sal-ammoniac powder, £775 ; A. M. Holmes, insulator cups, 3¼ in. by 2¼ in., £106. 5s. ; B. L. Donne, cords £108. 3s. 4d., telephones £8,462. 10s.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Ltd.)

The forty-eighth ordinary general meeting was held on Thursday last week under the presidency of Mr. J. HERBERT TRITTON.

The SECRETARY (Mr. John I. Bethell) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said : Gentlemen, much of importance has occurred since I last addressed you. The outbreak of war in August immediately affected all telegraphic communications, especially those connecting Germany with the Allied countries. The Indo route to India and beyond was totally interrupted in Germany on July 31, 1914, without notice, and before the declaration of war. Later the cable connecting Odessa with Constantinople was disconnected at both ends. These interruptions have necessarily curtailed the usefulness of the Company's system, restricting our working to the transmission of traffic between Russia and places east of that country. The shareholders may have felt surprise that the Company's revenue has not diminished, although our route has been interrupted since July 31, but some of you may remember that in the early days this Company entered into reciprocal working arrangements with the Eastern and Associated Telegraph Companies. These arrangements provide for the maintenance of revenue of the different parties to the Agreement for a specific period, despite the fact that the revenue contributed by one of those parties may be reduced or entirely stopped. We have at times heard complaints made of such mutual working arrangements, but the position of this Company might have been serious [illegible] such arrangements been entered into. [illegible] has been amply demonstrated in the case. We [illegible] British Government on the subject of the future of the Company, and have received an assurance that facilities will be given to the Company for the re-establishment of the Indo route. I do not propose [illegible] question of the route that will eventually be decided upon by the Company, and must ask you to be satisfied with the assurance that the matter is receiving the serious attention of your Directors, and that [illegible] being taken to ensure the continuity of the Company's [illegible]

The Company's lines in Russia have been placed entirely at the disposal of the Russian Government, and we are glad to know that the Russian military authorities are making very considerable use of them. The Company's line passes through a part, a considerable part, of the area where constant fighting is taking place, and through the town of Warsaw. I am glad to report that, since war began, our London staff has been employed by the Eastern Company in London. That Company has suffered from severe pressure, owing, amongst other causes, to the fact that our Indian and Trans-Indian traffic has been carried by their cables, and we are glad to assist them by the loan of our experienced operators. It is satisfactory to learn from Sir John Denison-Pender, managing director of the Eastern Telegraph Co., that they have rendered valuable services.

You will see from the accounts that the Directors have voted the sum of £250 to the Prince of Wales' Fund as a first contribution. We have also made a contribution to the Red Cross Organisation, inaugurated by the Director-General of Telegraphs at Petrograd in connection with his department, and we have received a graceful letter of acknowledgment from the Director-General. These will doubtless have your approval. The war, of course, put a stop to practically all our wireless experimenting, and our large station in France was taken over by the French Government, while our small station in this country was taken over by our own Government. You will note that the directors propose to set aside £10,000 towards wireless and other technical development. We are hoping to make experiments in the course of a few weeks with a wireless transmitting set of comparatively small power, coupled with reception by an improved Orling wireless relay, and we have every reason to believe that the experiments will give satisfactory results. The restoration of the Company's route may very likely necessitate some experimental work, and the Directors think it prudent to set aside this sum to meet the expenditure that will be incurred in making such experi- [illegible] towards possible downward fluctuations in our investments. Although the Government has fixed minimum prices it must not be assumed that [illegible] We [illegible] Company's reserves will have been strengthened.

The financial side of the report calls for little comment. The revenue [illegible] £172,352 for 1913, showing an [illegible] carried to profit

and loss of £100,988. This is the first occasion in the history of the Company upon which our net revenue has reached £100,000. The expenses are £88,395, as compared with £91,441 for 1913. The decrease is accounted for by the interruption of our communications, certain items of expenditure having been lessened owing to this fact. The carry-forward this year is £20,592, as against £6,461 last year. The Directors are of opinion that a larger carry-forward is desirable at the present time. The principal, if not the only, item of interest in the balance-sheet is the entry of £50,000 War Loan, for which we were glad to be able to subscribe. I now move the adoption of the report and accounts, the declaration of the dividend and bonus, the provision of a further £10,000 to meet possible expenditure in connection with wireless development work, and a special distribution out of interest accrued on certain investments.

Sir WILLIAM R. BROOKE, K.C.I.E., seconded the motion.

In reply to Mr. J. T. Reynell, the CHAIRMAN said that, besides the contributions to patriotic funds, they would give the British Red Cross Society £250. With respect to the men who are employed by the Company in this country who have left us to serve with the Colours, they were, of course, keeping their places open, and were giving them full pay in addition to their Army pay. (Hear, hear.)

The retiring directors, the Right Hon. Sir Francis Mowatt, G.C.B., and Sir William R. Brooke, K.C.I.E., were then re-elected, as were the retiring auditors, and an amendment in the Articles of Association having been approved, a hearty vote of thanks to the Chairman, the Directors and the staff was carried unanimously, and the proceedings terminated.

Cuba Submarine Telegraph Co. (Ltd.)

The eighty-fifth ordinary general meeting was held on Wednesday, Mr. GEORGE KEITH presiding.

The SECRETARY (Mr. A. C. Austin) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: I am glad to say our business for the past year has practically held its own, which I am sure you will consider very satisfactory. The message receipts fell off very considerably during the first six months of the year, due to increased competition and the less active state of trade generally. The improvement shown in July, and the large increases, owing to the war, in August and September, practically compensate for the falling off of the previous months. On October 1 came the reduction of rates to the British West Indies, resulting in decreases in October and November, followed by an increase in December, due to the commencement of the sugar harvest. Altogether the traffic receipts for the whole year show a decrease of £317. Interest on investments has increased £75, and the total revenue, including transfer fees, comes out at £38,244, or £246 less than it was in 1913. On the other hand, there is a large increase in the expenditure. Since the commencement of the war our through communication to the West Indies has been open night and day, which has largely increased the operating expenses in consequence of the payment of overtime to the staff. The cost of cable repairs in shallow water also shows a large increase. The income tax balance has been increased by the higher rate now imposed, and there is the balance of the cost of re-erecting the Cienfuegos office building over the amount recovered under the insurance policy on the old building, which was destroyed on Feb. 1, 1913. The aggregate of the other charges comes out less, and, altogether, the total expenditure amounts to £16,702, or £1,229 more than it was in 1913.

The result of the year's working shows a profit balance of £21,542, out of which interim dividends amounting to £7,000 were paid in October last, and after carrying £2,000 to the general reserve fund, £2,500 to the pension fund and £3,000 to the reserve against loss due to the depreciation of investments, the Directors now recommend the payment of final dividends of the same amount, making a total distribution for the year of 10 per cent., subject to income tax, on the preference shares, and 5 per cent., free of income tax, on the ordinary shares, and carrying forward £7,891, as compared with £7,848 brought forward from last year's account. I regret we have had to reduce the dividend, which we have been paying to the ordinary shareholders for a number of years. The lower dividend has been rendered necessary by the reduced year's profits and the uncertainty how long the war will last, and what the earnings of the business will be when it is over, in consequence of the reduction of rates on Oct. 1 last, to which I have just referred. We are also paying the dividend as we have always done, free of income tax, but, in view of the increased rate which will have to be met this year, it may become advisable in future to let the shareholders pay their own income tax, and, if possible, make a corresponding increase in the dividend, in place of paying it free of income tax as hitherto. In these uncertain times it behoves us to husband our resources and to make the Company's position as strong as possible.

The figures in the balance-sheet are all favourable. The general reserve fund now stands at £100,000, and the pension fund at £10,824. The reserve against loss due to depreciation of the investments has been increased to £23,091, and we hope that some appreciation may take place during the present year, and that no further increase to this reserve will become necessary. Sundry credit and debit balances are considerably higher than they were last year, but they are all good and fully secured. They vary from year to year, and greatly depend upon the position of the outstanding accounts at the close of the year. Our main cables are working well and giving an efficient service. I have, however, to mention that the earthquake, which took place last December, on the south coast of Cuba, broke the duplicate cable between Santiago and Cape Cruz, which, I am glad to say, was successfully repaired in March last. Since then the duplicate cable between Cienfuegos and Batabano also became interrupted in shallow water near Batabano, and has just been repaired. The expenses of both these repairs will appear in the current year's accounts. As regards the present year, the abnormal conditions due to the war still continue. The traffic passing over our cables is well maintained, and the earnings of the business, as far as they have been made up, compare favourably with what they were for the corresponding period of last year. I now move the adoption of the report and accounts.

Mr. CHARLES W. PARISH seconded the motion, which was carried unanimously.

Resolutions approving the dividends, re-electing the retiring director (Mr. J. P. Hooper) and the retiring auditors, approving a contribution by the Company in aid of the British Red Cross Society having been carried unanimously, a hearty vote of thanks to the chairman, directors and staff brought the proceedings to a close.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have issued the accounts for the year ended March 31, 1915. Three quarterly interim dividends of 15s. per cent. on the ordinary stock, and £1. 10s. per cent. on the preferred stock, were paid in May, August and October, 1914 (absorbing £157,500), and in January last the directors paid the final dividend for the year 1914, amounting to £1. 10s. per cent. on the ordinary, the preferred and the deferred stocks. These payments absorbed £262,500, being the rent paid by the Western Union Telegraph Co. for the year, equal to 3¾ per cent. on the ordinary stock, 6 per cent. on the preferred stock, and 1½ per cent. on the deferred stock. The balance at credit of revenue account (£71,250. 4s. 9d.) includes £5,625. 4s. 9d. interest received, and the balance of £65,625 is available for payment of dividends for the quarter to March 31 1915.

BABCOCK & WILCOX (LTD.)—At the meeting last week, the chairman (Mr. John Dewrance) said the net profits for the year 1914 amounted to £402,947, and it was proposed to pay a dividend on the ordinary shares of 9 per cent. (in addition to the interim dividend of 5 per cent. paid last October) after placing £150,000 to reserve, leaving to carry forward £69,491. In view of the war he considered the report a very satisfactory one. In replying to questions, he said that with regard to the dividend for the whole year being less by 2 per cent. than that of the previous year, the conditions at the present time were very different from what they were when the interim dividend was declared last autumn. Every trading company in the country was facing huge loss, and the wisdom of paying the dividends they proposed at present was arguable. Under the circumstances the directors had done the best they could. With regard to the company's foreign works, the less said about them the better. The directors knew nothing about the German company and did not want to discuss it. With regard to Russia, that country was in a very peculiar condition, and the shareholders knew as much as he as to what the future of Russia or the future of France would be.

BRITISH THOMSON-HOUSTON CO. (LTD.)—The report for the year 1914 states that prior to the outbreak of the war the company was making excellent progress in all its departments, but the business was seriously disturbed in many directions in August and September. In a comparatively short time satisfactory readjustments were made to cope with the new conditions with the idea of doing as much work as possible to fill orders to meet (directly or indirectly) the requirements of the Government, and at the same time carry out so far as reasonably possible its obligations to its other customers. Over 1,000 employés joined the Colours, being a large percentage of those eligible for military service. The loss of this number of employés and the difficulty in filling their places (even partially) has been a source of considerable embarrassment, but those who remained have loyally supported the efforts of the management in all directions. For months past the company has been manufacturing munitions of war at its various factories, and it has bought a large number of machine tools for this purpose. It is gratifying to note that notwithstanding the disturbed financial conditions the collections were excellent during the whole of 1914; practically none of its customers availed themselves of the moratorium, and the losses from bad debts were so small as to be inappreciable. This condition of affairs under the circumstances is remarkable and indicates the strong financial condition of the country.

The buildings and machinery at Rugby, Coventry and Willesden have been maintained in first-class condition, and all buildings under construction and authorised at date of last report have been completed and are now in use. At the end of December, due to the number of employés joining the Colours who were familiar with the stocks of finished apparatus and work in progress, it was physically impossible within a reasonable time, to take an actual inventory of the Rugby main factory, so that in making up the accounts for the year the company has relied upon the book figures, and, although in past years the inventory figures have shown a considerable increase over the book figures, and there is reason to believe the percentage of increase would have been equalled (if not exceeded) for 1914, the company has taken no profit on this account, but has allowed the book figures to stand. In the lamp factory at Rugby, in the factories at Coventry and Willesden, and in all branch offices, a complete inventory has been taken in the usual way. The profits for the year after deducting all expenses and charges other than interest on debentures and loans are £130,867. 14s. 11d., and, with £12,944. 0s. 7d. brought forward, the total is £143,811. 15s. 6d. The amount paid for interest on debentures and loans during the year was £56,704. 12s. 3d., leaving a net profit of £87,107. 3s. 3d. The directors have appropriated for depreciations £73,309. 10s. 9d. in order to still further strengthen the company's position, and £13,797 12s. 6d. has been carried forward. Heretofore the first two items on the credit side of the company's balance-sheet

have been "Goodwill, patents and licences" and "Investments in patent owning company." The second item is of substantially the same character as the first, and as the company owns all the shares in the "Patent owning company" the directors have decided to consolidate the items under the first title. Since the closing of the books debentures of the par value of £4,240 have been redeemed, making the total par value of debentures retired to date £30,025, and leaving a net amount outstanding of £181,975, against £186,215 at Dec. 31, 1914.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The report for 1914 states that 15,387,471 units of electrical energy were sold, compared with 14,070,927 units in 1913. The number of houses connected is 8,180, compared with 7,597 at Dec. 31, 1913. The profits amount to £140,609. 10s. 9d., which, with balance brought forward and interest received on money at deposit, makes a total of £148,140. 13s. 4d. After deducting interim dividend of 3½ per cent. on the ordinary shares paid in November last, the dividends paid and accrued on the preference shares, &c., the available balance is £102,476. 4s. 3d. The directors recommend that £52,000 be placed to credit of depreciation and renewals account, that £10,000 be added to reserve fund and that a final dividend be paid on the ordinary shares for the second half-year at rate of 5½ per cent., making 9 per cent. for the year, which will leave £11,481. 13s. 5d. to be carried forward after providing for directors' extra remuneration of £2,500 and a bonus of £1,406 payable to the staff in India. The expenditure on capital account last year amounted to £61,443. 5s. 6d., the total outlay to Dec. 31 last being £1,270,144. 12s. 3d. The demand for electrical energy continues to increase, and the directors have, since Dec. 31, 1914, found it necessary to issue additional capital.

CALCUTTA TRAMWAYS CO. (LTD.)—At the recent meeting the chairman (Mr. E. C. Morgan) said that the capital expended last year was £18,900 on additional rolling stock, &c. On the other hand, they had credited the capital account with £8,100, the cost of the Lancashire boilers installed in 1902, but which had been superseded. The boilers were sold for £1,787 and the balance (£6,313) had been charged to depreciation. It was proposed to add £15,000 to that fund out of the profits. In the first seven months of the year, up to the commencement of the war, the earnings were still on the up grade, as they had received £9,000 more than in the corresponding period of 1913. Unfortunately, the war turned the tide, and the total increase was only £1,032. Their expenses had increased, but they were able to maintain their dividend at 9½ per cent.

CITY OF SANTOS IMPROVEMENTS CO. (LTD.)—At the recent meeting the chairman (Mr. D. M. Fox) said the past year's revenue had been affected by the depression in trade. After paying all charges, the available balance was £30,628. The directors had set aside £4,000 to tramway renewals account and they recommended payment of a final dividend of 2½ per cent. on the ordinary share capital, making 5 per cent. for the year, leaving £6,628 to be carried forward. The additions to capital expenditure were £126,696, notably in completion of permanent way and paving, equipment and rolling stock of the tramways, additional electric light and power transmission lines, &c., new workshops and foundry; also gas, water and electric meters. The falling off in the tramway passenger and freight traffics, mostly occurred in the last five months of the year, and was clearly traceable to the inactivity of the business community following the crisis.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—The net profit for 1914 was £8,906. 0s. 3d., which, with £1,390. 19s. 10d. brought forward, makes £10,297. The directors recommend the appropriation of £2,500 for depreciation of buildings and machinery and £1,000 to reserve, payment of dividend (already paid) on the six per cent. preference shares for the half-years ended Sept. 30, 1914, and March 31, and a dividend on the ordinary shares at 6 per cent. for the year to March 31, 1915, leaving £1,697. 0s. 1d. to be carried forward (subject to payment of directors' fees for past year). Business during the period under review has been satisfactory, although the output has suffered somewhat from the dislocation inseparable from the war. The value of orders on hand is considerable and the prospects for the coming year are good.

EASTERN TELEGRAPH CO. (LTD.)—The directors' report for the year ended Dec. 31, 1914, states that the revenue amounted to £1,645,741. 7s. 8d., from which are deducted £621,865. 11s. for ordinary expenses and £164,583. 6s. 4d. for expenditure relating to maintenance of cables, sundry differences in exchange, income tax payable abroad and interest on temporary loans, leaving £859,292. 10s. 4d., to which is added £25,686. 11s. 9d. brought forward, making a total available balance of £884,979. 2s. 1d. After providing for income tax payable in England, interest on mortgage debenture stock and dividends on preference stock, which absorb £177,237. 10s. 7d., there remains £707,741. 11s. 6d., out of which the directors have placed £390,000 to general reserve fund, £5,000 to insurance of [illegible] fund and have paid three interim dividends of 1¼ per cent. each on the ordinary stock, aggregating £150,000. The directors now recommend the declaration of a final dividend on the ordinary stock of 1¼ per cent., and interim of 2 per cent., amounting together to £150,000, [illegible] on the 12th inst. (tax free), and making, with the three previous payments on account, a total distribution of 7 per cent. for the year. It is proposed to carry forward the balance of £32,741. 11s. 6d. The general reserve fund has been charged with £273,972. 18s. in respect of [illegible] and other special expenditure, and after crediting the £390,000 referred to above the net addition to the fund for the year is £116,027. 2s.

The register of transfers of the ordinary stock will be closed from the 5th to the 12th inst. inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) The gross receipts for the year 1914 amounted to £[illegible] as against £738,129. 7s. 1d. for the previous year. The working expenses, including £61,174. 13s. 10d. for maintenance of cables, absorb £364,978. 14s. 11d., against £354,864. 6s. 3d., leaving a balance of £454,604. 14s. 8d. From this is deducted £13,754. 17s. for income tax payable in England and £30,096 for interest on debenture stock, leaving £410,753. 17s. 8d. as the net profit for the year. After adding £30,616. 19s. 11d. brought forward the available balance is £441,370. 17s. 7d. Three interim dividends of 1¼ per cent. each have been paid for the year, and it is now proposed to distribute a final dividend of a like amount on the 12th inst., making with the interim dividends paid a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year. The sum of £200,000 has been transferred to general reserve, and the balance of £31,370. 17s. 7d. carried forward. The balance of cost (£194,078. 12s. 5d.) of the Penang–Singapore–Hongkong cables has been charged against the general reserve fund. The sum of £35,443. 13s. 1d. has also been charged against the fund for partial cable renewals carried out during the year, together with the loss (£43,901. 10s. 2d.) incurred on the sale of investments.

The register of transfers are closed from the 4th to 11th May inclusive.

EVERED & CO. (LTD.)—At the recent meeting it was reported that, after providing for debenture interest and income-tax, the net profit was £7,639. The directors recommend a dividend of 4 per cent. (tax free); £1,000 has been written off plant and £1,925 carried forward.

GENERAL ELECTRIC CO. (U.S.A.)—The report for 1914 states the value of the orders received was $83,748,521, against $111,819,142 in 1913, and the sales aggregated $90,467,692, against $106,477,439. Profit from sales was $8,970,963, against $10,269,605, and the total income was $11,855,384, against $14,065,789. In the report of the chairman (Mr. C. A. Coffin), it is stated that business experienced marked contraction during the past year, and while there was an advance of about 25 per cent. in the value of orders received, the total number of transactions was practically equal to that of 1913. The employés engaged in the factories and by subsidiary companies at the end of 1914 was about 1,500 less than in 1913.

JOHNSON & PHILLIPS (LTD.) At the meeting last week, the chairman (Mr. Robt. W. Blackwell) said that the 1914 trading profit (after providing £7,529 for maintenance of buildings and plant) was £37,119 (or £3,944 better than in 1913. With £12,755 brought forward, the total was £49,874. After paying directors, auditors' and trustees' fees, interest on debenture stock and reserve re debenture sinking fund, &c., the available balance was £24,295. He could repeat what he said at the last and previous meetings, namely, that their business was improving steadily in extent and value, and would, in his opinion, continue to improve. The balance sheet showed that the company occupied a sound and strong financial position. They had a large amount of work in progress. Their stock-in-trade had been taken on safe and conservative lines. Every department showed a profit on the year's working. Their stock-in-trade and work in progress represented £154,988 (or only £4,558 less than in 1913.) During 1914 they spent on additions to buildings and plant, £16,933 and set aside for depreciation £8,000. Their first debentures had decreased from £175,000 to £118,136. The Board recommended payment of a dividend at rate of 5 per cent. per annum on the ordinary shares, leaving to be carried forward £15,545. They did not consider that it would be justifiable to declare a larger dividend under existing conditions. He looked forward to the future of Johnson & Phillips with every confidence. Its manufacturing plant was well maintained and had been vastly improved during the past few years. Its shops had been, and were well employed, and he could see no reason why its turnover and profits should not increase steadily, especially when happier times came to the country at large.

The report and accounts were then adopted.

LISBON ELECTRIC TRAMWAYS (LTD.)—The result of the operations for 1914 (after deducting interest and amortisation on debentures of the Cia Carris de Ferro de Lisboa and after payment of £25,610 for interest on and redemption of debentures of this company and also payment of London office expenses and directors' remuneration, shows a net profit of £84,708. 12s. 8d., which, added to £1,749. 1s. 7d. brought forward, gives £86,457. 14s. 3d. Of this amount £15,000 has been placed to credit of depreciation reserve and £5,000 to exchange reserve and £19,012. 12s., formerly standing to the credit of "premium on ordinary share capital," has also been transfered to depreciation reserve to adjust the decrease in this year's appropriation from profits. An available balance of £66,457. 14s. 3d remains, out of which the usual 6 per cent preference dividend (£25,533. 3s. 8d.) has been paid. In November an interim dividend of 3 per cent. was paid on the ordinary share capital, and the directors now recommend the payment of a final dividend at same rate, making 6 per cent net for the year, leaving £2,882 19s. 5d to carry forward. The tramways carried 63,758,037 passengers, earning Es.1,938,210879,3, as compared with 58,840,923 passengers and Es.1,861,056893,9 in 1913. The traffic has been more than maintained, but the increased cost of supplies (especially coal) and the falling off in the average rate of exchange from 46·199d. to 43·43d. resulted in a diminution of the profit to the extent of nearly £20,000. The extension of the power plant was completed during the year and is in satisfactory operation. One of the most important of the Ascensores lines was electrified and re-opened to traffic during the period, and the remainder of the system will be completed in the course of the current year. The board regret to record the death of the secretary (Mr. S. W. Jameson), which occurred on March 26 last. Mr. Jameson was secretary of the company since its inception, and Mr. F. Hames, the acting secretary, has been appointed his successor.

ORIENTAL TELEPHONE & ELECTRIC CO (LTD.)—Mr. H. Johnstone Grewing presided at the meeting last week, and referred with regret to the death of Mr. E. St. J. Ackers, who died on the 18th ult. at his home in Gloucester. Mr. Ackers was one of the oldest, if not the oldest, shareholder in the company, and he was a director since 1884. Since the death of their late Chairman Sir Auckland Colvin in 1908 Mr. Ackers had been in the habit of taking the chair at the annual meetings. The election of Mr. Ness to a seat on the board was in order to fill the vacancy caused by the death of Mr. Ackers. The progress at all their branches had been maintained. The net increase in revenue of the China company was £1,619, and the number of new lines added was 235. The Bengal company showed an increase of £3,143 in net revenue and 358 new lines added, and the Bombay company an increase of £2,403 and 199 lines. The dividends paid by the two former companies remained the same as last year (5 and 7 per cent.), but the Bombay company felt itself able to increase its dividend by 4 per cent. to 16 per cent. In regard to the Egyptian company, as they all knew, Egypt had been very much affected more so perhaps, than any other of their Eastern agencies by the war; and, in addition to that, for the last seven or eight years it has had a series of misfortunes. To have been able to maintain their position there, in the circumstances, would have been an achievement of no small merit; but, in addition, they had been able to show a slight advance on the previous year. At most, if not all, of their exchanges very considerable demands had been made upon their services both by the military and civil authorities, and they had succeeded in meeting their requirements in every case; in fact, their managers had been complimented on the assistance they had been able to afford to the various Governments in Singapore on the occasion of the recent riots, and also in Egypt and Hong Kong.

PAIGNTON ELECTRIC LIGHT CO. (LTD.)—At the recent meeting the directors reported that the net profit for the past year was £719. 12s. 9d. A sum of £491 was written off, and £229 was carried forward. 42 additional consumers were connected during the year. The chairman (Mr. W. J. Ham) said there was every prospect of a dividend next year.

RICHARDSONS, WESTGARTH & CO. (LTD.)—The chairman (Mr. W. J. Richardson) presided at the recent meeting and said the most satisfactory results for the past year, achieved on a turnover approximating to that of the preceding year, demonstrated in a conclusive manner the sensitiveness of the profit and loss margin in all large competitive businesses. A relatively small increase in selling prices, together with reductions in cost of manufacture, had resulted in a considerable increase in nett earnings, notwithstanding adverse influences. The work in hand at the date of the last meeting, was known to carry round about a 5 per cent. margin, and for contracts booked immediately afterwards somewhat better prices were obtainable, though they fell again towards the end of the year. Such prices, however, would not themselves have sufficed to yield the return shown. By standardisation of manufacture and such works re-organisation as the directors had been able to carry out, it had been possible to effect economies in cost of production, and to appreciably augment the initial margins, especially those carried by the earlier contracts. A considerably increased contribution to profit had been made by the turbine department during the year, and the directors believed that the anticipations formed in putting that adjunct to their properties would be realised. Within a few weeks of war being declared some 500 had left to join His Majesty's Forces. The shipyards suffered similar depletions, and work on both ships and engines was at once retarded. During the bombardment of the Hartlepools by the German Fleet, the works were considerably damaged by shell fire, whilst eight employees lost their lives. The damage had been assessed by experts at £3,500, a claim for which had been lodged with the Bombardment Damage Committee appointed by the Government. In several departments, however, full resumption of work had not yet been possible, with consequent further effect upon output. The directors were still of opinion that it would be wise to reconstruct the company, but a necessary preliminary would be a revaluation of their entire assets. The works of the Heavy Stampings Co. at Middlesbrough were on lease to a large firm of motor manufacturers, with an option of partnership at the end of this or next year. The works were fully employed and they anticipated that the option would not only be exercised, but that the future of the Heavy Stampings Co. would be satisfactory. As to the general prospects for the present year, it would be presumptuous even to hazard a forecast. Already the wholesale requisitioning of shipyards for Government work had led to the almost total suspension of mercantile marine work. The company had secured a share of Admiralty work, largely on the time and material basis, but a very much larger volume would be necessary to recoup the losses that would be incurred on the deferred merchant work, due to accumulated interest charges and the great loss of time per week on same.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—The directors report that, notwithstanding the dislocation of trade during the last five months of 1914, the [illegible] to 26,510,198, compared with 25,812,031 in 1913, an increase of 698,167 units. The surplus, after payment of all working expenses and interest on prior lien debenture stock, and making due provision for depreciation of new plant, amounts to £5,347 7s. 7d., compared with £2,915 11s. 4d. for 1913, or an increase of £2,431 16s. 3d. The accumulated profit is now sufficient to deal with the indebtedness of £13,500 due to certain members of the Treforest Company for overcharges. The continued [illegible] of the business necessitates the provision of further capital, for which the [illegible] and the directors [illegible] and, subject to these and [illegible] being accomplished, the directors [illegible] to be able to make a payment in respect of interest on the original debenture stock in the course of the coming year.

SOUTHPORT TRAMWAYS CO. (LTD.)—The directors' report for 1914 states that since the inauguration of electric traction an annual payment of £1,053 has been made to Southport Corporation for the maintenance, repair and renewal of a portion of the permanent way and electrical equipment. The total amount paid to Dec. 31, 1914, to the Corporation for maintenance is £13,677. 0s. 8d. During the same period the company paid under the leases to the Corporation a total of £72,661. 8s. 9d. for the right of user of the tramways. The total revenue for 1914 (including £106) brought forward amounted to £17,142. After deducting all expenses chargeable to revenue, including £5,573 payable to the Corporation (in addition to amount referred to above) and a provision of £500 for renewals, the balance is £650. The directors recommend that £500 be placed to reserve, leaving to be carried forward £150.

SUBMARINE CABLES TRUST.—The revenue for the year to April 15 amounted to £25,175. 4s. 3d., and the expenses to £1,359. 1s. 4d., leaving £23,816. 2s. 11d., to which is added £30. 3s. brought forward, making an available balance of £23,846. 5s. 11d. After providing £16,236 to meet payment of the coupons, the sum of £7,560 has been transferred to redemption fund, leaving £50. 5s. 11d. to be carried forward. Since the last report 63 certificates have been redeemed (exclusive of the coupons of reversion) at £120 per certificate, two by tender and 61 were drawn by lot on the 29th ult., absorbing £7,560. By a resolution of the trustees, £4,300 Anglo-American Telegraph Co.'s preferred stock has been sold during the year, and the proceeds have been invested in shares of the Great Northern Telegraph Co.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The revenue for 1914 amounted to £55,523. 7s. 3d., from which is deducted £17,633. 6s. 4d. for ordinary expenses and £8,536. 9s. for expenditure relating to maintenance of cables, sundry differences in exchange and income tax abroad, leaving £29,353. 11s. 11d., to which is added £66. 2s. 5d. brought forward, making a total available balance of £29 419. 14s. 4d. The sum of £542. 16s. 5d. has been provided for income tax, £19,000 has been transferred to general reserve fund, and an interim dividend of 2 per cent. (tax free), absorbing £4,621. 16s., was paid in December last. The directors now recommend the declaration of a final dividend of 2 per cent (tax free), payable on and after the 13th inst., making, with the interim distribution, 4 per cent. for the year, the balance of £633. 5s. 11d. being carried forward. Sir Albert J. Leppoc Cappel, K.C.I.E., has been appointed to a seat on the board in the place of the late Mr. Robert Kaye Gray.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The gross receipts during 1914 amounted to £61,129. 5s. 8d., against £53,645. 16s. in 1913, and the working expenses were £43,054. 9s., compared with £47,586.2s.6d. The revenue account shows a balance of £18,074. 16s. 8d., and after providing £6,000 for interest on the 4 per cent. debentures and £800 for interest on the 4 per cent. income bonds, the balance is £11,274. 16s. 8d., to which is added £719. 19s. 8d. brought forward, making a total of £11,994. 16s. 4d. A sum of £10,000 has been deducted from this amount on account of depreciation in value of the company's investments, and the balance (£1,994. 16s. 4d.) is carried forward. The directors regret that, in view of the necessity for making this provision, they are unable to recommend the payment of a dividend.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors in their report for the half-year ended Dec. 31, 1914, refer with regret to the recent death of Sir John Cameron Lamb, C.B., C.M.G., who had been a director of the company since 1906, and Sir Alex. F. King, K.C.B., has been elected to a seat at the board. For the half-year the amount to credit of revenue is £49,935. 2s. 1d., against £38,699. 0s. 11d. for the corresponding period of 1913, and the expenses have been £31,251. 15s. 6d., against £25,629. 16s. 4d. The balance is £18,683. 6s. 7d., to which is added £1,825. 2s. 5d. interest on investments, and £922. 0s. 1d. brought forward, making an available total of £21,430. 9s. 1d. The directors propose the payment of dividends of 6s. per share on the first and second preference shares for the six months to Dec. 31, and of 9d. per share on the ordinary shares (tax free), leaving £6,348. 16s. 4d. to carry forward. The traffic receipts for the six months, taken as a whole, show an increase. While on the one hand the receipts in August and September were materially benefited as a result of the war in Europe, there was a great falling off in the months of October, November and December owing to the reduction in rates consequent upon the carrying out of the new agreement with the Imperial, Canadian and Colonial Governments, as well as to the continued competition at Porto Rico. At the same time the pressure of war conditions has necessitated a continuous day and night service at their stations, involving a greatly increased expenditure. The cost of maintenance of cables was practically the same as in the corresponding period of last year. As in the case of most other companies, the investments in respect of reserve funds have considerably depreciated—viz., to the extent of about £15,000. The directors consider that the present circumstances render it undesirable to make any specific provision for this depreciation.

WESTERN CANADA POWER CO. (LTD.)—The gross earnings for 1914 were $31,800 and operating expenses $8,150, leaving a surplus of $228,650. An additional expenditure of about $80,000 is required to complete the installation of the third generating unit; and the installation of the fourth generating unit (which is partly paid for) will require about $165,000. The completion of the dams necessary to operate the four units to their full capacity will cost $400,000, and the completed installation will then produce 52,000 H.P. The directors now propose to increase the capital stock and to create an issue of preference shares, in the hope that, if the financial stringency is prolonged, holders of its

mortgage securities may eventually decide to convert these securities into preferred shares.

WESTON-SUPER-MARE & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the chairman (Mr. Geo. J. Somerville) said that the working accounts for the year showed a credit balance of £9,250. Dividends at rate of 6 per cent. on the preference and 3 per cent. on the ordinary shares for the year were declared and £809 carried forward.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS (LTD.)—The past year's revenue was £28,359. After deducting expenses (including debenture interest, repairs and maintenance, and providing £2,000 for renewals) the profit was £2,350, to which has to be added £134 brought forward. The directors propose to place to reserve £400, and to pay a dividend on the ordinary shares of 1 per cent. per annum, carrying forward £386

YORKSHIRE (WOOLLEN DISTRICT) ELECTRIC TRAMWAYS (LTD.)—The revenue for 1914 was £65,385, an increase of £2,876. After setting aside £4,500 to renewals fund, there remains £9,697, which, added to £1,891 from 1913, makes an available balance of £11,588. The directors propose to place £2,000 to reserve, to pay a dividend at rate of 3¼ per cent. per annum on the ordinary shares, and to carry forward £2,587.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

EAST LANCASHIRE ELECTRICAL CO. (ACCRINGTON) (LTD.) (140,029)—Reg. April 21, capital £1,000 in £1 shares, to carry on the business of electric, silver or nickel platers and polishers, electric light and power engineers, makers of electric cooking and heating apparatus and machinery for electrical, mechanical and textile purposes. Private company. First directors are G. W. Somerville and F. G. Clarke. Reg. office: Paradise-street, Accrington.

ELECTRICAL WHOLESALERS' FEDERATION (LTD.) (140,094).—Reg. April 27, as company limited by guarantee, not having a share capital. For the purpose of registration, the number of members is declared not to exceed 100, but the Committee may register an increase. Each member is liable for not more than 5 guineas in the event of winding up. The objects are to promote and protect the interests of wholesale dealers in, and factors and suppliers of, electrical goods and appliances, to promote the consideration and discussion of all questions affecting the wholesale electrical trades, to procure, circulate and supply information (including status information), to obtain the most favourable terms and rates from manufacturers of goods and from railway and shipping companies and other carriers, to encourage the settlement of disputes by arbitration, to act as or nominate arbitrators and umpires, to promote displays of electrical goods, machinery, appliances and fittings and drawings of same at National and International Exhibitions, and to watch over and protect the interests of persons engaged in selling electrical goods and appliances. The subscribers are: M. Beales, engineer; F. Pooley, engineer; R. W. Smith, engineer; F. S. Smith, engineer; A. G. Beaver, electrical engineer; P. L. Davies, electrical engineer; and G. O. Donovan, electrical engineer. All persons, firms or companies who are bona fide wholesale dealers in or factors or suppliers of electrical goods and appliances are eligible as members. The management is vested in a Committee of not less than seven nor more than 12 members. Manager: F. S. Smith. Reg. office: Amberley House, Norfolk-street, Strand, W.C.

MORTGAGES AND CHARGES.

AUTOELECTRIC TRANSMISSION (LTD.)—Debenture dated April 15, 1915, to secure £200, charged on company's undertaking and property, present and future, including uncalled capital. Holders: A. A. Knight and H. L. Mocatta.

BRITISH ELECTRIC AUTOMATIC MACHINES (LTD.)—Debenture and agreement in connection therewith, both dated April 12, 1915, to secure £1,000, charged on the company's undertaking and property present and future, including uncalled capital. Holders: Kleinwort, Sons & Co.

NORTH-EASTERN ELECTRIC SMELTING CO. (LTD.)—Mortgage dated April 16, 1915, to secure £6,250, any further moneys which may be advanced or become owing, charged on premises in Wadsley and company's undertaking and property, present and future. Holder: Secretary of State for War.

G. H. TURNER & CO. (LTD.)—Issue on April 21, 1915, of £500 debenture, part of series of which particulars have already been filed.

WILLIAM DENTON (LTD.)—Mortgage debenture dated April 20, 1915, to secure £250, charged on company's undertaking and property, present and future. Holder: L. J. Smith.

CITY NOTES.

MEMORANDA (May 5) Bank rate 5 per cent. Date of Account, 1914. Consols 66⅞. Consols Pay Day June 1. Stocks and Shares Ticket Days May 12 and 27. Pay Days May 13 and 28. Price of silver 24d.

AUCKLAND ELECTRIC TRAMWAYS (LTD.)—The directors have declared an interim dividend of 7d. per share (free of tax) on the ordinary shares

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The directors recommend payment of a final dividend at the rate of 11 per cent. per annum for the half year ended 31st Dec., 1914, making, with the interim dividend paid in November last, 9 per cent. for the year. The number of units sold to consumers during the four weeks ended Feb. 26, 1915, amounted to 990,763, compared with 1,080,419 in the corresponding four weeks of 1914. The number of units sold for four weeks to March 26 amounted to 1,212,991, against 1,220,009

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—The directors recommend a dividend of 10 per cent. on the ordinary shares for the past year, the same as the last ten years. For 1912-13 there was also a bonus of 7s. 6d. per share in shares and for 1913-14, a bonus of 2s. per share (10 per cent.) in cash.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—A dividend of 1s. 3d. per share (at rate of 5 per cent. per annum) less tax, has been declared for the quarter ended March 31.

COLOMBO ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The directors have declared a dividend of 10 per cent. for the year 1914. £20,000 has been transferred to general reserve and renewal fund, and £8,010 carried forward.

GELL TELEGRAPHIC APPLIANCES SYND. (LIMITED & REDUCED).—A petition for the confirmation of the reduction of the capital from £40,000 to £20,000 will be heard by Mr. Justice Neville on May 11.

HOLSWORTHY GAS & ELECTRIC SUPPLY CO. (LTD.)—The directors have declared a dividend of 4 per cent. for the past year, against 3½ per cent. in 1913.

LA PLATA ELECTRIC TRAMWAYS CO. (LTD.)—The accounts for 1914, after providing for debenture and other interest, show a credit balance of £6,614, which the directors recommend to be carried forward.

MONTREAL LIGHT, HEAT & POWER CO. (LTD.)—The directors have declared a dividend of 2½ per cent. on the paid-up capital stock (being at rate of 10 per cent. per annum) for the quarter ended April 30.

NAIROBI ELECTRIC POWER & LIGHTING CO. (LTD.)—An extraordinary meeting was held on Wednesday when a resolution converting the preference shares into ordinary shares in consideration of a bonus of 12½ per cent. being paid in fully-paid ordinary shares (or cash at the option of the company) was passed.

REUTER'S TELEGRAM CO. (LTD.)—The directors have appointed the secretary of the company (Mr. Walter F. Bradshaw) to be manager and secretary. Mr. Bradshaw has been connected with the company since 1874, and is thoroughly conversant with every branch of the Company's business.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—The directors have declared a quarterly dividend of 2½ per cent.

SUBMARINE CABLES TRUST.—Announcement is made on another page of the drawing of 61 certificates of this Trust, for £120 sterling each (£7,320), for payment by Messrs. Glyn, Mills & Co., 67, Lombard-street, London, E.C. Interest on the certificates ceased April 15.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, May 5. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Stock	Last Dividend	Name.	Price, Wed., May 5.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
		Bournemouth & Poole E.L. Ord.		7 1 0	Mar, Sept
		Do. 4½% Cum. Pref.		4 5 4	Jan., July
		Brighton & Hove & Dist. Ord.		4 17 3	Feb, Aug
		Brighton & Kemp Town Ord.		5 19 1	Mar., Sept
		Central Elec. Supp. G. Deb. St		4 5 5	..
		Charing Cross West End & City Debs.		4 7 11	Jan., July
		Do. 4½% Pref.		5 7 6	..
		City of London Elec. Lt. Ord.		6 7 3	Feb, Aug.
		Do. 6% Pref.		4 19 6	May, Nov
		Do. 5% Deb. St.		4 10 10	June, Dec
		Consett & D. E. 6% Pref.		5 12 6	Feb., Aug
		Do. Ord.		4 13 1	May, Nov
		Edmundson's Elec. Supp. 4½% Debs.		5 12 6	July
		Kensington and Knightsbridge Ord.		6 4 2	Feb, Aug
		London Elec. Supply 6% Pref.		6 1 3	..
		Do. 5% Max. Pref.		4 15 5	Jan, July
		Metropolitan E. Supp. Ord.		5 9 10	May, Aug.
		Do. 4% Deb.		4 15 3	July
		Newcastle & Dist. E.L. 6% 2nd Dbs		6 1 10	Mar, Sept
		Newcastle-on-Tyne E.S.S.% 2nd Mt. Db. St.		5 1 0	Mar, Sept
		North Metropolitan E. P. Supp. 6% Pref		6 1 4	Apl., Oct
		South London E.S. 1st Mort. Debs.		5 6 3	Jan, July.
		Urban Elec. Supp 4½% Db. St.		5 11 11	Apl, Oct
		Westminster E. Ord.		4 4 4	Mar, Sept
		Do. 5% Pref.		4 7 1	Jan, July.
		Electric Railways & Tramways.			
		Brighton Tramways Ord.		5 19 9	Apl, Oct
		Do. 5% Cum. Pref.		6 6 7	Feb, Aug
		Central London Guar. Assented Ord.		5 7 7	..
		Do. 5% Pref.		5 4 10	..
		Liverpool Tramways Ord.		5 12 11	Feb, Aug
		Do. 5% Pref.		5 16 6	Jan, July
		Do. 4% Pref.		4 11 7	Mar, Sept.
		Do. 4% Debs.		4 11 7	Jan, July.
		Metropolitan Ry. Con. Ord.		4 3 4	Feb, Aug
		Do. 5% Pref.		4 10 0	Jan, Aug
		Do. 4% Deb.		4 14 5	Feb, Aug

[illegible] interest [illegible]

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name.	Price, Wed., May 5.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways—*cont.*		£ s. d.	
St.	3½%	Metropolitan Dist. Ry. 3½% A Debs.	83	4 3 4	Jan. July
St.	3½%	Do. 3½% Debs.	83½	4 3 10	Jan. July
St.	..	Metropolitan Dist. Ry. Ord.	17	..	Feb. Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	73½	6 2 5	Feb. Aug
St.	6%	Do. 6% Perp. Debs.	127	4 13 3	Jan. July
St.	4%	Do. 4% Debs.	87	4 9 11	Jan. July
St.	4%	Do. 4% Deb. 1943-63	87	4 11 10	Jan. July
St.	4%	Do. 4% Guar. Stock	87½	5 3 4	Mar. Sept
10	..	Underground E. Rys. of London Shares.	11	..	..
1/10	..	Do. A Ord.	1/8	..	..
St.	6%	Do. 6% 1st Debs.	113½	5 6 11	Mar, Sept
..	6%	Do. 6% Inc. Bds. A to Sup. 15	8½	7 8 4	Mar, Sept
..	4½%	Do. 4½% Bds.	111½	4 8 6	Jan, July
5	..	Yorkshire W. Riding Ord.	5½	..	March
		Electric Manufacturing, &c.			
1	1/0	Babcock & Wilcox Ord.	28	6 0 10	Apl, Oct
1	1/0	Brit. Aluminium Ord.	14	4 13 11	Mar
100	5%	Do. Prior Lien Debs.	98	5 2 10	Jan, July.
1	7/1d.	Do. 6% Pref.	8	6 12 10	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	11½	6 11 2	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	6¼	4 16 0	Jan, July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	1⅛	5 12 11	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	14	7 17 6 5	April
100	6%	Do. 6% Prior Lien Debs.	102	5 17 2	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73½	5 8 10	Jan, July
5	5/0	Callender's Cable, &c., Co. Ord.	11⅛	6 6 0	Jan, July
5	2/6	Do. 5% Pref.	4⅛	5 1 3	Feb, Aug
1	15%	Castner Kellner	3½	4 8 11	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	1⅛	7 14 10	Sept
5	..	Edison & Swan U Elec Lt A. £3 pd.	3	..	Feb, Aug
1	6%	Elec. Construction Ord.	1⅛	9 2 11	May
St.	4%	Do. 4% Debs.	69	5 15 11	Jan, July
10	6/0	General Electric 6% Pref.	11⅝	5 17 0	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	14½	6 17 11	Feb, Aug
5	2/6	Do. 4½% Cum. Pref.	6	4 10 0	..
St.	4½%	Do. 4½% Deb.	96	4 13 9	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	9	5 11 1	Feb, Aug
10	5%	Do. Pref.	8¾	5 16 9	Apl, Oct
100	4%	Do. 4% Debs.	97½	4 2 2	Apl, Oct
12	36/0	Telegh. Con. & Main. Co.	37½	6 7 7	Mar, July
100	4%	Do. 4% Debs.	95	4 4 3	Jan, July
1	12½%	Vickers Ord.	11⅜	6 13 9	May, Aug
1	6d.	Do. 5% Pref.	1⅛	4 14 1	May, Aug
St.	4%	Do. 1st Debs.	93½	4 5 7	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	104½	4 0 1	Jan, Dec
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	106½	5 12 11	Fb My, Aug. N
St.	30/0	Do. Def. Ord.	22½	6 11 10	Fb, My, Aug. N
St.	4%	Commercial Cable 4% Debs.	77	5 3 11	Ja. Ap. Jly. O
10	5%	Cuba Submarine Ord.	8½	5 13 10	May, Nov.
10	10/0	Do. 10% Pref.	16½	6 3 1	..
5	5/0	Direct Spanish 10% Pref.	7⅝	6 13 4	..
10	4%	Direct United States	6½	6 3 8	Ja. Ap. Jly. O
St.	25/0	Eastern Tel. Co. Ord.	136	5 2 11	Ja, My, Jly, O
St.	17/6	Do. 3½% Pref.	74½	4 14 0	Ja, My, Jly, O
St.	4%	Do. 4% Debs.	93½	4 6 0	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	92	4 7 0	Feb, Aug
10	2/6	Do. Ord.	13½	5 3 3	Ja, Ap, Jly, O
10	22½%	Gt. Northern Tel. Co. with Coup. 6.	29½	7 0 3	Ja, My, Jly
25	13%	Indo-European	17	5 15 9	May, Nov
1	2/-	Marconi's Wireless Tel. Co.	1⅛	11 17 5	April
1	1/4½	Do. 7% Pref.	1⅛	10 6 11	July
10	1/3	West India & Panama Ord.	1⅜	9 8 6	May, Nov
10	6%	Do. 1st Pref.	8⅞	6 19 2	May, Nov
10	3/0	Western Telegh. Co.	13½	5 2 3	Mr, Jly, O. Dec
St.	4%	Do. 4% Deb. St.	84½	4 7 8	Jun, Dec
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	124½	6 8 9	Ja. Ap, Jn. O
5	5%	Cuban Telephn. Co. 5% Bds.	80	6 5 0	Jan, July
1	7/6	Monte Video Telephone Ord.	3	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	97½	4 12 1	May, Nov
1	10%	Oriental Telephone Ord.	2⅛	5 0 0	Apl, Oct
St.	4%	Do. Db. St.	86	4 13 4	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	88	5 2 3	Jan, July
5	3/0	United River Plate Ord.	6¾	5 4 1	Apl, Oct
5	5%	Do. 6% Cum. Pref.	4⅞	5 2 3	Jan, July
St.	4½%	Do. Deb. St.	93½	4 16 1	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	11⅛	5 8 6	Sp, Dc, Mr, Jn
10	3/0	Do. 6% Pf.	11⅛	5 0 6	Sp, Dc, Mr, Jn
100	5%	Mackay Companies' Comm'n.	50	6 5 0	Ja, Apl, Jly, O
..	4%	Do. $100 Pref	70	5 14 3	Ja, Ap, Jly, C
100	6%	Submarine Cable Trust Certs.	127	4 14 6	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	89½	5 10 7	Jun, Dec
St.	4½%	Do. 4½% Debs.	83½	5 3 0	Jan, July
St.	4%	Do. 4% Debs.	83	4 16 3	Jan, July
5	2/-	Do. 5% 1st Pref.	4⅛	6 1 7	Jan, July
5	2/-	Do. 5% 2nd Pref.	3½	7 1 11	Jan, July
100	8½	Brazilian Traction Ord.	90½	10 13 4	Fb, M Aug, N
100	8½	Do. 6% Pref.	73	6 11 2	Ja, Apl, Jly, O
5	4/0	Brisbane Trams Ord.	7½	5 10 4	May
5	2/6	Do. 5% Cum. Pref.	4½	5 9 8	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	81½	5 4 6	..
5	9d.	Calcutta Elec. Trams. Ord.	1	7 6 2	Mar, Sep
5	5%	Havana Elec. Ry. 5% Bds.	88½	5 13 6	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	5	6 0 0	..
100	5%	Manaos Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Trams Common St.	4½	..	Fb, M. Aug, N.
..	5%	Do. 5% Bds.	57	8 15 5	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922).	100	4 10 0	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & F. 50 yr. Bds	79½	6	Jun, Dec
100	4½%	Do. 4½% 1st Mort. Bds.	96½	4 14 3	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Anglo-Arg. Elec. Supply Pref.	5⅞	5 14 4	Mar, Sept
St.	..	Do. 5% Debs.	103½	4 16 7	Jun, Dec
1	..	Bombay E. S. & T. 6% Pref.	1⅛	5 14 3	..
..	..	Calcutta E. S. Corp. Ord	1⅛	6 13 1	Apl, Oct
..	..	Do. Pref.	4½	..	..
..	..	Canadian Gen. Elec. Common St.	70	7 10 4	Ja, Apl, Jly, O
..	..	Melbourne Elec. Supply 5% 1st Mt. Debs.	102½	4 17 9	June, Dec
1	..	Do. 5% Cons. Deb. St.	11⅛	4 18 0	Apl, Oct
..	..	Spanish Prov. Electric Bds.	81½	4 18 9	Jan, July
..	..	Do.	1.2	4 13 9	Ja, Apl, Jly, O
St.	4½%	Toronto Electric Light St.	94½	4 11 2	Jan, July
St.	4½%	Do. 4½% Debs.	94½	4 15 0	May, Nov
1	..	Victoria Falls & Transvaal Pwr. Ord.	1⅛	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	89	6 3 8	Jan, July

† Includes Omnibuses, &c.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date May 5, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	11¾d.
Solid Drawn Copper Tubes	13¾d.
Brazed Copper Tubes	13¾d.
Brazed Brass Tubes	13¾d.
Brass Wire	11¾d.
Copper Wire	12¾d.
Rolled Brass	11¾d.
Brass Sheets	12¾d.

	per ton.
Copper Sheets	£100 0 0
Spelter	£64 10 0

	per ton.
Antimony	£95 0 0
English Lead	£21 0 0

Old Metals.	per ton.
Clean Scrap Copper	£73 0 0
Brazlery Copper Scrap	£68 0 0
Clean Scrap Brass	£53 0 0
Old Lead	£18 0 0
Old Zinc	£15 0 0
Hollow Pewter	£115 0 0
Black Pewter	£85 0 0
Gun Metal	£62 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date May 4, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£60 0 0	Old Lead	£19 0 0
Clean Mixed Brass	£52 0 0	Tea Lead	£18 0 0
Clean Copper	£72 0 0	Old Zinc	£46 0 0
Clean Copper Cuttings	£74 0 0	Hollow Pewter	£120 0 0
Brazlery Copper	£68 0 0	Soaped Black Pewter	£85 0 0
Gun Metal	£64 0 0		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	No. of weeks.	Aggregate. Amount.	Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	April 23	1,564	— 31	48	78,534	+ 2,229
Anglo-Argentine	.. 29	50,995	— 816	17	867,396	— 92,482
Ashton-under-Lyne	May 1	461	— 17	5	2,332	— 143
Ayr Corporation	.. 1	308	+ 4	5	16,527	— 1,270
Bath Electric Trams. Ltd	..	..	..	..	..	..
Birkenhead Corporation	.. 2	1,326	— 116	5	44,419	— 347
†Birmingham Corporation	April 24	13,125	— 187	4	44,419	— 2,336
Blackburn Corporation	.. 28	1,172	— 147	5	6,132	— 937
Bolton Corporation	May 2	2,666	— 152	5	12,334	— 1,847
†Bournemouth Corporation	April 23	2,048	+ 4	4	9,023	— 47
Bradford Corporation	May 1	6,363	— 5	5	29,132	— 1,755
Brighton Corporation	.. 2	971	— 25	5	4,521	— 727
†Bristol Trams & Carriage	April 31	9,038	+ 499	17	148,266	+ 12,999
Burmah E. Trams & Ltg.	May 1	R3,707	R445	17	..	— R39,219
Burnley Corporation	.. 1	1,477	— 361	5	7,915	— 1,042
Burton Corporation	.. 2	281	— 5	5	1,277	— 157
Bury Corporation	.. 2	1,334	— 31	58	6,333	— 683
Calcutta Tramways Co.	.. 1	₹60,267	— ₹5,413	17	₹1,000,002	— ₹76 686
Camborne-Redruth	.. 1	129	— 11	17	2,099	— 150
Cardiff Corporation	April 24	2,425	— 359	3	8,855	— 1,799
Central London Railway	.. ..	..	..	..	..	..
Cork Electric Trams Co.	.. 29	523	— 21	17	7,655	— 315
Croydon Corporation	.. 28	1,728	— 54	3*	6,084	— 515
*Derby Corporation	May 1	959	— 90	4	4,573	— 388
Dover Corporation	.. 1	284	+ 31	4	1,265	+ 104
Dublin United Tramway	April 17	1,3	+ 17	17	2,184	+ 52
Dublin United	.. 30	8,9	+ 393	17	98,354	+ 5,521
Dundee Corporation	.. 28	1,281	— 45	50‡	63,381	— 1,374
East Ham Council	May 1	1,1	+ 239	4	5,940	+ 1,197
Erith Urban Council	.. ..	..	..	..	..	..
Exeter Corporation	April 30	355	— 5	4	1,526	— 153
Glasgow Corporation	May 1	22,426	— 526	43‡	974,911	— 8 685
Glossop Trams	.. 1	118	+ 8	18	1,991	— 201
Gloucester Corporation	April 25	297	— 34	4	1,263	— 173
†Halifax Corporation	.. 27	2,034	— 125	4	8,792	— 847
Hastings Elec. Trams Co.	.. 29	872	— 122	17	13,088	— 688
Hong Kong	May 1	$10,199	$170	17*	$192,2.6	— $170
Huddersfield Corpn.	.. 1	2,1	+ 251	5	11,855	+ 541
Hull Corporation	.. 1	2,4	— 72	4	13,723	— 1,218
Ilford District Council	.. 1	6	— 122	4	2,835	+ 491
Ilkeston Corporation	April 25	111	— 29	4	4 74	— 69
Ipswich Corporation	May 1	4	— 6	4	1,961	— 74
Isle of Thanet Co.	.. 1	310	— 153	30	9,055	— 2,387
Kilmarnock Corporation	.. 1	1	— 2	50	7,976	— 751
Lanarkshire Trams Co.	April 24	1,870	— 72	17	30,130	— 1,927
Lancashire United	.. 28	1,629	— 54	17	26,496	— 370
Leeds Corporation	May 1	8,401	— 5	5	38,654	+ 42
Leicester Corporation	.. 1	2,939	— 36	18	49,252	— 73
Lytham Corporation	.. 1	2	— 9	50	35,046	— 279
Lincoln Corporation	.. 1	1	— 2	5	654	— 62
Liverpool Corporation	.. ..	..	..	..	..	..
Liverpool Overhead Rly.	.. ..	..	..	..	..	..
Llandudno & Colwyn Bay R	April 30	3	+ 69	21	4,645	+ 703
London County Council	.. 21	45	+ 5,544	3	148,189	+ 13,176
London Elec. Ry. Co.	.. ..	..	..	..	..	..
London United	.. ..	..	..	..	..	..
Lowestoft Corporation	May 1	1	— 15	30	4,982	— 562
Maidstone Corporation	.. ..	..	..	..	..	..
Manchester Corporation	.. 1	17	— 659	4	78,034	— 2,783
Mersey Railway	.. ..	..	..	..	..	..
Nelson Corporation	.. 1	1	— 33	4	660	— 188
Newcastle-on-Tyne Corpn.	.. 1	9	+ 921	4	26,860	+ 2,347
Newport (Mon.) Corpn.	.. 1	1	— 41	4	3,574	— 345
Northampton Corporation	April 30	1	— 13	4*	2,924	+ 264
Oldham Corporation	May 1	4	— 3	6	12,428	— 1,121
Perth (N.B.) Corporation	.. ..	..	..	..	..	..
Perth (W.A.) Elec. Trams	.. ..	..	..	..	..	..
Portsmouth Corporation	.. ..	..	..	..	..	..
Preston Corporation	.. ..	..	..	..	..	..
Rotherham Corporation	April 28	4	+ 68	4	4,210	+ 332
Salford Corporation	.. ..	..	..	..	..	..
Shanghai	.. ..	..	..	..	..	..
†Sheffield Corporation	May 2	8,494	+ 826	5	45,279	+ 1,765
Singapore Trams	March 27	$10,1	$6	13*	$136,732	— $20,108
Southampton Corpn.	April 28	1,324	— 20	4	5,400	— 144
Southend Corporation	.. ..	1	— 220	4	3,263	— 975
Stirybridge, Hyde, &c., Jt. B.	.. ..	..	..	..	..	..
Sunderland Corporation	May 2	1,3	— 3	5	6,495	— 373
Sunderland District	April 28	1	— 3	26	13,842	— 1,128
Swindon Corporation	.. ..	1	— 3	4	739	— 8
Tynemouth Corporation	.. ..	1	— 36	16	8,232	— 111
Wallasey Corporation	May 1	1,177	— 47	4	5,317	— 659
Walsall Corporation	.. 1	3	— 71	18	11,630	+ 648
Warrington Corporation	April 22	421	— 6	4	1,713	— 82
West Ham Corporation	.. 29	2,966	+ 133	4	12,713	+ 391
Wolverhampton Corpn.	.. ..	1	— 36	4	4,251	— 302
Yorkshire W.R. Trams	May 2	1,534	— 173	18	26,530	+ 841

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses, &c. ‡ Minus 2 days. ‖ Minus 3 days. ‖ Plus 3 days.
¶ Plus 2 days. ** Comparisons with previous week, or last year.

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NOTES.

Submarine Telegraphs in War Time.

IN the reports of the meetings of the various submarine cable companies, which appear in another column, there are features of public interest outside the record of continued prosperity and commercial usefulness of the great submarine cable companies, which have their centre in London. The war service record of each enterprise whose proceedings we report, give emphasis to the importance, the indispensability, and, above all, the dependability, of the submarine telegraph cable, which has in no single instance failed Britain and her Allies in the great world campaign in which they are so strenuously engaged. In dealing with a question of this kind one naturally turns to the larger enterprises, the greater including the less. At the meeting of the Eastern Extension Australasia & China Telegraph Co., Sir JOHN WOLFE BARRY presented a statement of the operations of the Company which especially sheds lustre on the service, and covers with honour the superintendent and staff of the Company at the Cocos Islands. It is a splendid record of noble service rendered. As Sir JOHN pointed out, a grave catastrophe might have resulted from a visit to Cocos of the German commerce raider, "Emden," but thanks to the foresight and level-headedness of the men responsible for the conduct of operations in that out-of-the-way field, the deep-laid scheme of the commander of the German vessel, who might reasonably have expected the fullest measure of success for any operations he had planned, caused comparatively small physical damage, and still less was he able to interrupt for long the normal working of the station. As the result of a careful look out the cables were actively employed in notifying the appearance of the "Emden," and the Company's wireless station at Cocos succeeded in notifying the fine Australian warship, "Sydney," of the threatened danger, and by this means a serious disaster was avoided. It was gratifying to the shareholders, as it will be to the widespread staffs of the submarine telegraph companies, to know that the efforts of the Cocos men have not only been fully appreciated by the directors and officials at headquarters, but that the Home Government and the Committee of Lloyd's have also expressed their appreciation of the services rendered. The record of Cocos is, we feel sure, but the record of what other station staffs will accomplish if the occasion arises. Several times in the past, British telegraph men abroad have been called upon for special service of more or less similar character, and they have always risen to the occasion; Cocos stands out as a brilliant example of fine work well accomplished. The services of the Eastern Extension Company have, during the present war, been equally well rendered to the public in taking up the traffic of the Pacific Cable owing to the destruction caused by the German raider "Nürnberg," at Fanning Island. At Singapore, on the other hand, the Company's staff were the victims of the cruel mutiny which caused the loss of several valuable lives, and telegraph men will sincerely condole with the families of their colleagues who were thus treacherously and purposelessly done to death.

At the general meeting of the Eastern Telegraph Company, also reported on another page, Sir JOHN WOLFE BARRY was able to give an excellent account of the Company's work during the anxious time from August to December, and also to review briefly the submarine telegraph position at the present time. This Company's great services to the public have been no less conspicuous than those of the sister Company, and the foresight which added to the "via Eastern" service the new cables, and renewals and repairs to the older cables, is indicated in every line of the Chairman's speech, thus enabling the Eastern and Associated Companies to render adequate service even in such times

of very great pressure and anxiety as the present. No fuller justification for the building up of great reserves for the purposes of rendering the submarine telegraph service capable of meeting the fullest demands of the country, even in such unforeseen circumstances as have prevailed since August last, could possibly be needed, and the manner in which the abnormal demands upon the Eastern and Associated Companies' services have been met is a matter worthy of national recognition. We may indeed say there is the best evidence available over a vast field of operations that the foresight, skill and technical capacity of the submarine service have met the strain of the situation to the fullest extent, not without difficulty nor without anxiety, but with complete success, as is shown by the appreciation which the Cable Companies have received from all who have called upon their services in a time of great stress. Some measure of this pressure will be realised from the Chairman's reference to the services of Sir JOHN DENISON-PENDER, the vice-chairman and managing director, whose statement as to the friendly relations existing between the officials and himself will account for much of the success of the Company. That the public, largely owing to circumstances outside the control of the Companies, has been debarred from certain privileges which had been planned for their benefit, is not to be set against the Companies' services. After the earlier pressure of work had been removed the facilities which the telegraph companies had readily given to the telegraphing public in the form of deferred and other reduced-charge telegrams were resumed, and the public is, moreover, promised the full measure of cheap and effective submarine telegraph service as soon as the Government requirements make this possible. At the Eastern meeting Sir JOHN WOLFE BARRY repeated the appreciation which the directors and officials of the Company feel of the patriotic devotion and high sense of duty shown by the staff of the Company, both on shore and afloat. This whole-hearted co-operation under trying and sometimes risky conditions was the subject of some very feeling remarks from the Chairman, and it is not surprising to hear that the services demanded from the officials and staff of the submarine cable companies, as we understand, at the express wish of the naval and military authorities, has somewhat reduced the number of submarine telegraph men in the firing line. This notwithstanding, a large number of the Eastern and Associated Companies' Head Office staffs are at the front or in training, and all have been liberally dealt with by the Companies, with the full approval of the stockholders.

Electricity Supply at Coventry.

DOUBTS have sometimes been expressed as to the wisdom of supplying electrical energy for power at low prices, such as 0·5d. per unit. Time after time the timid engineer has pointed out that the average price per unit was considerably higher than such a figure, and that there was considerable risk in selling at low prices, because the low-priced units might eventually become the bulk of the output. On the other hand, progressive engineers thought otherwise, and were prepared to back their opinions with practice. From time to time we now see the happy results of this policy. Coventry is a case in point. Six years ago the output amounted to only about $4\frac{1}{4}$ million units, but during the past year the units sold amounted to $20\frac{1}{2}$ millions, and this was $4\frac{1}{4}$ millions more than in the preceding year. The lighting part of the load is now only 6·9 per cent. of the total, so that the output is almost wholly for power purposes, and yet the net profit was nearly £23,000. This happy result has been obtained by careful management, and by following the sound policy of making concessions to consumers whenever the profits admitted of this being done. Thus it is that electrical energy is now given at such prices that it is not worth while for any manufacturer to put down private plant for his needs, and consequently electric power is being supplied to most of the large engineering works at Coventry.

Industrial Research.—On Thursday last week, Mr. Pease informed a deputation from the Royal Society and Chemical Society at the Board of Trade that a scheme had been approved in principle according to which substantial additional assistance would be given by the Government to scientific education and industrial research.

"Tramways and Light Railways Association Journal."—The April number of this Journal contains a full report of the judgment of the House of Lords on the appeal of the London County Council *re* the assessment of the L.C.C. tramways in the Borough of Islington. A report is also given of a case before the Leicester County Court for damages against the Leicester Corporation through a tramcar accident.

Royal Engineers (T.F.)—The following appointments have been made :—

No. 4 Electric Lights Company, Devonshire (Fortress) Engineers: Mr. Geo. O. Tipping to be second lieutenant.

Electric Lights Companies No. 3, Glamorgan (Fortress) Engineers: Lieut. J. W. Law to be temporary captain; Second Lieut. H. K. Benson to be temporary lieutenant.

Electric Lights Companies No. 4, Glamorgan (Fortress) Engineers: Second Lieuts. J. L. Wilson, T. Challoner and C. H. Law to be temporary lieutenants.

Determination of Magnet Polarity.—The "Engineer" gives particulars of a search coil due to Dr. E. Rosenberg used to determine the polarity of the parts of a magnet system. A compass is often employed for this purpose, but the possibility of reversal by the strong fields present renders its use unsafe. The search coil is made up of 580 turns, having a resistance of 1·5 ohms, wound on an iron bar 10 mm. diameter and 63 mm. long. The coil is connected to a milli-voltmeter. To determine the polarity of a pole, one end of the apparatus is brought up to it and quickly withdrawn—the direction of the deflection obtained is an indication of the polarity of the pole. The apparatus is sufficiently sensitive to indicate the polarity of the commutating poles of a machine due to remanent magnetism. It is suggested that this might be useful, after a tramway accident, for instance, in indicating whether a machine had last run as a motor or as a generator if the direction of rotation were known.

Electric Taxicab Development in the United States.—The electric taxicab is fast establishing itself in the United States as a superior and more economical vehicle to operate than the petrol cab. The most extensive application of electrics to taxicab service is at present in Berlin, where about 600 electric taxicabs are in use. The best example of electric cab development in the United States is, strange to say, in Detroit, the home of the petrol car. The Detroit Taxi & Transfer Co. is now operating a fleet of 10 electrics, which is being increased to 70 or more. The first electric with which this company experimented showed a mileage of 1,375 miles in one month, and by the time it had run 12,000 miles it had

proved itself a success beyond a doubt. During this mileage the car had not had any accidents or repairs. It is stated that the next few months will witness an initial installation of electric taxicabs on a large scale in New York, and the company responsible for this innovation will shortly extend its service to the principal cities throughout the States. According to Mr. MacDowell, president of the Motor Taximeter Co., experiments with several makes of electric vehicles have shown that the electric taxicab can be operated for something in excess of 20 per cent. less cost than the petrol car. There is also, of course, the advantage of cleanliness and ability for quicker and smoother acceleration in traffic.

Census of Generating Plant in the United States.—The Bureau of Census Returns on generating equipment and output of Central Stations in the United States for 1912 has recently been issued. The following table gives information as to the growth of generating plant from 1902 to 1912.

Central Electric Stations and Electric Railways.

	Total.		Kind of dynamos.					
			D.C. constant voltage.		D.C. constant amperage.		Alternating and polyphase current.	
	Number.	Kw. rating.	Number.	Kw. rating.	Number.	Kw. rating.	Number.	Kw. rating.
1912	15,393	7,642,755	4,967	1,161,213	820	82,152	9,606	6,399,390
1907	15,297	4,432,641	5,872	1,347,962	1,685	80,992	7,740	3,003,687
1902	15,786	2,110,597	6,684	1,055,411	3,539	145,866	5,563	909,320

The amount of purchased energy from central electric stations and electric railways in 1912 amounted to 5,580,821,386 units, for which the amount paid was £8,524,175, the average price being 0·4d. per unit. The total horse-power of the various stations in 1912 was 11,193,699, as compared with 6,618,011 in 1907. Of this power, 10,108 steam-driven units furnished 8,116,086 H.P., while 1,164 gas and oil engines gave 135,225 H.P. and 3,316 water wheels gave 2,942,388 H.P. The total kilowatt rating of the dynamos was 7,642,755 kw., of which 1,243,365 kw. was in the form of direct current and 6,399,390 kw. alternating current. The total output of stations was 17,585,662,014 units, as compared with 10,621,406,837 units in 1907.

Invention of the Electric Telegraph.—The question of who is and who is not entitled to claim priority in the invention of the electric telegraph is one of frequent discussion. Recently the claim has been put forward in the "Spectator" in favour of Ronalds. The following letter is of interest, and shows how similar are the cases of wire and wireless telegraphy, so far as the question of priority of invention is concerned. To whosoever the merit of actual invention and early experiments may be accredited, to Cooke, to Wheatstone, to Vail and to Morse (as to Marconi in the case of wireless) belong the chief credit for the commercial exploitation of electric telegraphy.

THE INVENTOR OF THE ELECTRIC TELEGRAPH.

TO THE EDITOR OF THE "SPECTATOR."

SIR: I have read with much interest the letter in the "Spectator" of March 20th which makes a claim to displace Morse, Cooke, and Wheatstone in favour of Francis Ronalds (1823) as the inventor of the electric telegraph. It is strange that a claim dating from nearly 100 years earlier—a claim made and recognised by very great authorities—should have been overlooked in this controversy. It is beyond dispute that the electric telegraph was "invented" by Stephen Gray as early as the year 1729. Stephen Gray is, of course, recognised as one of the true pioneers of electric science, the man to whom is due the division of all materials into electric and non-electric conducting and non-conducting. In the year 1718 Gray, like many another devotee of research, was so lacking in this world's goods that George, Prince of Wales, a Governor of Charterhouse, on April 7th of that year nominated him as a Brother of Charterhouse, and on June 24, 1719, as our books record, he was duly sworn in on admission "for ye Prince." It was [illegible] at Charterhouse and in its courts that Stephen Gray conducted his long series of experiments in the transmission of the electric current along a length of conducting material so as to produce movement, and thereby communication. He tried wire, cord, and silk in various shapes, and he is said to have at last established a communication with the rooms of another Brother in a distant part of the court or courts till he had finally satisfied himself. In the "Morning Post" of Friday, January 23, 1874, will be found the report of a lecture delivered the night before in the Great Hall of Charterhouse by Dr. Benjamin Ward Richardson on "Electricity." The lecturer stated that on June 14, 1729, at the house of Mr. Granville Wheeler, Stephen Gray laid what might be called the first electric telegraph, by which he transmitted electricity along 870 ft. of wire insulated in silk thread stretched across a series of double poles. In 1731 the results of Gray's experiments were laid before the Royal Society, and in 1732 he was elected a Fellow, and shortly afterwards received the Fothergillian Gold Medal. He died February 15, 1735.

Here we have not a mere general forecast of an electric possibility—of the kind that has often flitted through the brain of the man of science in other branches—but an actual realisation of results, and a translation into practical effects of the principles which he had discovered. When Gray sent his first current along his conductor in the courts of Charterhouse he had made the first electric telegraph. The fact that his invention was to lie asleep for over 100 years before it was to be taken up by practical commerce in no way weakens his claim. He was old when his invention at last took shape. He died at 83. He was without capital. He was a man "of particular disposition and not amiable"; so absorbed it is said, in his researches as to be difficult of approach, though generous and open as to all his discoveries; a man, therefore, with no great store of friends and backers. His invention, too, fell in an age of little commercial enterprise. But it was complete and ready to hand when, a hundred years later, the development of steam had kindled the spirit of enterprise and made it ready to apply the discovery of the forgotten Brother of Charterhouse to great practical ends. The lecturer in 1874 claimed that there was no name of equal distinction connected with Charterhouse. It may be much to claim, but certainly, if distinction may be reckoned by the results to mankind, it would be hard to find a name, save perhaps that of Watt, which has a better claim, either inside Charterhouse or out of it, to be remembered in the world.—I am, Sir, &c.,

The Master's Lodge, Charterhouse, E.C. GERALD S. DAVIES.

Of course, Stephen Gray had only static electricity at his disposal, and electrical methods were commercially impracticable until the voltaic cell (not steam power) was discovered. His work is therefore in a somewhat different category from that of Morse, Cooke and Wheatstone.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Dr. H. W. Malcolm contributes a further instalment of an article on the "Future Progress of Cable Telegraphy" (p. 198).

We publish an article by Mr. F. M. Denton, on the "Gyroscopic Compass" (p. 191).

A report of the Conference of the electricity and gas undertakings on Coal Supplies, held at the Institution of Electrical Engineers on the 6th inst. is given on p. 195.

We abstract a Paper on "The Applicability of Electric Propulsion to Battleships, together with the Experience gained with it on the 'Jupiter,'" by Lieut. S. M. Robinson (p. 189).

An article on a "Method of Testing Instrument Transformers," by Mr. P. G. Agnew, is reproduced (p. 205).

We describe the recent extensions at the South Shields Electricity Works (p. 207).

Companies' Meetings and Reports.—Meetings of the Eastern Telegraph Co., Eastern Extension, Australasia & China Telegraph Co., Great Northern Telegraph Co., West India & Panama Telegraph Co., West African Telegraph Co., West Coast of America Telegraph Co., Submarine Cables Trust and Imperial Continental Gas Association are reported, and the directors' reports abstracted include those of the Anchor Cable Co., Argentine Tramways & Power Co., Callender's Cable & Construction Co., Chiswick Electricity Supply Co., Delhi Electric Tramways & Lighting Co., Marconi's Wireless Telegraph Co. of America, London & Lancashire Fire Insurance Co., Merthyr Electric Traction & Lighting Co., Rhondda Tramways Electric Supply Co., Richard Johnson, Clapham & Morris, Stratford-on-Avon Electricity Co., Swansea Improvements & Tramways Co., Western Union Telegraph Co. and Sir W. G. Armstrong, Whitworth & Co. (pp. 220-224).

OBITUARY.

Dr. F. S. PEARSON. Among the victims of the "Lusitania" outrage there were many engineers, and we regret to notice among those who were drowned [illegible] Dr. F. S. Pearson, the well known American consulting electrical engineer. Dr. Pearson was a Member of the American Institute of Electrical Engineers and was closely identified with the development of hydro-electric power in Mexico,

and in Brazil and other parts of South America. He was President of the Barcelona Traction, Light & Power, the Mexican Light & Power, the Mexico Tramways and the Rio de Janeiro Tramways Companies, and a director of the Bahia Tramway, Light & Power, Mexico Electric Tramways and Sao Paulo Tramway, Light & Power Companies.

OTHER "LUSITANIA" VICTIMS.—Mr. Jas. R. Kelly, head of the firm of J. R. Kelly & Co. (Ltd.), engineers, of Leeds; Mr. Geo. E. Latham, electrical engineer, of New Brighton; and Mr. E. Gorer, a director of Venner's Electrical Cooking & Heating Appliances (Ltd.), also lost their lives in consequence of the "Lusitania" outrage.

Among the saloon passengers in the "Lusitania" who do not figure in the list of the saved we regret to notice the names of Mr. A. Drake, son of Mr. Bernard Drake (chairman of Messrs. Drake & Gorham), and Mr. G. Maurice, a director and manager of the fixtures and heating department of the General Electric Co.

MR. H. F. FRIEDERICHS.—We regret to record the death of Mr. H. F. Friederichs, borough electrical engineer at West Hartlepool, which occured on Sunday night. Mr. Friederichs went to West Hartlepool in 1889 as Sir Alex. Kennedy's representative in connection with the erection of the Corporation electricity supply undertaking, and when the generating station had been built and the plant laid down he was appointed borough electrical engineer, a position which he still occupied. Various extensions of the plant have been carried out by him, including the installation of the waste heat plant, by means of which the waste steam from the Seaton Carew blast furnaces is utilised for generating electric current. He was a member of the "Point Five" Association. Mr. Friederichs, who was 50 years of age, was born at Penang, in the Malay Peninsula.

APPOINTMENTS VACANT AND FILLED.

A competent engineer is required to take charge of a power station (containing 6,000 kw. turbo-alternators, step-up transformers, &c.) in Argentina. *See advertisement.*

An electrical engineer is required to take charge of running and repairs of mine plant in Borneo, consisting of steam turbine, Diesel engine, three-phase generators, centrifugal pumps, &c. *See advertisement.*

The Commissioners for the Port of Calcutta require an assistant to the superintendent of machinery. Candidates must have had thorough mechanical and electrical training. Salary Rs.450 per month, rising by increments of Rs. 50, to Rs. 600, with free quarters, &c. Applications to the consulting engineer and London agent (Mr. J. Angus, M.I.C.E.), 17, Victoria-street, S.W., by May 28.

An assistant electrical engineer is required by the Government of Malta for service in the electric lighting department. Salary £150 per annum. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, S.W.

Southport Corporation invite applications for the position of manager of their electric tramways. Salary £300 per annum. Applications (on forms provided) to the Town Clerk by May 19.

Bolton Tramways Committee have appointed Mr. C. Beech, of Derby, to be car-shed superintendent at £200 per annum. There were 93 applicants.

INSTITUTIONS AND SOCIETIES.

Society of Engineers.—At a recent meeting of this society Mr. A. H. Barker read a Paper on the subjects of heating and ventilation which, he stated, had received but little attention in their scientific aspects. Physiologists were not even agreed upon what was a healthy temperature for human beings to live in. The heating and ventilating engineer aimed at producing comfort, but was baffled by the fact that a man was comfortable only when he thought he was. Air which, judged by chemical analysis, was impure might feel fresh and sweet, and vice versa. The only legitimate function of the engineer was to produce and control specified movements of air and other effects, while it should be the duty of the physiologist and hygienist to specify what were healthy and comfortable conditions. In connection with heating, the expression "temperature of a room" was generally understood to mean the reading of a thermometer suspended in the room, but this reading did not necessarily indicate the temperature of the surrounding air, or form a reliable guide to the feelings of the occupants of the room. The air temperature, the radiant temperature, the quantity of convected heat and the quantity of radiant heat must all be determined, but first the relation between the thermometer reading, the air temperature and the radiant temperature must be determined. The freshness of air in a building depended on keeping the air temperature relatively low and the radiant temperature high. The chemical composition of the air had, within wide limits, no effect on the human organism, whereas its temperature and humidity were very important.

Aeronautical Society of Great Britain.—The third Wilbur Wright Memorial Lecture will be delivered by Prof. G. H. Bryan, F.R.S., on "The Rigid Dynamics of Circling Flight," at the Royal Society of Arts, John-street, Adelphi, London, on Thursday, May 20th, at 8:30 p.m., when Mr. F. W. Lanchester will preside. Immediately preceding the lecture, the Gold Medals of the Aeronautical Society, awarded respectively to Prof. Bryan and the late Mr. E. T. Busk, will be presented by Major-General R. M. Ruck, C.B. (Chairman of the Council), to Prof. Bryan and to Mrs. Busk (on behalf of her son).

EDUCATIONAL NOTE.

University of London, University College.—A new edition of the University College (London) "Pro Patria" is in course of preparation, and will be issued shortly.

Past and present students or their relatives and friends on their behalf are invited to send full particulars of the capacity in which they are serving the country at the present time. In the case of the Army, rank and regiment should be given; in the case of the Navy, rank and ship. Particulars should be addressed to the Publications Secretary, University College, London (Gower-street, W.C.).

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 14th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Meeting at the Institution of Civil Engineers, Great George-street, London, S.W. Paper on the "Distribution of Heat in the Cylinder of a Gas-Engine," by Prof. A. H. Gibson and Mr. W. J. Walker.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at 39, Victoria-street, London, S.W. Paper on the "Production of Sound from Wind Vibrations," by Mr. G. C. Simonds.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington, London, S.W. Agenda: Papers on "Precision Resistance Measurements with Simple Apparatus," by Mr. E. H. Rayner; "Some Novel Laboratory Experiments," by Mr. F. W. Jordan; and "On Electrically Maintained Vibrations," by Mr. S. Butterworth.

SATURDAY, May 15th.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Lecture on "Advances in the Study of Radio-Active Bodies," by Prof. F. Soddy, F.R.S. (Lecture I.)

MONDAY, May 17th.

NEWCASTLE SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Annual General Meeting at the Mining Institute, Newcastle-upon-Tyne.

TUESDAY, May 18th.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Lecture on "Advances in the Study of Radio-Active Bodies," by Prof. F. Soddy, F.R.S. (Lecture II.)

ILLUMINATING ENGINEERING SOCIETY.

8:15 p.m. Meeting at the Royal Society of Arts, 18, John-street, Adelphi, London, W.C. Discussion on "Some Points in Connection with the Lighting of Rifle Ranges."

THE NATIONAL RELIEF FUND.

(Treasurer, H.R.H. The Prince of Wales.)

This great National Fund, for the relief of those amongst the needier classes who are widowed, orphaned and otherwise affected by the fighting in which our troops and ships are now taking part, urgently seeks contributions however small. These can be sent with the following note, which can be cut out, filled in, put in an envelope and sent *unstamped*, addressed H.R.H. The Prince of Wales, Buckingham Palace, London.

Date .....

I enclose £ s. d. *toward the Prince of Wales*

NATIONAL RELIEF FUND.

Name .....

Address .....

.....

THE APPLICABILITY OF ELECTRICAL PROPULSION TO BATTLESHIPS, TOGETHER WITH THE EXPERIENCE GAINED WITH IT ON THE "JUPITER."*

BY LIEUTENANT S. M. ROBINSON, U.S.N.

Before dealing with the applicability of electric propulsion to battleships the author discusses the probable arrangements of such an installation, referring to the differences from the equipment used on the "Jupiter." In choosing a method of propulsion for battleships, there are six points to be considered. They are, in order of their importance :—(1) Reliability, (2) manœuvring qualities, (3) economy, (4) space occupied, (5) weight, (6) care and upkeep.

Reliability.—The reliability of induction motors and large high-speed turbo-generators for land use has been well known for some time, but up to about 1½ years ago had not been demonstrated on board ship. However, experience at sea with them has not developed any trouble, and their reliability is now unquestioned. There are several things that go to make an electric installation more reliable than any other. First, the installation is in duplicate throughout and the breaking-down of one engine does not affect the ship except at high speed ; it might be said that this is true of other installations, but it is not true in the same sense nor in the same degree that it is with the electric drive. For example, if one turbo-generator breaks down, the ship can still run in a perfectly normal manner up to a speed of about 19 knots. Then, too, there is the question of auxiliaries ; with other forms of propulsion, if the auxiliaries in one engine room break down, that engine room may be almost entirely put out of commission. Of course, the main air and circulating pumps are cross-connected, but when operating that way they are not very satisfactory and I have seen a battleship forced to stop because the forced lubrication pumps in the starboard engine room broke down. If the ship had gone ahead with the port turbines, the starboard turbines would have revolved and burned out the bearings, so that it was necessary to stop the ship and repair pumps ; with the electric drive it would be a simple matter to shift to the other engine room and make repairs without stopping. There is one other thing that makes this installation more reliable than other forms of turbine drive, and that is the fact that the turbine revolves in the same direction all the time. The importance of this can not be overestimated, as it is believed by operating engineers that the greater amount of blading trouble that ships have had is nearly always due to the distortion that occurs when backing.

Manœuvring.—As regards manœuvring qualities, it is believed that the electric drive is far superior to any other method, the control being so much simpler. Instead of big, heavy throttles to open and close, there are light, easily handled oil switches, and a speed controller that can be handled with one finger. The engine room watch required for a battleship would be just half what it would be with other means of propulsion, as one engine room would be idle practically all the time. In a rough sea there is no racing, with its attendant strains on machinery and on the personnel on watch. The standing qualities are also superior to those of other installations, for at a very small expense in the way of steam, the main turbine can be kept running very slowly and the engine room is then ready to answer signals at any time ; this might be of great importance to a battleship. The backing qualities of this installation are also superior to other forms, particularly turbine installations. It is possible to obtain full power in the astern direction.

Economy.—None of the older forms of propulsion, such as reciprocating engines or direct-connected turbines, can compare at all favourably with this method, the gain in economy being over 20 per cent. both at high and cruising speeds. Mechanical reduction gears have been developed to a high degree, and it is very probable that in quite a number of cases mechanical gears would be preferable to the electric drive. For battleships I do not believe there is any question of the relative economy of the two methods—the electric drive is far superior. The electric reduction method possesses two inherent advantages that the mechanical method can not overcome. First, the electric installation uses only one turbine at low powers ; second, the induction motors are fitted with pole changers which allow the turbine to be run at normal speed with the ship cruising at very low speed—in other words, the electric drive permits of two speed reductions while the mechanical gear has only one. These two advantages exist no matter how the two installations may be laid out, and they far outweigh the difference in the losses of the two methods. In addition to the two advantages just stated, there are a number of other things entering into a comparison of the two methods that make it very doubtful if the mechanical gear would be as good, even at the high speeds, as the electric reduction. It would probably be necessary to use at least four turbines with a mechanical gear instead of two with the electric method ; this fact alone would make the electric reduction the more efficient of the two. Then there are also the very considerable losses due to the friction and windage of the backing turbine. Also there would be a saving due to the fact that only one set of auxiliaries would be used at a time.

Space Occupied.—As regards the actual space that the machinery would occupy, the electric drive would take up less space than any other installation, with the possible exception of the mechanical gear. The arrangement of the machinery, however, is so much more flexible with the electric drive than with other methods that it is probable it would occupy less space than would the gears. It lends itself very readily to watertight subdivision.

Weight.—The next point to be considered is that of weight, and here again the electric drive is superior to any other method, with the possible exception of mechanical gears. It is rather difficult to say exactly how the two methods would compare either as regards space or weight as a great deal would depend on the number of turbines used with the mechanical gear in order to get 30,000 shaft H.P. However, if the largest sizes of geared turbines now at sea are any guide, the weight of the electric drive would be less than the weight of the geared turbine.

Care and Upkeep.—As regards care and upkeep, the electric drive is greatly superior to either reciprocating engines or direct-connected turbines ; also, due to the fact that the turbines do not have to reverse, it would be superior to the geared drive in that it would have less blading trouble. Either of the two latter methods, however, is very satisfactory in this respect, as a high-speed turbine is so small that it is easily handled and repaired by the ship's mechanics.

This completes the case of the electric drive for battleships ; all points have been considered and in every case it has been seen that it has no superior. There are, however, some points that have been made against electric propulsion, and these will be taken up before proceeding to a discussion of the "Jupiter's" installation. First, there is the danger from large quantities of water in the engine room ; however, this danger is more fancied than real, as all the wiring could be placed well overhead, being taken out of the tops of the motors and generators. The generators could be placed high enough to insure their safety and the motors could be placed in watertight pits so that the engine room could have enough water in it to put the auxiliaries out of commission before reaching the main engines. The next point is that, when operating with one turbine, all motors must run at the same speed if they run at all ; this fact has been found to be no handicap in actual operation. The next point is that, in turning, the inboard screw does not slow down ; this slightly increases the turning circle, but does not increase the space necessary to turn in, as the inboard screw can always be stopped or backed.

Before taking up the work of the "Jupiter's" engines, a brief description will be given of the ship and her propelling machinery. The "Jupiter" is of the twin-screw, single-deck type. She was designed for a speed of 14 knots, developing 5,500 shaft H.P., with a load displacement of 19,300 tons, at a draught of 27 ft. 8½ in. The general dimensions of the ship are as follows : Length, 542 ft. ; beam, 65 ft. ; draught, mean designed, 27 ft. 8½ in. There are three double-ended, return-tubular, marine type Scotch boilers, and one upright donkey boiler. The main boilers are 23 ft. long, 16 ft. in diameter, and have a heating surface per boiler of 6,460 sq. ft. These boilers are designed for a working pressure of 190 lb. per sq. in., but safety valves were set for 200 lb. per sq. in. for the preliminary trial. Howden's forced draught system is used. The incoming air to the blowers, which are of the Sturtevant type, passes through the motors and generator, thus giving a certain amount of preheating to the air which is used for combustion.

The main propelling machinery consists of a nine-stage Curtis turbine, a two-pole, three-phase, alternating-current generator, two 36-pole, three-phase induction motors, two water-cooled rheostats, and one main switchboard. The turbo-generator has an overall length of 27½ ft. with an extreme height of 9½ ft. The turbine has a weight of 28·7 tons and runs normally at 1,990 revs. per min. The generator is a two-pole machine weighing 35·7 tons, normal volts 2,300, normal amperes 1,370, normal frequency 33·2, normal excitation 250 amperes, with a rated capacity of 5,450 k.v.a. The rotor core length is 60 in. and the air gap $1\frac{3}{16}$ in. The motors have a rated capacity of 2,750 H.P. ; normal at 110 revs. per min. The excitation for the main generator is taken from one of the ship's 35 kw. generators.

The turbo-generator furnishes power to the motors, the function of the generator and motors being solely that of a reduction gear. All changes of speed are made by changing the speed of the turbine, thus varying the frequency of the generator, and consequently the speed of the motors, the reduction in this case being 18 to 1, plus the

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slip of the motors. The motors are wound for only one number of poles and, therefore, the speed ratio is not changeable as it would be for a battleship installation; the reason for this is that such change is not necessary as the cruising speed is practically the maximum speed. Speed changes are accomplished by means of a small control stand in front of the switchboard. A small hand-wheel on this stand, working through a worm, worm wheel, and set of bell crank levers, changes the position of the fulcrum about which the governor acts, thereby varying the speed of the turbine. One of the three-phase windings from the generator is led to the two motors direct. The other two leads are taken to the main switchboard, then through "ahead" or "astern" oil switches, and then to the motors.

Each motor is installed in a watertight pit which cannot easily be filled with water from below. However, the motor windings are all made waterproof and fireproof, and are intended to give safe running when partially submerged. The rotor windings are connected to collector rings, which are in turn connected to the water-cooled rheostats. These collector rings can be short-circuited by a slider, operated by a lever and working on the motor shaft. The short-circuiting device consists of a brass segment under each ring, and a corresponding segment on the slider. In addition to these devices there is an auxiliary device working with each main device. The auxiliary consists of a carbon block on the solid segment and a brass contact on the slider; these contacts are held in place by flat springs on their back and will thus be forced into contact before the main contacts are, and will leave the carbon blocks after the main contacts have let go. The purpose of these auxiliary contacts is to prevent the main contacts from being burned when operating the short-circuiting lever. These short-circuiting levers are locked, when in the "resistance out" position, by electric solenoids in series with the field of the main generator; this prevents this lever from being moved out of this position while the circuit is alive. It was found in the factory that excessive burning took place when it was attempted to short-circuit the collector rings with full field on, and the lock was put in to prevent this.

There are two water-cooled rheostats, one for each motor, the total weight of both being 5·8 tons. Each one consists of a top header, bottom header, three larger porcelain cylinders at the bottom, three small porcelain cylinders on top of these, and one non-inductive resistance inside each of the large porcelain cylinders. These resistances are made of calorite, and consist of spiral coils laid up on a wooden spindle and having alternate coils connected oppositely from the others so as to make the resistances non-inductive. The large porcelain cylinders rest on rubber gaskets on the bottom header, the resistances sit inside these cylinders, a rubber gasket and a brass ring go on top of each large cylinder, and the small cylinders are placed on these gaskets. The top header rests on gaskets on the tops of the small cylinders. The rheostats are supplied by water either from the main circulating pumps or the flushing pump. These rheostats are capable of running under full load for an indefinite length of time. Since the "Jupiter's" installation was made a new type of induction motor has been brought out, which makes it possible to do away with these water-cooled rheostats.

The main switchboard is supplied with a voltmeter, ammeter and indicating wattmeter for the main generator, with a voltmeter and ammeter for the field of the generator, with a frequency and speed indicator for main generator, with ammeter and recording wattmeter for the motors, with "ahead" and "astern" oil switches for the motors, with a field switch for the main generator, and with a rheostat and switch for the field of the exciter. The control stand is in front of the switchboard. The "ahead" and "astern" oil switches have mechanical interlocks so that the "ahead" and "astern" switches for a motor cannot both be thrown in at the same time. There is also a mechanical interlock from the short-circuiting levers to the oil switches, which prevents the oil switches from being thrown in when the rheostats on the motors are short-circuited by the levers.

The operation of the machinery may be divided into three different conditions. Starting with all auxiliaries in operation, the turbine running, and an exciter cut in on the field of the generator, the operation under different conditions would be as follows:—

1. Getting under way, coming to anchor, going alongside a ship, or in general, handling the ship where much reversing might be expected.

Under these circumstances the resistances would be kept in on both motors. The operation in this condition is very simple. To go ahead or astern on either motor, simply close the "ahead" or "astern" switch; this requires about one-half second for each motor.

2. When it is desired to do economical cruising.

This condition will arise after a certain amount of ship handling has been done, and both resistances will, of course, be in on the two motors; it will be necessary to cut the resistances out of the motors. To carry out this, first open the field switch of the exciter; second move the control wheel of the turbine to "slow speed"; third, move both short-circuiting levers so as to short-circuit the rheostats; fourth, close the exciter field switch; fifth, bring the turbine up to the desired speed. The total time required for these operations is about 35 seconds; about 20 of these seconds are used up in waiting for the field circuit of the generator to die out sufficiently to allow the short-circuiting levers to be moved. As has been previously stated, the short-circuiting levers are locked by solenoids in series with the field of the generator. When the exciter field switch is open the main field will, of course, die down and allow the short-circuiting levers to be moved.

3. When doing economical cruising, with resistances out of both motors, a signal is received to back either one or both motors.

First, open the "ahead" oil switches; second, move the short-circuiting levers so as to put in the resistances; third, close the "astern" or "ahead" switches as desired. The total time required for these operations is about three seconds. When the installation was first designed, the solenoid locks in the generator field circuit were so arranged as to prevent the short-circuiting levers being moved either to cut out or cut in the resistances, but it was found that, with the motors dead (that is, with no oil switches closed), the short-circuiting levers could be moved with impunity, so that notches in the lock were filed to allow the short-circuiting levers to be moved to the "resistance in" position without changing the field of the generator. This was a great improvement as it made it possible to give practically instantaneous backing at all times and under all conditions.

The General Electric Company, of America, in its contract with the Government, guaranteed a water-rate of 15 lb. of water per shaft horse-power-hour delivered to the propeller shafts at 10 knots, and a water-rate of 13 lb. of water per shaft horse-power-hour delivered to the propeller shafts at the highest speeds attainable. The Government guaranteed to furnish steam to the turbine at 190 lb. (gauge) or to allow an increase of 1 per cent. per specified horse-power for each 10 lb. of reduction in steam pressure. It also guaranteed to furnish 28·5 in. of vacuum or to allow an increase in the water-rate of 5 per cent. per specified horse-power per inch of reduction in vacuum. The results of the preliminary trial are given in the table.

The "Jupiter" has been in commission over a year and a-half. During that time she has conducted two official trials and has carried on the usual routine work of a navy collier. She has steamed about 14,000 miles and has been handled a great deal around docks, in narrow channels, and other places where a great deal of engine handling was required. About one-half of the steaming has been done in the tropics with circulating water over 80° F. and with correspondingly poor vacuum, so that the economy of the ship is known under all conditions. The fuel economy has proved to be excellent being, on the average, about 25 per cent. better than the best of her sister colliers.

During the whole period of commission, two repairs have been made to the main engine. The first was to reblade the first stage of the turbine. This work was done entirely by the ship's mechanics. The first stage blading was injured by a bolthead from the segment carrying the fixed blading. The accident was in no way peculiar to the electric drive as it might very well have happened to any other engine. The other repair was to replace one of the porcelain cylinders which carry the resistances; this cylinder was cracked when the ship went into dry dock, but it was never discovered whether the cracking was due to the oiler putting undue pressure on the cylinder or due to some strain brought on it when the ship settled on the keel blocks. At any rate the damage was repaired by two machinists in about two hours.

The amount of work expended in keeping the equipment in condition has been very small. In operation the "Jupiter's" engines have been highly satisfactory. There has been only one time that anything has happened during the handling of the engines and that was the tripping out of an exciter. The lighting set was immediately put on for exciting and the engines were ready to use again in about 1½ minutes. The handiness of the engines has been proved more than once; the ship has been handled a great deal in narrow waters and around docks. She steers very badly at times and the quick response of the engines has more than once helped in getting out of difficulties. The engines have been used to swing ship for compass deviation without putting any way on the ship at all, the total space used for swinging being little more than the ship's length. The backing qualities of the engines have proved to be all that could be desired; if the ship is cruising with the resistances in, the time taken for reversing is practically nothing at all; if the resistances are out it takes a few seconds—not more than three. When under way the engine room is very cool, due to the fact that the generator is fitted

Trial Data.	48 hours.	24 hours.
Date of trial	Feb. 14/14	Feb. 18/14
Speed, in knots	14·99	10·01
Draught, mean	27 ft. 9 in.	27 ft. 7¼ in.
Displacement, in tons	19,452	19,350
Pressures (gauge) :—		
Main steam, boilers, pounds	193·8	193·9
Engine room, pounds	185·8	186·44
Turbine, pounds :	168·4	180·56
First stage, pounds	56·0	8·5
Forced lubrication, pounds	30·0	30·0
Oil to governor relay, pounds	80·0	75·0
Steam seals, pounds	5·0	5·0
Auxiliary exhaust (absolute)	23·19	23·68
Air pressure to boilers, in in. of water	0·712	...
Vacuum, inches	28·2	28·5
Revolutions or double strokes per minute :		
Starboard motor	116·72	77·077
Port motor	116·72	77·077
Main turbine	2,130·0	1,410·0
Wet air pumps	3,600·0	3,600·0
Dry air pumps	112·0	113·0
Circulating pumps	193·0	196·0
Feed pumps	22·0	17·0
Blowers	329·0	...
Temperature, in degrees Fahrenheit :—		
Main injection	55·0	55·0
Overboard discharge	78·0	72·0
Hottest bearing (middle)	133·0	115·0
Oil from cooler	99·0	85·0
Feed water	191·9	215·9
Field amperes, main generator	251·5	184·0
Volts, main generator	101·4	69·44
Volts, main generator	2,580·6	1,524·0
Amperes, starboard motor	725·0	395·0
Port motor	755·0	413·0
Main generator	1,480·0	808·0
Kilowatts, starboard motor	2,692·7	712·5
Port motor	2,833·1	751·3
Total kilowatts	5,525·8	1,463·8
S.H.P., starboard shaft (torsion meter)	3,603·258	1,053·959
Port shaft (torsion meter)	3,548·677	961·08
Total (torsion meter)	7,151·9	2,015·04
Water consumption data :—		
Total pounds per hour	105,764·0	40,666·0
Pounds per hour auxiliaries	22,212·0	15,246·0
Turbine	83,552·0	24,820·0
S.H.P. (turbine)	11·68	12·316
Guaranteed water rate, pounds	13·0	15·0
Fuel consumption data :—		
Pounds of coal per hour	11,900·0	5,050·0
Pounds per hour per S.H.P.	1·662	2·5056
Pounds per sq. ft. heating surface	0·613	0·261
Tons per day	127·39	54·082
Kind of coal	New River & Georges Creek	
Quality of coal	Run of mine	Run of mine
Slip of propellers, per cent.	9·9	8·74
S.H.P. per sq. ft. of grate surface	15·9	4·48
Knots per ton of coal	2·82	4·43

with air impellers at each end which take their suction from the engine room, thus ensuring a good circulation of air. After all, the greatest test of the satisfactory working of any machinery is whether or not the men who are actually handling it and caring for it are pleased with it. If this test applies to the "Jupiter's" machinery it certainly is an unqualified success. In particular is this true if the matter is referred to the coal passers in the fire room who have to handle much less coal than do the men on sister ships. The ship can make her contract speed of 14 knots without using forced draught at all.

A NOTE ON THE GYROSCOPIC COMPASS.

BY F. M. DENTON.

Amongst the important developments that have been made possible by electricity, one which is surprisingly little known, even amongst electrical engineers, is that of the gyroscopic compass. New attention has lately been called to this apparatus in connection with an endeavour to eliminate automatically all its usual errors.

The nature of the action of the gyroscopic compass may be explained by reference to an ordinary electric motor with shaft horizontal. If such a motor were mounted upon frictionless castors, or simply placed upon a smooth and level sheet of ice, it would set itself so that its shaft would point in ordinary latitudes approximately north and south in such a way that its own rotation would be, like that of the earth, from west to east. Thus, if its rotation seen from the commutator end were counterclockwise the commutator would point north.

Instead of using castors or a sheet of ice, the motor might be suspended, like the bob of a pendulum, by its eye bolt. Such is in principle the arrangement used in the Anschütz, which is, perhaps, the best known gyro-compass.

The directive force of such a compass depends upon the mass, radius and angular velocity of the rotor, as well as upon the latitude in which the compass is being used. The rotor of the Anschütz is about 6 in. in diameter and 1 in. long axially. It rotates at 20,000 revs. per min. Such rotation, with absolute freedom from vibration and at the expense of only a few hundred watts, would hardly have been possible except by electrical means. The rotor consists of a squirrel cage embedded in steel. The stator has a two-pole winding, and is supplied with 333 cycle three-phase current.

As compared with the magnetic, the gyroscopic form has two main advantages, over against which, however, must be set its great cost and the extent of the electrical equipment necessary. The possibility of having any desired number of auxiliary compasses, all controlled by one master compass, makes the gyroscopic instrument desirable upon all large vessels, and its insusceptibility to magnetic fields makes it of especial value upon ships of war. Many of our own vessels are equipped with this form of compass, and it is being installed on all the battleships and submarines of the United States navy.

The forms of gyro-compass at present in use (of which the Anschütz is typical) are subject to errors on account of latitude, acceleration and velocity of the ship, and for accurate work correction must be introduced for each of these factors. Naturally, therefore, a good deal of thought is being put upon the problem of designing a gyro-compass in which these corrections shall be unnecessary.

Simple as the gyroscope is in principle, the details of its action demand complicated mathematical treatment. Suggestions for improvement in the instrument often appear difficult to deal with mathematically, and are costly to examine experimentally. In such a case it behoves the investigator to take the precaution, at the outset, of examining into the general question of the *possibility* of solution of any problem before him.

The Anschütz type of compass involves the use of one or more gyroscopes and pendulums, and it has errors of latitude, acceleration and velocity. Interest has lately been aroused in the question of a gyro-compass involving only a gyroscope and a pendulum, which shall be independent of the errors found in the Anschütz instrument. It does not seem to have occurred to anyone to remark that the problem is impossible of solution. The following simple consideration may, therefore, be of interest. The endeavour is first to give a common-sense explanation of the properties of a gyroscope, and then to indicate a line of thought by aid of which it may be realised that no combination of gyroscopes and pendulums (damped or undamped) can provide a compass which is independent of latitude, acceleration or velocity of the ship.

It follows from first principles that the path of a body which is thrown tends to lie all in one plane. Similarly, it follows that if a massive circular ring be rotating in its own plane the direction of this plane, and therefore also the direction of the axis of spin, tend to remain fixed. On the application of an external torque the rotating ring tends to set itself so that its own plane is that of the applied torque. This causes what is called "precession," and is a fact which also follows from first principles. It may be compared with the simple fact that if a body which is thrown, say, in a northerly direction (so that the plane of its path would, ordinarily, be a vertical plane pointing north and south) is acted on by an east wind, the body tends to move in a vertical plane pointing east and west. (The remarks just made take no account of the effect of the earth's movement in space, such omission being not unusual in dealing with the phenomena of falling bodies.)

A massive rotating ring provided with an axle is called a gyroscope.

The characteristic of a gyroscope, that it tends to set itself so that its own plane of rotation is that of any torque which may be applied to it, may be illustrated by reference to a windmill.

If an observer, looking along the direction of an east wind at the sails of a windmill, were to throw a stone so as to strike the tip of the topmost sail, the tendency would be, *if the sails were stationary*, to overturn the windmill. If the sails were already rotating clockwise the effect of the stone would be to set the windmill round so that its sails would point north, whilst for a counterclockwise rotation the sails would tend to point south. In each case the plane of the sails would tend to become that of the torque imparted by the projectile. At the instant before being struck the topmost sail (assuming clockwise rotation) would have a velocity due north. The projectile had a velocity due west. The resultant velocity would be, therefore, north-west, and, in its endeavour to travel north-west, the sail would cause the mill to face towards the north. The amount by which one blow would cause the mill to face round would depend upon the force of the blow; but a succession of blows, always at the topmost sail, would ultimately set the mill right round towards the north (the righting effect due to the tail being neglected).

Now, if the sails of the mill be thought of as a gyroscope with horizontal axle, the effect of the succession of blows may be thought of as a torque tending to raise one end of the axle and lower the other. Such a torque would produce precession, so that if the axle were originally pointing east and west it would ultimately move into the meridian.

In this illustration an important and peculiar assumption has been made—namely, that the windmill is not firm upon its foundations, but that the impact of a projectile will tilt it over somewhat. Without such an assumption it would be untrue to say that the sails would be skewed round. The torque due to the projectile would be counterbalanced by an equal and opposite torque due to the reaction of the bearings of the shaft carrying the sails. The effect of the force applied to the top sail of a *rigid* windmill might be compared with that of a projectile striking the upper edge of the rotor of a motor set upon ice, and so imparting a torque to it. A similar torque could be given to the armature by downward pressure applied to the commutator or to one end of the shaft. Such pressure would cause no precession, for the simple reason that an equal and opposite torque would at once be set up by the reaction of the bearings upon the shaft. The motor would precess only if the bearings failed to provide a reaction equal to the applied force. The suspension of the motor by its eye bolt provides a condition similar to that of the tiltable windmill.

This explanation should make clear the meridian seeking property of the motor; for if the axle of such a motor were originally pointing east and west the rotation of the earth would cause the one end of the axle to dip and the other to rise *in space*, the effect of this applied torque being such as ultimately to set the motor axle north and south, in which position, except for the effect of latitude, the plane of rotation of the motor would be that of the torque given to the motor by the earth.

Having thus dealt with the principle of the gyro-compass by reference to one or two particular illustrations, the more general treatment should present no great difficulty.

If a gyroscope could be mounted so that its axle formed the diameter of a smooth hollow sphere, and this sphere could be made to float, in suspension, in the midst of a liquid having no viscosity, the gyroscope would possess three degrees of freedom, and the direction of its axle would remain fixed in space independently of the earth's movement. Should, however, the condition of non-viscosity be departed from in any the least degree, every movement of the vessel containing the liquid would impart a torque to the sphere and the direction of the plane of spin of the gyroscope would be altered. Thus it will be seen that if the direction of the plane of rotation of a gyroscope is to be used as a definite direction of reference, the unavoidable constraint put upon the instrument by its means of suspension must be definitely known. The simplest definite constraint that can be applied is to fix the direction of one of the axes of rotation.

In the case of the motor upon ice the shaft of the motor (its axis of spin) would be constrained to turn in a horizontal plane, that is to say, the frame of the motor would be constrained to turn always about a *vertical* diameter of the rotor.

A gyroscope without constraint has three degrees of freedom. It can rotate about its own axle, it can turn bodily about any diameter of the rotor, and at the same time it can turn about a second diameter at right angles to the first. If an ordinary gyroscopic top be taken and mounted so that its axle bridges across between the two prongs of a fork whose shaft is held in a vertical socket in which it can turn freely, the direction of one of the diametral axes of the rotor becomes thus definitely fixed with reference to the earth's surface—it is made *vertical*. In a similar manner any one of the axes of rotation may be held in any desired direction with reference to the earth's surface.

In a gyro-compass the direction of the axis of spin is to be used either directly or indirectly to determine the meridian; hence this axis must be able to move in a horizontal or not too oblique plane, a condition readily satisfied by fixing the diametral axis vertically. This condition was fulfilled in the case of the motor set upon ice. In saying that the direction of the constrained axis shall be definitely known we must, of course, realise that direction can only be known relatively. A direction may be defined, for instance, as horizontal or vertical or by reference to a compass, or it may be defined by reference to some group of stars. Directions horizontal or vertical are those most readily obtained; they are directions relative to the earth's surface. Directions by the compass are relative to a plane containing the earth's axis of spin. None of these directions is fixed with reference to the stars.

The object of a compass is to determine direction relatively to a plane containing the earth's axis of spin. In the form of compass here under consideration direction is determined first with reference to the earth's surface, and then with reference to the earth's axis. A pendulum determines the first direction (for it usually hangs vertically) and a gyroscope, controlled through the pendulum, determines the latter direction, its axis of spin pointing along the meridian. It has here to be shown that the pendulum and gyroscope alone, are insufficient to determine direction with reference to the earth's meridian unless the latitude be known in which the apparatus is being used.

If one of the diametral axes of a gyroscope be held vertically (in which case, of course, the axis of spin becomes horizontal) rotation of the earth causes this fixed axis to turn somersaults in space. This motion being imparted to the gyroscope the latter tends to set itself so that its own plane of spin is parallel to the plane of rotation of the earth, and its own axis of spin is along the meridian. Strictly, this will only be the case if the gyro-compass is at the earth's equator, for it is only here that the somersaults of the vertical axis occur in one plane. At any other latitude the surface of revolution of the *vertical* axis will be a cone. Most simply, perhaps, the matter may be looked at thus: At the equator it is clear that the spin axis will set itself along the meridian, for with such a setting the earth's rotation causes the spin axis to move parallel to itself in space and so imparts no disturbing torque. In any other latitude the fact that the spin axis is kept horizontal brings it about that, if pointing along the meridian, this axis will *not move parallel to itself*—since successive meridians *converge*. The axis of a gryoscope tends, however, to remain parallel to itself; hence in this case it must tend to point somewhat away from the meridian. The error is not usually great, since any deviation from the meridian brings the direction of the axis of spin out of parallel with the axis of the earth when looked at along the direction of a meridian plane and so precessional force comes into play. This precessional force is of the same nature as that due to deviation from the meridian when the gyroscope is at the equator. The magnitude of the error depends upon the latitude, for it depends upon the rate of convergence of successive, horizontal, meridian lines.

The latitude error may be dealt with in another way. It has just been shown that the axle of a gyroscope, one

of whose diametral axes is fixed vertically, will, when at the equator, point exactly along the meridian. In any other latitude the conditions will be the same as at the equator, *provided the fixed axis is not vertical, but perpendicular to the earth's axis.* If the fixed axis is vertical a latitude error will be introduced.

An error similar to that due to latitude may be introduced at the equator by tilting the fixed axis out of the vertical. If this axis be tilted northward by, say, 30 deg., the instrument will at once point a little to the east of the meridian, just as it would if, with vertical axis, the instrument were used in latitude 30 deg. north.

Correction for the latitude error can only be made by some device which is susceptible to change of latitude. The pendulum, damped or undamped, indicates only the direction of the force upon its bob (the variation of the period of oscillation of the pendulum with latitude is not such as to be of practical importance), and this is no indication of the direction of the earth's axis of rotation.

It should be clear from what has been said that a balanced gyroscope would be free from error due to latitude if its constrained diametral axis were fixed, not vertically, but perpendicular to the earth's axis of spin. Thus a motor hung by its eyebolt and balanced so that its axle was horizontal, would point along the meridian when placed at the equator. In latitude, say, 30 deg. north, the north end of the axle would point east of the meridian. If the position of the eyebolt could be so changed that the motor axle sloped at an angle of 30 deg. with the horizontal, the latitude error would disappear.

Now it would be mechanically inconvenient to adopt such a method of latitude correction, moreover the gyroscope would probably be difficult to control. Upon this point an ordinary gyroscopic top is instructive. If it be set spinning and suspended by a string fixed to its equator (a wire is usually provided, forming an equator) its axis will remain roughly horizontal, the slight unavoidable lack of balance causing slow precession about the diametral axis defined by the string. The axle may be brought into a plane parallel to the earth's axis by fixing a second string to one of the screws and tying it to the first. This gyro compass is thus corrected for latitude, and provided its speed is great enough and its balance is good, its axle will point north and south. If, now, one end of the axle were raised momentarily and then let go again, the top would precess vigorously and would return but slowly to its original position. Difficulties of this sort would work against such a method of latitude correction applied to a suspended gyroscope. The method used in the Anschütz compass is much simpler and more convenient. It consists in hanging a weight upon one end of the gyro axle, the size of the weight being different for each latitude. This imparts to the gyroscope a torque about the horizontal diametral axis. Precessional force is thus produced tending to move the axle in a horizontal plane. By proper choice of this weight, which for all latitudes is small, the precessional force is made to balance exactly the force tending to take the axle out of the meridian, and so the latitude error is eliminated although the fixed axis is approximately vertical.

Turning, now, to the effect of acceleration of the ship we know that a pendulum hangs vertically only when its point of support is either at rest or moving with uniform velocity. Thus a pendulum gives no exact indication of direction, even with reference to the earth's surface if it is being accelerated. It follows, then, that acceleration will introduce an error just as latitude does.

It remains to show that the compass under consideration must be subject to error due to the ship's velocity. Uniform velocity will not affect the pendulum, but it will affect the gyroscope. Only when it is due east or west will the ship's velocity have no disturbing effect. If, for example, the ship be going north, that is to say, cause the gyroscope to be carried round in a plane whose direction is north and south, there will be a tendency for the plane of spin to set itself in the plane of the ship's movement, and so the axle of the gyroscope will move out of the meridian. No gyroscope can possibly distinguish between motion due to the ship and that due to the earth, and if the motion be uniform the pendulum is unaffected. Hence the velocity error is unavoidable in an instrument employing only gyroscopes and pendulums.

In all the forms of gyro-compass which have hitherto proved successful, the gyroscope is allowed to take up its natural position in which its axis of spin is approximately along the meridian, and its direction of rotation like that of the earth, the gyroscope being thus in stable equilibrium. In the recently suggested form called the "Sea Star" compass* it is proposed to put the north-seeking end of the gyro axis south, and the south-seeking end north, so that the rotation of the gyroscope is in the opposite direction to that of the earth, and the gyroscope is in unstable equilibrium. The very slightest deviation from the meridian (at the equator) would then cause the compass to seek the stable position by a movement of precession in which the axis of spin would begin to rise or to dip out of the horizontal. Any such rise or dip would cause contact to be made upon terminals carried upon a damped pendulum. These terminals would control a small motor called the "meridian motor," so geared as to pull the compass into the meridian again. One of the claims is that such a compass would have no latitude error. This claim appears to be in error, since such a compass, if balanced, would point due north, with axle horizontal only when at the equator. The action of the meridian motor ought to be made to depend upon departure from a position which is different for each latitude, not upon departure from the horizontal position. In other words since the position of the contacts is determined by a pendulum, and the pendulum gives no indication as to the direction of the earth's axis unless the latitude be known, a latitude correction would have to be applied to the reading of the compass, or, alternatively, the position of the contacts upon the pendulum would have to be set specially for each new latitude.

In making the broad statement that no combination of gyroscopes and pendulums can produce a compass free from latitude and other errors, sight is not lost of such facts as this, that a gyroscope may be used for the determination of latitude. If, for instance, a gyroscope running at fixed speed were mounted in such a way that whilst a number of different slopes were being given to the diametral axis which ordinarily would be kept vertical, the precessional torque imparted to the gyroscope by the earth's rotation might be measured, in a plane perpendicular to this axis, it would be found that the maximum possible observed torque would occur when the plane containing both the axle and the constrained axis of the gyro was perpendicular to the earth's axis of spin (and pointed, therefore, due east and west). Measurement of the least angle between the rod of a pendulum and the plane just spoken of would give the latitude. Here a number of measurements of torque would have to be made, and the apparatus is not regarded as a simple combination of a gyroscope and a pendulum.

A complete account of the principle of the gyroscope, giving all the mathematics, and that in a form readily applicable to practical problems, has recently been published under the authorship of Sir G. Greenhill in a "Report on Gyroscopic Theory," prepared by the advisory committee for Aeronautics of the National Physical Laboratory. In aeronautics the gyroscopic action of the engines and the propellor is of great importance and recently, in aeroplane work, special gyroscopes are being used as stabilisers and as direction indicators. In such cases the excessive and erratic accelerations to be dealt with make the use of pendulums very difficult and there would be much scope for a gyroscope having three degrees of freedom if such an instrument were practicable. Owing to the indeterminateness of the unavoidable constraint put upon such a gyroscope by its means of suspension the indications of the instrument would never be accurate, though if the dimensions and speed of the gyro were sufficiently great and friction small the indications might be reliable enough during short periods of flight. The small frictional forces would have to act for a number of hours before they would produce much

* See a Paper read before the Institution of Marine Engineers, by Mr. E. K. Scott, on Oct. 5, 1914.

change in the direction of the axle of the gyroscope, which would tend, of course, to remain fixed in space.

A brief account of the Sperry gyroscopic stabiliser was given in the issue of "Flight" for January 29th. It is there stated that in aeroplane work "the first, foremost and all-important requirement is a base line which will hold the true horizontal plane regardless of any motion or forces created by the aeroplane in flight." It is claimed that the Sperry stabiliser has solved the problem, ensuring "perfect maintenance of a true horizontal plane regardless of any movements of the aeroplane." Details of the apparatus are not given, but the claim made is more than could possibly be fulfilled by any combination of gyroscopes and pendulums. Since "perfect" maintenance of a true horizontal plane is spoken of the use of a gyroscope with three degrees of freedom is out of the question—because it would demand absolutely frictionless suspension. Some combination presumably is used involving definite constraint, and this surely demands a pendulum. A pendulum would introduce errors due to acceleration and to velocity of the aeroplane, though damping the pendulum might greatly reduce the errors due to accelerations of short duration.

Prof. Gray's recent Kelvin lecture has set everyone thinking about gyroscopes and spinning tops, so that a favourite greeting is "Good morning, why does a top stand up?" Mr. Swinburne has reprinted a neat common-sense explanation in the March issue of the "Journal" of the Institution of Electrical Engineers. It seems to me good that the fashion of thus trying to connect mathematics with common sense should be encouraged. Unfortunately, this sort of thing is found to annoy our mathematical Mastersingers, who regard mere common sense as not to be mentioned in the same book with mathematics. This is especially unfortunate for the average student, for he is apt to leave school with a knowledge of mathematics comparable with the man's knowledge of Greek who had become expert in the scansion of Greek verse without ever having learned the meaning of the words. And so if it does not seem too irrelevant to the question of the gyro-compass, I should myself like to add to the elementary discussion of the spinning top as follows: I will assume that the windmill example sufficiently demonstrates the fact that a gyroscope tends to set itself so that the direction of its own plane of spin coincides with the plane of any torque that may be applied. Only one other simple thought is required for the explanation of the spinning top. Everyone has seen how the tall, round milk cans used for the wholesale transport of milk are handled. Such a can is shod with an iron hoop forming the base upon which it stands. It is moved by being tilted over slightly so that it can be rolled upon the lower edge of the iron hoop. If now, in handling such a can a man were to stand upon a fixed spot, he could, by clockwise rotation of the tilted can, cause it to describe a clockwise circle about him. If to do this required that the man, always facing the can, should give, say, four complete revolutions to the can with reference to his own hands, a little thought will show that in describing one complete circle the can has really made four plus one rotations about its own axis. The man himself has rotated once, and this rotation has been imparted to the can. In other words the lock on the milk can has five times pointed north, although it has only four times pointed towards the man.

To turn then to the spinning top. If a top were rotating (say, clockwise, as seen from above), with its axis vertical, it would, in the absence of friction, go on so rotating for ever—in an endless sleep. But if a momentary puff of wind were to blow upon it tilting it slightly, say, towards the east, the effect of gravity would apply to the top a torque from west to east in a vertical plane. The top would seek to spin also in a vertical plane from west to east. To bring this about the axle would incline towards the south. This would cause the gravitational torque to be from north to south in a vertical plane and the [illegible] the top would then move so that the top's plane of spin would incline to become north to south, that is to say, the axle would be east and west. The plane of the earth's torque would thus incline to point east to west and the top would lean to the north, and so on. The top would never be able to fall the way the earth pulled it, but its axle would describe a double cone (like a rotating X) with the centre of gravity of the top at its waist.

It should here be noted that the action could not take place unless the top actually did incline somewhat in the direction of the applied torque. Such a condition had to be made possible in the case of the windmill by allowing the mill to be tiltable. And if the disturbing torque were great or the spin of the top slow the disturbing torque would overthrow the top. Under perfect conditions, friction being absent, the top once disturbed would go on describing the same double cone for ever. The application of a clockwise horizontal torque would make it stand up and go to sleep, whilst a counter clockwise torque would overthrow it. Now, in practice, there is friction between the peg and the table, and as soon as it is tilted the peg describes a circle, moving round in the manner of the tilted milk can. If the peg described a complete circle upon the table in one second and the rate of spin of the top, speaking of it as though it were a drill, were 100 revs. per second, the spin in space would be 101 revs. per second. That is to say, the friction of the peg upon the table would have the effect of an applied torque tending to increase the spin. The plane of this torque would be the plane of the table and its direction like that of the top clockwise as seen from above. The top would move so as to make the direction of its own plane of spin coincide with this applied torque and it would, therefore, tend to go to sleep.

An egg-shaped top is a very interesting case for the application of the windmill and the milk can rules. If the egg were like a lemon, equally blunt at both ends, and were set spinning upon one of its shorter diameters, everyone knows that it would quickly stand up so as to spin upon its longer diameter. If the egg-shaped body be thought of as unusually light in the middle and heavy at the ends the case is seen to be comparable with that of a top made up of a short spindle having half-way up it a cross-arm carrying a ball at each end. The short spindle and the longer weighted cross-arm correspond respectively with the shorter and the longer diameters of the egg. It would be most difficult to make such a top continue to spin with its axle vertical; it would fall over and tend to spin upon one ball with the cross-arm as the axis of spin. For if we suppose that for a short time it should be spinning (clockwise as seen from above) with its spindle vertical, and at an instant when the cross-arm pointed east and west a puff of west wind were to strike it, imparting a torque from west to east in a vertical plane, it would momentarily tilt over to the east. This would cause gravity to set up a torque, also from west to east in a vertical plane, and in its endeavour to make its own plane of spin agree with this applied torque, the spindle would be tilted towards the south. There would, however, be no cross-arm in this plane of tilt at the instant considered, and so the precessional action would be interrupted. The ball which was pointing east would strike the table. It would here be brought to rest were it not that the milk-can action would begin, for the other ball continuing its own motion would describe clockwise circles about the spot where the first ball struck the table. This action would impart to the cross-arm a clockwise spin, equivalent to an applied torque in a horizontal plane and so the cross-arm would tend to stand up and spin about its own axis.

If instead of a dumb-bell like cross-arm on a short spindle the spinning body were a lemon-shaped heavy-ended solid set spinning upon one of its shorter diameters, the process just outlined would, even at low speeds, cause the body actually to stand up and spin about its longer axis. The uniform shape of the body would enable the change of position to be brought about much more readily and gently than in the case of the dumb-bell.

Should the top be shaped like a sea-bird's egg, blunt at one end and sharp at the other, and be so weighted that it would stand when at rest upon its blunter end, it would be found to spin steadily only upon its sharper end. For if we suppose that it were set spinning upon its blunter end, with clockwise spin as seen from above, and a puff of west wind tilted it momentarily to the east, the gravitational torque thereby introduced would be such as to tend to pull it back again, because of the heaviness of the blunt end (reminding us of the bullet-bottome

bottles, paper policemen and the like, which automatically stand up again when knocked over). That is to say, gravity would introduce a torque from east to west in a vertical plane. In its endeavour to adjust its own spin to agree with this applied torque the egg would incline towards the north. This would cause gravity to impart a torque from north to south and so the egg would tilt west. The precession would thus be counter-clockwise. The milk-can action would have the effect of a counter-clockwise torque, and in its endeavour to accommodate itself to this torque the egg would have to turn over so as to spin upon its sharper end.

An extreme case of such action is that of a hemispherical bowl. It stands stably as a bowl, but if set spinning in this position endeavours to turn over and soon is spinning upon one point of its rim, finally falling inverted upon the table.

An ordinary egg though blunter at one end than the other will not stand upon either end when at rest. It can, therefore, be spun upon either end. If it be set spinning upon its side, arguments like those just given show that it will shortly stand up and spin upon its sharper end.

Finally, the interesting case may be considered in which the top instead of being merely the shape of an egg is indeed an egg unboiled. In such a case spinning, if it occurred at all, would occur only with the egg lying on its side. Consideration of the previous cases reminds us that the mere spinning of a top goes on independently of the milk-can action, but that such action is essential to the process by which a top when tilted becomes upright and goes to sleep. Every case in which a top rises, apparently against gravity, depends upon the milk-can action. By this action the circling motion of the peg of the top upon the table imparts torque, in a horizontal plane, to the body of the top, wherefore, by the windmill rule, the top tends to become upright. At first sight the milk-can rule seems to imply that a top after tilting spins more rapidly than before. This would, of course, be impossible, since the peripheral velocity of the peg of a top could not be automatically increased by the mere rolling of the peg upon a fixed horizontal table. In practice a top, left to itself, is all the time slowing down. The importance of the milk-can action is that it introduces a torque in the plane of the table.

Now if the top were an unboiled egg, or any sort of shell filled with a not too viscous liquid, the circling of the peg and shell would not impart appreciable torque to the mass of the top (the liquid) and such a top would not rise against gravity, it would spin only in a position in which, when at rest, it would be stable.

It should be pointed out that in this discussion no attempt has been made to consider the effect of any movement of the earth in space, except that of rotation about its own axis of pin.

Useful works of reference upon the subjects of gyroscopes and of gyro-compasses are the following: "Spinning Tops," by Prof. J. Perry (Romance of Science Series); "Spinning Tops and Gyroscopic Motion," by Harold Crabtree (2nd edition, just published by Longmans, Green & Co.); "The Gyro-compass," by G. K. B. Elphinstone (Elliott Brothers).

CONFERENCE ON COAL SUPPLIES.

As was stated briefly in our last issue, an important conference of the electricity and gas undertakings was held last week at the Institution of Electrical Engineers. Great interest was taken in the matter, and the lecture theatre was crowded with delegates to overflowing. The chair was taken by Sir Herbert Woodall (president of the British Commercial Gas Association), supported by Sir John Snell (president of the Institution of Electrical Engineers).

The CHAIRMAN expressed his satisfaction in attending [illegible] meeting in the common interests of the gas and electrical industries. It marked, he said, a new departure in regard to the operations of these two great industries, and he had no doubt that before they left the meeting opportunity would be taken to express to the council of the Institution the attitude of those who were not electricians for their assistance. The situation which faced them, and which they were called [illegible], was without precedent, and was one of grave importance to the welfare—he might almost say to the safety—of their country. Coal was essential to the manufacture of gas, and hardly less so to the production of electricity. Winter made a much larger demand than summer, and large stores of coal should now be accumulating to meet again the heavy and inevitable call of winter, instead of which they had found it difficult, and in some cases impossible, for some time past to procure what had been necessary from day to day. Their reserves had been steadily vanishing, and they were face to face with a prospect of the adequacy and the continuance of supply becoming impossible. He was told the other day by an official in a responsible position in a Government department that he (the chairman) over-rated the importance of such a catastrophe, and that he (the official) was prepared to carry on his work by candlelight, and was not alarmed at the prospect of darkness. The one idea he had before him was to bring the war to a successful end. With the latter purpose they were all at one; to its achievement they were all prepared ungrudgingly to contribute all that was needed of time, effort or money. But, having a great purpose in view, it was surely well to consider with care the means by which it was to be accomplished. This the man of one idea sometimes failed to do; with a great distant haven to reach, it was supreme folly to scuttle the ship by which alone the journey could be made. On more than one occasion they had been met with a suggestion that their petitions and remonstrances were lacking in patriotism, and that their attitude was rather that of greedy traders seeking simply the maintenance of profits, and to that end asking for preferential treatment. They indignantly repudiated such imputations. They represented institutions which had accepted from Parliament duties of a public character and of great importance. Obligation was imposed upon them to fulfil those duties, and in return certain exclusive privileges were granted them, hedged round by restrictions and limitations in the public interest. If they failed to perform the duties imposed upon them, no one else, except after long delay, could take them up, and the whole community must suffer. Those duties included not simply the lighting of the public ways, but also the lighting and warming of the houses of both rich and poor and of public buildings, which included barracks, hospitals, camps and factories for the manufacture of great guns and rifles, clothing for soldiers and sailors and all the manifold munitions of war. Gas and electricity were used in a vast number of industries, not for lighting only, but for heating and power, and failure of supply would involve the reconstruction of the users' plant, which would be impossible, even at great cost, without long delay, and would upset the whole activities of the country and reduce materially the output. The cooking of probably half of London's food—and the same might be said of other towns—was done by gas. There were in and around London about a million families taking in pennyworths a supply for lighting and cooking, and many important industries were depending on the secondary products of coal distillation. At the present time many gas companies had so adapted their plant that they were producing materials of vital importance to the Government in carrying out the war. That aspect of the question was so far recognised in Germany that definite instructions had been sent throughout the country encouraging the use of gas in order that the waste of coal for heating purposes should be avoided. The use of gas and coke was prescribed so that the coal might be carbonised in close vessels in order to recover those products which were now found to be of such urgent and vital importance. With regard to the immediate cause of the trouble, only recently there was sufficient coal available at the pits, but the difficulty lay in the carrying of it. The Admiralty needed a vast fleet of steamers as tenders to the warships and as transports for troops, materials and stores, and they commandeered all the vessels they thought suitable, largely for the coast service, leaving a number insufficient for the ordinary service. For those left available the owners were enabled to demand very high rates, with the result that the rate from the Tyne to London, which before the war was 3s., became four times that amount. The greatly increased needs of the War Office led to a congestion of traffic on the railways, and, although the rates were not increased, the delays became very embarrassing. To meet the situation at sea the Government allowed certain enemy ships which were interned in our ports to be brought into use for the service of the public utility departments and undertakings. Freights continued high, partly because the Government, who might, he thought, have been content with a charge such as that which they paid for the commandeered ships, elected to pay the extravagant rates required by private owners. Now the position was altered. The supply of coal had fallen below the demand, and the charges for what was obtainable had been put up very heavily, and because of the shortage there was a plethora of ships and the rates of the freights had fallen. The present difficulty was the greater. It was no longer a question of money; they were faced with the prospect of a coal famine. Unlike, however, a famine due to natural causes, this was a preventible famine, due to causes which could and ought to be dealt with. The reduction of output was due largely to the withdrawal of the great number of miners who had gone to swell the noble army who were fighting or preparing to fight their country's enemies. All honour to them, and those others who might yet follow in their steps, but not less to those who were with equal devotion carrying the burden of keeping up the output of supplies as far as lay in their power. When the men at the front made the great election to risk, and if necessary surrender, their lives, there would probably have been no deficiency in supplies if the remaining men at home had made greater efforts to fill up the gap. Wages had been raised materially, and as the average miner was not given to saving it took a longer time off work to spend the money. The owners were partly responsible for that. They were demanding the uttermost amount which the needs of the country and its industries rendered available. The men knew the profits which attached to those high prices

and they would be more than human if they did not demand their share. It was hoped that some limitation might be put upon the profits of collieries and royalty owners. The question of workmen was more difficult, but by payment of wages on a scale goverend by weekly output, by compulsory saving of part of the miners' earnings, or some other way—but, best of all, by appeal to their patriotism, their care for friends at the front and helpless ones at home—an improvement could surely be made. He presumed the export of steam coal, which the Government required, was prohibited, and he thought that should be extended to other public services. The Government had appointed a Committee to deal with the subject, and the gas and electricity suppliers could probably press their case effectively by seeking an interview with that Committee. By keeping their industries going they were keeping employed men who would otherwise be suffering want, and they were earning money to help furnish the Chancellor of the Exchequer with the vast sums he told them were necessary to carry out the terrible war. In the way open to them they desired to serve their King and country with the utmost of the power left to them, and they had the right to demand that their hands should not be tied.

Sir JOHN SNELL welcomed the gas delegates, and remarked that it was not always that the two industries were so happily able to co-operate. His council desired him to say they were desirous of doing all that was possible to assist in the most important matter now under discussion, provided it did not embarrass the Government or the authorities in the proper conduct of the war, which, of course, must come first and foremost in all their minds Coal was necessary to the gas and electrical industries, both for reasons of public health and public safety, and there were many industries turning out nothing but munitions of war, which were dependent entirely upon either a public electricity supply or upon gas-driven plant to enable them to continue their output. Anything which would tend to shut down or embarrass the public supply given by the electrical or gas undertakings would be distinctly injurious in the national interest. What they wanted to do was to endeavour to improve the output from the pits—he understood that in some cases the pits were only working four days a week—and they wanted to improve the transport facilities from the pits to their various undertakings. Although he was told that the difficulties which existed at the beginning of the war as to the delay with railway trucks had to some extent been mitigated, if the Government could enable greater facilities to be given for sea transport it was possible that the present congestion of the railways would be further relieved and the undertakings still further benefited.

Ald. KAY (Chairman of the Manchester Gas Committee) said that he thought the resolution, which had been handed to him to propose, would, after the remarks of the Chairman and Sir John Snell, meet with approval, but he would like to say how much he appreciated the efforts that had been made to further the earlier efforts of the gas industry and the electrical industry to impress upon the Government the necessity for doing something—and doing that something quickly—to help the position. In his opinion time might be found more valuable than money at the present moment, because one could not control a large undertaking for gas or electricity supply without viewing with great alarm the condition of the coal stocks to-day and comparing them with normal times. In an undertaking, with which he was fairly familiar, they were worse off to-day than they were after the coal strike—a position which ought never to have arisen, and for which there was no justification. Their stocks were so depleted that on March 31 they were 70,000 tons below normal, and to-day they were not obtaining much more than their consumption; they should be adding to their stocks instead of depleting them. It was a serious problem, and they were doing all they could to help loyally the Government by keeping up their supplies to those factories and firms who were making munitions of war. The resolution was :—

"That this meeting congratulates the Government on having appointed a Committee to deal with the exportation of coal, and hopes this may be effective in limiting exports, but views with the deepest concern the depleted stocks of coal and the difficulty under present conditions of renewing them for present and future requirements, and urges the Government to take further and immediate steps (*a*) to increase the output of coal from the pits; (*b*) to give greater facilities for the transport of coal by rail; and (*c*) to have regard in the requisitioning of steam colliers to the requirements of the public utility undertakings which depend for their supplies on sea-borne coal."

It would be apparent to all that the Government must move at once in that direction. Unless progress was made at once they could not hope to meet the winter demand with anything approaching safety, because it would be only necessary to have a week or two's delay to find the whole business crumble to dust. Such a position was terrible to contemplate, and he was afraid that the Government themselves did not recognise the very great importance of keeping the public utility undertakings going at any cost. A man who said he was content with candle light could not know the enormous responsibilities what attached to gas and electricity undertakings. Companies owning such undertakings were tied down hand and foot as to prices, dividends, &c., and he did not think their worst critic could say it was a question of pounds, shillings and pence at the present moment. The chief factor was supply. He trusted the members would appreciate the seriousness of the position and give the resolution their hearty support.

Mr. [illegible] (Joint Managing Director of the City of London Electric Lighting Co.) said that he had great pleasure in seconding the resolution and in thanking those concerned on behalf of the companies supplying electricity in London for the splendid opportunity they had [illegible] platform so many of their friends in the gas industry. A week or two ago Parliament approved of the election of a Committee to investigate the necessity of providing for the needs of house coal for London, especially during the next winter. The report of that Committee had been published, but he had not heard of any steps being taken to carry those recommendations into effect. He agreed to the necessity of providing a cold store and a stock of sufficient magnitude to meet next winter's demands, and if prompt measures were not taken it was hopeless to expect to obtain the necessary supply in the later months of this year. Their necessity for coal was as great if not greater than that of anyone else, and he thought the Government should put them first on the list and say they should have their supply, whatever occurred to other people. They found it almost impossible to bid against the Admiralty for Welsh coal, as the latter were willing to pay 35s. per ton f.o.b. Cardiff, and they had to seek elsewhere. The gas companies depended more or less upon one class of coal, but the electricity suppliers had a larger range of selection, and their demands would not be very difficult to meet with a reasonable amount of consideration from the Government. The supply of coal for the whole electrical industry was only one-tenth of that of the gas companies. But it should be remembered that electricity undertakings were assisting in supplying power to the factories engaged in producing munitions of war for the purpose of killing their enemies. Unfortunately, the press of this country was often writing articles to kill the Government, but the Government had done their best to meet a most difficult state of things, and he was expressing the views of his brethren in the electrical supply industry when he said they had to acknowledge with their thanks the straightforward and generous conduct of the coal trade generally so far as the supply was concerned. They had no wish to charge them with having made undue profits out of the difficulties of the country, and he believed some of the coal merchants had actually sustained a loss. He did not think they should blame the intermediaries who were engaged in bringing the coal from the collieries to their works. They had no one to blame, but they would ask the Government to put their demand first because they were equivalent to the coal cellars of this country.

Mr. JOHN BOND (President of the Institution of Gas Engineers) said the Council of his Institution had had under consideration this question and had approached on many occasions the various departments of the Government, and the Board of Trade were now taking steps to restrict the exportation of coal. He believed that this great movement had been brought about chiefly through the energies of the Manchester District Institution of Gas Engineers, and an important part in that had been played by Ald. Kay and Ald. Phillips. It was of the utmost importance that the Government should secure for both the gas and electrical industries a proper amount of coal, because the nation largely depended upon them for munitions of war, and he sincerely hoped the Government would take immediate action to see that they got their proper supplies.

Mr. R. A. CHATTOCK (city electrical engineer of Birmingham), who represented the Municipal Electrical Association, said that there were some hundreds of electrical undertakings in this country under municipal management, the supply from which was being utilised in the production of war material, and the coal burned in those undertakings last year was upwards of 2,000,000 tons. Most of those undertakings were running with very small margins of stock. The stocks had been reduced to something like 25 per cent. of what they were at the commencement of the war. Those were average figures. The light supplied to the private user only represented about a tithe of the power and lighting that was being supplied to the factories, and it was that supply they had to safeguard and maintain at all costs. The power supply of the electrical undertakings was being used almost exclusively for the production of war materials. The Government had helped certain undertakings to obtain more coal, but this had only been arranged at a largely increased cost. The average increase was about 50 per cent. on what was being paid before the war. That represented to the municipal electrical undertakings an increase of something like £500,000 to £600,000 per annum for coal, and he considered that in going to the Government they ought to emphasise this point and ask for assistance in getting coal at a reasonable price.

Mr. REGINALD NEVILLE, M.P., said that he would like to know whether any concrete suggestion had been put forward for getting over the difficulty. Could any suggestion be made to the Government which the Government would say was a good one, and that they would do their best to carry it out? His own experience of Government officials was that unless one went with something concrete it would be found that the Government would be very polite, hear all they had to say and thank them, but they would have great difficulty in getting any further. He suggested that they should all apply themselves particularly to some way in which they could get over the difficulty with which they were faced. There was a great difficulty about the interned ships, and there was no chance, so far as one could see, of getting more ships. He did not know whether there was any possibility of the gas and electrical industries combining and getting hold of some colliery to work themselves. It was a risky business, but in time of war they had to take risks. They should point out strongly to the Board of Trade that their statutory duties compelled them to do various things which in time of peace were perfectly right, but in time of war in face of a deficit of coal were extremely onerous and difficult to carry out.

Bailie IRWIS (Glasgow) said that the resolution embodied what was the minds of most of the gentlemen there. They were not prepared to recommend to their consumers that they should economise to the extent of reducing their consumption, but they were prepared to bend every [illegible] bring pressure to bear upon those who were responsible for the maintenance of the present position. They had before them the indication of the Board of Trade of their probable action with regard to the export of coal and they might expect great benefit from that

Sir ALEXANDER KENNEDY said that he strongly supported the resolu-n and also wished to endorse Mr. Bailey's statement that in London the naviour of the firms who were supplying them with coal left absolutely hing to be desired.

Some speakers having expressed the view that they should request the vernment to fix the price of coal, the Chairman said a resolution would ne on later dealing with the price question.

Mr. H. JONES (chairman of the Gas Companies' Protection Associa-n), in supporting the resolution, said that the question was one for the nsumers of both electricity and gas, and when the Government found t the voters objected to being fleeced, something would be done.

Sir D. FORD GODDARD, M.P., said they had an exceedingly good case to to the Government with, and could make their case very clear. He thered from certain conversations he had had with those in the coal lustry that there was nothing which would add more largely to the pply of coal than some restriction of the exportation. He did not nk the Government realised the enormous extent which the coal ques-n bore upon the workers of the country. They must have coal to carry their industries, and he fully agreed with Mr. Chattock that they uld get coal at something like a reasonable price.

Bailie LINDSAY (Chairman of Edinburgh and Leith Gas Cor-rations) said they were all agreed that there was a great scar-y of coal, and thought the question of price ought to stand aside. om the latest figures he had available, if the export of coal were irely prohibited to other than our Allies, that would not provide a fficient source of coal, and it seemed strange to him that they had not , through the Government, gone to the kernel of the question—the reased working of the men at the pits. Why had they not acted on se 4 of the Coal Mines Regulations Act, 1908? This clause read: is Majesty may, in the event of war or of imminent national danger great emergency, or in the event of any grave economic disturbance to the demand for coal exceeding the supply at the time, by Order in ncil suspend the operation of this Act to such extent and for such od as may be named in the Order for and as respects certain coal es or any class of coal mine." This clause might have been written erday or to-day. It could not have been better framed to meet the umstances.

fter some further remarks by a few speakers, the resolution was put ne meeting and carried unanimously.

d. PHILLIPS (Salford) said that he fully agreed with every word of irst resolution, but, in his opinion, it did not go far enough. It left a very important matter, not the principal thing, but a very im-ant secondary matter, the question of price, and he proposed to move olution in the following words:

"That the Government be asked to take such steps as may be cessary to reduce the price of coals to reasonable limits."

ch a resolution did not commit anybody there, and he knew was little difference of opinion amongst those who had spoken, probably also amongst the audience, but still the question of price n important matter in itself, and they could not afford to give it an ute go-by, especially when a Departmental Committee of the Board ade reported: "We have pointed out that prices have risen owing to emporary lack of equilibrium between supply and demand, and they risen without relation to the cost of production." It might take a time to explore fully the meanings concealed or involved in those s "the cost of production." It might mean that an artificial scar-would send prices up. He was not going to make any aspersions, hen they had the report of the committee, under heading No. 5, that rices did not shortly return to a reasonable level," did not that that, in the opinion of an impartial committee, asked by the nment to report without fear or favour, prices were not at a reason-evel? "If prices did not shortly return to a reasonable level, the rnment should consider a scheme for assuming control of the out-f collieries during the continuance of the war." They must have o any price rather than go without it, but they would have coal at a nable price if they could get it. Therefore, they should emphasise portion of the report, and say to the Government what he proposed eeting should say in the resolution which he had proposed. Surely, could be no objection on the part of anybody in that room or out of having the price of coal at a reasonable limit, whatever that was, ey did not ask for anything more, but when they remembered that hing like 20 million tons of coal were consumed by the gas and city undertakings of this country it was evident that every 1s. se in price amounted to close upon £1,000,000 having to be found. heard of increases of 9s., 7s., 6s. and 5s., and if they translated these illions of pounds it was evident that somebody was being taxed to a reat extent. They wanted that amount kept within reasonable limits.

F. HALL (chairman of the Workington Corpn. Gas Committee) said s representing one of the smaller gas committees the question of was a serious one. If it were a fact that prices were fixed by com-n in the various districts by the coal owners, possibly they would ve to complain. He referred to an article in a recent issue of the and Coal Trades' Review," in which it was stated that there was ompetition between individual collieries and between different districts. He happened to live in a district and was associated ork in the district in which every pound of coal was gotten by the rland Coal Association, and he proposed to read extracts of recent between one of the collieries and himself. Early in April he saw a ntative of this colliery and arranged for the delivery of certain

[illegible]

fixed by the Coal Association, so he (the speaker) acknowledged the letter in these terms, "On behalf of the committee, I thank you for your letter of the 1st inst., and sincerely trust that you will be able to exercise such influence upon the Association as will enable you to invoice this parcel of coal at the price not exceeding . . ." The reply he received was, "In reply to yours of the 3rd, we regret to inform you that we have not been able to obtain any reduction of the new price fixed by the Coal Association. This figure must, therefore, be paid for the coal you take from us between April 1 and June 30." This was not free trade between coal owner and coal user. Every pound of coal sold was regulated by prices fixed by the Coal Association. He thought Ald. Phillips perfectly right in urging upon the Government the advisability of a strong inquiry being made into the reasons and ways the prices of coal were fixed for gas and electricity undertakings. He ventured to suggest that if the Government did so they could give them information as would lead to the opening of their eyes.

Ald. WHEATLEY (Huddersfield) said it sounded a strange note to him that they should ask for coal to be made cheaper. It was a national necessity, and if the Government knew its duty it would know that it should have command of the coal as well as of ammunition. It would see that coal be got for the well-being of the people at a rational and reasonable price. They must not blame the colliery proprietors for putting the price on, but blame themselves that they had not command of a thing that they could not live without. The nation should regulate the price, and he hoped this phase of the question would be strongly emphasised.

Bailie W. B. SMITH (chairman of Glasgow Electricity Committee) supported the resolution, and said the Government might be asked to put into immediate force what they had decided the previous day, an Order in Council prohibiting the export to other countries, instead of waiting till May 13. If the Government would stop the export of coal to Amsterdam, Rotterdam, Norway and Sweden, the price of coal on the Glasgow Exchange would come down immediately.

Sir JOSEPH BELLAMY said that in going to the Government to ask them for something the matter should be well thought out by the committee as to the way the remedy might be applied. Districts varied in circumstances and conditions, labour charges, &c. The Government would require to know what the expenses of the collieries were in excess of those before the war to get some reasonable idea of the extra charges the collieries had to bear, which should be paid for by consumers. They wanted some inquiry as to the charges which should be legitimately laid upon them. The question of price was affected by restriction of output, and the men should be allowed greater latitude in working longer than eight hours a day. There ought also to be some relief from a different method being adopted with interned ships.

Mr. JOHN CHRISTIE (borough electrical engineer, Brighton) said his undertaking depended entirely on seaborne coal. They were paying about £15,000 for the partial services of a coaster, and the profits of the owners of these vessels must be colossal. In approaching the Government the Chancellor of the Exchequer's attention should be called to make a surcharge on the owners of craft of that sort whereby their profits might be limited to about 15 per cent.

Mr. JAMES T. RANDELL (Southend Gas Co.) moved an amendment, "That the deputation ask the Government to endeavour to fix prices in accordance with the increased cost of production on the renewal of contracts."

The Chairman, however, did not see his way to accept this amendment.

Ald. Phillips' resolution was then put and carried by a very large majority.

The CHAIRMAN then proposed a third resolution:

"That a representative deputation of the gas and electricity industries be appointed to present our case to the Members of Parliament and to take such further action as may be found advisable. That a conference with Members of Parliament, to be held in London on ....., to seek their aid in urging upon the Government immediate action to give effect to the above recommendations. That each authority represented pledges itself to take steps to secure the presence of their Member or Members of Parliament at the proposed conference."

The following names of the deputation were submitted:—

Sir Ryland Adkins, M.P. (director of Herne Bay Gas & Electricity Co., Ltd.), Mr. Edward Allen (engineer of Liverpool Gas Co.), Mr. F. Bailey (joint managing director City of London Electric Lighting Co., Ltd.), Mr. J. Ferguson Bell (manager and engineer of the Derby Gas Light & Coke Co.), Sir Joseph Bellamy (chairman of the Plymouth & Stonehouse Gas Light & Coke Co.), Mr. John Bond (President of Institution of Gas Engineers), Mr. W. G. Bradshaw (chairman of the Commercial Gas Co., London), Dr. Charles Carpenter (chairman of the South Metropolitan Gas Co., London), Mr. W. A. Chamen (engineer and general manager of South Wales Electrical Power Distribution Co.), Mr. R. A. Chattock (acting President, Incorporated Municipal Electrical Association), Mr. F. E. Cooper (secretary, Gas Companies' Protection Association), Mr. A. C. Cramb (President Elect, Incorporated Municipal Electrical Association), Mr. W. T. Dunn (secretary, Institution of Gas Engineers), Mr. Hardman A. Earle (Yorkshire Electric Power Co.), Sir J. Fortescue Flannery, Bart., M.P. (director of the South Suburban Gas Co., London), Sir D. Ford Goddard, M.P. (chairman of the Ipswich Gas Light Co.), Mr. J. S. Highfield (engineer and manager, Metropolitan Electric Supply Co., Ltd., London), Capt. R. S. Hilton (secretary and manager of the Birmingham Corporation Gas Department), Bailie Irwin (chairman of the Gas Committee, Edinburgh Corporation), Mr. [illegible] (secretary of the Southampton Gas Light & Coke Co.), Mr. H. E. Jones (chairman of the Westminster [illegible] Gas Co.), Mr. [illegible] Kay (chairman of the Manchester Corporation Gas Committee), Sir

Alexander Kennedy, F.R.S. (consulting engineer to the Westminster Electric Supply Corpn., Ltd.), Mr. A. Masterton (engineer and manager of the Edinburgh and Leith Corporation Gas Department), Mr. C. H. Merz (Newcastle-upon-Tyne Electric Supply Co., Ltd.), Mr. Reginald Neville, M.P. (chairman of the Brentford Gas Co., London), Mr. G. W. Partridge (chief engineer and manager, London Electric Supply Corpn., Ltd.), Mr. S. L. Pearce (chief electrical engineer, Manchester Corporation), Ald. F. S. Phillips (chairman of the Salford Corporation Gas Department), Mr. W. E. Price (engineer and manager of the Hampton Court Gas Co.), Mr. P. F. Rowell (secretary of the Institution of Electrical Engineers), Mr. A. H. Seabrook (general manager, Borough of St. Marylebone Electricity Supply), Bailie W. B. Smith (chairman, Glasgow Corporation Electricity Committee), Mr. James Smith (engineer, Belfast Corporation Gas Department), Sir John Snell (President of the Institution of Electrical Engineers), Mr. C. P. Sparks (engineer-in-chief, County of London Electric Supply Co., Ltd.), Sir Albert Stanley (managing director of London Electric Railway Co.), Mr. C. D. Taite (engineer and manager, Lancashire Electric Power Co.), Mr. Hanbury Thomas (managing director, Sheffield United Gas Light Co.), Mr. F. J. Walker (Conference of Chief Officials of London Electric Supply Companies), Mr. D. Milne Watson (general manager, the Gas Light & Coke Co., London), Sir Corbet Woodall (Governor of the Gas Light & Coke Co., London).

Sir JOHN SNELL seconded the resolution, which was carried.

Sir JOSEPH BELLAMY proposed on behalf of the gas interests a hearty vote of thanks to the Institution of Electrical Engineers for allowing them to hold the meeting in that building; this was seconded by Mr. E. Allen, and carried with acclamation, Sir John Snell making a short speech in reply.

The meeting was concluded with a hearty vote of thanks to Sir Corbet Woodall for presiding.

THE FUTURE PROGRESS OF CABLE TELEGRAPHY.*

BY H. W. MALCOLM, D.SC.

(*Continued from page* 98.)

Summary.—An analytical study is made of the problem of increasing the speed of the submarine telegraph cable, and of rendering it, if possible, distortionless. The problem is attacked from first principles in order that clear ideas may be obtained. The discussion comes under three heads: (*a*) Distortion and how it is produced; (*b*) Present-day methods of reducing distortion; and (*c*) The loaded submarine telegraph cable. Tables and diagrams are given throughout so as to render the results readily available to those who have not the time to follow the processes by which they are obtained.

LOADED CABLE AND CONDENSERS.

Now, suppose that the cable is to earth through a condenser at both the sending and the receiving ends. The periodic solution is

$$C_r = \frac{V_s}{(Z_s Z_r) \cosh Pl + (Z Z_r / Z_s + Z_r) \sinh Pl}$$

Here $\varphi(q) = (Rl + qLl) \left\{ \frac{\sin x}{x} \frac{Kl}{qK_s K_r} + \frac{\sin x}{x} \left(\frac{1}{qK_s} + \frac{1}{qK_r} \right) + \cos x \right\}$,

where $x^2 = l^2 (R + qL) . qK$. Also $\frac{d}{dq} = \frac{dx}{dq} \cdot \frac{d}{dx}$,

where $\frac{dx}{dq} = \frac{2KL^2 q}{2x} = \frac{KR^2}{2x} = \frac{KR^2}{2x} \sqrt{1 - \frac{4x^2 L}{KR^2 . R}}$

Hence

$$y\varphi'(q) = (Rl + 2qLl) \frac{\sin x}{x} \frac{dx}{dq} \left[\frac{1}{2} qlR + qLl \right) \left\{ \frac{Kl}{K_s K_r} \frac{x \cos x - \sin x}{x^2} - \left(\frac{1}{K_s} + \frac{1}{K_r} \right) \sin x \right\}$$

which becomes on substitution for $\frac{dx}{dq}$

$$y\varphi'(q) = \frac{R l \sqrt{1 - \frac{4Lx^2}{KR^2 . R}}}{2} \left[\frac{2 \sin x}{x} + \frac{1}{x} \left\{ \frac{Kl}{K_s} + \frac{Kl}{K_r} \right\} - \frac{1}{\sin x} \left(\frac{\cos x}{x} \right) \right]$$

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Table XXXIII.

x	$\frac{4Lx^2}{R . KR^2}$	$\frac{R}{2L} \sqrt{1 - \frac{4Lx^2}{R . KR^2}}$	$\frac{4}{R} \sqrt{1 - \frac{4Lx^2}{R . KR^2}} \left[\frac{2 \sin x}{x} + \frac{1}{x} \left(\frac{Kl}{K_s} + \frac{Kl}{K_r} \right) \left(\frac{1}{\sin x} - \right. \right.$
2·6272	0·2761	9·7752	+ 51·378
5·307	1·1266	4·0874	−429·32
8·067	2·6031	14·546	+223·41
10·909	4·7611	22·282	−206·32
13·819	7·6385	29·602	+191·63
16·782	11·265	36·811	−175·94
19·786	15·658	43·989	+160·66
22·817	20·826	51·157	−146·72

Table XXXIV.—*Fig.* 48, *Curve A.*

t (sec.)		0·4	0·5	0·6	0·7	1·0	1·5
$\frac{Rt}{2L} - \frac{Rt}{2L} \sqrt{1 - \frac{4Lx_1^2}{R . KR^2}}$	...	0·6854	0·8567	1·0278	1·1999	1·714	2·571
$e^{-\frac{Rt}{2L}} \sinh \frac{Rt}{2L} \sqrt{1 - \frac{4Lx_1^2}{RKR^2}}$		0·2518	0·2123	0·1789	0·1506	0·0901	0·03
1st term, +	...	12·94	10·91	9·19	7·74	4·63	1·96

Finally,

$$C_r = \frac{4E e^{-\frac{Rt}{2L}}}{Rl} \sum_x \frac{\sinh \frac{Rt}{2L} \sqrt{1 - \frac{4Lx^2}{KR^2 . R}}}{\sqrt{1 - \frac{4Lx^2}{KR^2 . R}} \left[\frac{2 \sin x}{x} + \frac{1}{x} \left(\frac{Kl}{K_s} + \frac{Kl}{K_r} \right) \left(\frac{1}{\sin x} - \right. \right.}$$

where $$\tan x = \frac{\frac{Kl}{K_s} + \frac{Kl}{K_r}}{x - \frac{1}{x} \frac{Kl}{K_s} \frac{Kl}{K_r}}$$

When L is zero, (32) reduces to (66)*, the formula for a cable with signalling condensers.

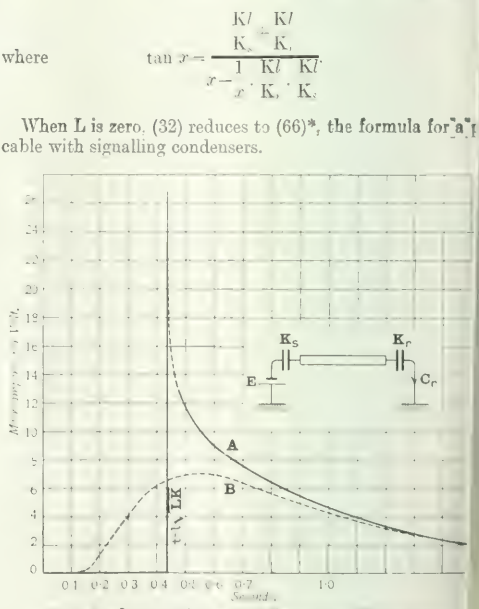


FIG. 48.—LOADED CABLE WITH SIGNALLING CONDENSERS.

Curve A.—$K = K_r = K/10$, $L/R = \frac{KR^2}{100}$. Curve B.—$K_s = K_r = K/10$, L

When $K_s = K_r = K/10$ and $L/R = KR^2/100$ as before the first term in the series is hyperbolic, and all the subsequent terms are circular. The values of x are contained in Table XXXIII. (taken from Table XVI.)† and from it Table XXXIV. is calculated, and plotted in Fig. 48, curve A. Curve B gives the current in the case of the plain cable.

The circular terms from x_1 to x_5 have been calculated only for $t = 0·45$, 0·5 and 0·6. The probable course of the curve

* "Theory," THE ELECTRICIAN, May 31, 1912, p. 316.
† "Theory," *loc.*

lower values of t is shown by the dotted rt of the curve. The height at time $\sqrt{LK}$ is the same as in curve A, Fig. 47 d curve A, Fig. 40.

Comparing curve A, Fig. 48 with curve Fig. 47, it is evident that the effect of e second condenser is to cut away the il of the signal. This result might have en anticipated from a comparison of the rresponding curves in the non-loaded ble, Fig. 16, curve A, and Fig. 17, rve A.*

The area between the curves and the e axis is the same in both cases and equal to the charge in the receiving ndenser. Curve A may be regarded as rmed from curve B by cutting away the ea to the left of the vertical ordinate ough $t = \sqrt{LK}$ and adding it on the ht to curve B.

Loaded Meshes and Condensers.

It is now necessary to consider the effect the signals which is produced by the continuities necessitated by coil loading in conjunction h signalling apparatus. Suppose, as before, that the le is replaced by a series of n loaded meshes as in Fig. connected to earth through condensers at the ends To ain the arrival current in this case return to the n-mesh erminant. To the first constituent of the determinant is r added Z_s, and to the last, Z_r. Substituting as before $\cos\theta$

$1-\frac{q\,.\,KR/^2}{2n(n-1)}$, and expanding the determinant, it follows that

$$= \frac{1}{\sin\theta}\left[(Rl+qLl)\frac{\sin n\theta}{n}+\frac{q\,.\,Kl}{n-1}\left(\frac{1}{K_s\,.\,q}+\frac{1}{K_r\,.\,q}\right)\sin(n-1)\theta\right.$$
$$\left.-\left(\frac{1}{K_s\,.\,q}+\frac{1}{K_r\,.\,q}\right)(\sin n\theta-\sin(n-1)\theta)\right].$$

e equation $\phi(y)=0$ gives the required θ root

$$)=\frac{\epsilon\,Rl\sqrt{1-\frac{8n(n-1)(1-\cos\theta)L}{R\,.\,KR/^2}}}{\sin\theta}\left[\frac{\sin n\theta}{n}\right.$$
$$\frac{q\,.\,Kl}{2n(n-1)\sin\theta}\left\{(Rl+qLl)\cos n\theta-\frac{n-1}{n}\sin n\theta\cot\frac{\theta}{2}\right.$$
$$\left.\left.-\left(\frac{1}{K_s\,.\,q}+\frac{1}{K_r\,.\,q}\right)(n\cos n\theta-(n-1)\cot(n-1)\theta\sin n\theta)\right\}\right].$$

ich θ is to be substituted for y.

nce, finally,

$$\frac{n\sin\theta\sinh\frac{Rl}{2L}\sqrt{1-\frac{8n(n-1)(1-\cos\theta)L}{KR/^2\,.\,R}}}{\left[\sin n\theta\left(\frac{1}{K}+\frac{1}{K}\right)\right.}$$
$$\left.-2(n-1)(1-\cos\theta)\left\{\frac{n\sin\theta}{2(n-1)\sin\theta}\cot\frac{\theta}{2}\sin n\theta\left(\frac{1}{K}+\frac{1}{K}\right)\right.\right.$$
$$\left.\left.\left(\frac{1}{K}+\frac{1}{K}\right)(n\cos n\theta-(n-1)\cot\frac{\theta}{2}\sin n\theta)\right\}\right]$$
(33)

$$\frac{\left(\frac{1}{K}+\frac{1}{K}\right)\left(\frac{1}{K}+\frac{1}{K}\right)}{(\cos\theta-1)\left(\frac{1}{K}+\frac{1}{K}\right)-2(n-1)\left(\frac{1}{K}+\frac{1}{K}\right)}$$
(34)

Certain particular cases of this formula are of interest.

1. When n is infinite the formula reduces to (32), the arrival current in a loaded cable with signalling condensers.

2. When $K_s = K_r = \infty$, the formula becomes [illegible]

* Heavy, The Electrician, May 31, 1912, p. 314.

Table XXXV.—*Fig. 49. Roots of* $\tan 20\theta = \frac{\sin\theta}{1\cdot2214 - 1\cdot5786\cos\theta}$

	θ.	20θ.	$\sin\theta$.	$\cos\theta$.	$\sin 20\theta$.	$\cos 19\theta$.	$\sqrt{1}$ etc.	$2E/Rl\cdot\frac{20\sin\theta\sinh\frac{Rl}{2L}\sqrt{\ }}{\sqrt{\ }}$ —
1	7° 54·3	π − 21° 53·7	0·13753	0·99042	+0·37291	−0·86777	0·84188	−55·621
2	15° 52·1	2π − 42° 38·0	0·27343	0·96189	−0·67730	−0·52247	0·34058	−501·90
3	23° 55·9	3π − 61° 22·0	0·40564	0·91403	−0·87776	−0·08185	1·27628	−262·19
4	32° 6·8	4π − 77° 44·0	0·53160	0·84710	−0·97714	−0·33942	1·9099	−258·20
5	40° 24·9	4π − 88° 17·0	0·64829	0·76138	−0·99955	−0·67084	2·5008	−249·46
6	48° 49·2	5π − 76° 25·0	0·75266	0·65841	−0·97203	−0·88626	3·0634	−232·71
7	57° 19·0	6π − 66° 20·0	0·84167	0·54000	−0·91590	−0·98764	3·6033	−210·42
8	65° 53·2	7π − 57° 43·0	0·91274	0·40856	−0·84542	−0·98985	4·1208	−185·68
9	74° 30·9	8π − 50° 18·0	0·96370	0·26699	−0·76940	−0·91201	4·6133	−160·28
10	83° 11·5	9π − 43° 50·0	0·99295	0·11855	−0·69256	−0·77320	5·0791	−135·66
11	π − 88° 5·3	10π − 38° 7	0·99944	0·03336	−0·61726	−0·59068	5·5145	−112·49
12	π − 79° 21	11π − 33° 0	0·98277	0·18481	−0·54464	−0·38026	5·9175	−91·254
13	π − 70° 34·0	12π − 28° 22·0	0·94312	0·32246	−0·47511	−0·15554	6·2855	−72·114
14	π − 61° 47·2	13π − 24° 8	0·88120	0·47276	−0·40886	−0·07115	6·6158	−55·149
15	π − 52° 59·5	14π − 20° 11·0	0·79855	0·60193	−0·34503	−0·99876	6·9063	−38·390
16	π − 44° 10·5	15π + 16° 30·0	0·69685	0·71721	−0·28402	−0·13912	7·1554	−28·094
17	π − 35° 21	16π − 13° 0	0·57857	0·81563	−0·22495	−0·14950	7·3616	−17·964
18	π − 26° 31·1	17π + 9° 37	0·44650	−0·89478	−0·16706	−0·13493	7·5234	−10·092
19	π − 17° 41	18π − 6° 21	0·30376	−0·95275	+0·11060	−0·10102	7·6394	−4·482
20	π − 8° 50·5	19π − 3° 10	0·15370	−0·98812	−0·05524	−0·05403	7·7097	−1·121

Table XXXVI.—Fig. 50, Curve A.

t (sec.)	0·3	0·4	0·42	0·5	0·6	0·7	1·0	1·5
$\epsilon^{-\frac{R}{2L}t}$	0·03184	0·01010	0·00802	0·00320	0·00102	0·00032	0·00001	...
$\frac{Rl}{2L}\sqrt{\ }$	0·5450	0·7266	0·7629	0·9079	1·0894	1·2718	1·817	2·724
$\epsilon^{-\frac{R}{2L}t}\sinh\frac{Rl}{2L}\sqrt{\ }$	0·2891	0·2417	0·2331	0·2017	0·1682	0·1402	0·0813	0·0328
1st term	16·08	13·44	12·97	11·22	9·36	7·80	4·52	1·82

series in (27), the arrival current in a set of loaded meshes without end apparatus.

3. When there is only one signalling condenser, and K_s or $K_r = \infty$, the formula reduces to

$$C_n = \frac{1E\epsilon^{-\frac{R}{2L}t}}{Rl}\sum_n \frac{\cos^{\frac{\theta}{2}}\cos^{\frac{2n-1}{2}}\theta\sinh\frac{Rl}{2L}\sqrt{1-\frac{8n(n-1)(1-\cos\theta)L}{R\,.\,KR/^2}}}{\left\{1-\frac{\sin 2n\theta}{2n\sin\theta}\sqrt{1-\frac{8n(n-1)(1-\cos\theta)L}{R\,.\,KR/^2}}\right\}}.$$
(35)

where
$$\tan n\theta = \frac{\cot\frac{\theta}{2}}{2(n-1)\frac{K_r}{Kl}+1}. \quad \ldots\ldots \quad (36)$$

In the general formula (33) let $n=20$, and let $K_s = K_r = \frac{Kl}{10}$ and $\frac{L}{R} = \frac{KR/^2}{100}$, as before. Then (34) becomes

$$\tan 20\theta = \frac{\sin\theta}{1\cdot2214 - 1\cdot5786\cos\theta}.$$

The situation of the roots of this equation is shown graphically in Fig. 49. At $\theta = 39° 19'$ the fraction becomes ∞, and reappears on the other side of the ordinate as $+\infty$. When $\theta = 180$ deg., both curves cut in the horizontal axis, but on substituting $\theta = \pi$ in C_n the corresponding term is zero. After $\theta = 180$ deg. the points of intersection are the same as those to the left, but in the inverse order and below the horizontal axis. They yield no new terms to the series. The 20 roots corresponding to the 20 meshes are indicated on the diagram, and their exact values are contained in Table XXXV. When n is infinite the number of roots tends to infinity, and Fig. 49 changes into Fig. 17.*

The first root makes the expression under the square-root in the formula for C_n positive, and the first term in the series is, therefore, hyperbolic. All the remaining 19 terms are circular.

* Heavy, The Electrician, May 31, 1912, p. 316.

Table XXXVII.—*Fig. 50, Curve A.* t = 0·42 sec.

n	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
$R't$ / $2L_n$	1·643	6·130	9·216	12·07	14·78	17·39	19·89	22·26	24·51	26·61	28·56	30·33	31·93	33·33	34·53	35·52	36·30	36·86
Sin do..	0·997	0·153	0·207	−0·478	0·799	−0·994	0·800	0·268	−0·584	0·996	0·278	−0·883	0·487	−0·943	0·029	0·823	0·985	0·742
Term ...	−500·3	−40·1	−53·5	−119·2	−186·0	−209·2	−159·7	−42·9	+79·2	+112·0	+25·4	−63·7	−26·9	+36·2	−0·8	−14·8	+9·9	3·3

Sum of Terms = −1,158: Sum $\times e^{-R't/2L}$ = −9·29: Total (with first term from Table XXXVI.) = +3·67.

The values of the first term are contained in Table XXXVI. When t is greater than 1 second $e^{-R't/2L}$ is less than 0·00001, and the circular terms may be neglected. They are calculated here for t=0·30, 0·40, 0·42, 0·44, 0·46, 0·48, 0·50, 0·52 and 0·60 second. A single example is given in Table XXXVII. The complete curve is given in Fig. 50, curve A.

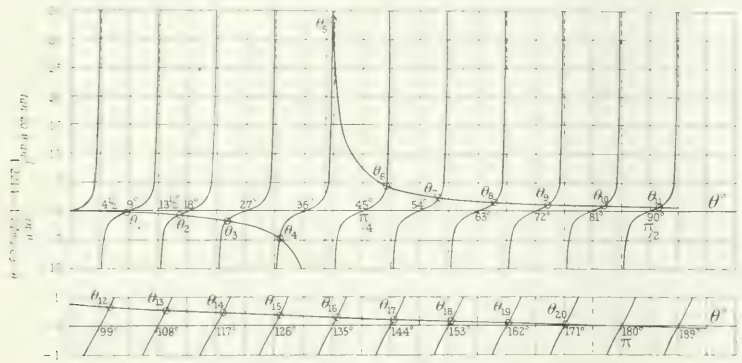


Fig. 49.

On comparing Fig. 50 with Fig. 48, it is seen that the mesh curve is also straight at the period of most rapid growth, but is inclined to the vertical. The influence of the subdivision is further shown in the rounding off of the base of the curve, and also of the tip, leading to a reduction in the height of the curve before it reaches a steady

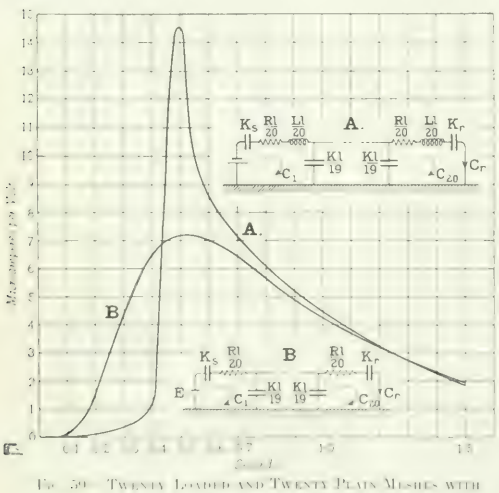


Fig. 50.—Twenty Loaded and Twenty Plain Meshes with Condensers.

Curve B is for the same set of meshes and apparatus, without inductance. The formula for this case may be obtained directly, or from (33) by putting L zero. The arrival current

$$\frac{C}{E} = \frac{1}{Rl} \sum_{n} \frac{n \sin\theta \; e^{-\frac{Kt}{Ks} - \frac{Kt}{Kr}2(n-1)(1-\cos\theta)}}{\sin n\theta - \left[\frac{Kl}{Ks} - \frac{Kl}{Kr}\right]\left[\frac{n\sin\theta - \sin n\theta\cos(n-1)\theta}{2(n-1)\sin\theta\sin(n-1)\theta}\right]} \qquad (38)$$

where θ has the same set of values as before. The values of C_{20} calculated from (37) are contained in Table XXXVIII.

For the purpose of comparison the four curves of Figs. 48 and 50 are brought together in Fig. 51.

As in the case of the cable with apparatus, it is clear from the closeness with which curves C and D approximate to each other that subdivision into 20 meshes produces little change in the curve of arrival current when the cable and meshes do not contain inductance. The same argument as before may therefore be adduced here with a certain degree of plausibility: that the effect on Curve A of redistributing the resistance and capacity—leaving out the inductance at equidistant intervals—would be only slight, and that Curve A is a close approximation to the true discontinuously-loaded cable curve, which may lie between it and curve

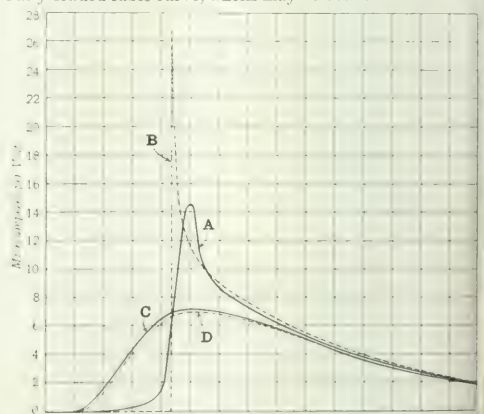


Fig. 51.—Comparison Between Cable and Meshes, with Condens... Curve A—20 lo... es. Curve B.—Loaded cable. Curve C.—20 plain m... Curve D.—Plain cable.

Table XXXVIII.—*Fig. 50, Curve B.*

t (sec.)	0·1	0·2	0·3	0·4	0·5	0·7	1·0	1·5	2·0
a_1	19·80	16·75	14·17	11·99	10·14	7·26	4·39	1·90	0·82
a_2	43·91	22·26	11·60	5·96	3·06	0·81	0·11	...	...
a_3	37·10	8·26	1·84	0·41	0·09	...	...	...	...
a_4	17·07	1·18	0·08	...	...	...	...	...	...
a_5	4·83	0·07	...	...	...	...	...	...	...
a_6	0·91	...	...	...	...	...	...	...	...
C_{20} (mm.a. per v.)...	0·16	+1·65	4·34	6·43	7·17	6·45	4·28	1·90	0·82

(*To be concluded.*)

PHYSICAL SOCIETY.

At the meeting held on April 23rd at the Imperial College of Science, London, Dr. A. RUSSELL, M.A., Vice President, in the Chair, a Paper on

"The Theories of Voigt and Everett regarding the Origin of Combination Tones,"

by Prof. W. B. MORTON and Miss MARY DARBYSHIRE, was read by the former.

Voigt connects the existence of deficient and over-tones with the fact that the stationary points of the compound vibration-curve, when the primary tones have equal energies, can be grouped in a certain way on sine curves, which recur in the periods of these combination-tones. As against this view it is urged (1) that the same points can equally well be grouped on a whole series of curves with other frequencies; (2) that the distinctness of the combination-tones would on this theory vary greatly with phase-relationship of the primaries: (3) that the tones would disappear when the energies of the primaries are not very unequal. Voigt applies a similar method to the case where the upper tone is weak compared to the lower to account for Koenig's second beat-tone. The first of the above objections again applies.

Everett supposed that the distortion of the vibration-curve in passing through the ear would bring in the note whose frequency is the highest common factor of the primary frequencies. The effect of a special kind of distortion has been tested, consisting in a proportional reduction of ordinates in one direction. The result does not confirm Everett's contention, but shows the appearance of the summation and difference tones.

Mr. F. J. W. WHIPPLE thought the matter was an extremely interesting one, and that the type of distortion assumed by the authors was very feasible. He suggested that an amplification of the theory might be applicable to musical instruments. For example, much of the beauty of the tones of a violin was attributed to the presence of many additional notes besides the fundamental. Quite possibly an asymmetry in the vibrations of the sounding board was responsible for the addition of combination tones of the higher harmonics.

Mr. D. OWEN referred to the case of a man who had no ear-drums, but could nevertheless hear combination tones, which Prof. Morton had cited as an instance in which unsymmetrical vibration of the receiving system could not be the cause of these tones. He presumed that this subject was very deaf, and that any sounds which he could hear at all would be very loud. Consequently, there would be violent displacements of the bones of the ear, and one would expect considerable asymmetry in their vibrations.

Dr. RUSSELL thought that the authors had without doubt completely demolished Voigt's theory, which seemed to have no physical basis whatever. With regard to the unsymmetrical vibrations of the drum, he supposed Helmholtz in his investigation had treated the tympanum as a thin plate, but the attached bones and adjacent fluid would render the problem much more complex.

Prof. S. P. THOMPSON (communicated): Though it is well to discuss the theory of combination tones it is much more important to be certain first *what are the facts*, to account for which some theory is required. Hence I raise the vital question of what the facts are: According to von Helmholtz, the combination tones are of two kinds, differential and summational. That is to say, when two tones of respective frequencies m and n are simultaneously sounded, the ear hears the *difference* tone, of frequency $m-n$, and the *summation* tone, of frequency $m+n$; and these are ear-manufactured, and cannot be heard in any resonator, and have nothing to do with beats. According to Koenig, the combination tones are simply beat-tones (and were so regarded also by Thomas Young), and cannot be heard in any resonator. If any supposed combination tone is heard in a resonator, that is a proof that it exists objectively in one or other of the two primary tones, and that, therefore, one or both of the two primary tones is not a *pure* tone, but contains the alleged combination tone as a harmonic. Koenig found that beats and beat-tones fall into two series (called superior and inferior), corresponding respectively to the two remainders—positive and negative—to be found by dividing the frequency of the higher tone by that of the lower tone. Thus, let the two primary frequencies be 40 and 74. Then, if we divide 74 by 40, it goes once with a positive remainder of 34, or it goes twice with a negative remainder of 6. Koenig heard, in these circumstances, a rapid beat corresponding to 34 and a slow beat (superior) of 6. If we take as primaries the note of frequency 3,328 and the note 2,048, there will be heard, according to von Helmholtz, the difference tone 1,280, and the summation tone 5,376. According to Koenig, there will be heard the (inferior) positive remainder 1,280 and the (superior) negative remainder 768. As a matter of fact, two tones are heard, the stronger being 768, and the weaker 1,280. The summation tone 5,376 is not heard at all. If we take, again, two forks giving 2,304 and 1,024, the only combination-tone heard is 256, which is neither difference nor sum. It is the (positive) remainder heard by dividing 2,304 by 1,024. Voigt's theory accounts for this, von Helmholtz's does not. Koenig, who in his life-time tuned with his own hands some tens of thousands of forks, and used the beat-tones to determine the tuning of his high-frequency forks of inaudible pitch, had never been able to hear any tones corresponding to the summational numbers. They simply do not exist if the primary tones are pure.

Prof. MORTON, in reply, said he could not say how far combination tones might be produced by the sounding board of a violin. They certainly could be produced by the membrane of a telephone receiver. He had not quoted the man with no ear drums as a case in which asymmetry was not responsible for these tones, but only as one in which we had to go further back than the tympanum for the seat of this asymmetry. A German author had tried to locate this in the motion of the fluids of the ear. Helmholtz's investigation of the vibration of the drum was even less satisfactory than the chairman had supposed, as he treated it simply as an oscillating particle. The analysis had more recently been extended to the case of a membrane and similar results obtained, but even this was still remote from the actual case of the ear drum.

A Paper entitled

"Experiments on Condensation Nuclei Produced in Gases by Ultra-Violet Light,"

was read by Miss MAUD SALTMARSH.

The Paper gives the following results which have been obtained from experiments: Nuclei produced in air by ultra-violet light which has traversed a few centimetres of air are not affected by an electric field of 50 volts per centimetre; the nuclei are equally effective in producing condensation of water, toluol and turpentine vapours, and they are formed even by light which has traversed 50 cm. of air; alcohol vapour condenses without expansion on much smaller nuclei than does water vapour; no nuclei were formed by the light unless oxygen or CO_2 was present in the gas; no trace of H_2O_2 could be detected in the clouds formed on the nuclei; oxygen containing ozone also contains nuclei for condensation, and these nuclei have similar properties to those formed by ultra-violet light; the nuclei can be destroyed by heating the air containing them. It seems probable that the nuclei formed by ultra-violet light do not cause condensation by virtue of any particular chemical composition, but that they are particles large enough to act like dust particles as centres round which condensation can begin.

Prof. O. W. RICHARDSON said the author had succeeded in eliminating a number of substances to which these effects had from time to time been attributed. The method employed was extremely sensitive, one or two ions being easily detected. Of the various substances eliminated the only one which he was not quite certain of was ozone. The elimination of this seemed to rest on the results of Lenard and Ramsauer. Did the author think these results were absolutely conclusive?

Mr. D. OWEN said that the explanation of the action of ozone in causing cloud formation was difficult if regarded as a direct effect. Possibly ozone acting on water vapour might give rise to hydrogen peroxide, in which case the suggestion of Mr. C. T. R. Wilson of a lowering of the saturation vapour pressure would apply. However the failure, in the case of fogs produced by ultra-violet light, to detect hydrogen peroxide by the titanium oxide test, which, according to Dr. Senter, can detect one part of hydrogen peroxide in 10 millions, seemed to exclude the action of hydrogen peroxide. As a possible alternative, the agency of oxides of nitrogen might be suggested. It would be of interest to test whether the phenomenon occurs when nitrogen is entirely excluded. In conjunction with chemical tests of amount present, quantitative data enabling the resulting lowering of the vapour pressure to be calculated should enable the problem in question to be definitely solved.

Dr. H. BORNS remarked that the detection or identification of hydrogen peroxide was not always easy. In experiments of the kind described in the Paper effects might be ascribed to hydrogen peroxide which were really due to nitrogen oxides. Such oxides would be produced when air was drawn through hot quartz tubes, and might help to account for the peculiar observations mentioned in the last part of the Paper.

Miss SALTMARSH, in reply, was not aware of any work having been done on the effect of oxides of nitrogen in producing condensation nuclei. In reply to Prof. Richardson, Lenard and Ramsauer had not stated that ozone was ineffective. They laid great stress on the presence of minute quantities of impurities. They attempted to get rid of these by condensing them out at low temperatures. They held that the ozone reacting on these traces of impurities was instrumental in producing the effects.

A Paper entitled

"On the Self-Induction of Solenoids of Appreciable Winding Depth,"

by Mr. S. BUTTERWORTH, was taken as read on account of the lateness of the hour.

The existing formulæ for coils of this type—viz., those of Rosa and Cohen—are shown to be inaccurate, the error amounting to one-fifth of 1 per cent. for the best formula when the winding depth is one-tenth the diameter of the coil. For greater winding depths the error is larger. The inaccuracy in Rosa's formula is due to the neglect of curvature in correcting for thickness, while in Cohen's formula the error is due to the approximate method of development. New formulæ are developed by methods which are free from such approximations, and which apply to any coil for which the length is greater than twice the diameter, and the winding depth is less than one-tenth the diameter. These formulæ are capable of giving eight-figure accuracy. Simplified formulæ are also given which are suitable when only four-figure accuracy is required.

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In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY MORNING, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Advertisements of all kinds of which no proofs are required before first insertion can be accepted up to FIRST POST THURSDAY MORNING.

COAL SUPPLIES.

Last week an important step was taken by the Institution of Electrical Engineers in joining hands with the Institution of Gas Engineers, and holding a conference of electricity and gas undertakings in regard to the present very serious position of coal supplies. We think the Council of the Institution is to be congratulated upon this step, for there is no question that the subject is most important. Moreover, it is not one that affects merely one section of the industry; it is vital to the industry as a whole, and is therefore essentially a subject that should be handled by the Institution. We may indeed go further and say that the matter concerns far more than the electrical industry, for it affects every individual throughout the length and breadth of the land, rich and poor alike.

When it is remembered that the electricity and gas undertakings consume about 20,000,000 tons of coal per annum, it is seen that an advance of merely one shilling per ton means an increase of one million pounds per annum, and thus an advance of many shillings per ton is equivalent to so many millions sterling which have to be found, largely by industrial concerns. Further, if the price of coal is increased for domestic purposes this entails expenditure of many millions of pounds by private individuals, with consequent inefficient expenditure of money. It is a sort of tax which does no good.

From the nature of the supply, it is probably from the individual point of view that the gas industry is chiefly concerned in this particular problem. With electricity supply, on the other hand, it is otherwise. The greater part of electrical energy is now being used for industrial purposes, and therefore a large proportion is being directly useful for the purpose of manufacturing munitions of war. If the price of coal is raised the cost of manufacture of these munitions must also be increased, and if the supply of coal is inadequate these important manufactures may be seriously hampered.

It is not that exception is taken to a rise in prices if this rise is unavoidable, but what is felt is that the increase in the

cost of coal hitherto has been largely unnecessary. We feel strongly, therefore, that the electricity and gas supply industries should protest against unnecessarily high prices, and should urge the Government to take immediate and energetic steps in the matter. One step has already been taken, namely, to prohibit the export of coal. This, in itself, may make an important difference in the situation, not only by relieving the home market, but by preventing coal from going to "neutral" countries where it may be used to the disadvantage of our cause.

In our last issue we were able to give a brief account of what occurred at this important meeting, and in our present issue a detailed account of the proceedings will be found. It will be seen from this account that there was some difference of opinion as to whether the Government should be merely called upon to take action or whether a definite course should be suggested. Some speakers held that it was much better to go to the Government with suggestions that such and such steps should be taken. Yet it is more than questionable whether gas engineers, or electrical engineers, are in a position to judge exactly what should be done, what steps would give relief, and what measures are feasible. On the other hand, the Government have every means at their disposal to assist them in deciding on any course of action. A Committee has already reported on the subject; consequently, there is no doubt that much valuable information is in the hands of the Government. We think, therefore, that the somewhat indefinite resolutions which were adopted at the meeting are more suitable than definite suggestions, and that the object of the industries affected at the present moment should be to call upon the Government to act, and to act promptly. There is no question that the state of affairs will become very serious if merely a policy of drift is adopted. The Conference was largely attended, was representative, and we trust the deputation which is to wait upon the Government will prove effective in ameliorating the situation.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

The Electric Furnace: Its Construction, Operation and Uses. By Dr. ALFRED STANSFIELD. (New York: McGraw Hill Book Co.) Second edition. Pp. xiii. + 415. 17s. net.

No one has followed the development of the electric furnace more closely than the author of this book, and anything from his pen is certain to be worth careful study. Unlike many modern text-books, this one has not been hastily written, but is the outcome of many years' work, not only in the study of the subject, but also in the method of presenting it to the reader. The book originated with a series of Papers written for the "Canadian Engineer" dealing with the construction and use of the electric furnace. These Papers formed the basis of the first edition, which in its turn has been re-written and brought up to date with recent additions, until the second edition is more than twice the size of the first.

So much has been written recently upon the subject of electric furnaces for the production of iron and steel that it is refreshing to find this subject occupying a relatively small section of the volume, whereas the remainder of the book deals with a large number of less known but intensely interesting and important applications of the electric furnace.

The first five chapters deal at some length with the history, classification, efficiency, construction and operation of the various types of electric furnaces, while Chapter VI. is devoted to laboratory furnaces. The next three chapters deal with the electric smelting of iron and the production of steel from pig iron and direct from the ore. Ferro alloys, carbides and silicon compounds are discussed at some length, as are also the electric smelting of zinc and various electrolytic processes.

In addition to those mentioned, a large number of processes are described, the importance of which is hardly realised, and the average reader will probably be surprised to hear of an annual output amounting to thousands of tons of such products as phosphorus and carborundum manufactured by the electric furnace. Those who had the advantage (or disadvantage) of an early laboratory training will remember that evil smelling liquid known as carbon bisulphide, and, unless they know more about the subject than we did before reading this book, it will come as something of a shock to them to read of an electric furnace producing 17,000 lb. of bisulphide per day.

In the last chapter, which deals with the future of the electric furnace, the author shows his knowledge of the subject by discussing the question in a sane and thoughtful manner, and wisely refraining from any flights of imagination. As he very truly says in his introduction: "The halo of romance that has always surrounded electricity in all its forms has caused the wildest schemes to be originated and has given them a hearing; while, on the other hand, practicable electric smelting processes have been considered visionary."

We have no hesitation in saying that this book will be of as much interest to those engaged in chemical and metallurgical industries as to those interested in electric furnaces.

E. F. LAW.

Drawings for Electrical Engineers. By G. D.Eng., A.M.I.E.E. Edited by G. UDNY YULE. (London: G. Routledge & Sons, Ltd.) Pp. 92. 70 illustrations. 2s. net.

This book is intended for the young electrical engineer who desires to acquire an elementary knowledge of the construction and proportions of the chief types of electrical machinery. The author does not attempt to give rules for proportioning the different parts of a generator or motor. Instead of this he has collected a number of scale detail drawings of the parts of motors and generators from several manufacturing firms and used these to illustrate the descriptive matter.

This training of the eye is useful training, especially for students. The scale to which the drawings are reproduced is, of course, a small one; but the student can with advantage reproduce the drawings to a larger scale. This usually gives one a better idea of the proportions. This training, combined with the experience gained in practice, is considered by the author to be quite sufficient to enable one to design machinery, but it must be kept in mind that many sound rules for proportioning machine parts, developed by engineers, have been verified by actual experience; formulæ being only the shorthand used to express the results of experience.

There is usually difficulty in obtaining working drawings of value from manufacturers, and the author has succeeded in obtaining a good collection. Only illustrations of small machines are shown and it would be an improvement if some drawings of large machine parts could be obtained. A few sectional drawings of complete machines would also be an improvement, as such drawings give a better idea of the proportions of the machine parts than the detail drawings. Indeed the detail drawings are usually made from dimensions obtained from sectional lay-outs which have been checked by all the means at the disposal of the manufacturer.

R. LIVINGSTONE.

Matriculation Mechanics. By W. BRIGGS and G. H. BRYAN. 3rd edition. Pp. viii. 363. University Tutorial Press. 3s. 6d.

The above text-book, as its title indicates, contains those parts of elementary statics and dynamics required by students desirous of taking the matriculation examination of the University of London, and is published for the use of such students. It is written mainly, we suppose, for the private student who is unable to obtain oral tuition in the subject. From the point

of view of passing the particular examination for which it is written, the book is admirable, but it cannot be regarded as a modern text-book on the teaching of elementary mechanics.

Most teachers are agreed nowadays as to the necessity of experimental work in teaching this subject, experiments to be performed by the pupil as well as shown by the teacher. What there is of experimental work in this book is confined to a single chapter at the end. It seems to us that it would have been much better if this work had been incorporated in the chapters dealing with the subject of each experiment. There is a danger of it not being read at all in the position which it now occupies.

No use is made of elementary trigonometry in the book, and we venture to think that this is a mistake. The gain by its use more than compensates for the trouble taken to learn what is necessary for this purpose. Moreover, the majority of students taking mechanics in matriculation will be pursuing further mathematical studies and will already have learned all the trigonometry required for this purpose. The treatment given in the book encourages the use of the triangle of forces in each case where the problem is one in which three forces act on the body. This, of course, is distinctly beneficial to the student, but the use of trigonometry would not detract from this advantage. There is no chapter on friction, hence the efficiency of a machine can never be dealt with, and this is a much more important point than the mechanical advantage of such a machine. Apart from these criticisms, the book will no doubt serve a very useful purpose, and no student who knew the contents would fail to pass the examination. The diagrams are very clear, and the printing all that could be desired.

H. C. K.

Practical Iron Founding. By J. G. Horner. P.p. VIII.+409. (London: Whittaker & Co.) 4th edition. 5s.

This book has now reached its fourth edition, a fact which seems to show of itself that its pages may be considered as the outcome of much practical experience. And not only this; a life of experience in an iron foundry is not of itself sufficient as a qualification for the author of a book such as this is; there must also be something of the pen of the ready writer, and something of the teacher's craft. We think it may fairly be said that the author presents us with a comprehensive survey of the work which goes on in a modern foundry; originally, in the first edition, his scheme was on a more limited scale, and was more of the nature of an outline sketch. But the pressure of the times and the general expansion of modern ideas have brought much in their train, and have even touched the iron-founder, who is by instinct probably one of the most conservative of mortals. One can well understand the shudder of disapproval with which the appearance of the first moulding machine was received, and the conclusive arguments by which it was shown that the product of such a mechanism could never be first class. The author devotes a good deal of space to describing various types of moulding machines, and the rapid growth of this branch of the work has been quite remarkable of late years.

The new edition of the book contains just twice as many pages as the preceding edition, and this expansion is partly due to new phases of work, such as machine moulding, which were quite undeveloped when the book was originally written. For those who know it not, it may be said that the whole of the iron-founder's work is described in its pages, including the description of sands and their preparation, the melting and testing of iron, and all the details of the methods by which dry sand and green sand are so moulded as to turn out the finished casting. An excellent feature of the book is its many photographic blocks and drawings (283 in all). Ironfounding, like every other branch of scientific and engineering work, tends to get more and more complicated as time goes on; the intricacies of casting a monobloc four-cylinder petrol engine, with its water jacket and the internal passages which have replaced the induction and exhaust pipes, seem so serious that one might easily believe the [illegible] to be impossible. And even now there is a demand for still greater accuracy, and thinner walls in the casting. We [illegible] and further temptation to expand the book. In its present form it covers all the ground fully and in detail; any further expansion of its contents ought to be neutralised by corresponding excisions. But as it stands, the book is useful to young and old alike.

Working of Steam Boilers. By E. G. Hiller. Pp. 147. (Manchester: Taylor, Garnett, Evans & Co.) 5th edition. 1s. 6d.

This is the fifth edition of a book on the subject of the working of steam boilers by the chief engineer of the National Boiler and General Insurance Co., of Manchester. It is of the severely practical order, and indeed in connection with such a subject, nothing but practical experience is of any use. But even those in charge of boilers too often live, as it were, from hand to mouth; possibly too much is left to the periodic visit of the boiler inspector, and even he is not always regarded as an indispensable necessity. The electric light installation is not usually an offender in this respect; probably this is because skilled supervision is continuously on the spot. But we must not adopt too pharisaic an attitude; probably we are, at bottom, like other men, and boiler explosions are not altogether things of the past. Any intelligent man, who has to do with boilers, it matters not who he is, would profit by having a book of the nature of the one under review on his shelves. It contains the condensed essence of many years of experience in connection with insurance of boilers; it has some good drawings and photographic blocks, showing defects that arise in the process of years, and it is written throughout in a simple style that nobody can fail to understand.

Soft Soldering, Hard Soldering and Brazing. By J. F. Hobart. (London: Constable & Co.) Pp. xiii.+190. 4s. net.

This is a small volume which should prove useful not merely to the amateur but to the professional mechanic whose work includes the various types of soldering. To the amateur, in particular, the proper soldering of a joint is by no means always an easy matter. But the author of this book gives so much detailed information, and deals with matters not merely from a rule-of-thumb point of view, that these difficulties should be reduced to a minimum. In the first chapter a useful table of alloys with their melting points is given, and the necessary operations of soldering are explained in a general way. The following chapters deal with the operations in detail, with solders, fluxes and soldering fluids, and difficulties in operation. A chapter of some length is devoted to the operation of wiping joints, and this is followed by a chapter on electric soldering. Some interesting information is here given. The advantages of the electrical method (which are marked) are pointed out in detail and the precautions to be adopted. The book closes with a practical chapter on the important operation of brazing.

Bill's School and Mine. By W. S. Franklin. Pp. vi.+98. (S. Bethlehem, U.S.A.: Franklin, MacNutt & Charles.) 50 cents.

In this little book the author deals, largely in narrative form and in a sketchy manner, with certain phases of education, calling attention first to the loss that must be suffered by boys educated purely in towns, through lack of out-door training, which calls into being resourcefulness and a knowledge of nature on the part of boys born and bred in the country. Later on, the author deals with the study of science and the great importance of clear and rigorous thinking. As an illustration he examines the fundamental ideas underlying motion. He then refers to various aspects of education, and remarks that "the greatest educational problem of our time is to make use of commercial and industrial establishments as schools to the extent that they are schools." The author evidently takes a broader view of education than is usual.

Motor Cycles: A Practical Handbook on their Building, Care and Management. Edited by Bernard E. Jones. Pp. viii.+152. (London: Cassell & Co., Ltd.) 1s. net.

This is a small volume, which is written rather for the amateur engineer-motorcyclist than the average pleasure cyclist. One special feature of the book is an explanation with working instructions and drawings of how to build a light two-stroke motor cycle, while the subject of ignition is also dealt with at very great length. The usual descriptive information of the motor cycle and its parts is but briefly given, together with short chapters on the location of engine faults, overhauling and riding.

A METHOD OF TESTING INSTRUMENT TRANSFORMERS.*

BY P. G. AGNEW.

Summary.—The author gives details of a method, which makes use of induction watt-hour meters for determining the differences in ratios and phase angles between two "voltage" or two "current" transformers of the same range.

Attempts to determine the constants of instrument transformers by using wattmeters or watt-hour meters in both the primary and secondary circuits have not met with much success. Modern transformers have such good characteristics that the small differences to be measured are more or less masked by the unavoidable errors of measurement. Moreover, such a method is not applicable to high voltage or large current ranges, which are commercially the more important. Modern induction watt-hour meters can, however, be used to determine the difference in ratios and also the difference in phase angles either of two "voltage" transformers or of two "current" transformers, provided the two transformers are of the same range. If, then, the ratio and phase angle of one of the transformers are known, it may be treated as a standard transformer and the constants of other transformers determined in terms of the constants of the standard.

Outline of Method.—For voltage transformers an auxiliary current is passed in series through the current coils of the two meters, which are duplicates, and the voltage coil of each meter is connected to one of the transformers. If the meters were adjusted to precisely the

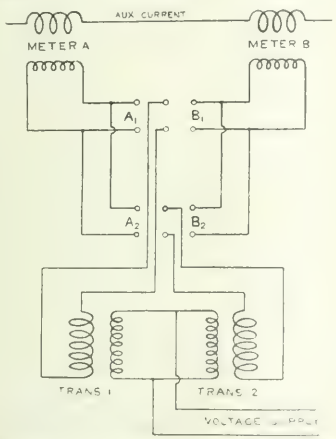


FIG. 1. DIAGRAM OF CONNECTIONS FOR COMPARING "VOLTAGE" TRANSFORMERS.

same rate the ratios of the transformers would be inversely proportional to the number of rotations of the meters in a given time. Practically the meters cannot be adjusted to precisely the same rate, but the difference in rates may be eliminated by interchanging the meters. The difference in the phase angles may also be determined by changing the phase of the auxiliary current, so that the meters are working on low power-factor, since this difference in phase makes the meters run at different speeds, as they are connected to one or other of the transformers. From this data and a knowledge of the difference in ratios obtained at unity power-factor the difference in phase angles can be calculated. A diagram of connections for testing a "voltage" transformer by this method is shown in Fig. 1. The ratio measurement may be carried out with a single-phase source of supply. If a three-phase source is available it is convenient to use a lamp bank for the auxiliary current, putting it on to the same phase with the transformers for the ratio measurement and on either of the other phases for the phase-angle measurement.

Fig. 2 shows the arrangement of circuits for testing "current" transformers. The use of the current and the voltage coils of the meters is inverted in respect to their use in the case of the "voltage" transformer. The primaries of the "current" transformers are in series, and the current coils of the two meters are connected alternately to the two transformers. An auxiliary current is applied to the voltage coils of the meters. Only two [illegible] the same way as for the voltage transformers.

* Article in the "Electrical World," slightly abbreviated.

Let m_a, m_b = the rates of the two meters (the rate being the ratio of the recorded watt-hours to the true watt-hours).
k = the disc constant of the meters (nominal watt-hours per revolution).
R_1, R_2 = ratios of transformers.
a_1, a_2 = phase angles of transformers (positive for the secondary leading opposition to the primary).
a_1, a_2 = number of turns made by meter A when connected to transformers Nos. 1 and 2 respectively.
b_1, b_2 = the same for meter B.
$\cos\theta$ = power-factor.

Consider the case of a meter connected to a "voltage" transformer and working on low power-factor with a lagging current. In making t turns a meter records tk watt-hours. Taking into account only the rate of the meter m and the ratio of the transformer R, this gives for the energy represented by the primary voltage and the auxiliary current $\frac{m}{tk}$R. But the meter is working at a power-factor of $\cos(\theta+a)$ instead of $\cos\theta$, and hence the expression for the energy finally becomes

$$\frac{tk\mathrm{R}\cos\theta}{m\cos(0+a)},$$

or

$$\frac{tk\mathrm{R}}{m\cos a\,(1-\tan a\tan\theta)},$$

or, since a is very small and hence its cosine may be taken as unity,

$$\frac{tk\mathrm{R}}{m\,(1-\tan a\tan\theta)} \text{ approximately.}$$

Applying this to a set of readings taken by interchanging the meters on the transformers

$$\frac{a_1k\mathrm{R}_1}{m_a(1-\tan\theta\tan a_1)} = \frac{b_2k\mathrm{R}_2}{m_b(1-\tan\theta\tan a_2)}, \quad . \quad . \quad . \quad (1)$$

$$\frac{a_2k\mathrm{R}_2}{m_a(1-\tan\theta\tan a_2)} = \frac{b_1k\mathrm{R}_1}{m_b(1-\tan\theta\tan a_1)}, \quad . \quad . \quad . \quad (2)$$

from which it may easily be shown that

$$\frac{\mathrm{R}_2}{\mathrm{R}_1} = \sqrt{\frac{a_1}{a_2}\cdot\frac{b_1}{b_2}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where the a's and b's are readings taken at unity power-factor, and that

$$\tan a_2 = \tan a_1 - \frac{1}{2\tan\theta}\left(1-\frac{a_2}{a_1}\cdot\frac{b_2}{b_1}\cdot\frac{\mathrm{R}_2^2}{\mathrm{R}_1^2}\right). \quad . \quad . \quad . \quad (4)$$

where the a's and b's are now readings taken at low power-factor.

Equation (3) is the general formula for the ratio R_2 in terms of the ratio R_1, and (4) is the general formula for the phase angle a_2 in terms of a_1 and the ratio of the ratios. These formulas may easily be put into convenient form for slide-rule computation by making a few allowable approximations, giving for the difference in ratios expressed as a fraction of the ratio of the standard transformer

$$\frac{\mathrm{R}_2-\mathrm{R}_1}{\mathrm{R}_1} = \frac{1}{2}\left(\frac{a_1}{a_2}+\frac{b_1}{b_2}\right). \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and for the phase angle

$$a_2 \text{ (in minutes)} = a_1 - \frac{3{,}438}{\tan\theta}\left[\frac{a_1}{2a_1}+\frac{a_2}{2b_1}+\frac{\mathrm{R}_2}{\mathrm{R}_1}-\frac{\mathrm{R}_1}{\mathrm{R}_1}\right]. \quad . \quad (6)$$

Equations (5) and (6) are the working formulas for ratio and phase angle respectively and may ordinarily be used instead of the more exact formulas (2) and (3). The approximations involved will amount to less than 0·1 per cent. in ratio for differences in the formula not exceeding 3 per cent., and to less than 0·01 per cent. in ratio for differences not exceeding 1 per cent.

In equation (6), which gives the phase angle, the signs are correct for "voltage" transformers connected to meters working on lagging current and for "current" transformers connected to meters work-

Data Obtained with Meters in Parallel on Same Load.

Run.	Per cent. of full load.	Number of turns. Meter A.	Number of turns. Meter B.
1	100	100	100·126
2	100	100	100·123
3	100	100	100·124
4	100	100	100·127
5	100	100	100·140
6	100	100	100·135
7	100	100	100·136
8	10	10	10·063
9	10	10	10·067
10	10	10	10·061
11	10	10	10·068
12	10	10	10·066

ing on leading current. If the conditions are reversed, the plus sign before the bracketed expression should be changed to minus. However, it may often be more convenient not to depend upon this relation, but to use the following facts as criteria to determine experimentally whether the transformer under test has a greater or a smaller phase angle than the standard transformer (1) Adding a non-inductive load to a "voltage" transformer always tends to lag the secondary voltage. (2) Adding inductive resistance in the secondary of a "current" transformer tends to advance the phase of the secondary current.

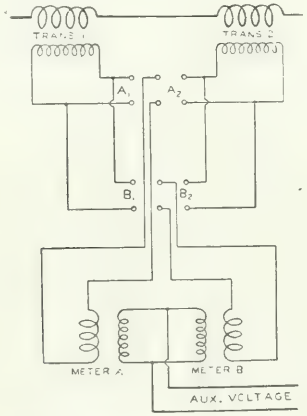


FIG. 2.—DIAGRAM OF CONNECTIONS FOR COMPARING "CURRENT" TRANSFORMERS.

Experimental Results.—Fig. 3 shows the results of the test of a 5,500 to 110-volt transformer by means of two watt-hour meters and another transformer used as a standard, compared with the results of a precision laboratory method. The full lines represent the results of the laboratory method, and the isolated points those of the watt-hour meter method. Each point is the average of two runs of 100 turns each, and readings were taken to 0·01 turn. Similarly, Fig. 4 shows the results of a comparison of the two methods for a 25 to 5 ampere "current" transformer. Each point is here also the average of two runs of 100 turns each, excepting at the lower currents, where fewer turns were taken.

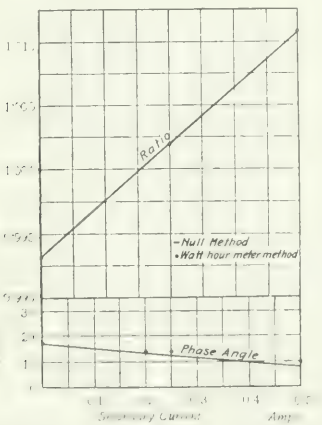


FIG. 3.—RATIO AND PHASE ANGLE OF "VOLTAGE" TRANSFORMER.

The meters used were of the type known commercially as K$_2$, the discs of which had been graduated in hundredths of a revolution. It will be seen that the accuracy obtained is greater than is required in commercial power measurements. The method is capable of determining ratio to 0·02 or 0·03 per cent. and phase angle to one or two minutes. It has been found possible more than to double the speed of the meters by shunting the magnets by small pieces of soft iron, and yet get equally accurate results. It is not generally realised that, under the very best conditions, modern induction meters will repeat consecutive runs to a precision of about 0·01 per cent. at full load. This is clearly shown by the table giving observations taken with the meters in parallel on the same load. The tenths of a division (thousandths of a revolution) were estimated in taking readings. The speed of the meters had been increased to double normal value by shunting the magnets.

There are cases in which it may be convenient to obtain a lump correction for both the ratio and the phase angle rather than to determine them and to correct for them independently. For example, in the case of a watt-hour meter and "current" transformer metering the energy supplied to an induction motor, if the standard transformer is inserted in series with the line and readings are taken at whatever power-factor the system is operating under, then one may consider R_2 in either equation (3) or equation (5) as the combined or over-all power ratio of the transformer. To carry this out in routine work it would practically be necessary to have a set of curves for the standard transformer giving this ratio calculated from ratio and phase angle for various power-factors. Yet, since these curves would be computed once for all for the standard transformer, it would obviate the necessity of going through a somewhat complicated computation for each transformer tested.

This process may be extended to the case in which both "current" and "voltage" transformers are used. For such a test one meter would be connected to both of the standard transformers (current and voltage), the other to both the transformers under test. Either equation (3) or equation (5) will in this case give the over-all power ratio of the two transformers under test (R_2) for the given condition in terms of the corresponding over-all ratio for the two standard transformers (R_1). This latter quantity could be taken from curves calculated for the two standard transformers, as mentioned above. Experimentally, the process is simpler than would appear at first sight, since no auxiliary current or voltage is required. This method

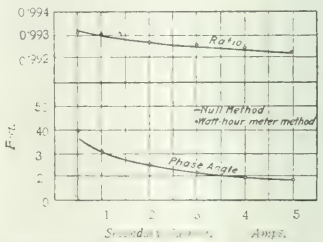


FIG. 4.—RATIO AND PHASE ANGLE OF "CURRENT" TRANSFORMER.

should prove useful in checking the transformers used in the metering of large blocks of power, either single-phase or three-phase.

The use of two of the portable watt-hour meters so largely employed in meter testing is much more convenient than that of the house-type meters with graduated discs, as the trouble of counting turns is eliminated. However, for economy of time in testing "current" transformers rated at 5 amperes secondary current a 5-ampere watt-hour meter is preferable to one of a 10-ampere range, as the length of time required for a test with a given accuracy is roughly only half as great. In general, a 1-ampere range or 2-ampere cannot be used on the light loads, as the impedance which would be introduced in the secondary of the transformer would be prohibitive. Of course, in the case of a voltage transformer the range is immaterial, as the current is an auxiliary one.

In testing "current" transformers it is very convenient to use as a source of current a step-down transformer giving only a few volts on the secondary, but having ample secondary current-carrying capacity. But in such an arrangement if the resistance in the secondary circuit is very low the current may lag very appreciably behind the voltage. This will produce a small error in the ratio measurement, but such a condition is readily detected by the measuring instruments in the circuit. The best way to overcome this difficulty is by the use of a phase-shifting transformer as a source of the auxiliary voltage. Such a transformer is of very great utility for many other purposes, such, for example, as testing meters at low power factor. If such a device is not available the error may be eliminated by a process of successive approximation.

It is important that the ratio and the phase angle of the standard transformer, whether of the "current" or "voltage" type, be determined under actual working conditions of load, including the meter. Multiple-range transformers are very convenient as standards, and good transformers have very accurately the same con-

stants for the different series-parallel arrangements of coils. If the no-load ratio of a voltage transformer be required it may be obtained very closely by adding a second or duplicate meter as load and then extrapolating to the no-load condition. While the present method has neither the high precision nor the elegance of the null laboratory methods, it has ample accuracy for commercial requirements, it is independent of ordinary line fluctuations, and no specialised apparatus is required.

EXTENSIONS AT SOUTH SHIELDS ELECTRICITY WORKS.

Since 1912 the electricity works belonging to the Borough of South Shields have been very considerably extended, and we give below some description of these extensions and of the plant installed, the whole of which has now been running

Before the present extensions took place the total plant capacity was 2,700 kw., which was installed in an engine room consisting of two large bays, 100 ft. long and between 30 ft. and 40 ft. in width. The old boiler house contained six marine type boilers, the coal for which was stored in a large brick wall bunker running the full length of the boiler house, firing being carried out by hand. The recent extensions comprise the laying down of two turbine sets in one of the engine-room bays, illustrated in Fig. 1. To make room for these sets two Maclaren-Ferranti sets, consisting of triple expansion marine-type engines direct coupled to 100 kw. single-phase alternators and a similar unit of 200 kw. capacity, have been removed, leaving only one old 200 kw. set in this bay. No. 1 turbine set comprises a turbine coupled direct to two generators—*i.e.*, 1,000 kw. 500-550-volt direct-current turbo-generator, with a radial-type commutator and a 1,100 kw. single-phase 2,100-volt 50-period alternator coupled in tandem

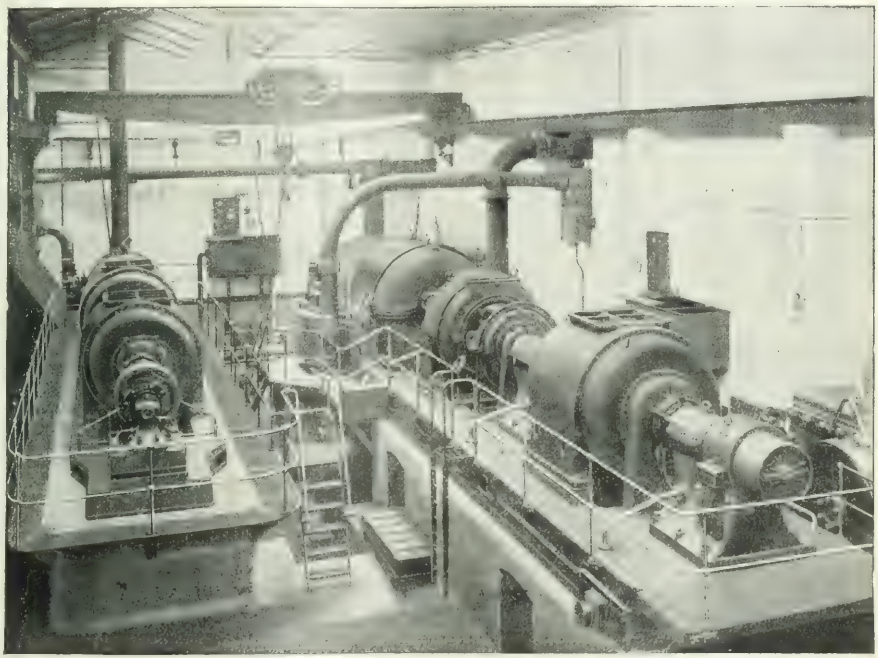


Fig. 1.—General View of Turbine Side of Power House, showing the Two Westinghouse Turbo-Generator Sets.

uccessfully since Christmas. A formal inspection and opening as not been possible up to the present, but it is hoped that he members of the Council will be able to inspect the works n the course of a week or so. The recent extensions include new boiler house and the installation of two turbine sets ggregating 3,500 kw. capacity.

To deal briefly with the historical aspect of electricity supply t South Shields, the first Electrical Committee was appointed 1892, and Alderman Rennoldson, the present chairman, was lected as its head. It is interesting to note that Alderman Rennoldson has held this position of chairman of the Electricity Committee without a break to the present day, a period f 22 years. It was not until 1895 that any material progress as made with the undertaking ; but on August 17, 1896, lectric light was first used for public street lighting, and a full upply was formally inaugurated on September 1, 1896. The otal capacity of the plant at that period was 210 kw., consisting of two 100 kw. alternators driven by triple expansion marine engines, and a small 15 kw. set to deal with periods of ight load.

and running at 1,500 revs. per min. This set was installed in 1912, and the second set was laid down in 1914. This No. 2 set comprises a turbine direct coupled to two 1,500 kw. 2,100-volt three-phase 50-period turbo-alternators, coupled in tandem and running at 3,000 revs. per min.

These sets are probably unique in so far as the arrangements of them are concerned, while at the same time they embody the latest features in design and construction. The differences in speed of the two sets shows the trend of design towards increasing speeds to obtain good results and lower prime cost per kilowatt. The turbines are of the Westinghouse-Rateau impulse type of standard design. They exhaust direct into Westinghouse-Leblanc surface-type condensers situated directly below the turbines. A 50 h.p. 440 revs. per min. Westinghouse direct-current motor is employed to drive the air and extraction pumps of the condensers. A feature of interest on the No. 1 set is the Westinghouse patent radial commutator, which is extremely effective in ensuring sparkless running, a point of considerable difficulty to obtain with nearly all turbo-generators. The alternators are of the compensated type, and

excited by means of the small generator seen in Fig. 1 coupled on to the end of the turbo-alternator shaft. They are capable of generating either three phase or single-phase current, the latter being obtained by an arrangement of the switchgear allowing one phase of the windings to remain idle, the other two phases in series supplying a single-pha e current. Special attention has been given to the end connections of the alternators, which are very strongly built to withstand the heavy mechanical stresses induced in them when overloaded.

Two rotary converters have also been put down, and these are of British Westinghouse manufacture of a capacity of 600 kw. They operate in conjunction with Westinghouse transformers, and convert the alternating current at 2,100 volts to direct current at 500 to 550 volts for power and traction purposes. The starting of these rotaries is entirely automatic by means of the Westinghouse self-synchronising method. Provision has also been made to start them from the direct-current side if so desired. No notable alterations have been made to the switchgear, new panels only having been added to control the new plant.

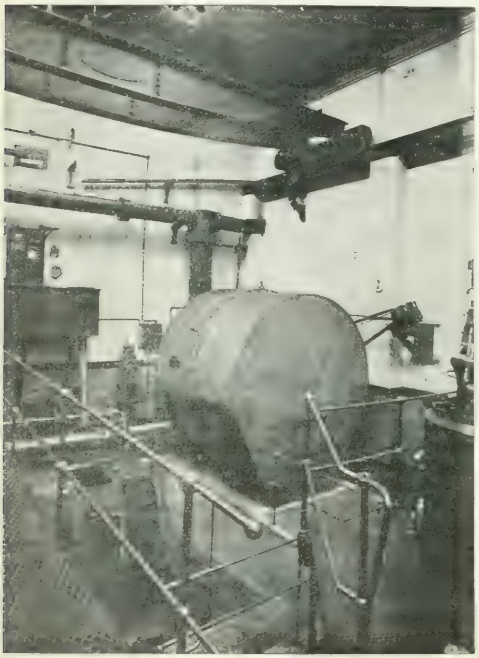


Fig. 2.—Air Filter, also Lea Recorder, of 2,000-kw. Set.

The air filter (Fig. 2) is of the "Heenan" type, and is capable of dealing with 24,000 cubic ft. of air per minute. The filtering surface in this type of filter consists of a large quantity of galvanised steel sheeting wound in spiral form round central cast-iron discs. Two of these discs are embodied in the machine, both being mounted on a steel shaft running in self-aligning roller bearings. The shaft is rotated at slow speed by means of machine-cut worm gearing, totally enclosed and running in an oil bath. The lower half of the drums dip into a built-up tank forming part of the casting, and containing water up to the level of the cast-iron discs. The sheets in passing through the tank carry up with them a thin film of water, which is spread out over the whole surface, and with which the air to be filtered is brought into intimate contact.

As the distance between each adjacent pair of plates is only a little more than $\frac{1}{8}$ in., it will be appreciated that the dust and foreign matter in suspension in the air is deposited on the wet surface, and is duly wiped off when the sheets return to the water level. No sprays are used in the construction of this machine, and the whole of the filter is extremely gentle, the effect being to prevent the discharge of any loose moisture. A very valuable cooling effect is obtained which amounts to as much as 15°F. or 20°F. in hot weather. Cleaning of the apparatus is very easily carried out, the operation consisting merely of running to waste the water contained in the tank and filling up again with fresh water. The filter is shown in Fig. 2.

With regard to boiler plant, a new boiler house, coal bunkers and coal conveyor were laid down during the 1914 extensions. This boiler house is situated right away from the old boiler house. To obtain an economical supply of coal a coal conveyor (Fig. 3) has been put down. The coal destined for the new steam boiler house is unloaded in skips by a steam crane and discharged into a new receiving hopper situated near the centre of the old coal bunker. From this, coal is automatically fed on to a belt-type conveyor carried on rollers provided with ball bearings, having a width of 16 in. The conveyor has a capacity of 30 tons per hour, and will operate with a minimum of attention. The conveyor is housed for its entire length, completely protecting it against wind and wet, and a walk is provided to enable the conveyor to be lubricated and cleaned without difficulty. From the conveyor the coal can be fed into any part of the new storage bunkers by moving the tipper accordingly. The new bunkers have a capacity of 560 tons, and from them the coal is gradually fed into the boiler grates. The present size of the boiler house enables four boilers to be laid down, two of which are already installed and working. A temporary sheet-iron wall, which can be easily removed, is situated at one end of the boiler house, and further extensions will enable the boiler-house capacity to be increased to contain eight boilers.



Fig. 3.—New Coal Conveyor across from the Wharf to the new Boiler House.

The two boilers now working are of the Babcock & Wilcox land type, each with 5,346 sq. ft. of heating surface, and having a normal evaporation of 22,000 lb. of water per hour from and at 200°F The boilers are fitted with integral superheaters having 770 sq. ft. of heating surface capable of imparting a superheat of 150°F. A superheat mixing valve is provided to enable the degree of superheat to be cut down to 60°F., in order that the boilers may work in conjunction with the reciprocating plant in the engine room, which was not designed to run with highly superheated steam. The feed water is heated by a Green's economiser, containing 288 pipes. Two boiler feed pumps of the single-cylinder direct-connected type are each capable of delivering 7,500 gallons of water per hour against a pressure of 160 lb. per square inch, and with a guaranteed steam consumption of 1 lb. of steam for 95 lb. of water delivered to the boilers.

The feed water for the boilers is obtained from the town supply, which has an initial hardness of from 25 deg. to 30 deg., and in consequence it has been found advisable to instal a Lassen-Hjort water softening plant capable of dealing with 24,000 gallons of water per day. By means of this the hardness is automatically reduced to 4 deg., and at the same time is heated by exhaust steam. The plant is fitted with patent automatic measuring and mixing apparatus, including a positive chemical discharge valve and patent locking gear, by which the measuring and operating of the water and reagents is carried out with absolute precision. An induced draught plant, consisting of two Musgraves "Ulster" type fans, has been laid down. These are driven through a flexible cable by Westinghouse variable-speed motors running at from 360 to 450 revs. per min. At the lower speeds each fan is capable of handling effectively the gases from two boilers, and at the higher speeds each fan can handle the gases from three boilers in case of need. A chimney constructed of mild steel plates has been erected, the height of which is 100 ft. and the diameter 7 ft. 6 in. in the parallel portion.

The circulating water for the condensers is at present lifted direct from the river Tyne into storage tanks capable of containing about 100,000 gallons of water by means of five Worthington steam pumps, each capable of delivering 33,000 gallons per hour. There is also a centrifugal pump direct coupled to a 50 B.H.P. Westinghouse direct-current motor, which can deliver 150,000 gallons of water per hour against a head of 50 ft. A further installation will be made during the present year of two 12 in. vertical centrifugal pumps made by the Worthington Pump Co. These pumps will be erected on the jetty, and will deliver water at a head varying from 51 ft. to 34 ft., according to the state of the tide. A separate suction pipe will be provided for each pump, both pumps delivering into a common discharge main 18 in. in diameter. Each pump will discharge 2,920 gallons per minute, the speed varying from 690 to 770 revs. per min. The pumps will be driven by two 73 H.P. direct-current motors running at 850 revs. per min., arranged on a level 17 ft. above the pumps, the power being transmitted by means of intermediate shafting. The pumps are designed for working submerged, a mechanical lubricator being fitted to ensure efficient lubrication.

The site of the extension is on the side of a hill, and this involved the removal of some 2,000 cubic yds. of earth. Owing to the formation of the subsoil, this task caused a certain amount of difficulty, as did also the foundation for the new 5,000 kw. turbo-generator set. The foundations for this set consist of a concrete monolith 41 ft. long by 8 ft. in width, which is raised 4½ ft. above the engine-room floor and carried 8 ft. below that level. This mass is interspersed with cable and air-carrying ducts, and entailed the construction of several various shaped moulds and heavy steel reinforcements where the concrete had been weakened by the presence of these ducts.

In conclusion, we must acknowledge our indebtedness to Mr. H. S. Ellis, the borough electrical engineer, under whose supervision the whole of these extensions have been carried out, for the information on which this article is based, and also to the British Westinghouse Electric & Mfg. Co. for the loan of certain blocks for illustrating the article.

CORRESPONDENCE.

THE HEAVISIDE LAYER.

TO THE EDITOR OF THE ELECTRICIAN

SIR: Everyone will agree with most of Dr. Lee de Forest's letter in the last issue of THE ELECTRICIAN, especially with the last paragraph, in which he refers to the interest which will be evoked by Mr. Fuller's valuable Paper. The curves shown in Fig. 10 of that Paper seem to give clear evidence of interference between two sets of waves travelling along paths of slightly different lengths. Prof. Wilberforce, who has been good enough to go into the questions raised in the Paper, has pointed out, however, that the numerical results obtained by Mr. Fuller are inconsistent with the view that, while one of these paths is directly along the surface of the earth, the other is the result either of a single reflection by a layer of discontinuity, such as the Heaviside layer, or even of any number of successive reflections from this layer and the surface of the earth. From Mr. Fuller's values of the successive wave-lengths which give maxima and minima at the receiving station the difference of length of the two paths can be estimated and shown to be of the order of 20 km. If the height of the reflecting layer is taken to be 80 km., this difference of path is obtained if there are three successive reflections—that is, if the waves which do not travel by the direct route, pass from the transmitting station to the layer, thence to the earth and thence to the layer again—before reaching the receiving station. In this case, however, the interference bands on the surface of the earth will enormously exceed in width the distance of 18 miles estimated by Mr. Fuller. In order to account for bands as narrow as that there would have to be about 49 successive reflections instead of three. The existence of this discrepancy can be shown to be independent of the assumed height of the Heaviside layer. Mr. Fuller's remarkable results would seem, therefore, rather to indicate that there are masses or clouds of ionised air, which serve as reflecting surfaces, which are so placed that two rays are produced which cross each other at a considerable angle. This was the suggestion originally put forward by Fessenden, to which I referred in my Paper before the Institution of Electrical Engineers. My object in writing this letter is to emphasise Prof. Wilberforce's point that the production of interference bands is no evidence of the existence of a fairly uniform stratum, such as is implied by the term "layer."—I am, &c.,

Liverpool, May 11. E. W. MARCHANT.

ON THE DIRECT MEASUREMENT OF POWER FACTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Murphy seems to consider it an omission that in my reply to his first letter I did not lay stress upon the fact that he has found the induction-dynamometer scheme to offer some advantages. As I had previously pointed out these advantages, I did not consider it necessary to make further comment.

With reference to the question of calibration, it is, perhaps, necessary to remind Mr. Murphy that my article was neither entitled nor connected with "Methods of Calibrating Power Factor Meters," so that I am unable to see what bearing his personal preference in this respect has upon the subject.

In my remarks on ligaments, I was referring, not to the results of careless connections, but to the somewhat frequent instances in which the ligaments, after having been in commission for some time, have become entangled or partially oxidised.

Since Mr. Murphy raises the point, I should explain that the short scale instrument shown in Fig. 15 was designed for a circuit of about 400 volts, the advantage of the type shown being that this was accomplished without the use of external resistances, which would have been essential with the plain dynamometer type.—I am, &c.,

London, May 10. R. D. GIFFORD.

VOLUNTEERS IN INDUSTRIAL WORK.

TO THE EDITOR OF THE ELECTRICIAN

SIR,—After communication with friends in different parts of the country, I am convinced that there are a large number of men on the staff of our universities, technical colleges and secondary schools who usually enjoy a fairly lengthy summer vacation, but who this year would be quite willing to forego a large portion of it if they could serve their country by so doing. Thus there are a large number of lecturers and demonstrators in electrical engineering who have had works experience, and who would be employed to best advantage in the electrical industry. Many could arrange to spend six to eight weeks from July to September in works were the way open.

If those firms who are doing Government work, and who can utilise help of this nature, will send in their names to THE ELECTRICIAN I feel sure there will be a ready response. Probably remuneration, according to the duties performed, would be a necessary condition.—I am, &c.,

Technical College, Huddersfield, May 11. WALTER M. WILCOX, B.Sc. (Eng.)

[We fear there would be a difficulty in works organisation, except possibly in testing.—ED. *E.*]

AN ELECTRICALLY-HEATED WATER STERILISER.

We recently had the opportunity of inspecting a system of water sterilisation for the use of troops due to Dr. P. G. Griffith. It consists of a series of six electrically-heated sterilising chambers mounted on a motor lorry, and supplied with current from a dynamo

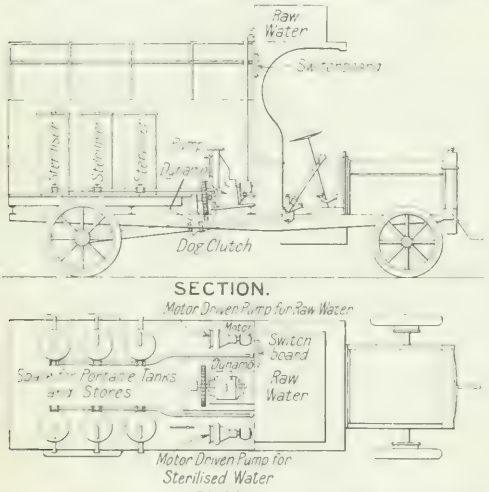


FIG. 1.—ARRANGEMENT OF STERILISING UNITS ON MOTOR LORRY.

driven off the main driving shaft of the lorry. Two electric pumps are used to pump the raw water to a tank on the roof, and to deliver the sterilised water into portable tanks or to water carts as required. The arrangement of the various units is seen in Fig. 1. The motor lorry is a 40 H.P. petrol machine of normal design, provided with cross members and stiffening girders to carry the heaters, motors, and dynamo. The dynamo is compound wound and designed to comply with the Admiralty specifications. The working voltage is 100 volts.

With regard to the sterilising chambers, one of which is shown in section in Fig. 2, these provide for the heating of the water up to 80°C. and subsequent cooling. It is well known that the germs of all water borne diseases such as typhoid, enteric, cholera and dysentry are destroyed at temperatures of from 65° C. to 72° C. Referring to Fig. 2, the raw water enters the chamber at F and passes up through the tubes of which there are 240 in each heater, to the sterilising chamber in which are immersed the heating elements. These are of the immersible type, loaded approximately to 1 kw.

The water then passes through a thermostatic controlling valve C, preventing egress of any water below a temperature of 80° C and down around the tubes conveying the raw water entering the sterilising chamber, resulting in an interchange of heat between the water entering and leaving the chamber, thus adding to the efficiency of the apparatus. A pump then delivers the water to tanks or water carts as required. A thermometer B and an air valve D are provided in each unit.

The thermostatic valve which prevents the water leaving the chamber under 80°C. is illustrated in Fig. 3. The opening for the passage of the sterile water is closed by a plug *a*, which is pressed

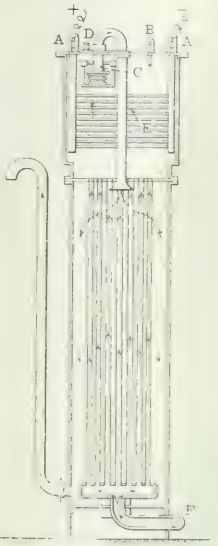


FIG. 2.—SECTION THROUGH STERILISER.

into position by the spring *b*. When the lethal temperature has been reached the capsules *c* expand, and by means of the stirrup *d* withdraw the plug *a* from its seating, and thus the passage of water is permitted. If the temperature of the water drops below that which is safe, the capsules collapse, and the plug is pressed back by the spring to the seating, so as to close it effectively. The capsules are filled with a liquid boiling at 80°C. and as the lethal temperature of all pathogenic organisms which are conveyed by water is 72°C., a sufficient margin of safety is allowed. In practice it is found that the capsules invariably collapse completely at 77°C.

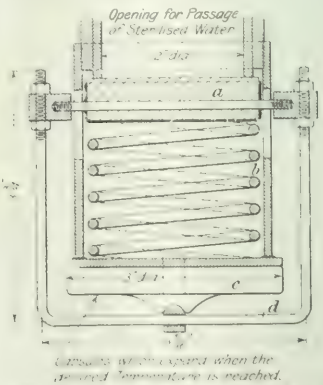


FIG. 3.—DIAGRAM OF REGULATOR. HALF FULL SIZE.

Each sterilising chamber is capable of delivering 60 gallons of water per hour, and each motor unit could easily supply 16,000 men with four pints of sterilised water per day, when working 24 hours per day, after allowing for all waste. The sterilising units are also made to be worked by means of separate coke-fired boilers, in which case the pumps are all hand operated. The whole apparatus is easily worked, and the value of such means of dealing with a doubtful water supply is universally recognised.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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AIR POLLUTION.

What may be termed a remarkable sign of the times has just been made manifest in the shape of a report on the subject of Air Pollution, issued by the Sanitary Committee of the city of Manchester. Probably there is no district in the country in which the industrial conditions, represented by hundreds of textile factories and engineering works, and the domestic conditions, represented by thousands of small dwellings, contribute to a more abnormal state of the atmosphere. The smoke abatement movement has proceeded upon scientific lines in the great cities and factory districts throughout the country, and those, who have been, and are now, prominently identified with it, are representative of every part of the community to which the removal of the causes of air pollution is of vital importance. The Air Pollution Advisory Board of the city of Manchester was appointed by the Sanitary Committee in December, 1912, and it was the outcome of a memorial presented to the Council by members of various scientific and other societies in the city. This Advisory Board is made up of members of the Sanitary Committee and also members of the Committees dealing with the art galleries, baths and washhouses, cleansing, education, electricity, finance, gas, improvement in buildings, parks and cemeteries and waterworks, together with a quotum of non-members of the Council having special knowledge and experience of the subject. The investigations of this sub-committee have been pursued upon scientific and systematic lines, and the report already referred to contains the results of their labours over a period of more than two years. From a commercial and industrial point of view the report is of immense value. We do not propose here to analyse its findings in detail, but we feel that every engineer in charge of an electricity department should obtain a copy of it and study it closely. Among the many interesting, not to say fascinating, problems with which the Committee have had to deal is that of the influence of air pollution upon the amount of light available during the normal periods of daylight. The results obtained from a study of this item alone would be considered, at any rate by illuminating engineers, as a complete justification for the work of the Committee and for the carrying into effect such recommendations as it may make. Illuminating engineers, who, after all, do their most important work in commercial and industrial circles, are never tired of pointing out that good lighting is as important to an industrial or commercial concern as good materials, good machinery and efficient workers. For this reason it is desirable that such steps as are possible should be taken, for commercial expediency alone, to purify the atmosphere, with the idea of raising the standard available of natural lighting during the hours of daylight. The figures, which are given in both tabular and graphical form, show the deposit of impurities in the shape of tar and carbonaceous matter, and are appalling testimony to the atmospheric conditions which prevail in the Greater Manchester area and in many of the industrial towns in the Lancashire district. These impurities are worked out in metric tons per square kilometre.

Turning to the principal causes of these impurities, the Committee fixes upon the domestic firegrate as the principal offender. The product of factory chimneys in the way of sooty material is extremely low by comparison with that emitted from the common coal fire in a domestic grate. The conditions for combustion are in the case of the factory boiler house as nearly perfect as they can be, particularly where modern mechanical stoking plant is installed. It is to the firegrate, therefore, that the Committee point, and the electrical engineer may now regard it as his special business, side by side with the gas engineer, to introduce a substitute which will banish this offender, at any rate, in industrial districts.

When the Advisory Board was formed it was given no administrative powers, and the suggestion is made that scientific and commercial tests be made on old and new types of firegrates by an exhibition in Manchester of various inventions relating to domestic heating. In order to bring these recommendations into effect, the general scope of the sub-committee has been extended by an increase of the membership to include individuals who will be able to carry the scheme forward a stage further. We anticipate a considerable amount of good from this effort, and meanwhile we congratulate the Advisory Board upon the results of its labours, and feel sure that electrical men throughout the country will do their utmost to help forward the good work to which the Committee has laid its hands.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week May 3, 1915, to May 8, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible] unenumerated, £2,515. *Denmark:* Unenumerated, £41. *Holland:* Elec. lamps, £1,798—13 pkgs.; lamp parts, £106. *Sweden:* Elec. machinery, £614; telephone materials, £410; lamp parts, £37; unenumerated, £45. *France:* Carbon candles, £837; elec. [illegible] *Spain:* Lamp parts, £32; unenumerated, 485 pkgs. *Italy:* Carbon candles, £22; wire [illegible]

EXPORTS.

[illegible] elec. machinery, £240; unenumerated, £1,046. *Wellington:* Wire and cable, £1,895; unenumerated, £474. *Adelaide:* Wire and cable, £1,514. *Brisbane:* Elec. machinery, £221; wire and cable, £659; unenumerated, £246. *Freemantle:* Elec. machinery, £21. *Dunedin:* Elec. machinery, £712; wire and cable, £53. *Christchurch:* Elec. machinery, £336; unenumerated, £109. *Perth:* Elec. machinery, £23; telegraph material, £29; unenumerated, £180. *Hobart:* Elec. machinery, £1,901; telephones, £140; unenumerated, £108. *Cairns:* Elec. machinery, £33. *Lyttelton:* Elec. machinery, £59; unenumerated, £219. *New Plymouth:* Elec. machinery, £285.

AFRICA.—*Durban:* Machinery, £214; elec. glow lamps, £100; unenumerated, £858. *Port Elizabeth:* Unenumerated, £149. *Cape Town:* Machinery, £129; wire and cable, £108; unenumerated, £312. *East London:* Elec. glow lamps, £268; elec. machinery, £267; wire and cable, £190; unenumerated, £133. *Delagoa Bay:* Elec. machinery, £33; unenumerated, £14. *Kilindini:* Telegraph material, £50; unenumerated, £586. *Beira:* Unenumerated, £30. *Zanzibar:* Telegraph materials, £34. *Mauritius:* Unenumerated, £40. *Madeira:* Telegraph material, £13.

EGYPT. *Port Said:* Wire and cable, £48; unenumerated, £178. *Port Sudan:* Elec. machinery, £386; wire and cable, £12; unenumerated, £498.

FIJI.—Telegraph material, £36; unenumerated, £49.

RUSSIA. *Petrograd:* Elec. machinery, £495.

SPAIN.—*Valencia:* Elec. machinery, £500. *Barcelona:* Elec. machinery, £23.

PORTUGAL.—*Lisbon:* Unenumerated, £133.

CHINA. *Hankow:* Unenumerated, £394. *Tientsin:* Unenumerated, £147. *Hongkong:* Elec. machinery, £53; wire and cable, £1,123; unenumerated, £201. *Shanghai:* Elec. machinery, £472; unenumerated, £10.

JAPAN.—*Yokohama:* Unenumerated, £25. *Kobe:* Elec. machinery, £198. *Nagasaki:* Unenumerated, £72.

INDIA, CEYLON AND INDO-CHINA.—*Bombay:* Elec. machinery, £515; telegraph material, £33; wire and cable, £1,573; unenumerated, £1,535. *Calcutta:* Wire and cable, £342; elec. machinery, £1,133; unenumerated, £454. *Madras:* Elec. machinery, £203; wire and cable, £361; unenumerated, £67. *Colombo:* Elec. machinery, £38; unenumerated, £44. *Karachi:* Unenumerated, £54. *Singapore:* Elec. machinery, £37; telegraph material, £42; unenumerated, £134. *Rangoon:* Unenumerated, £7. *Penang:* Elec. machinery, £49; unenumerated, £139. *Bankok:* Wire and cable, £207. *Sourabaya:* Unenumerated, £52.

CANADA.—*Montreal:* Unenumerated, £890. *Victoria, B.C.:* Unenumerated, £20.

NORWAY.—*Christiana:* Unenumerated, £90.

SWEDEN.—*Stockholm:* Wire and cable, £95.

FRANCE.—*Dieppe:* Wire and cable, £600; unenumerated, £229. *Marseilles:* Telegraph material, £23. *Boulogne:* Elec. machinery, £50; unenumerated, £155. *Bordeaux:* Unenumerated, £50. *Paris:* Elec. machinery, £20; unenumerated, £66. *Nantes:* Elec. machinery, £22. *Dunkirk:* Unenumerated, £20. *Havre:* Wire and cable, £2,021.

SOUTH AMERICA. *Buenos Ayres:* Elec. machinery, £311; wire and cable, £388; unenumerated, £1,972. *Moji:* Elec. machinery, £200. *Monte Video:* Unenumerated, £42. *Porto Alegre:* Wire and cable, £1,454. *Mejillones:* Wire and cable, £168. *Valparaiso:* Unenumerated, £27.

PERU.—*Guadeloupe:* Elec. machinery, £452.

BRITISH GUIANA.—*Demerara:* Unenumerated, £29.

HOLLAND.—*Rotterdam:* Unenumerated, £151.

U.S.A. *New York:* Unenumerated, £15. *Boston:* Unenumerated, £30.

MALTA: Unenumerated, £44.

GIBRALTAR: Elec. machinery, £63; unenumerated, £126.

GREECE. *Piræus:* Elec. machinery, £24; wire and cable, £45.

FOREIGN GOODS (duty paid and free).

Wellington: Unenumerated, £174. *Boulogne:* Unenumerated, £31. *Bangkok:* Unenumerated, £29. *Buenos Ayres:* Unenumerated, £168. *Madras:* Unenumerated, £16. *Rouen:* Elec. machinery, £73. *Rotterdam:* Unenumerated, £89. *Stockholm:* Unenumerated, £10.

IN TRANSIT.—*Adelaide:* Elec. lamps, £150. *Christchurch:* Elec. lamps, £100. *Melbourne:* Elec. lamps, £1,650. *Sydney:* Elec. lamps, £540.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

PARLIAMENTARY INTELLIGENCE.

ELECTRICAL ENGINEERS AND THE WAR.

On Thursday last week Mr. Wedgwood asked the Parliamentary Secretary to the Admiralty whether, in view of the important part of the War now at the British professional engineers, particularly the public bodies of the Institution of Civil Engineers, the Institution of Electrical Engineers, and of the Institution of Mechanical Engineers, the number of 12,000 had been exceeded, upon which Mr. Arnold-Forster replied: and whether he was aware that this was the only professional body which had probably by actual labour experience before admission to the grade of the institutions, and therefore peculiarly numbered in its ranks the consultants who [illegible] would be of [illegible] value in

Dr. Macnamara: [illegible] the answer to the first part of the question is in the negative. With regard to the second part of the question, I am unable to [illegible] certain terms of professional training [illegible] considered as equivalent [illegible] ship of the institutions referred to, but I do not think my hon. friend's inference is necessarily a sound one.

Mr. WEDGWOOD then addressed the same question to the Under-Secretary for War, and asked what number of professional engineers were actually serving in the ranks, whereby great experience of labour and mastery of materials was lost to the nation and its workers who must have advice and direction which constituted a national asset; whether the Government would consider the advisability of retaining a number of these professional engineers as retainers, essential to such an eminent and arduous profession and at least equal to those paid to medical and legal consultants; if he had considered whether the public recognition and extensive retention of these trained engineers in authorative positions would improve labour processes; whether these engineers would relieve a number of experienced military officers for service with the troops; how many of the professional engineers who had enlisted had offered their services for organising and other engineering work to the War Office and had not so far been retained; and whether, in view of the preventative, constructive and aggressive value of the work of this profession, the Government would take immediate steps to place its members in prominent positions in the legislature, and to extend its services beyond the Committee Rooms.

Mr. TENNANT: I am not aware that any civilian engineers have been retained at a salary of £3,000 a year or upward, nor can I state the number of members of the institutions serving with the Forces. The War Office is receiving much useful assistance from members of the civil engineering profession, and I recognise that it has been made that workers on war materials are being hampered owing to want of professional advice. It is not considered that labour processes could be improved by the extensive retention of trained engineers beyond those already in War department service. A certain number of civil engineers have already relieved military engineers for service with the troops. The applications from civil engineers are being considered, as I mentioned. I understand that 60 have been employed in various ways. I think that the last point would more properly be addressed to the Prime Minister.

PLYMOUTH CORPORATION BILL.

Last week a Select Committee of the House of Lords considered this Bill. Last year an Act was passed amalgamating Plymouth, Devonport and East Stonehouse into the new county borough of Plymouth and a statutory obligation was placed upon the new Corporation to consolidate the local and special Acts of the three municipalities, and the present Bill also confers further powers upon the Corporation in regard to electricity and gas supply, &c.

In regard to the electricity clauses, Mr. HONOURABLE LLOYD, K.C., explained that it was desired to make uniform throughout the whole of the new borough the exercise by the Corporation of the power to supply electrical fittings, &c.

On behalf of the local Mercantile Association, Mr. JEEVES opposed, maintaining that that was a case where the model clause against municipal trading should be inserted.

Mr. J. W. SPARK, borough electrical engineer for the Devonport area of Plymouth, said the wiring powers possessed by Devonport had been of great value to the borough, the working classes (which included a large number of dockyard men) being able to employ electricity for domestic and business purposes without extra expenditure.

Mr. W. G. HEATH, electrical engineer, then gave evidence on behalf of the Plymouth Mercantile Association. He said owing to the powers posssessed by Devonport Corporation electrical contractors had been prevented from obtaining work in the borough, and if those powers were extended to Plymouth, as was proposed, it would have a serious effect on his business.

Mr. W. J. CORSE, electrical engineer, of Plymouth, gave similar evidence.

Ultimately their lordships intimated that they would allow the clause to stand as drafted by the promoters.

LINCOLN CORPORATION BILL.

Last week the Local Legislation Committee of the House of Commons considered this Bill, which (inter alia) confers further powers for carrying on the electricity supply, tramways and gas undertakings. In connection with clause 57 of the electricity portion of the Bill, the city electrical engineer and tramway manager (Mr. Stanley Clegg) said it was proposed to acquire extra land compulsorily, as the Corporation had no land available. The cost of the new generating station would be £30,250 exclusive of cost of land, and it was intended to scrap a lot of the original generating plant. The clause was agreed to, the compulsory purchasing powers in regard to land to cease after five years.

On the part of the Bill dealing with motor omnibuses and tramways, Mr. Forbes Lankester, K.C. (for the Corporation) said his clients were the owners of the tramways, but owing to the physical formation of the ground, an extension of the tramways would be of very doubtful value and the Corporation thought it would be better and less expensive to introduce a system of trackless trolley vehicles. The tramway system ran north and south of the city, and it was proposed that the new route should be from east to west on the lower level of the city. No objection was made by anybody to the Corporation proposal which was to run motor omnibuses in any part of the city they desired, and outside of the city if thought advisable, with the consent of the local and road authori[illegible] and the Board of Trade.

Mr. WHITE, chairman of the Local Legislation Committee, said the proposa[illegible]

scheme was the best that could be devised to meet the requirements of the traffic.

The Committee disposed of the electricity and [illegible] of the Bill, only formal amendments being made, and then adjourned the further consideration of the Bill until the 18th inst.

Lurgan Provisional Order.—The Bill to confirm this provisional order has been passed by the Local Legislation Committee of the House of Commons. The Bill provides for the transfer of the undertaking of the Lurgan Gas Lighting & Chemical Co. to the Lurgan Council, and confers powers on the Council for the supply of gas and electricity, &c.

London Tramways & Improvements Bill.—A Select Committee of the House of Commons has this Bill under consideration. Owing to the opposition, the proposed extension of the tramway along Farringdon-road to Charterhouse-street has been withdrawn.

LEGAL INTELLIGENCE.

Prize Court Case.

The President of the Probate, Divorce and Admiralty Division last week delivered a considered judgment in the case of the Peonia, upon the suit of the Crown, asking for the condemnation as enemy property of five cases of electric fittings seized on board the Peonia, a steamship belonging to the P. & O. Company. The goods were claimed by Isaria (Ltd.). The facts of the case were reported in The Electrician for April 9 and 23.

In the course of his judgment the PRESIDENT said the claimants to the goods seized were Isaria (Ltd.), a company incorporated in England in May, 1912, and which at the outbreak of war had a registered office in London. The question was whether having regard to the constitution of the company the goods were enemy property subject to confiscation. At all material times there was an issue by the company of 1,250 shares of £1 each. Of these 1,244 were held by Isaria Zohlerwerke, of Munich (a German manufacturing company), one share was held by each of the four directors of Isaria (Ltd.), who were German subjects resident in Germany; one share was held by the secretary, a German subject, and the remaining share was a French subject, but who since the outbreak of war had resided in Munich and had been employed by the German company. The secretary left England on Aug. 3 for Germany, having purported to appoint one of the company's employees, Mr. Frank Morton, to be manager. His lordship, following the decision of the Court of Appeal in the case of the Continental Tyre & Rubber Co. (Great Britain) v. Daimler Co., said the claimants came forward as a company incorporated in accordance with the law of this country, and the claim was not made by the individual shareholders, subjects of a foreign country, enemy or otherwise. He came to the conclusion, therefore, that the goods seized were not enemy property and he accordingly ordered their release.

BUSINESS NOTICES.

The general offices of the Smethwick Marker Electric supply Co. are now at 47, Terminus-chambers, 6, Holborn-viaduct, E.C. Telephone, Holborn 682.

From the 15th inst. the registered offices of the undermentioned companies will be at Electric Railway House, Broadway, Westminster, S.W.: London & Suburban Traction, Metropolitan Electric Tramways, London United Tramways, South Metropolitan Electric Tramways & Lighting, North Metropolitan Electric Power Supply, North Metropolitan Electrical Power Distribution, Provincial (M.E.T.) Omnibus, and the Gearless Motor Omnibus Co.

The partnership between Fredk. C. Gaunt, Wm. H. S. Bartlett, Arthur C. Frost and Trumbell B. Batchelor (trading as the Colonial Mfg. Co.), electrical engineers and manufacturers, of Finsbury, Hornsey, has been dissolved by mutual consent. All Debts by the remaining partners.

Increase of Prices.—Owing to the increased cost of production (both in materials and labour consequent upon the [illegible] Messrs. Gutta Percha & Telegraph Works Co. are [illegible] compelled to advance the prices in their [illegible] rubber, [illegible] and cotton covered [illegible] the exception of lead [illegible] 17 inches, the prices of which [illegible] to be used on application.

Patent Development.—The proprietors of Goldschmidt's British patents Nos. 11,291 of 1910 and 8,387 and 11,832 of 1911 and 10,901 of 1912, desire to grant licences to [illegible] Messrs. W. P. Thompson & Co. [illegible] Liverpool.

The owners of patents Nos. 11,831 and 11,832 of 1912 [illegible] ment in receivers for printing telegraph [illegible] arrangements for exploiting same in the country. Particulars from Mr. A. E. White, patent agent, 88/90, Chancery-lane, London, W.C.

Sale by Auction.—Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by public auction at the Royal Arsenal, Woolwich, on Thursday, May 20, by order of the Secretary of State for War, at 11 a.m., some unserviceable and obsolete stores, including quantities of iron, brass, mixed metals, bronze, gunmetal, platinum, zinc, lead, &c., gutta percha and rubber, 386 electric lamp bases, electrical instruments, tools, wagons, lorries, &c. The lots may be viewed on Monday, Tuesday and Wednesday previous to and on morning of sale. Catalogues from Imperial House, Tothill-street, Westminster, S.W., the Ordnance Office, Tower, and the Ordnance Office, Royal Arsenal, Woolwich. Further particulars are given in an advertisement.

LIQUIDATIONS, &c.

A meeting to receive an account of the winding up of the Daylight Engineering Co. (Ltd.) (in liq.) will be held at the offices of Messrs. Eaglund & Owen, 98, Lombard-street, London, E.C., on June 1.

Deed of Assignment.—A dividend is to be declared under a deed of assignment executed on Dec. 9, 1914, by Albert Hartley and Richd. Wm. Leek, electrical engineers, 5, Keighley-road, Colne, and claims are to be sent by May 29 to Mr. R. A. Hargreaves, 2, Albert-road, Colne.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aldershot. The Council have submitted reasons to the L.G. Board for the urgency of the loan for the new plant at the electricity works, and tenders have been accepted subject to the consent of the Board being received.

Barnsley. On Tuesday the Council adopted a scheme of extensions at the electricity works estimated to cost £21,850.

Ald. ROSE, chairman of the Electricity Committee, said the scheme was urgently necessary; it would not cost the ratepayers a penny.

Basingstoke.—The Council have received the sanction of the L.G. Board to borrow £4,100 for extending the mains to the works of Messrs. Thorneycroft & Co. It is also proposed to give a supply of electric current to Messrs. Musselhwhite at Eastrop.

Battersea (London). The Treasury raise no objection to the proposal to borrow £15,750 for extensions of mains and for additional machinery in connection with the increased supply of current to Nine Elms district, and also to the recent application of the Council for a loan of £9,000 for general extensions of mains, &c.

Both amounts have been sanctioned by the L.C.C., but the application for sanction to borrow £9,000 for mains, &c., has not been sanctioned by the Treasury, and it will be necessary for this expenditure to be met out of revenue.

Bradford. It is proposed to extend the mains in Canal-road at a cost of £4,960, and other main extensions are projected in various parts of the city at an estimated expenditure of £2,320.

The Electricity Committee's agreement with Messrs. Mitchell Bros. in regard to the bulk supply of current is to be extended for a further period of 3½ years.

The Committee has decided to remit as from April 1 the rental charges for such hired are lamps as cannot be used by reason of the Lighting Restriction Order until such restrictions are removed.

Until further order, the maximum price to consumers who are charged for electricity under the maximum demand rate, is not to exceed 4d. per unit.

Bristol. On Tuesday the Corporation were recommended by the Electricity Committee to provide additional plant, including a [illegible] at a total cost of £26,949.

The Chairman of the Committee (Ald. Pearson) moved the adoption of the recommendation that they be authorised to apply to the L.G. Board for sanction to borrow £26,949. He said the position in connection with the [illegible] was that they had [illegible] for power purposes of [illegible] kw. [illegible] 1,754 [illegible] a supply of 3,763 kw. They had [illegible] connected to [illegible] 2,144 kw. and would [illegible] 1,110 kw. They estimated that during the [illegible] 384 kw. [illegible] plant and 1,000 kw. [illegible] that they must have [illegible] recovering the [illegible] £1,000 a year. [illegible] the plant [illegible] £1,000 a year, the power load [illegible] 1,000 kw. [illegible] 1,110 kw. and 298 kw. [illegible] 3,763 kw. [illegible] 3,763 kw. [illegible] 3,763 kw. [illegible] 3,414 kw. [illegible] 3,414 kw. [illegible] 11,426 kw. [illegible] 3,414 kw. [illegible] 3,414 kw. [illegible] 3,414

that they had done exceedingly well, because up to February they had put on 424 additional customers, and brought the power load to-day to just about 18,000 kw. capacity. He thought they would see that it was necessary they should have the additional machine, and they had no doubt it would be fairly well used at no distant date. They could not hope to get it until this time next year, even if ordered at once. It was not safe to run those stations unless they had one of their large machines to spare.

After debate the motion was carried. It was also agreed to apply for sanction to borrow £341 excess expenditure on certain work at the Avonbank works.

Burton-on-Trent.—High-tension mains are to be extended to the premises of two business firms in the borough.

Dundee. Application has been made to the Secretary for Scotland for sanction to borrow £20,000 for the electric supply department.

Haslingden (Lancs). Sanction has been recently received by the Council to loans of £4,600 for mains and £2,770 for services, switchgear and transformers.

Manchester. An inquiry will be held on the 21st inst. into the application of the Corporation for sanction to borrow £768,000 for the erection of a new generating station at Barton.

Northampton.—The Council have received notice from the Northampton Electric Light & Power Co. that it proposes to erect another generating station on the south side of the Nene, near Nunn Mills.

Sheffield. Mains are to be extended in various parts of the city at a cost of £12,620.

Of the amount over £11,000 will be spent on an additional extra h.t. feeder from Neepsend power station to Tinsley.

Formal sanction has been received from the L.G. Board to the borrowing of £134,373 for the electricity undertaking, made up as follows: £20,000 for sub-station buildings and equipment, transformers and power factor rectifiers (being part of application for £50,000), £86,813 for additional plant at Neepsend, and £27,560 for extension of buildings at Neepsend and purchase of 50-ton crane.

West Hartlepool. Agreements have been entered into for the supply of electrical energy to the Milton Saw Mills and to Messrs. Batchelor's works on Longhill. Application has been made to borrow £600 for laying a cable to the latter works.

Wolverhampton. A new feeder cable is to be laid from School-street sub-station to Lea-road at a cost of £1,130, and it is also proposed to carry out main extensions at a cost of £730.

GENERAL.

Belfast. The deadlock on the question of the reorganisation of the electric supply department still continues, for at the last meeting of the Corporation a prolonged discussion took place, and ultimately it was again referred back to the Council in committee.

On April 14 a resolution of the Council in committee was passed to give the Tramways and Electricity Committee a further opportunity to present a complete scheme for the reorganisation of the department.

Ald. Dr. KING-KEER having moved and Ald. JAFFE seconded the adoption of the minutes, a keen debate arose, and in the course of the discussion Councillor ATKINSON suggested a compromise. If the minutes were adopted it confirmed the Committee in their retention of the electrical engineer. If the Council felt that to act in the spirit of Ald. Tyrrell's resolution would be a hardship upon the engineer, there was a way of obviating that—viz., to allow the engineer to be retained in his original position, and to appoint a thoroughly competent and experienced man to take charge of the station.

Ald. DORAN said no direct charge had been formulated against the engineer. There were many heads of departments in the Corporation who required looking after quite as much.

Councillor RIDDELL proposed an amendment referring the matter back to the Council in committee, with a view to obtain the advice of the best expert upon station management obtainable. He did not think the Committee was capable of devising a scheme which was suitable.

Ald. BYRNE said the whole campaign of persecution against the station and the engineer had been originated by a few dissatisfied employés in the electric station.

The chairman (Ald. Tyrrell) and several others took part in the debate, and the amendment was withdrawn. Another amendment to instruct the Committee to submit a scheme of reorganisation was rejected by 21 votes to 19, and the report was then carried.

Bicester. In reply to a letter from a firm of electrical engineers in regard to the erection of electricity supply works, the Council have intimated that some residents had the matter in hand and would, no doubt, when the war was over, deal with it.

Birmingham. Last week the members of the Electricity Committee visited the temporary generating station which is being erected at Nechells.

The city electrical engineer (Mr. R. A. Chattock), the secretary to the electric supply department (Mr. Howard Foulds), and Mr. Arthur Harrison (of Harrison & Cox, architects for the permanent station) accompanied the members of the Committee. The station is designed to accommodate two 5,000 kw. turbo-alternators, with condensers, five wooden cooling towers and six boilers, each capable of evaporating approximately 33,000 lb. of water per hour. The plant is to be housed in a steel frame structure, covered with fireproof material. The Committee found the work had made great progress, and it is expected that by the end of August supply will be commenced. The contracts were only let at the end of 1914, so that if the station be ready in eight months, Mr. R. A Chattock (who designed the station), his staff and the contractors will have set up a good record for rapid power-house construction. The temporary station has been so designed that all the plant, cooling towers and constructional steel work can later be removed to form part of the permanent station. The site of the latter has been taken over from the Tame and Rea Drainage Board, and is in proximity to the Birmingham and Warwick Junction Canal and the Midland Railway main line. Existing conditions make it impossible to proceed with the original scheme, as the Treasury may veto capital, and the Committee are only proceeding with contracts already let—viz., for the ferro-concrete foundations and bases for the plant, and certain other works, including the construction of a coal hopper, a turn-table, a railway siding and cooling ponds.

Coventry.—It was reported to the Corporation recently that the British Thomson-Houston Co., the contractors for the 3,000 kw. turbo-alternator, had stated that they had been informed by the sub-contractors for the blading of the turbo-alternator, that the whole of the blading had been commandeered by the Admiralty, and that they were accordingly unable to complete the order in the time stipulated.

The Town Clerk wrote to the Admiralty, pointing out that the new turbo-alternator was required practically entirely for the supply of energy to firms who were engaged upon important Government work, and urging them to allow the order to be completed. Representatives of the Admiralty had been seen, and ultimately the Admiralty consented to the British Thomson-Houston Co. supplying the fourth turbine.

Dartford. In reply to a request by the Council that Messrs. Stuart & Moore should be allowed to proceed with their contract for the installation of fire-alarms, &c., the War Office have intimated that the firm (who are engaged on Government work) are in arrear with stores urgently required, and suggest that the Council might see its way to arrange for their work to be carried out by some other firm not engaged on Government orders. The General Purposes Committee is of opinion that it would not be desirable to engage another firm to complete the contract, but they are making temporary arrangements to deal with the matter.

Dover.—At the last meeting of the Corporation the borough electrical engineer (Mr. L. W. Woodman) stated that the Government issued badges to men of military age employed at electricity works on condition that they agreed to join the Army if called on. The men would rather have that badge than the municipal one suggested last month, and Mr. Woodman was ordered to make the necessary application.

East Grinstead.—The Urban Council's application for a provisional order has been granted, but it will not come into force until after the conclusion of the war.

Kingstown.—The transfer of the Electric Lighting Order has now been completed and the consulting engineer (Mr. P. J. Tierney) has been instructed to submit alternative schemes for a generating station at either Callaghan's-lane or Eden-road. When the plans have been passed by the Council the L. G. Board will be asked to hold an inquiry.

Islington (London).—The Lighting Committee has made a reduction of £380 in the charge for street lighting for the March quarter.

The Borough Treasurer reports that the works contemplated by the electricity department are as follows: Works sanctioned and completed, purchase of properties, £1,566; short length extensions of mains sanctioned at £4,975. The Finance Committee recommends that application be made to the Treasury for sanction to borrow these above amounts. Works sanctioned and in progress, erection of cooling towers, £4,250. As the cooling towers are urgently required for the efficient working of the undertaking and the contractors have incurred considerable expense on the work, which is well in hand, the Town Clerk has been authorised to make application for sanction to complete the work and to borrow the necessary money. Other works have been postponed.

At the Council meeting last week, Ald. Vorley submitted, on behalf of the Lighting Committee, a proposal to accept an offer of £1,510 for eight boilers at Eden-grove generating station. The offer was conditional upon the Council removing the brickwork and making clear the way out. The Committee thought the offer a favourable one, and it was adopted.

In consequence of the electrical engineer (Mr. A. Gay) being unable to obtain the services of a junior shift engineer, the Council is recommended to increase the salary attached to the position from £30. to £2 a week. The proposal will affect the whole of the junior shift engineers at present employed in the department.

London Electricity Supply.—On the 19th inst. a conference will be held at the County Hall (Spring Gardens, S.W.) on the subject of electricity supply in the greater London area.

The conference, which has been called by the London County Council,

will be attended by representatives of the London Borough Councils and other bodies affected by the L.C.C. Bill of the present session.

The Herts County Council have directed their Clerk to inform the London County Council that they are of opinion that any scheme for the supply of electricity in and near London should not include any part of the county of Hertford in its area of supply or rating area, and should not interfere in any way with any rights of purchasing electrical undertakings for the time being vested in any local authority in the county of Hertford.

Reciprocal Supply of Electricity.—London County Council have recently approved agreements between Woolwich Borough Council, the South Metropolitan Electric Light & Power and the West Kent Electric Co. for a reciprocal supply of electrical energy.

Stretford.—The Electricity Committee has arranged with their contractors for the supply of coal.

From April 1 last the Council will accept 72 per cent. of the monthly consumption at the normal rates under the contract, any quantity supplied beyond that amount to be 2s. 6d. per ton extra.

The Committee has been in negotiation with T. W. Glover & Co. with regard to the sale of the four 100 kw. sets at the generating station, and the chairman and clerk have been authorised to arrange for the disposal of the machinery at a price approximating £325 each.

Sutton.—It is proposed to shut down the steam driven plant at the local electricity generating station of the South Metropolitan Electric Tramways & Lighting Co. at Sutton and to use the station as a transformer station.

The Sutton Council are asked to approve a scheme whereby, instead of generating electricity by steam plant at Sutton, duplicate h.t. mains would be laid from Wandsworth to the present station, where the current would be transformed to the ordinary domestic pressure and distributed therefrom. The change will not call for any change of wiring or lamp in consumers' premises. A supply of electricity in bulk is to be taken from the Wandsworth station of the County of London Electric Supply Co.

Torquay.—The Corporation have been informed by the L.G. Board that they were not satisfied that there was any necessity for the purchase of the Victoria-parade premises for new offices and stores for the electric supply department, and that if they proceeded with the purchase they must do so on their own responsibility.

The Electric Supply Committee have, however, acquired the premises, but as it is imperative that the department should be supplied with temporary offices, it has been decided to take a house in Beacon-terrace.

At the Council meeting last week the chairman (Mr. A. J. Blackler) stated that the output and consumption of electricity were satisfactorily increasing. Although the premises on Victoria-parade had been purchased, there was no intention to proceed with any constructive work at present, but to rent premises quite close to the generating station, which it was thought would answer the purpose until better times prevailed.

The Torbay Hospital is to be supplied with electric current at 3½d. per unit.

Tunbridge Wells.—Last week the Council adopted a report by the borough electrical engineer (Mr. R. N. Torpy) recommending the provision of wrought steel headers and drums to two boilers in the electricity station in place of the existing c.i. headers and drums, as suggested recently by the L.G. Board.

The two boilers will be made into one large unit, and will have an extra steam capacity of 4,000 lb. per hour. The provision of superheaters will present an annual saving in steam consumption in the engine room of approximately 4 per cent. The cost of providing the two steel sections and drums (4,356 sq. ft. complete) is £1,010, and of the superheaters £270. Mr. Torpy also reported that the ordinary time required for rebuilding the existing cooling tower would be at least 14 weeks, that that would prevent the necessary overhauling of some of the machinery and boilers before the winter's load, and would interfere with the alterations to the boilers. The contractors were willing to carry out the work by double shifts, thus reducing the period to eight weeks, the extra cost being £35, which, after taking into account the additional expense of running the works on the "non-condensing" principle during the alterations, would be a saving of about £80, and would avoid the disadvantage of the delay. The Council authorised the contractors (Messrs. Witting & Partners) to expedite the work as suggested.

Walsall.—A clause varying the price per unit according to the rise or fall in the price of coal is to be inserted in all future agreements for a supply of alternating current in bulk.

The lighting of the new road from Aldewell to Bescot Bridge is to be carried out by lanterns suspended from the trees on the footpath on both sides of the road.

The Council is recommended to have the whole of the direct-current auxiliary transformers overhauled at a cost of £250. The Electricity Committee proposes to draw a l.t. main into the existing conduits in five roads at a cost of £450. With respect to the Council's application for sanction to a loan of £23,595 for the undertaking, the L.G. Board has authorised the borrowing of sums amounting to £16,700.

The sales engineer has enlisted for the duration of the war, and the engineer has been authorised to temporarily engage a man ineligible for military service.

Watford.—The Council have decided to defer all large extensions of the electricity undertaking and to make application for sanction for the money which has already been spent. The cost of future house connections, &c., will be paid for out of revenue.

Speaking on the report of the Electricity Committee authorising the electrical engineer (Mr. A. W. Barham) to report upon the question of increasing the charges for current, the chairman (Mr. Goodrich) stated at the last Council meeting that they would be compelled to raise the existing prices. The idea was that every endeavour should be made to carry on the undertaking to the best of their ability, spending as little money as possible for the present.

Wolverhampton.—The Council are recommended to grant increases of salary to Messrs. E. Stubbs (chief assistant, from £200 to £225 a year), T. Smith (distribution engineer, from £245 to £270), E. Forder (engine-room superintendent, £150 to £165), C. Bellhouse (boiler-house superintendent, £150 to £165), and J. H. Rothwell (chief clerk, £170 to £185).

LIGHTING, POWER & HEATING NOTES.

City of London.—At the last meeting of the Court of Common Council the City of London Schools Committee recommended that electric fans should be fitted in some of the class rooms at a cost of £130; and that authority should be given to proceed with electric light re-wiring in the school at a cost of £725. The proposal to re-wire the school was withdrawn for this year.

Economy of Electric Lighting.—It is announced that the cost of the public electric lighting of Clones for the season ended April 30, 1915, was £89 odd, compared with £126 odd for gas lighting for the same period in the previous year.

Oulton Broad.—On the street lighting contract, the Oulton Broad Electricity Co. offer to make a deduction of 5 per cent., in addition to the allowance made in respect of fuel, but the Council consider that an abatement of 50 per cent. should be made owing to the restricted street lighting.

The company has applied to the Board of Trade for their formal sanction to the continuance of overhead supply wires within the district, and for certain short extensions proposed to be carried out. The Council has given permission to erect additional overhead wires in a number of roads.

Poor Law Institution Lighting.—Bantry Guardians have instructed a special Committee to report on a proposal to adopt electric lighting for their premises.

Wimbledon.—The Electric Lighting Committee propose to reduce the charge made for street lighting, whereby one-eighth part of the amount of instalments of loan, sinking fund and interest will be charged against street lighting instead of one-sixth part as heretofore.

TRACTION NOTES.

Bradford. The Tramways Committee has approved a scheme for providing a central terminus at Forster-square.

Burnley.—About 20 tramway employés enlisted last week, 10 going to the recruiting office on May 7th in a body.

Dublin-Blessington Tramway.—Recently a deputation of seven Irish M.P.s and Mr. Tierney, manager of the Dublin & Blessington Steam Tramway Co., waited upon the Secretary to the Admiralty (Dr. Macnamara) in regard to the electrification of the line.

Some time ago the company decided to electrify their line, and arranged for the purchase of electrical machinery and tramcars, but the outbreak of war prevented the delivery of the engines by the British firm which had secured the contract, the Admiralty having commandeered the works. The deputation asked that the Admiralty should consent to the completion of the work and the delivery by the contractors of the engines and accessories without undue delay. Dr. Macnamara, while pointing to the necessity to secure all the material which they could obtain for the successful prosecution of the war, said the Admiralty were anxious not to interfere unnecessarily with any business, especially a public undertaking like the Blessington Tramway Co. He promised the deputation to do his best to accede to their request.

Electric Scavenging Vehicles.—At the last meeting of Dover Council the Local Committee presented a report on the question of the borough scavenging was to be carried

The report recommended that the Council should themselves undertake the scavenging, and that six electrical vehicles should be purchased from Edison Accumulators (Ltd.), the Committee having seen this system at work and considered it satisfactory. The vehicles would cost £970 each. The present cost of scavenging, street sweeping, &c., was £6,374 yearly, and the Committee estimated that by the employment of the new system the cost would be reduced to £4,910, thus showing an estimated saving of £1,464. The latter sum also includes £1,690 yearly to be paid for the electrical vehicles, which would be paid for in four instalments, so that after four years there would be a further saving of £1,690 annually, less

amount for depreciation of the vehicles, which the Mayor estimated at £500 a year.

The Council approved the tenders submitted, but found tenders must be invited prior to giving the order for the vehicles.

Leeds. The tramway extension to Holbeck from the York-road terminus was opened for traffic last week.

London County Council.—The Finance Committee has reported that in view of a letter from the Treasury to the effect that the proposed expenditure of £79,270 on the reconstruction of the Rundle-road and Grove-road tramways does not appear to be urgent; but with regard to the proposed expenditure of £88,000 on two additional turbo-generators at the Greenwich generating station, it is recognised that it is a question of urgent importance which cannot be delayed indefinitely, but rather that the London County Council should consider whether it is possible to postpone the expenditure concerned, wholly or in part, for six months or a year. It is added that they will not be able to go on borrowing the money when declared absolutely necessary. The Finance Committee say they are not yet able to submit recommendations on the matter.

Sheffield.—Application is to be made to the Board of Trade for an extension of time in respect of the Attercliffe, the Woodside, and Ecclesall tramways.

The Corporation propose to purchase a 2-ton Edison battery vehicle at £970 for refuse collection.

The proposed tramway extensions at Woodseats and Ecclesall are to be deferred for the present.

Women Tramcar Conductors. The experiment of employing women as tramcar conductors at Maidstone has proved to be a success, and four are now employed.

Salford Corporation have also employed women as conductors and 16 have so far been engaged.

Glasgow Corporation have now over 100 women conductors in their service.

EMPIRE NOTES.

Australasia. In connection with the proposal of Doncaster (Victoria) Council to borrow £1,750 for an electric lighting scheme, a poll of the ratepayers is to be taken.

Footscray and Melbourne Victorian State Councils have instructed Mr. V. J. Crowley to report upon the Keilor-burn electricity generating plant and to supervise the overhauling of the plant.

The recent Australian Associated Chambers of Commerce recently passed a resolution in favour of placing the telephone, telegraph and postal departments of the Commonwealth under the control of commissioners.

India. Indian Engineering states that Mr. L. Snowbridge, electrical engineer, has been engaged by Darjeeling Municipality to report on a scheme for establishing power stations on the Mahanady river, on Phalbazar and the Rangit and on the Teesta.

The system when completed will provide electrical energy for the tea gardens throughout the district down to Dim Dimma in Jalpaiguri, and on the Nepal border as far down as Nuxalbarie (including Siliguri).

Mr. S. G. Forbes recently read a Paper on the Cauvery power scheme before the Mysore Engineers' Association. The author stated that the fourth installation of 4,000 H.P. was nearly complete, and that, with a fifth installation of 4,000 H.P. to be put in next year, will make 21,000 H.P. generated at the falls. Under the new agreement with the Kolar Mining Companies working 92 miles away, the Mysore Government are to supply them with 14,321 H.P. at the rate of 1 rupee daily for 1 year with the option of taking a further 2,000 H.P. on the terms as under to the Government.

FOREIGN NOTES.

Argentina. The Province of the River Plate says the Compania Italo-Argentina de Electricidad recently inaugurated new works and power house in Calle Dos Setiembre, Buenos Ayres.

The new station and power house, situated between Calle Ayerza de Mayo and Paseo de Julio, has a capacity of 8,000 to 10,000 H.P. The third installation in Calle Rivadavia is under construction.

Colombia. Patent Record. The legislature of the Republic of Colombia has passed a law, dated Dec. 10 of last year, for the protection of trade marks in Colombia.

Inventors, manufacturers, traders and others, have the same rights as the national, provided that the country where the article has been produced grants similar favours to Colombian marks. Registration of a mark confers a privilege for twenty years, renewable for the same period.

Cuba. The Cuban Council has granted to the Cuban Electric Power and Lighting Co. a concession to install electric power and lighting plant in Cienfuegos. Senor B. Cabarrocas is President, Senor F. Diaz de Noguera, Secretary, and Senor J. F. Pinto and H. Lopez, Board Members, and of Cienfuegos.

France. The French Customs Department have issued a circular giving indications of the scope of certain headings in the prohibited export list.

"Telegraphic apparatus" includes electrical apparatus for land, submarine or wireless telegraphy and heliograph apparatus.

"Carbons for electricity" applies only to electrodes, and not to other carbons prepared for electrical use.

Italy. Decrees have been issued authorising the Communal Authorities of Rome to construct and work by electric traction an extension of the Piazza Colonna–Piazza Santa Croce tramway, and an extension of the line from the Via Po to the Zoological Gardens, and authorising the Società elettrica Sarda to construct and work electric tramways in Cagliari.

Norway.—It is stated that the work of "harnessing" the Saude waterfalls near Stavanger is to be completed in 10 years, and power to the extent of 20,000 H.P. will be utilised by January, 1918. An American company has agreed to take a supply of electrical energy from the works, and has commenced to build factories near the fjord. The British Vice-Consul (Stavanger) can probably supply further details.

Russia.—A consular report states that electrical apparatus imported into Russia in 1913 was valued at 3,255,240 roubles (£337,004). The weight of such imports increased from 402 tons to 448 tons.

In an article on "Prospects of British Industry" in the Russian Supplement to "The Times" of Monday last it is stated that Russia is a large buyer from Germany of electrical plant and apparatus. The trade in dynamos, motors, &c., represented a total annual value of £240,000; in metallic filament and other lamps a value of £466,000; in electrical appliances for illumination and transmission of power £272,000—a total to these items alone of nearly £1,000,000 a year. Our trade in the same materials for the year 1913 had a total value of less than £60,000. While the question of price may have been an important factor in determining the destination of Russian orders for electrical plant, it is probable that a considerable proportion of this trade could be secured by British houses.

In another article on the same supplement M. Vladimar Savitzky, secretary of the Russo-British Chamber of Commerce, says the question of German domination in the Russian electrical industry was discussed in detail at a recent conference of representatives of this industry in Petrograd. It was shown that the few existing factories in Russia obtained tungsten and everything indispensable for the manufacture of electric lamps from Germany as ready-made products, and that all the necessary material could be found in abundance in the Empire and merely await utilisation.

Spain. The Ministerio de Fomento has given permission to Don José Alfaro Juárez to utilise, at the maximum rate of 6,300 litres per second, the waters of the Rio Segura, in the district of Yeste, for the production of motive power for industrial purposes.

A consular report states that imports into Spain in 1913 included dynamos, electric motors, &c., up to 400 kilos, valued at 9,500,000 pesetas (about £356,250), compared with 6,100,000 pesetas in 1912; from 401 to 2,500 kilos, 6,900,000 pesetas, against 4,600,000 pesetas; from 2,501 to 5,000 kilos, 2,300,000 pesetas, against 1,100,000 pesetas, and over 5,000 kilos 10,000,000 pesetas, against 5,000,000 pesetas; and incandescent lamp bulbs, with mounting, 5,300,000 pesetas, against 5,800,000 pesetas. Dynamos, electric motors, &c., imported from Germany in 1912 were up to 400 kilos 4,132,000 pesetas, against 3,173,000 pesetas in 1911; and from 401 kilos 7,577,000 pesetas against 5,888,000 pesetas.

MISCELLANEOUS NOTES.

Inquest. An inquest was held on Tuesday on A. J. Lawrence, who was killed by the Metropolitan District Railway (London), on the 6th inst.

Evidence was given that during the heavy storm on the 6th inst. a District Railway train, on which deceased was a gateman, had to be stopped in the tunnel between West Kensington and Earl's Court station on account of the floods, the water being 3 ft. deep. The conductor of the train (EDGAR HURLEY) said he warned Lawrence not to get into the water on account of the electric current. A minute later he heard a splash and a shout from the rear of the train, and found deceased in the water.

ALEXANDER ALLEN, a C.I.D. officer, related how he reached deceased, who was floating head downwards in 3 ft. of water. Artificial respiration was performed for two and a half hours, but without success, and Lawrence never regained consciousness.

Dr. WETTER said death would result from contact with the electrified wheels, and was not due to drowning, and a verdict of accidental death was returned.

Marylebone London.—The Electric Supply Committee report that the Electrical Engineer has obtained leave of absence for the period he has joined H.M. Forces. The total number of employees who have enlisted is 92.

The Committee have made arrangements to carry out certain work for the Government at the generating station.

Suggested New Scandinavian-American Cable.—An Exchange telegram says: According to the "Politiken Tageblatt," a new cable is about to be laid between the Scandinavian States and the United States, which will not, as heretofore, pass via England. The preliminary work has been carried out, and the estimated cost will amount to 30,000,000 marks.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during April, 1915, and (*b*) the aggregate figures from Jan. 1 to April 30, with the increases or decreases compared with the corresponding periods of 1914:

Electrical machinery, (*a*) £148,309 (including generators and motors other than for aeroplanes, motor cars and cycles, £22,480, and electrical machinery unenumerated, £125,823) (decrease £5,764; (*b*) £580,464 (including generators and motors other than for aeroplanes, motor cars and cycles, £87,055, and electrical machinery unenumerated, £502,409) (increase £52,929); telegraph and telephone cables other than submarine, (*a*) £3,802 (decrease £5,478), (*b*) £9,009 (decrease £17,248); telegraph and telephone apparatus, (*a*) £7,264 (decrease £8,422), (*b*) £18,361 (decrease £66,897); other electrical wires and cables, rubber insulated, (*a*) £13,362 (decrease £3,754), (*b*) £58,302 (decrease £29,042); other insulations, (*a*) £4,329 (decrease £2,296), (*b*) £10,365 (decrease £22,270); carbons, (*a*) £14,841 (increase £2,090), (*b*) £35,570 (decrease £23,826); glow lamps, (*a*) £9,175 (decrease £2,775), (*b*) £43,832 (decrease £18,726); arc lamps and electric searchlights, (*a*) £290 (decrease £249), (*b*) £1,153 (decrease £13); parts of arc lamps and searchlights (other than carbons), (*a*) £8,104 (increase £1,001), (*b*) £26,930 (decrease £6,213); primary and secondary batteries, (*a*) £7,858 (increase £726), (*b*) £43,069 (increase £12,429); meters and measuring instruments,* (*a*) £1,933 (*b*) £8,004; switchboards,* (*a*) £9, (*b*) £2,963; electrical goods and apparatus, unenumerated, (*a*) £19,176, (*b*) £54,764. Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £90,143 (decrease £33,515), (*b*) £283,712 (decrease £269,675).

Exports.—The exports of electrical machinery, material, &c., (*a*) during April, 1915, and (*b*) from Jan. 1 to April 30, with the increase or decreases compared with the corresponding periods of 1914, were as follows:

Electrical machinery, (*a*) £143,432 (including railway and tramway motors, £36,930, generators and motors other than for aeroplanes, motor cars and cycles, £51,720, and electrical machinery unenumerated, £54,782) (decrease £60,912), (*b*) £442,352 (including railway and tramway motors, £55,506, generators and motors other than for aeroplanes, motor cars and cycles, £182,056, and electrical machinery unenumerated, £204,790) (decrease £475,087); telegraph and telephone cables, submarine, (*a*) £15,800 (increase £31,585), (*b*) £146,275 (increase £45,310); other than submarine, (*a*) £50,786 (increase £29,504), (*b*) £138,734 (increase £12,198); telegraph and telephone apparatus, (*a*) £27,179 (increase £4,073), (*b*) £69,381 (decrease £29,845); other electrical wires and cables, rubber insulated, (*a*) £24,288 (decrease £6,329), (*b*) £88,978 (decrease £36,108); with other insulation, £29,056 (decrease £19,170), (*b*) £120,665 (decrease £29,208); carbons, (*a*) £217 (decrease £826), (*b*) £1,736 (decrease £1,722); glow lamps, (*a*) £13,928 (increase £3,316), (*b*) £43,850 (decrease £1,187); arc lamps and searchlights, (*a*) £719 (decrease £877), (*b*) £1,342 (decrease £4,040); parts of arc lamps and searchlights (other than carbons), (*a*) £1,647 (decrease £1,377), (*b*) £3,967 (decrease £10,340); primary and secondary batteries, (*a*) £12,944 (decrease £5,283), (*b*) £6,849 (increase £10,050); meters and measuring implements,* (*a*) £8,922, (*b*) £49,530; transformers,* (*a*) £9,574, (*b*) £19,532, switchboards,* (*a*) £2,398, (*b*) £16,180; electrical goods and apparatus unenumerated, (*a*) £41,471 (decrease £36,053), (*b*) £190,711 (decrease £127,138). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £238,899 (decrease £43,713), (*b*) £959,632, (decrease £86,489).

* Not enumerated separately in previous years.

TENDERS INVITED.

Mechanical Stoker.

The Electric Supply Committee of DUBLIN Corporation invite tenders for the installation of an Underfeed Stoker at one of their Babcock boilers at the Pigeon House works. General conditions, specification and form of tender from the city electrical engineer, Mr. Mark Ruddle, Fleet-street, Dublin, and tenders, addressed to the Chairman, Electric Supply Committee, Corkhill, Dublin, by noon Tuesday, May 25. *Secretary appointment.*

Coal Handling Plant, Steam Feed and Water Pipes, &c.

MANCHESTER Electricity Committee want tenders by noon June 2) for coal unloading crane, conveying plant, &c., at their Barton power station.

LEEDS City Council invite tenders for the supply and erection of Steam Feed and Water Pipes, &c., in connection with an extension of works, involving the addition of 18,000 kw. of plant. Conditions, &c., from the manager of the Electricity Dept. (Mr. C. Nelson Hefford) and tenders to town clerk, Sir Robert E. Fox, Town Hall, Leeds, by 10 a.m. May 26.

DARLINGTON Corporation require tenders by May 20 for supply and laying of c.i. Condenser Water Pipes for the electricity department. Specification, &c., from the Borough Electrical Engineer.

Boiler, Rotary Converter or Motor Converter, &c.

LEIGH Corporation require tenders by noon May 21 for supply of Vertical Tube Boiler, 250 k.w. Rotary Converter or Motor Converter and Switch Panel. Specification from Borough Electrical Engineer.

Turbo-Generators.

The NEW SOUTH WALES GOVERNMENT [illegible] AND TRAMWAYS DEPARTMENT require tenders by noon July 21 for supply and erection of a 250 k.v.a. Direct-coupled Turbo-generator. Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Electric Vehicles.

DOYLE Corporation require tenders by [illegible] May 18 for the supply of SIX Electric Vehicles, [illegible] Elevators, &c. Specification can be seen and forms of tender obtained at the office of the Borough Engineer.

Electric Drive for Lift.

MANCHESTER Guardians want tenders by May 19 for the Conversion of a Hydraulic Lift at the Infirmary, Crumpsall, Manchester, into an Electric Lift. Specification can be seen at the office of Mr. A. J. Musgrove, 23, [illegible] Manchester.

Wiring.

FINCHLEY Urban Council require tenders by noon May 31 for wiring 100 workmen's dwellings. Specification, &c., from the Engineer, Church End, Finchley.

Cooling Towers.

SHEFFIELD Electric Supply Committee require tenders by 10 a.m. May 28 for the Supply and Erection of Two Natural Draught Cooling Towers, with all Fittings, Pumps, Pipework, &c. Specification, &c., from the General Manager and Engineer, Mr. S. E. Felden.

Electrical and General Stores, Coal, &c.

GRANGEMOUTH Corporation want tenders for annual supplies, including Electric Lamps, Oils, &c. Schedules from the Burgh Engineer.

MANCHESTER Electricity Committee require tenders by 10 a.m. May 26 for 12 months' supply of Stores, including Cables, Asbestos and Rubber Goods, Acids, Dynamo and Carbon Brushes, Electrical Accessories, Lamps, Wire, Insulators, Pitch, Transformers, &c. Forms of tender from Mr. F. E. Hughes, Town Hall, Manchester.

DERBY Corporation want tenders by May 20 for one, two or three years' supply of Coal for the electricity works and main drainage pumping station (about 40,000 tons per annum). Specification from the Town Clerk.

Excavations and Concrete Work.

SHEFFIELD Electric Supply Committee want tenders by 10 a.m. May 28 for Excavations and Concrete Work (contract No. 139). Specification, &c., from the Engineer and General Manager.

Railway Carriage Lighting, Track Transformers, Signals, &c.

The time for the receipt of tenders by the VICTORIAN RAILWAY COMMISSIONERS for the supply of Material for Railway Car Lighting and Electric Lighting Material for Car Repair Shops is extended to June 2. Specifications from the Commissioners' Offices, Spencer-street, Melbourne.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 2 for 300 Driver Trap Stop-rod [illegible] such further [illegible] be required during five years, and for Rotor Dummy Wheels and Axles for 10 Electric Street Railway Cars. Specifications from Railway Offices, Spencer-street, Melbourne.

SYDNEY & SUBURBAN [illegible] noon next July 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

Motors.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 30 for supply of Four Electric Motors, varying from 7 B.H.P. to $\frac{1}{2}$ H.P. (Contract 28,771). Particulars from the Commissioners' Offices, Spencer street, Melbourne.

Commutator-Grinding Lathe, Motor Generator, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 30 for 13 in. Centre Lathe for turning or grinding commutator (contract 28,757), and 9 kw. Motor Generator and Accessories (contract 28,760). Specifications, &c., from the Commissioners' Offices, Spencer-street, Melbourne.

Cables, Transformers, Switchgear, Induction Motors, &c.

Tenders are invited for the supply of Four 250 k.v.a. Three-phase Transformers and for the supply of 9,680 yds. of 0·05 sq. in. Three-core Lead-covered Cable to the CITY OF MELBOURNE. Tender forms from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co., Pptv. (Ltd.), Billiter-square-buildings, E.C., to whom tenders by 11 a.m., May 18.

LAUNCESTON (Tasmania) Council want tenders by 4 p.m., July 26, for converter, switchgear, underground feeder cable, &c. Specifications, &c., from the City Electrical Engineer.

WIGAN Electricity Committee invite tenders (by May 29) for h.t. three-core Paper and Lead-covered Armoured Feeder Cable, Transformer and Switchgear.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. at British port of 2,600 yds. Three-core c.h.t. Armoured Cable and 79 Three-phase Induction Motors in various sizes between 5 B.H.P. and 80 B.H.P., complete with slide rails and foundation bolts. Specifications, &c., from Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, Westminster, S.W., to whom tenders by noon May 20.

Tram Rails, &c.

PORTSMOUTH Tramways Committee invite tenders for 100 tons Steel Girder Tram Rails, 6 tons Fishplates and 3 tons w.i. Tie-bars. Tenders to Town Clerk by June 1.

Telegraph and Telephone Instruments and Material, &c.

The Deputy Postmaster-General, Sydney (N.S.W.), will receive tenders until 2:30 p.m. June 16 for the supply of 400 pony pattern Morse Sounders to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specification, &c., from the Deputy Postmaster-General.

The Commonwealth of Australia Postmaster-General's Dept. give notice that the date for the receipt of tenders for a Telephone Switchboard for Warwick (QUEENSLAND) has been further extended from June 1.

Circuit-Breakers.

JOHANNESBURG Municipal Council require tenders by noon June 1 for the supply of 24 Double-pole Automatic Oil-immersed Circuit-Breakers of 200 amperes capacity. Specifications from the Controller of Stores, Pleinsquare, Johannesburg.

Hydro-Electric Plant.

The MINISTERIO DE FOMENTO, MADRID, will receive tenders until 1 p.m. May 18 for supply of Plant and Material for a hydro-electric station in connection with the Principe Alfonso drainage works. Conditions of tender may be seen at the Ministerio de Fomento, Madrid.

Submarine Cable.

The SPANISH POSTS AND TELEGRAPHS DEPARTMENT want tenders by June 22 for the laying of a submarine cable from Cadiz to Laraiche and for the repair of certain cables. The "Madrid Gazette" of April 23, containing the conditions of tender, &c., can be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

LONDON COUNTY COUNCIL.—The Highways Committee have received the following tenders from electrical firms for the supply of cables in connection with the extension of the Woolwich tramways, also for the hire of a temporary supply of power proposed to be obtained from the Council's generating station:—

Western Electric Co. (London), £22,971 10s.; Callender's Cable & Construction Co., £23,061 1s. 6d.; Johnson & Phillips, £23,927 17s. 8d.; W. T. Glover & Co., £24,101 18s. 8d.; W. T. Henley's Telegraph Works Co., £24,989. 15s.; Siemens Bros. & Co., £24,994. 2s.; British Insulated & Helsby Cables, £26,035. 16s.

Estimate of Chief Officer of Tramways £21,262. Since the date of that estimate, March 2, 1915, the price of copper has materially advanced.

The tender of Tyler & Freeman (at £271) has also been accepted for the installation of domestic telephones, &c., at Maudsley Hospital.

SOUTHWARK (LONDON).—The following tenders for annual supplies are recommended for acceptance:—

For cable: Siemens Bros. & Co., copper bar, $2\frac{1}{4}$ in. by $\frac{1}{4}$ in., £34. 10s. per 110 yds. and £1,193 per mile; 0·5 by 0·2 by 0·5 L.T.C., £1,663 per mile; 0·3 by 0·125 by 0·3 ditto, £1,058 per mile; 0·2 by 0·075 by 0·2 ditto, £743 per mile; 0·1 by 0·05 by 0·1 ditto, £466 per mile; 0·05 by 0·025 by 0·05 ditto, £285; 0·023 by 0·023 concentric, £130. 10s.

For meters: Reason Mfg. Co. (five items), Electrical Apparatus Co. (five items), General Electric Co. (12 items), Chamberlain & Hookham (three items), Landis & Gyr (three items).

Eleven tenders were received for the cable and the same number for the meters. The tender of the British Insulated & Helsby Cables is also recommended for acceptance to supply a feeder pillar for £50.

DUBLIN.—The Electricity Supply Committee recently reported on the tenders received for the supply of carbons.

The Committee purchased 20,000 pairs of carbons for the old type of the city arc lamps from the London Commercial Electrical Stores, and subsequently, in order to keep up the lighting of the city, they purchased from the same company the following supplies of various lengths of carbons: 3,000 pairs at £10 per 1,000, 4,000 pairs at £15. 10s., and 2,000 pairs at £12. 18s. 4d. per 1,000. The Committee were anxious to effect an arrangement for a full supply of the carbons for the year ending March 31, 1916, and they invited tenders. Some of the tenders were incomplete, and could not be considered, and the Committee regretted to find that in no case could a proper guarantee of delivery be made. Under these circumstances the Committee think that the best arrangement which the Corporation can effect is to make substantial purchases in the open market. The best tender offered for carbons for the open-type arc lamps was that of Messrs. W. Geipel & Co. (at £12. 12s. per 1,000 pairs), but without any proper guarantee of delivery. An offer was received of immediate delivery from the firm of 40,000 pairs at £12 per 1,000, and the Committee decided to make that purchase. For the flame arc lamps carbons the lowest tenders were those of C. W. Webster, and the Committee purchased 20,000 pairs of 15 in. carbons at £8. 10s. 1d. per 1,000 pairs, 15,000 pairs of 12 in. at £6. 16s. 1d. per 1,000 pairs, and 20,000 of $25\frac{5}{8}$ in. at £2. 18s. 9d. per 1,000 ft., all the carbons for the different types of lamps to be of the standard dimensions required. These supplies will suffice until the end of October next.

BASINGSTOKE.—The Corporation have accepted the tender of Cole, Marchent & Morley for a Diesel engine, at £1,798.

Belliss & Morcom tendered at £1,987; Willans & Robinson at £1,803; Mirrlees, Bickerton & Day at £1,810; Hick Diesel Co. at £2,210 (too late). For the dynamo the tender of the Phœnix Dynamo Co. at £350 was accepted.

For partial transformation set and switchgear (110 kw.) the tender of Bruce Peebles & Co. at £431 was accepted. The British Thomson-Houston Co., £464 and £496; Siemens Bros. Dynamo Works, £403; General Electric Co., motor generator, £543 and reducer set, £377; Crompton & Co., £620; Rees Roturbo Co., £479; Brush Electrical Engineering Co. £512 and £467; Electric Construction Co., £464; Mather & Platt, £490 and £528; British Westinghouse Co., £566.

HALIFAX.—The Tramways Committee have accepted the tender of the General Electric Co. for the supply of three rotary converters, transformers and switchgear required in connection with conversion of the Hipperholme and Hebden Bridge sub-stations plant to three phase 50-cycle a.c. supply, at £2,563.

WINCHESTER.—The Corporation have accepted the tender of C. A. Parsons & Co. for a 500 kw. turbo-generating set, at £3,991.

DUNDEE.—The Corporation have accepted the tender of W. H. Allen, Sons & Co. for the erection of the pipe line for the new pumping station at Carolina Port.

LEITH.—Siemens Bros. Dynamo Works have received an acceptance of their tender for the supply of carbon filament lamps from the Corporation tramways department for the ensuing 12 months.

HENDON.—The tender of the Hendon Electric Supply Co. (£197 12s. 6d.) has been accepted by the Education Committee for wiring the Wessex Gardens school.

Four tenders were received. A similar number of tenders were also received for wiring Bell-lane School, but consideration of these tenders has been deferred.

WEST HAM.—The Electric Lighting Committee recommends the acceptance of the tender of the British Thomson-Houston Co. for the supply of 100 motors required in connection with the alterations to the equipment of the tramways, together with the necessary gear, for £103. 10s. each.

TUNBRIDGE WELLS.—The Council have accepted the tender of Babcock & Wilcox for providing two steel erections and drums for two boilers for £1,010, and supplying tubes for £279. A contract has also

been entered into with Watkins & Pattrick for installing existing and rebuilding new cooling towers at £1,085.

PADDINGTON.—The Guardians are recommended to accept the tender of S. Hammond & Co. at £360 for repairing telephone instruments, &c., and keeping same in repair for 12 months.

DARLINGTON.—The Corporation have accepted the tender of E. Green & Son for the supply and erection of an economiser, and that of Herbert Morris (Ltd.) for a travelling crane.

BATTERSEA (LONDON).—The Council are recommended to accept the tenders of Chamberlain & Hookham and Electric Limited for 12 months' supply of meters.

ROCHDALE.—The tender of Siemens Bros. Dynamo Works has been accepted for the supply of Westinghouse motors, switchgear, &c., to the Rochdale Corporation Electricity Department for twelve months.

BRADFORD.—The tenders of Hadfield Limited at £5,750 and Edgar Allen & Co. at £4,114 have been accepted by the Tramways Committee for the supply of points and crossings.

The Electricity Committee has accepted the tender of the Birch Electrical Engineering Co. (Ltd.) for two 600 k.v.a. three-phase transformers at £222 each.

PRESTON.—The Electrical Apparatus Co. have received from the National Electric Supply Co. a renewal of the present contract for the sole supply of motor starters for the period of 12 months.

ALDERSHOT.—The Council have accepted the tender of C. A. Parsons & Co. for a turbo generator at £3,858, and that of Babcock & Wilcox for a boiler, at £1,118.

STRETFORD.—The tender of the General Electric Co. has been accepted by the Council at £670. 1s. for the supply of cable.

HOLMFIRTH.—The Council have accepted the tender of Robt. Turner for the erection of electricity station buildings.

ILFORD.—Ilford Urban Council have accepted the tender of the Edison Accumulators (Ltd.) for the supply of a 4-ton electric coal waggon.

HONG KONG.—The Hong Kong Electric Co. have placed the following contracts for their new power station :—

United States Steel Products Co., steel structural work, &c.; Babcock & Wilcox, boiler plant and coal handling plant; Burch Thomson Houston Co., turbo-alternators and switchboard.

The contracting engineers are Messrs. Preece, Cardew & Snell & Rider.

Condensing Plant Contracts.—The Mirrlees Watson Co. have recently received orders for condensing plant from the following :—

Tsingtao Corporation (three sets); St. Lydia Coal Mining Co. (two sets); Munroe & Adam Hemerde Co. (per Turner & Chalmers, fifth set); Cie Francaise Thomson-Houston (for Tuilière Power station, fourth set, also for Velaux power station, third set); and Thames Sulphur & Copper Co. (three sets). Orders for plant for Bamako (French Senegal, Russia, Japan, Straits Settlements and West Indies have been booked.

Meter and Time Switch Contracts. Messrs. Chamberlain & Hookham have received contracts for annual supplies of meters from Colwyn Bay Urban Council and Edinburgh Corporation.

Venner Time Switches (Ltd.) have also received a further repeat order from Cardiff for 99 time switches.

Furnace Contracts.—The Monometer Mfg. Co., of Birmingham, have received orders from the India Rubber, Gutta Percha & Telegraph Works Co. for tin and hardening furnaces; from the British Insulated & Helsby Cables (Ltd.) for cable furnace; Messrs. Parsons for Admiralty bearing metals; Nestlés and Anglo-Swiss Condensed Milk Co., solder melting furnaces; Coventry Premier (Ltd.) and Acton Metal Co. for aluminium furnaces; and many others.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Accrington. The accounts of the electricity department for the year ended March 31 show capital expenditure £160,405 (increase £29,795), of which £105,467 is loan charges.

Revenue was £28,802 compared with £27,678 in previous year, and working expenses were £21,613 (£17,978), leaving gross profit £7,189 (£9,699). Interest required £3,758 (£3,107), depreciation £6,146 (£5,588), and income tax, &c., £358 (£271), the net result being £3,073 (compared with a surplus of £677). Average price received for all purposes was 0·966d. (1·022d.) per unit, and working expenses were 0·818d (0·737d.). Units generated were 7,242,252 (7,503,748), and sold, 6,342,564 (5,856,030). Total maximum supply demanded was 2,307 kw. (against 2,876 kw.).

Bradford.—On Tuesday the annual financial statement was made by Mr. Jas. Hill, chairman of the Finance and General Purposes Committee.

Mr. Hill said that the approximate profit on the year's working of the supply department was £12,000, from which it was proposed to write off upon plant about £7,000. The balance of £5,000 made up the available total £22,500, and from that he proposed to apply £5,000 as compared with £5,000 in 1914, in aid of rates. The gross profit was £2,500 less than in 1913-14, but in view of the increased price of coal and abnormal costs in various directions, he considered the result satisfactory. There was a slight increase in the income, which rose from £141,000 to £146,000. Upon capital account £16,000 had been spent during the year, making the total £940,000, but of that sum £400,000 had been repaid, leaving the present net debt £500,000.

The profit on the tramways was £27,500 compared with £40,000 last year. £2,000 had been expended upon renewals and £22,500 had been written off. The total expenditure was £78,000, from which it was proposed to apply £5,000 in relief of rates, leaving £5,000 to carry forward. The receipts were £10,000 less than that of the previous year by £10,000, but the increased mileage run, the increase of wages, together with the allowance to employees who had joined the forces, had involved increased expenses of £8,000, whilst the cost of power to meet the extra mileage had involved £2,000. Interest on loans and sinking fund charges accounted for £4,000, and £2,000 in respect of the new tracks. To-day's total £40,000 represented expenditure. There had been expended upon capital account during the year £24,000. £32,000 had been written off the capital account, leaving a present debt of £610,000, which was £30,000 less than last year, although during the year £24,000 had been added to the capital account, and £22,500 out of reserve upon renewals.

Coventry. The accounts of the electricity department for the year ended March 31 show total capital expenditure £[illegible] to £17,036, less £23,330 written off for obsolescence and superseded plant, and £17,063 has been repaid.

Revenue was £77,913 (compared with £71,208 in previous year), working and general expenses were £33,142 (against £28,375), leaving gross profit £44,771 (£42,832). After taking into account £21,943 (compared with £16,294 in previous year) brought forward from previous account, and after providing for interest, stock redemption fund, sinking fund, property tax, reserve fund £15,250 (against £11,600 in previous year), and contribution in aid of rates (£6,000 against £4,500), &c., the surplus was £23,148 (against £21,943 in previous year), of which £22,830 is net profit for the year. Units generated were 22,899,550 (against 18,842,280), and sold 20,249,018 (16,508,338). The total maximum supply demanded was 10,584 kw. (9,240 kw.),

Nottingham.—The accounts of the electricity department for the year ended March 31 show a net surplus of £13,402 after providing for capital charges.

Revenue was £97,940, and gross profit £42,018. Interest required £11,464, sinking fund £2,833, and instalment of loans £14,087, and of the balance £3,902 has been placed to reserve, and £9,500 devoted to relief of rates. Units sold were 12,860,348 (increase 228,508). The capacity of the plant at the three generating stations is 14,000 kw. The length of distributing mains is 67 miles. Applications received for supplies of current were 166, making a total of 4,861. The number of (equivalent) 32-watt lamps connected was 492,555 (increase 24,138). Additional motors connected were 140 in number and aggregated 695 h.p., making a total of 1,769 motors and 6,937 h.p.

The revenue of the tramways department was £179,315 (increase £3,935) and working expenses were £112,583 (against £108,273), leaving gross profit £66,731 (against £66,767). Interest required £13,852, and redemption of loans £32,732, and of the remainder £6,164 has been placed to reserve and renewal fund, and £2,400 contributed in aid of rates. Passengers carried were 41,210,964 (increase 673,090), car-miles run [illegible] (increase 216,188), and [illegible] (decrease 0·24), and working expenses to 7·13d. (decrease 0·32d.).

West Hartlepool.—The accounts of the electricity supply department for the year ended March 31 show total capital expenditure £143,133 (increase £7,616), and £42,076 of the debt has been extinguished.

Revenue was £17,654 compared with £16,191 in previous year, working [illegible] were £7,852 against £7,005, leaving gross profit £9,802 against £9,186. [illegible] £4,000, and £1,000 has been placed to reserve, leaving £4,802 available for the reduction of the debt. Units generated were 2,[illegible] sold 1,[illegible] Average price received for current [illegible] was 1·[illegible] per unit. The total capital expenditure on the supply [illegible] £[illegible] and £[illegible] has been repaid. [illegible] £[illegible] in consideration of energy supplied free of charge.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.)

The 54th ordinary general meeting of this company was held on May 12 at Electra House, E.C., Sir JOHN WOLFE BARRY presiding.

The SECRETARY (Mr. A. B. Hardie) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: I propose on this occasion to review the situation generally. The accounts show that the gross revenue for the year ended December 31, 1914, was, in round numbers, £1,645,000, which is about £183,000 in excess of the previous year. On the other hand, however, the total expenses during the same period have been correspondingly heavy. From one cause and another they exceed those for 1913 by about £107,000. There is also an increase of about £3,500 in the interest on 4 per cent. mortgage debenture stock, due to the issue of £103,294 of this stock in November, 1913, to meet some additional capital expenditure. The result of the year's working, therefore, is that after providing for the usual dividends on our various stocks, and the same bonus as formerly—viz., £2 per cent. for the year on the Ordinary stock—we are able to carry to the General Reserve Fund £390,000, which is the same amount as we carried to that fund in 1912. This fund has been charged during the year under review with about £274,000 in respect of new cables and other special expenditure, so that the net addition to the fund for the year is about £116,000. There still remains to be charged £200,000, being the balance of cost of the Aden–Colombo cable. This will be dealt with during the current year. There is one other item in the accounts to which I should like to refer. You will no doubt have noticed that the amount set aside as a provision on account of investment fluctuations, which is shown at £325,000, has not been altered this year. When I last had the pleasure of addressing you I pointed out that the operation of varying some of our investments had resulted in an actual realised loss on securities sold of about £66,000, which had been charged against the General Reserve Fund. Although after having done this, the approximate depreciation was still slightly in excess of the provision made, there had subsequently been an improvement in the total value of the securities, and we did not think it necessary to increase the provision of £325,000. As the Stock Exchange was closed on the date to which the present accounts are made up, the usual method of valuation could not be adopted, and we feel that even now it is difficult to arrive at anything like an accurate appraisement. We have therefore decided to hold the matter over until the end of the current year, when it is hoped that we may be able to arrive at something more definite; and if the depreciation of the securities seems to require that course, we shall then consider the desirability of increasing the provision now made. The renewals of some of the older sections in the Red Sea, and the new cable from Aden to Colombo, have materially assisted us in maintaining a satisfactory service to India and the Far East during the exceptional times of pressure which we have experienced, and which still exist; more especially as the alternative route to India by the Indo-European Company's system has been continuously interrupted since July 31 last, and the Government Pacific Cable to New Zealand and Australia was also interrupted from Sept. 8 to Nov. 5. If further proof were required of the importance of maintaining a substantial reserve fund, it could be found in the example now before us, which shows that we have been able to carry out this important work at a cost of about one million pounds, the whole of which will have been met by appropriations from our reserve fund. This policy, which the directors have so consistently followed throughout, enables them to meet any exceptional and unforeseen demands which may arise, more particularly at a time such as the present, when so much pressure of work has been so suddenly placed upon us. This great war has been so far-reaching, that practically every part of our vast and widespread Empire has been seriously affected, and the necessity for rapid trustworthy means of communication between the Mother Country and the Overseas Dominions has been more than ever realised. Our aim has been not only to improve the speed of our service, but to render it as secure as possible against total interruption. With only a single cable this might occur at any time, either from natural causes or, in the event of war, from the malicious acts of enemies. In order, therefore, to provide an efficient permanent service, we have taken, for years past, the precaution of connecting the most important points of our system by several cables laid along widely different routes. I know that our work is appreciated by the Government, and we are glad to feel that we are able to render a useful service to the country. Although certain restrictions have necessarily been imposed by the Government in the regulations affecting commercial, press and social telegrams, it must be a satisfaction to all concerned that we have been able to maintain a constant service throughout our system.

Under the landing licenses, which control the relations between the Governments and the companies, all Governments have the power of taking possession of the companies' offices and controlling the traffic. On Sunday, August 2nd last, the British Government exercised this power. The following day the transmission of code messages was suspended and the public was only permitted to send messages in plain French or plain English at full rates. The altered conditions of working necessitated by the special regulations enforced by the authorities, naturally created, at first, considerable delay in the transmission of commercial traffic. In order to meet the demands of the Government, and at the same time provide as good a service for important commercial correspondence as was possible under the circumstances, we considered it imperative in the interests of all concerned, to suspend the transmission of "deferred" and "week-end" telegrams. Whenever we see an opportunity of granting additional facilities to the public, we endeavour to do so. For some years past the Associated Companies have been desirous of charging plain language telegrams exchanged with extra-European countries in the same manner as code telegrams, viz., by grouping the letters so that 10 letters are only charged as one word. A proposal to give effect to this idea was submitted by us to the International Telegraph Conference at Lisbon in 1908; but our suggestion was not adopted. In order to relieve the public from having to pay full rates for messages which had—according to the special regulations issued by the Government last year—to be expressed in plain language, we thought that the system of counting 10 letters to the word might be acceptable to our customers, it being equivalent to about half rates, or equal to the charge for "deferred" telegrams. After negotiations, this method of counting was introduced on Sept. 23rd last. Some of the Colonial Governments, however, found objections to this arrangement, and after it had been in operation for a few weeks it was withdrawn, and, as an alternative, codes were again allowed with certain limitations. Meanwhile, on October 1st this Company re-introduced "deferred" messages, and, although we have not been able at present to re-introduce "week-end" telegrams, those interested in this service may rest assured that, subject to the prior claims of Government and ordinary commercial telegrams, "week-end" telegrams will again be accepted for transmission as soon as it is considered expedient to do so. The companies have also arranged for the free transmission over their lines of messages sent by Government departments relating to the wounded, and have also notified their acceptance at quarter rates of any messages between soldiers, sailors or nurses of the Expeditionary Forces and their relatives in almost any part of the world.

There is another matter arising out of the war which I should mention to you. By an agreement dated May 28, 1878, certain arrangements were made between this Company and the Indo-European Telegraph Department of the Indian Government and the Indo-European Company, for maintenance of alternative routes, pooling traffics and dividing receipts in agreed percentages, with the usual provision that in case of interruption of either route for a specified time, the interrupted company should cease to participate in the receipts. The advantages of the agreement were fully explained by my predecessor in the chair to a general meeting held on July 11, 1878, when the agreement was unanimously approved and full powers were given to the Board to carry it into effect, or modify details. Part of the Indo-European route passes through enemy territory, and, as I have already stated, that service to India is completely interrupted; but the maintenance, or rather re-establishment of an allied route is as much to our interest now as it was in 1878. Your Directors have, therefore, decided to extend the dates and continue the payments mentioned in the agreement, so as to give the Indo-European group a reasonable opportunity of establishing an efficient alternative route after the war, and this arrangement will be, I am sure, satisfactory to you.

Before I conclude, I wish to record our appreciation of the patriotic devotion and the high sense of duty shown by our staff on shore and on board our cable repairing ships during a time of such great anxiety to us all. The good results to which I have referred could not have been achieved without their whole-hearted co-operation under trying and sometimes risky conditions. The ships' staff have done valuable work in maintaining communication, and the shore staff have dealt with the traffic as expeditiously as possible under the conditions of censorship imposed by the Government. They have been working long hours during weekdays, Sundays and holidays, and all, both on board ship and on shore, have cheerfully given up their periodical furloughs in order to meet the demands of their country. (Cheers). In this, I include not only our staff abroad, ashore and afloat, but also in a marked degree the head office staff and our employees at our stations in Great Britain. In association with this subject I would especially refer to the great services rendered by our managing director, Sir John Denison-Pender, who has not spared himself in working day and night in the service of the company and of the country. It being impossible speedily to replace our highly trained and technical staff, the authorities do not desire them to enlist; and although many of them would have liked to take a more active part in the war, they have—with some few exceptions—accepted the ruling of the Army Council, who have expressed the view that, having regard to their special qualifications, they are serving their country better by remaining at their post than by joining the fighting forces. A large percentage of the administrative staff at head office have, however, joined the forces, and although their work is more or less of a special character, we have given every facility to the eligible men to join the active services, and have agreed to reinstate them when they return, granting them full pay. The temporary vacancies thus created have, to a large extent, been filled; by the employment of experienced female clerks who had lost their permanent situations owing to the war. You will be glad to hear that, at the cost of our stations', ships', and head office staff, a very efficient repairing ambulance car has been equipped and placed at the disposal of the Red Cross Organisation for the service of the British Forces, and that our staff have made, and are making, regular and handsome contributions to the Prince of Wales' Fund from our stations in all parts of the world. I conclude by moving the adoption of the report and accounts, the payment of the preference dividend of 3½ per cent., less tax, a dividend of 1½ per cent. and bonus of 2 per cent., both tax free, on the ordinary stock, making with previous payment a total distribution of 7 per cent. for the year.

The VICE-CHAIRMAN AND MANAGING DIRECTOR (Sir John Denison-Pender) seconded the resolution, and, referred to the remarks of the chairman in regard to the pressure of work due to the war. He said that Sir John Wolfe Barry was aware of the very close and friendly relations which existed between the managing director, the heads of departments and the officers and staff of the company. He thanked the chairman for the kind references made in regard to himself. It would, however, be impossible for him to carry on the work successfully without that whole-hearted assistance of the staff, which he had always received from the highest to the lowest. (Cheers.)

The motion was then carried unanimously.

The retiring directors (Sir John Wolfe Barry and Sir Albert J. Leppoc Cappel) were then re-elected, as were the retiring auditors.

A cordial vote of thanks to the chairman and directors followed, and the CHAIRMAN, in replying on behalf of himself and colleagues, expressed the pleasure the board felt at receiving a vote of thanks at a time like the present, and he assumed that the vote would apply also to their valuable staff for all the services they had rendered.

The proceedings then terminated.

Eastern Extension, Australasia & China Telegraph Co. (Ltd.)

The 81st ordinary general meeting of this company took place at Electra House, E.C., on Tuesday, May 11, Sir JOHN WOLFE BARRY presiding.

The MANAGER AND SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: The gross receipts for the past year amounted in round numbers to £819,000, against £738,000 for 1913, an increase of £81,000. This satisfactory result is partly due to our having had to transmit the whole of the Australasian traffic for nearly two months, when the Government Pacific Cable system was interrupted by the attack made upon the Fanning Station by the German cruiser "Nurnberg," on Sept. 7 last. Working and other expenses amounted in round numbers to £379,000, against £365,000 for 1913, an increase of £14,000. This increase is accounted for by the additional staff required in connection with the working of our new cables between Colombo, Penang, Singapore and Hong Kong; the revision of the staff scales of salaries and allowances brought into force at the beginning of last year; the growth of traffic, and the payment of higher income tax. The net profit for the past year was roundly £411,000, and after adding £30,000 brought forward from the previous year, there remained an available balance of a little over £441,000. The usual quarterly interim dividends of 2s. 6d. per share each have already been paid for the past year, and it is now proposed to distribute a like amount to-morrow, making a total dividend of 5 per cent. for 1914; it is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution to the shareholders, free of income tax, of 7 per cent. for the past year, and to carry forward £31,000, against £30,000 for 1913. After making the usual additions to the maintenance, ships' insurance and depreciation funds, £200,000 has been transferred from revenue balance to the general reserve fund. On the other hand, the fund has been debited during the past year with £273,000 (for the balance of cost of the Penang-Singapore-Hong Kong cables, £194,000; for partial cable renewals, £35,000; for loss incurred on the sale of investments during the year, £44,000). These operations thus deplete the general reserve fund by £73,000, and leave it at the end of the year at £656,000.

When I last had the pleasure of addressing you I indicated that the loss created by the sale of investments during the past year would be deducted from the provision shown in the balance-sheet of £200,000 for investment fluctuations; but, seeing that the war has very materially affected the value of all classes of investments, the Directors have considered it a wiser policy to charge the whole loss against the general reserve fund, and leave the £200,000 intact. Our reserve fund investments have been carefully re-valued on the basis of the official prices quoted at the end of last year and on March 31 last, from which it is found that the provision already made is sufficient to cover the existing depreciation. With regard generally to the changed conditions brought about by the war, our chief duty and endeavour has naturally been to efficiently maintain telegraphic communication, and although we have had a good deal repairing work to carry out from time to time, we have so far been fortunate enough to be able to carry on the traffic without a single interruption of any importance. This, of course, is mainly due to the Associated Companies having so many different cable routes to the chief centres of commerce, and possessing a large fleet of cable steamers and other repairing facilities. You will not, however, be surprised to learn that considerable dislocation in the traffic arrangements has been caused by the war, especially in the early days before the altered conditions were fully established and provided for; but the Directors have done everything in their power to meet the requirements and convenience of the public, whilst at the same time fulfilling their duties to the State, who are entitled in time of war to have the right to take possession of the Company's cables and control the traffic. This right was exercised by the British Government on Sunday, August 2 last, and on the following day the transmission of all public code and cipher telegrams was suspended, and the public were only allowed to send their telegrams in plain French or English language at full rates. Seeing that Government telegrams are entitled to precedence over all the Companies' cables, and keeping open the line of communication for the transmission of this class of traffic is a matter of the first importance, it was decided to suspend the transmission of deferred and week-end telegrams to enable us to provide such a commercial service as was possible under the altered conditions. Naturally, considerable delay resulted in the transmission of public telegrams, and the telegraphing public complained of the inconvenience, and also of the additional expense which they were consequently incurring. For some years past the Associated Companies have been in favour of charging for plain language telegrams exchanged with extra-European countries by grouping the letters so as to count 10 to each word, and although at one time they hoped to be able to carry this innovation, at the last Telegraphic Conference (at Lisbon) the proposal was not officially sanctioned. With a view, however, to assist in meeting the war requirements, it was thought that an arrangement of this kind might be introduced, and thus relieve the public from having to pay full rates for plain-language messages, and, after entering upon negotiations on the subject, the 10-letter system of counting was introduced on Sept. 23. Some of the Colonial Governments, however, found objections to the arrangement, and, after the system had been in operation for a few weeks, and was giving satisfaction to the telegraphing public, it was withdrawn, while, as an alternative, coding was again allowed to be introduced with certain limitations. On Oct. 1 the Eastern and Eastern Extension Companies found themselves in the position of being able to resume the transmission of deferred messages. The financial result to the telegraphing public of the 10-letter counting while it lasted was that they were charged about one-half the ordinary rates, or about the same as for deferred telegrams, and the Associated Companies have done everything in their power to quicken the transmission of the deferred telegrams in order that the public might have as good and trustworthy service on these favourable terms. The Companies are unable as yet to resume the acceptance of week-end telegrams owing to the necessity of keeping the lines free to meet eventualities, but the telegraphing public may rest assured that, as soon as it is possible, with due regard to the prompt transmission of Government and ordinary commercial telegrams, week-end telegrams will again be accepted for transmission over the Eastern cables.

Having regard to the heavy traffic which we have at times to transmit, it is very fortunate that the new cables laid by the Eastern and Eastern Extension Companies between Suez and Hong Kong, via Colombo, were completed and opened for traffic before the outbreak of war. The shareholders will be interested to learn that we arranged some time ago for the *free* transmission over our lines of messages sent by Government Departments relating to the killed and wounded amongst the British Empire Forces, and also for the acceptance at *quarter rates* of telegrams exchanged between soldiers, sailors or nurses of the Expeditionary Forces and their relatives in different parts of the world.

As you are aware, the Company's Cocos Station suffered considerable damage from the attack made upon it on Nov. 9 last by the notorious German cruiser "Emden." Knowing that hostile vessels were actively at work in the Far Eastern waters, we had taken the precaution soon after the outbreak of war to prepare the staff for all contingencies. Consequently, when the "Emden" suddenly appeared off the islands in the early morning of Nov. 9 the staff were on the alert, and before the landing party could reach the station, they had communicated by cable with the Naval authorities as arranged, and also sent out wireless signals, in the hope that they would be picked up by one of the British warships believed to be in the neighbourhood. Fortunately, the Australasian contingent with its convoys was passing not far off the station at the time, and picking up the signals the naval officer in charge at once despatched the Australian cruiser "Sydney" with all speed to engage the enemy. The result was that the "Emden" was attacked before the landing force was able to finish its work of destruction. You will be gratified to learn that the staff's action on this occasion was much appreciated by His Majesty's Government. The Admiralty presented handsome gold watches, suitably inscribed, to the superintendent, who was responsible for sending out the wireless signals, and to the Company's doctor, who helped to succour the "Emden's" wounded. Letters of thanks and appreciation were also received from the Colonial Office and from the Committee of Lloyd's. The Directors lost no time in conveying to the staff at Cocos the Board's appreciation of their services, together with these marks of approval of the Admiralty, Colonial Office and Lloyd's Committee. The shareholders will be pleased to learn that although the landing party entirely destroyed the instrument room, with its working apparatus, by axes [one of these was exhibited in the meeting room] the Cocos station was able, thanks to the arrangements previously organised and the efficiency and energy of the staff under their trying ordeal, to resume working within 24 hours of the "Emden's" raid. This raid might easily have been attended with serious loss of life, but I am thankful to be able to say that no personal injury was inflicted on the Cocos staff.

Unhappily, a very different state of things resulted from the deplorable mutiny that broke out at Singapore in February last, when, among the many killed and wounded, three valued members of our staff, together with the wife of one of them, were murdered, and two others injured by wounds. The latter have made good progress towards recovery from their wounds, and are expected to be soon convalescent. The directors have expressed their sympathy and appreciation of the services of the Singapore staff, and I am sure that they will be endorsed by the meeting. (Cheers.)

Before concluding, I would like to record our appreciation of the patriotic devotion and the high sense of duty shown by our staff on shore and afloat in all parts of our system and also at our head office during a time of such great anxiety to us all. The good results to which I have referred could not have been achieved without their whole-hearted co-operation. The ships' staff have done valuable work in maintaining communication, sometimes under trying and risky conditions, and the shore staff have dealt with the traffic as expeditiously as possible under the conditions of censorship imposed by the Government. They have been working long hours on week-days, Sundays and holidays, and all, both on board ship

and on shore, have cheerfully given up their personal furlough in order to meet the demands of the country. In connection with this subject I should not be doing justice to one who has worked perhaps the hardest of us all if I did not say how much this Company and the other companies are indebted to the unrivalled exertions of Sir John Denison-Pender, whose who has been at work early and late at the office directing, controlling and advising not only our staff but the Government officials who wished to consult him.

It being impossible to speedily replace our highly trained and technical staff, the authorities do not desire them to enlist, and, although many of them would have liked to take some active part in the war, they have, with some few exceptions, accepted the ruling of the Army Council, who expressed the view that, having regard to their special qualifications, they are better serving their country by remaining at their posts than by joining the fighting forces. As many, however, as could be safely spared were allowed to enlist, and their places are not only being kept open for them, but they are, at present, being granted full pay. (Cheers.) It will further interest you to know that two of your directors, the Hon. George Perkins and the Hon. Arthur Brodrick, have been serving with His Majesty's Forces since the outbreak of war. I now move the adoption of the report and accounts and the declaration of the dividend and bonus, free of income tax, set out therein.

The VICE-CHAIRMAN (Sir John Denison-Pender), in seconding the motion (which was carried unanimously), thanked Sir John Wolfe Barry for the kind remarks he had made concerning his (the Vice-Chairman's) services, and the shareholders for the cordial way they had received those remarks. He had been nobly supported during these anxious and arduous times by the heads of departments and the whole of the staff at head office and throughout the service. Without this mutual help the success of the Company's operation would have been impossible.

The retiring directors (the Hon. A. G. Brodrick and Sir Albert J. Leppoc Cappel) and the retiring auditors were then re-elected.

A hearty vote of thanks to the chairman, directors, manager and secretary and staff at home and abroad was cordially given.

The CHAIRMAN, in acknowledging the vote, said he accepted this with great satisfaction, and he would like to associate with the staff the name of the General Manager, who, as well as the staff, had had much to do. (Cheers.)

The proceedings then terminated.

West India & Panama Telegraph Co. (Ltd.)

The seventy-sixth ordinary general meeting was held on Wednesday, under the presidency of Mr. WALTER BISHOP KINGSFORD.

The SECRETARY (Mr. J. Winser) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: Before proceeding to business I have to express, on behalf of my colleagues and myself, our deep regret at the death on March 30 of Sir John Cameron Lamb, after a long and very painful illness. To fill the vacancy thus created on the board we invited Sir Alexander Freeman King to join us, and he has been duly elected. Sir Alexander was, until recently, Secretary to the Post Office, and his accession to the Board cannot fail to strengthen materially the administration of the Company's affairs.

The revenue was more than that for the corresponding period, and although expenditure was somewhat heavy, the ratio of expenses to income was slightly less than in the December period of 1913. The half-year's working shows a net profit of £18,683. 6s. 7d., compared with £13,069. 4s. 7d., an increase of £5,614. 2s. Ever since the outbreak of the war we have been obliged to carry on our business under such varied and unusual conditions that it is almost impossible for me even approximately to forecast the future. The strict but necessary censorship which since last August has been in force at most of our stations, and the partial prohibition of the use of codes throughout the West Indies, have very much hampered business and have greatly disturbed our normal working conditions as to cause the directors some anxiety as to their probable future effect upon the profits of the Company. I may remind you that these are already adversely affected by the reductions in rates which came into force on October 1. These greatly reduced rates have no doubt been a great boon to the telegraphic public. For the present, however, I regret to say that the growth in the volume of the traffic gives little reason to hope that the lower rates will be compensated for by new business; at all events while the restrictions already referred to continue to be in force. I told you at our last meeting that we were hoping to have both cables [illegible] and we shall no doubt be required, to keep our stations open day and night, thus causing us much extra expenditure, and subjecting our operating staff to very severe strain. Our clerks have worked admirably throughout this very trying emergency, and we feel that great praise is due to them for their loyal and willing service. I regret that the report and accounts cannot be adopted and that the dividend cannot be declared.

Mr. H. W. BIRKS seconded the motion, which was carried unanimously.

The retiring director (Mr. Birks) and the retiring auditors were re-elected, and a vote of thanks to the chairman, directors and staff terminated the proceedings.

West African Telegraph Co. (Ltd.)

The thirty-sixth ordinary general meeting was held on Wednesday, Sir JOHN DENISON-PENDER, K.C.M.G., in the chair.

The SECRETARY (Mr. Frederick L. Robinson) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: [illegible] The gross receipts for the year 1914 amounted to £87,300 against £85,900 for the preceding year, £1,500 or an increase of £1,400. The working expenses were [illegible] owing to the [illegible] and military operations on the coast which are taking place in connection with the terrible war now raging. The sum received for messages is £42,600, compared with £34,600 for the previous year, an increase of £8,000. The total expenses for the year were £26,100, against in 1913 £29,600, a decrease of about £3,500, chiefly owing to a much smaller expenditure on cable repairs. The amount expended on cable maintenance varies considerably from year to year, and, as I have repeatedly pointed out, one year's expenses form no criterion as to what the next year's expenses are likely to be. In 1913 we spent under this head £12,000, and this year only £7,000, and yet the same care and foresight have been exercised in each case. The only item in the general expenses calling for remark is that of £434, the contributions made by this Company to various war funds. I venture to think that this sum spent in the direction indicated meets with your entire approval. The net result of the year's working is that, while maintaining our usual dividend of 4 per cent., we have been able to carry the very respectable sum of £19,000 to the general reserve fund, which now stands at the nominal figure of £315,000. It must, however, be borne in mind that the securities representing this fund have depreciated in value, although, owing to the present restricted nature of Stock Exchange operations, it is difficult for me to tell you to what actual extent depreciation has taken place. Fortunately for us, there is no necessity at this time to realise any part of our reserve fund, and the interest we receive from it, which forms part of our revenue, is not in any way disturbed. I now move the adoption of the report and accounts, and the declaration of the dividend.

Sir HENRY C. MANCE seconded the motion, which was carried unanimously.

The CHAIRMAN: Before I put the next resolution, which is for the re-election of a director, I should like to say that two of your directors, Mr. Brodrick and my son, Mr. J. C. Denison-Pender, are at the present time serving their King and country abroad, and it has been found necessary to add another director to the board. I have, therefore, great pleasure in proposing the re-election of Sir Albert Cappel, who has been a director for many years of our joint companies, and has been connected with telegraphy all his life, and will, therefore, add considerable strength to the West African Board.

The motion was carried unanimously, and a vote of thanks to the Chairman, Directors and staff terminated the proceedings.

West Coast of America Telegraph Co. (Ltd.)

The eighteenth ordinary general meeting was held on Tuesday, under the presidency of Sir J. DENISON-PENDER, K.C.M.G.

The SECRETARY (Mr. Frederick L. Robinson) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, the revenue of the Company for the year ended 1914 amounted to £61,129, against £53,646 in the preceding year, thus showing an increase of £7,483. The working expenses compared with those for 1913 showed a decrease of £4,532. Ships' repairs to cables—the most important part of our expenses—are lower by £2,686 for the year 1914 compared with the previous year, but, as I have so often pointed out, this item at any time may be a heavy one. The duration of interruptions for 1914 was 112 days against 97 in 1913, but taking into account the state of things since August, owing to the presence of German cruisers after the outbreak of war on the coast, this is very satisfactory, and due to a great extent to the vigilance of our staff on the coast that so little delay occurred in carrying out repairs. Before I put the resolution which follows I wish to point out that a considerable part of the capital of this Company is in stocks which mature at an early date, and therefore provision must be made if not to the full extent, still such provision as will enable the directors to deal with the financial position when the time comes. This is the reason, I regret to say, why we are unable to recommend a dividend on the ordinary share capital of the Company, more especially as there is also a considerable depreciation in the value of the securities in the reserve fund. This is by no means confined to our Company, but is universal, the more so when reserves are invested in gilt-edged securities, such as ours. I now move the adoption of the report and accounts.

The motion was carried unanimously. The retiring director and the retiring auditors were re-elected, and a vote of thanks to the chairman, directors and staff terminated the proceedings.

Submarine Cables Trust.

The forty-fourth ordinary annual general meeting took place on Wednesday, Sir JOHN DENISON-PENDER in the chair.

The SECRETARY (Mr. Sydney Colletti) read the notice convening the meeting.

The CHAIRMAN said: Our total receipts for the year ended April 15 last amounted to £24,175, and after deducting £1,359 for expenses, and adding £30 brought forward from last year's account we have an available balance of £23,846. £16,236 has been distributed in half-yearly interest at the rate of 6 per cent. per annum net, leaving £7,610. We have redeemed during the year £1,000 out of £1,400 per certificate. These absorbed £1,440 and the balance of £170 os. 11d is carried forward to the next account. During the year the Trustees have continued their policy of re-distributing some of the investments of the Trust, and accordingly £4,300 Anglo-American preferred stock has been sold, and the proceeds have been reinvested in the shares of the Great Northern Telegraph Co. You will be interested to know that the number of certificates that we have now acquired amounts in all to 1,556 out of the original 1,500, leaving 644 certificates still outstanding. I now move the adoption of the report and accounts.

The motion having been seconded was carried unanimously. The retiring auditors were then reappointed, and a vote of thanks to the Chairman and his colleagues brought the meeting to a close.

ANCHOR CABLE CO. (LTD.) The accounts for 1914 show a profit of £31,779, making with amount brought forward £47,629. The sum of £3,500 has been allowed for depreciation of plant and it is proposed to pay a dividend of 15 per cent. for the year and to carry forward £32,129.

ARGENTINE TRAMWAYS & POWER CO. (LTD.)—The report for the year ended Sept. 30 last states that the first section of the tramway (about 8¼ miles) was opened to public service on March 26, 1914, and the second section (about 7¼ miles) on March 31, 1915. The remaining section was at the date of the last advices from Santa Fe nearly completed. The first part of the lighting and power system was put into operation at the beginning of March, 1915, and it is believed that by now practically the whole lighting system has also been completed.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—Mr. J. M. Falkner, who presided at the recent meeting, said the labour problems were very different to those anticipated when the war broke out. Instead of want of employment and consequent distress, there was a demand for labour such as had never before been known in the district. There was continuous pressure on the working classes, which must involve a heavy physical strain if regular hours were kept, and their large earnings carried with them their own temptations. The trouble about loss of time was due to a minority. Men were now working who under ordinary circumstances would not be acceptable; the higher skilled society men, especially the older ones, and those who had been long in the service of the firm, were working long hours, and giving an honest output. Since August they had engaged thousands of men, and they needed thousands more. The Government had now taken up the question with new organisations and they hoped for good results. On last year's working they had a divisible balance of £1,125,601, and they recommended the transfer of £200,000 to reserve and the payment of 12½ per cent. on the ordinary shares, carrying forward £334,038. The war had greatly affected their usual operations. All foreign work had been suspended.

BARCELONA TRACTION, LIGHT & POWER CO. (LTD.)—At a meeting of the holders of the 5 per cent. 1st mortgage 50-year bonds on Tuesday resolutions were passed empowering the creation of [illegible] per cent. preferred A bonds for £2,000,000 and a [illegible] Board [illegible] and also consenting to the payment in cash of the [illegible] on the 5 per cent. bonds being suspended until June 1, 1918, and consenting to the discharge of the said instalments by the issue of [illegible] 10 year notes of an equivalent amount.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—The report for 1914 states that the profit was £98,692 (against £91,862 in 1913), which, with £24,577 as to be added amount brought forward (£124,591), leaves, after the £223,284. The directors propose to pay a dividend on the ordinary shares at the rate of 10 per cent. per annum (less tax), being 10s. per share, whereof 5s. was paid on Nov. 2 last, and 5s. will be paid on the 21st inst., also to pay a bonus of 5s. per share (less tax), leaving to carry forward £163,169. For 1913 the distribution was the same. All the departments of the company's factory were profitably engaged to their utmost capacity up to the end of July last, but on the declaration of war much of the business in hand was stopped. It has been possible to reorganise the factory to meet the altered conditions of trade, with the result that the works at present are now busy in some of their departments and well occupied in the others. Considerable trouble has recently been experienced in regard to labour, and the situation still remains unsettled. Shortly after the outbreak of hostilities several orders of some importance were received from the company by the Admiralty and the War Office. Owing to the rearrangement of plant and machinery necessary to execute this work, comparatively little of it was completed at the expiration of 1914, and practically no profit has yet accrued to the company through these war contracts. Important contracts in connection with the British telephone system, to which reference was made in last year's report, were placed to the company's hands in the early part of the year, and, in order to deal efficiently therewith, some expenditure on contract plant was incurred.

CHISWICK ELECTRICITY SUPPLY CORP. (LTD.)—During 1914 a sum of £4,357 was spent on capital account for machinery, &c. The profit, after paying sinking fund premium and trustees' fees, was £8,386. Interest on first mortgage debenture stock (£3,600) has been [illegible] £1,780 credit of net revenue account. The directors propose to pay a dividend on the shares at rate of 6 per cent. for the year, and to carry £1,018 to depreciation reserve fund.

DELHI ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.) [illegible] ...ipts during 1914 were £9,798 6s. 10d. from the [illegible] ...ing and £18,887 2s. 2d. from the electric [illegible] ...ding £2,981 4s. 3d. on account of current [illegible] ...enue from the tramways shows an increase of 10 per cent., and the ...s revenue from the electric supply undertaking ... tramway) an increase of 19 per cent., and further expansion in this ...ch may be hoped for as soon as additional ... demand for power supply is satisfactorily ... develop the department. The net revenue was £8,155 6s. 6d. ...ed with £6,252 10s. 6d. in 1913 and £2,990 16s. 0d. ... 2 ... rging general expenditure in London and Delhi, and debenture and ... interest, the profit is £3,957 19s., and with £[illegible] ... £4,861, the total available balance is £4,152 ... is transferred to depreciation reserve and £78 14s. ... over account, leaving to be carried forward £78 10s. 6d. The net ... of the year's operations may be regarded as ... fact that during the latter period of the year ... ll branches of the undertaking was experienced ... new Diesel engine and generator have given ... station in June last. Owing to the continued ... it has become necessary to provide further plant, and arrangements have been made to provide a link with the Government power station. The cost of the necessary plant, together with additions to feeder cables which are being installed, will have to be met out of surplus revenue.

GREAT NORTHERN TELEGRAPH CO.—At the meeting which was held at Copenhagen on the 8th inst., Rear-Admiral F. C. C. Bardenfleth, D.R.N., in rendering an account of the working of the company during 1914 on behalf of the chairman (Commodore E. Suenson, D.R.N.), who was unavoidably prevented from being present, owing to illness, said that the terrible war, which during the last five months of the year under review had not only set aflame the most important countries in Europe, but had also spread the conflagration to the Far East and to almost every other part of the globe, had compelled all the Governments, belligerent as well as neutral, to adopt certain measures for the exercise of a control over the telegraphic and postal service. As a result of those measures their accounts with other administrations had been much delayed, and for that reason the directors had been obliged to postpone the general meeting until that day. The strict neutrality observed during the war by the Danish Government, as well as by the Governments of Sweden and Norway, had made it the plain duty of the company to follow similar principles in its dealings with the administrations of the several countries in which the company's cables were landed. They had always followed those principles of neutrality and discretion and had thereby gained the absolute confidence of the Governments concerned in the perfectly impartial and loyal service of the company. In 1914 15 interruptions had occurred to 10 cables in Europe, whilst, in the Far East, six cables had suffered 28 interruptions. The company's cables in the Baltic (between Denmark and Russia) became interrupted towards the end of November last year, and, unfortunately, owing to the war, it had not as yet been possible to repair them. In Europe the s.s. "H. C. Orsted" had been occupied for 105 days, of which 32 days were for other Administrations; in the Far East the [illegible] Store Nordiske" and the "Pacific" had been occupied for 188 days, of which 41 and six respectively were for others. The Wladiwostock and Kiachta routes had worked very satisfactorily and carried a considerable part of the traffic exchanged between Europe and the Far East; but the traffic via the company's lines had sensibly decreased since the war broke out. The line to Mongolia between Kiachta and Peking had been overhauled during the year, a constant supervision was, however, required to keep the line in efficient working order. The Japanese Government cable between Shanghai and Nagasaki was opened for traffic on Jan. 1, 1915, after the Japanese Government had secured the necessary consent of the Chinese Government. The cable is only to be used for the transmission of telegrams written in Japanese Kana characters and for Government telegrams exchanged terminally between Shanghai and Japan. In the spring of last year a convention was concluded between the Russian and Japanese Governments regarding the junction, at Sukhalen and at the frontier of Chosen, of the telegraphic systems of the two Governments. The rates for telegrams exchanged terminally via those new connections between Russia and Japan had been fixed at very low figures and in such a manner as to preclude the company's Wladiwostock-Nagasaki cables from competing for the traffic at equal rates, the traffic of which they were thus deprived, and which they had vainly tried to retain for their route by a heavy reduction of rates, was not inconsiderate; in other respects the convention did not affect the company's [illegible] traffic. At the last meeting it was mentioned that certain negotiations were proceeding with the Chinese Government. Those negotiations were rather protracted, and it was only in August last that a final settlement was arrived at. The arrangements mainly secure for the company the Chinese Government's approval of, and co-operation in, the arrangements entered into with Japan in 1913. The traffic over the company's cables had been extremely heavy owing to the war, and continued so, especially in Europe. At the outbreak of the war all direct connections between the telegraph systems of the United Kingdom, France and Russia on the one side and those of Germany and Austria-Hungary on the other side were broken off. The burden of all the telegraphic correspondence between Russia and her allies was cast upon the company's system, whilst other classes of traffic also increased considerably over and above the normal, the average number of words contained in the telegrams being increased, owing particularly to the universal prohibition of the use of code. Col. E. V. Tychsen died on Dec. 18 last, and the board had requested Mr. W. Weimann to fill the vacant place. The directors also regretted to announce that from July 1 Mr. F. C. C. Nielsen, after about 45 years' active service in the company, had, owing to failing health, tendered his resignation as the company's [illegible] engineer, a post in which he had filled [illegible] ...ability for over 24 years. Mr. Nielsen's connection with the company would not be entirely severed, as he had consented to be retained in a consulting capacity and thus give them the benefit of his great experience and intimate knowledge of the company's affairs in England. Although the financial results of the year had been eminently satisfactory, it should [illegible] that the [illegible] ... the war ... company's ... and. The [illegible] ... the ... expected increase of receipts warranted the distribution of a total dividend ... for the year of 22 per cent. ... and ... the board pro[illegible] ... to the reserve and to [illegible] ... The [illegible] ... £[illegible] ... £107,260, but the [illegible] ... and [illegible] ... had both decreased. The expenses increased by £21,120, "salaries and ... be £17,880, [illegible] ... the ... of carrying the increased ... according ... expenses ... £[illegible] ... £[illegible] ... £[illegible]

IMPERIAL CONTINENTAL GAS ASSOCIATION (LTD.)—At the meeting last week the chairman (Sir Chas. Jessel) said that some of their properties were in the area of the war. The gas works of the Wazemme Co. (in which they held 17,000 out of 28,000 shares) were only slightly damaged, and gas was being supplied normally. The electricity works there, in which they were also largely interested, were affected by the fact that the supply of power was their principal source of revenue, but the Germans had removed from the French factories all raw material and such parts of the machinery as they wanted for their own purposes. He gave particulars of their works in other towns in France and Belgium, but in regard to Austria and Hungary, he could say no more than that they knew nothing of what was going on, but they had every reason to suppose that things were in a normal condition. As to Germany, their secretary (Mr. Wilson), who had journeyed to Amsterdam, had learned that business was proceeding satisfactorily, the only difficulties encountered having been caused by the absence on military duties of many employés. The consumption of gas in Berlin for the half-year ended Dec. 31 had fallen off only 12·13 per cent.; in January the falling off was 12·25 per cent., and in February the decrease was 7¼ per cent. In Hanover the results were better. The fact was that, owing to the scarcity and high price of oil and coal for domestic use, the Germans had been officially recommended to burn gas and electricity for lighting and to use coke for heating.

MARCONI WIRELESS TELEGRAPH CO. OF AMERICA.—The report for 1914 states that the number of ship and shore equipments now operated by the company is about 20 times that of three years ago. The company's service has been steadily extended and apparatus developed to a standard recognised by the Government, the steamship owners, railroads and large industrial companies. It was found necessary to raise the rental figure of the ship equipment contracts acquired with the purchase of the assets of the United Wireless Telegraph Co. In addition to progress made in ship and shore communication much has been accomplished with the high-power stations for long distance work. In the northern district on the Pacific Coast there had been completed a powerful station at Ketchikan, Alaska, and a chain of wireless stations to cover that territory had been planned. At Juneau the company had another station under construction, and the United States terminal at Astoria, Oregon, was nearing completion. The latter plant was to have been ready by about May 1, and the first link in the chain would then be opened to public service. The company's Transpacific service between San Francisco and Honolulu was opened on Sept. 24, and with but few interruptions of short duration (due to the failure of the power company to supply current) had been working continuously ever since. The arrangements made for direct service between New York and London had been practically completed when the outbreak of the war forced the officers to set aside the vigorous campaign through which it had been planned to secure a share of the Transatlantic cable business. The duplex stations at Belmar and New Brunswick (N.J.) were completed and being tested in July, when word came that the corresponding English stations at Carnarvon and Towyn (Wales) had been commandeered by Great Britain for the Admiralty. A strong transoceanic department had been organised, and 24 hour service was to be provided through a new commercial office in the heart of New York's financial district. The gross earnings from operations were $756,372 and general operating and administration expenses $634,958, leaving net earnings $121,614. To this must be added income from investment of surplus funds $150,274, giving net income for year (before charging reserves) $271,888. Of this there has been applied for depreciation of coast stations $30,037, for depreciation of ship stations $29,473, against expiration of patents $50,000 and contingencies $12,500, leaving a surplus of $149,877.

LONDON & LANCASHIRE FIRE INSURANCE CO. (LTD.)—The annual report shows a successful year's working. The net realised profit in the fire department was £146,033, in the accident department £80,150 and in the marine department £22,573, an aggregate of £248,756. £180,300 is placed to reserve, which has now reached the handsome total of £3,466,344. The total security to policy holders now amounts to £6,107,594.

MERTHYR ELECTRIC TRACTION & LIGHTING CO. (LTD.)—The directors' report for 1914 states that the capital expenditure amounted to £13,689. The revenue was £24,685, compared with £24,034 in 1913, and after deducting all expenses chargeable to revenue (including £2,561 for debenture and other interest), and setting aside £2,000 to renewals fund, the surplus is £5,362. The directors propose to place to reserve £1,000 to pay dividend at the rate of 7 per cent. per annum on the ordinary shares and to carry forward £723.

RHONDDA TRAMWAYS ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the directors' report stated that the control and management of the undertaking was in the hands of the Rhondda Tramway Co., who were entitled to all profits, and therefore the profit of £2,000 had been transferred to the Tramway Co.

RICHARD JOHNSON, CLAPHAM & MORRIS (LTD.)—There was a net profit of £29,024 on the past year's work, and with £6,198 brought forward the total was £31,222. A dividend of 7½ per cent. on the ordinary shares, making 10 per cent. for the year, has been declared, £7,500 has been placed to reserve, and £9,308 carried forward.

STRATFORD-ON-AVON ELECTRICITY CO. (LTD.)—At the recent meeting the directors' report stated that, though there was a considerable accession of consumers during the year 1914, the revenue for the latter half showed a slight decline, and expenditure was also less. The directors might have recommended a small dividend but in the present circumstances it was deemed wiser to strengthen the reserve and increase the amount to be carried forward. After allocating £200 to reserve and depreciation the available balance was £189. Directors' fees absorbed £50 and £139 was carried forward. 74,451 units were sold for lighting, 56,370 for power, and about 12,000 for heating. The average price obtained was 3·26d.

SWANSEA IMPROVEMENTS & TRAMWAYS CO.—The directors report states that the revenue for the year amounted to £66,716. 1s., a decrease of £2,030 8s. 9d. compared with 1913. The available balance is £16,229. 8s. 1d., and the directors, after placing £3,000 to reserve and payment of dividends of 6 and 5 per cent. respectively on the two classes of preference shares, propose to pay a dividend at rate of 6 per cent. per year on the ordinary shares in respect of which an interim dividend at the rate of 5 per cent. per annum for the half-year was paid in October last. The balance forward is £2,831.

WESTERN UNION TELEGRAPH CO.—The accounts for the year ended Dec. 31, 1914, show gross operating revenues $46,264,776.61, operating expenses, including repairs, reserved for depreciation, rent for lease of plants, taxes, &c., amounted to $40,578,750.90, and after adding income from loans and investments ($1,022,611.30) and deducting interest on bonds of Western Union Co. ($1,337,242.50), the balance is $5,371,394.51. The surplus at Dec. 31, 1913, was $9,705,791.85, and after adding balance for 1914 and balance of other surplus reserved transferred to surplus account ($3,451,921.72), and deducting amount transferred to reserve for accrued depreciation as representing depreciation accrued on ocean cable plant prior to Dec. 31, 1913 ($1,000,000.00), miscellaneous adjustments ($8,300.92) and dividends paid and declared ($3,988,886.00) the surplus is $13,531,921.16. The report states that the value of telegraph lines and equipment has been increased by $3,851,798; there have been added to land line plant 2,449 miles of pole line, 27,458 miles of iron wire, 15,752 miles of copper wire and 2,464 miles of wire in cables, a large portion of the latter being underground. At the close of the year there were 25,784 offices operating in conjunction with 1,581,571 miles of telegraph wire, 210,515 miles of pole line, and 26,768 miles of ocean cables, the latter having been extended by 494 miles. The report states that, pursuant to an agreement (which became effective on Jan. 1, 1915), the Canadian Northern Telegraph Co. and the Great North Western Telegraph Co. combined, under the name of the latter company and acquired control of the shares owned by the Western Union Co. in the Great North Western Co., equal to 66 per cent. of the capital stock. As a result of the consolidation the lines of the new Great North Western Telegraph Co extend entirely across Canada from coast to coast and the Western Union Co. will benefit by obtaining a strong ally in Canada.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ANGLO-BURMAH WOLFRAM SYND. (LTD.) (140,174).—Reg. May capital £500 in £1 shares, to carry on the business of dealers in an treaters and smelters of wolfram ore, &c. Private company. Re office: Ocean House, Great Tower-street, E.C.

ARDEE ELECTRICAL CO. (LTD.) (4,235.)—Reg. in Dublin on April 2 with a capital of £5,000 in £1 shares, to acquire and carry on the busine of an electric light, heat and power producer, generator and distribute &c., carried on by J. W. McKeever, J.P., at Ardee, Co. Louth. Priva company. J. W. McKeever is first director. Reg. office, Ardee, Co. Lout

BERGASSE ROTARY ENGINE (PARENT CO.) (LTD.) (140,090).—Re April 27, capital £6,000 in 5,000 participating non-cumulative preferen shares of £1 each and 20,000 deferred shares of 1s. each, to carry on t business of motor engine and body builders, mechanical and gener engineers, electricians, &c. Private company. Reg. office: 1, Centr Building, Westminster, S.W.

FERGUSON, PAILIN & CO. (LTD.) (140,150.)—Reg. May 1, capit £10,000 in £1 shares, to carry on the business of electrical, mechanic hydraulic and general engineers, switchboard and cable makers, man facturers of machinery and apparatus of all kinds, &c. Private compan First directors are S. Ferguson (permanent), J. Pailin, G. Pailin, J. Pailin, A. Pailin and G. Pailin, jun.

FRANCIS POLDEN & CO. (LTD.) (140,231).—Reg. May 7, capit £5,000 in £1 shares, to carry on business of electrical and mechani engineers, manufacturers of machinery of all kinds, tool makers, me workers, &c., and to adopt an agreement with F. C. Polden. Priv company. First directors are F. C. Polden (permanent chairman a managing director) and C. J. Polden. Reg. office: 56, Cannon-street, E

H. L. V. PEARN & CO. (LTD.) (139,951).—Reg. April 14, capital £1,0 in £1 shares, to acquire from A. E. Lamkin, electrical engineer, t benefit of certain inventions, to develop and turn to account same, carry on the business of electricians, mechanical engineers, suppliers electricity, &c., and to adopt an agreement with the said A. E. Lamki F. H. Hadow and H. L. V. Pearn. Private company. First directo are A. E. Lamkin, H. L. V. Pearn and F. H. Hadow (chairman). Re office: 3 7, Southampton Buildings, Strand, W.C.

STATUTORY RETURNS.

BRITISH L. M. ERICSSON MFG. CO. (LTD.)—In return to March 31, capital is £200,000 in £1 shares (99,990 preference and 100,010 ordinary). All shares taken up. £1 per share called up on 50,010 ordinary, 8s. per share on 50,000 ordinary and £1 per share on 99,990 preference shares. £170,000 paid. £30,000 (12s. per share) considered as paid on 50,000 ordinary shares. Mortgages and charges, £50,000.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.)—The capital at March 18 is £2,100,000 in 130,000 preference, 130,000 ordinary, 80,000 City undertaking preference and 80,000 City undertaking ordinary shares of £5 each. 80,000 preference, 80,000 ordinary, 80,000 City undertaking preference and 70,000 City undertaking ordinary shares taken up. £1,200,000 paid on the preference, ordinary and City undertaking preference. £350,000 considered as paid on the City undertaking ordinary. Mortgages and charges, £1,087,178.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The capital in return to April 1 is £95,000 in 13,000 ordinary and 6,000 preference shares of £5 each. 12,931 ordinary and 6,000 preference shares taken up. £94,655 paid. Mortgages and charges nil.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The capital at April 2 was £400,000 in 40,000 preference and 40,000 ordinary shares of £5 each. All shares taken up. £5 per share called up on 39,880 preference and 32,616 ordinary. £362,480 paid. £37,520 considered paid on 120 preference and 7,384 ordinary. Mortgages and charges, £150,000.

JARROW & DISTRICT ELECTRIC TRACTION CO. (LTD.)—Capital in return to March 15 is £50,000 in £1 shares. All shares taken up and £1 per share called up. £49,961. 15s. paid (including £16. 15s. paid on 55 shares forfeited), leaving £38. 5s. in arrears. Mortgages and charges: £14,800.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—Capital at March 18 was £350,000 in £5 shares (50,000 ordinary, 10,000 1st preference and 10,000 2nd preference). 21,000 ordinary, 10,000 1st preference and 10,000 2nd preference shares taken up. £5 per share called up on 15,968 ordinary, 10,000 1st preference and 10,000 2nd preference shares. £179,840 paid. £25,160 considered as paid on 5,032 ordinary shares. Mortgages and charges, £115,000. Stock issued by company in conjunction with Notting Hill Electric Lighting Co. (Ltd.), £31,000.

LONDON ELECTRIC SUPPLY CORPN. (LTD.)—In return to March 11 capital is £1,300,000 in 200,000 ordinary shares of £3 each, 90,000 preference shares of £5 each and 250,000 unclassified shares. 111,000 ordinary and 89,840 preference shares taken up. £3 per share called up on the ordinary and £5 per share on the preference shares. £782,360 paid, including £160 paid on 160 shares forfeited. Mortgages and charges: £487,355.

MATHER & PLATT (LTD.)—According to return to March 13, capital £1,000,000 in 40,000 preference shares of £10 each and 600,000 ordinary shares of £1 each. All shares taken up. £10 per share called up on 2,200 preference and £1 per share on 25,000 ordinary shares. £317,000 paid. £683,000 considered as paid on the remainder. Mortgages and charges nil.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—According to return March 9 capital is £201,352. 10s. in 17,002 non-cumulative 6 per cent. preference and 2,998 cumulative 6 per cent. preference shares of £10 each and 27,050 ordinary shares of 1s. each. 11,402 non-cumulative preference, 2,998 cumulative preference and 27,050 ordinary shares taken up. £5,352. 10s. paid. Mortgages and charges, £64,000, and jointly with the Kensington & Knightsbridge Electric Lighting Co. (Ltd.), a further £1,500.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The capital in return to March 18 is £448,200 in £12 shares. All shares taken up, and £8,200 paid. Mortgages and charges, nil.

WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS (LTD.)—Capital in return to March 24 capital is £350,000 in £1 shares. 320,000 shares taken up. £320,000 paid. Mortgages and charges nil.

MORTGAGES AND CHARGES.

CELLYAR & SONS (LTD.)—Second debenture dated April 24, 1915, to secure £100, charged on company's undertaking and property, present and future, including uncalled capital, subject to prior debentures on which £436 remains owing. Holder, Mrs. K. F. Galton.

RESISTO-ELECTRICAL MFG. CO. (LTD.)—Particulars of £5,000 debentures, created April 12, 1915, have been filed, amount of present issue being £400. Property charged, company's undertaking and property, including uncalled and unpaid capital. No trustees.

NOVELTY CONSTRUCTION CO. (LTD.)—Memorandum of satisfaction to extent of £265 on April 12, 1915, of debentures dated May 31, 1912, during £915, has been filed.

RECEIVERSHIP.

H. TURNER & CO. (LTD.)—Notice of appointment of C. A. Turner, of station road, Willesden Junction, as receiver and manager on May 5, 1915, under powers contained in 2nd debenture dated 1 March 24, 1913, has been filed.

COMPANY INCORPORATED OUTSIDE THE U.K.

CANADIAN POWER, CEMENT & BRICK WORKS (LTD.) (1,418).—Particulars filed April 14. Capital $3,000,000 in $1 shares, $2,000,000 of cumulative preference and 1,000,000 common shares. Power to Nova Scotia in December, 1912. British address: 6A, Bishopsgate, E.C. Messrs. O. C. Bunch is authorised to accept service.

CITY NOTES.

MEMORANDA (May 12).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 66½. Consols Pay Day June 1. Stocks and Shares Ticket Days May 27 and June 10. Pay Days May 28 and June 11. Price of silver, 23¾d.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The 4 per cent. guaranteed debenture stock transfer books of this company will be closed from May 18 to 31 inclusive, preparatory to payment of interest due June 1.

CONSTANTINOPLE TELEPHONE CO.—A circular has been issued to the shareholders of this company (the Société Anonyme Ottomane des Téléphones de Constantinople) by Mr. M. Webster Jenkinson, the company's representative in the United Kingdom, stating that the Turkish Government have taken possession of the company's system in Constantinople. The general manager (Mr. F. Douglas Watson) and British staff were expelled and have arrived in England. Minutes describing the confiscation of the plant and property by the Turkish authorities have been received, and a protest has been addressed by the Constantinople directors to the Turkish Government. It is hoped that it will soon be possible for the British staff to return and for the company to resume possession of its plant, and an endeavour will be made to obtain reparation for the loss inflicted by the action of the Turkish Government. The Turkish authorities based their action on article 23 of the Convention, which conferred upon the State full power to inspect and supervise the service, &c., and also the right to assume control of the service on all or any part of the system when necessary for the public safety; the company shall have no right to demand compensation on this score. The matter is receiving the most careful consideration of the European directors, and every possible step has been and will be taken to protect the interests of shareholders and bondholders.

W. T. GLOVER & CO. (LTD.)—A petition has been presented to the High Court of Justice to confirm alterations in the articles of association to authorise the company to acquire and work lead, copper and coal mines, to smelt and work ores, to manufacture articles of lead and copper and alloys of same, copper and other metal wires, asphalt troughing, &c.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The directors have declared a dividend on the preference shares at the rate of 4 per cent. per annum for the six months ended March 31.

KAMINISTIQUIA POWER CO. (LTD.)—The directors have declared a dividend of 1½ per cent. (or at rate of 6 per cent. per annum) on the Common stock for the quarter ended April 30.

TRAMWAYS & GENERAL WORKS CO. (LTD.)—The directors recommend a dividend of 6½d. per share for the past year, carrying £207 forward.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, May 12. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shes.	Last Dividend	Name.	Price, Wed., May 12.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	91	7 3 7	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	93	4 15 4	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	91½	6 0 9	Feb, Aug
1	10%	Brompton & Kensington Ord.	23	5 19 1	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St.	90¾	4 8 5	.. ..
St.	4%	Charing Cross West End & City Debs.	91	4 7 11	Jan, July
5	2/3	Do. 4½% Pref.	4⅞	5 7 6	.. ..
10	9%	City of London Elec. Lt. Ord.	14½	6 6 4	Feb, Aug.
10	6%	Do. 6% Pref.	13⅜	4 19 0	Mar, Jly
St.	5%	Do. 5% Deb. St.	110	4 10 10	Jun, Dec
10	4½	County of London 4½% Pref.	11⅜	5 3 3	Feb, Aug
St.	4½	Do. 2nd Deb.	95¼	4 12 1	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	80	5 12 6	July ..
5	8%	Kensington and Knightsbridge Ord.	7⅛	6 4 2	Feb, Aug
5	3%	London Elec. Supp. 6% Pref.	5½	5 19 4	.. ..
St.	4%	Do. 4% Mort. Deb.	87	4 12 0	Jan, Jly
2	3½%	Metropolitan E. Supp. Ord.	3⅜	5 9 10	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	91⅝	4 18 3	Jan, Jly
1	6%	Newcastle & Dist. E.L. 6% 2nd Dbs.	96½	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S.5% 2d Mt. Db. St.	104½	4 14 9	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1	5 19 4	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs.	95	5 5 3	Jan, Jly.
St.	4½%	Urban Elec. Supp. 4½% Db. St.	80	5 8 11	Apl, Oct
5	7%	Westminster E.S. Corp. Ord.	7⅜	6 3 9	Mar, Sept
1	4½	Do. 4½% Cum. Pref.	4¼	4 14 9	Jan, Jly.
		Electric Railways & Tramways.			
St.	6%	British Elec. Traction 5% Debs.	83½	5 19 7	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	7⅛	7 15 9	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	7½	5 2 7	.. ..
St.	4%	Do. do. Assented Def. Ord.	7⅞	5 3 3	.. ..
10	9%	Lancashire Traction	8½	5 17 11	Feb, Aug
10	4%	London Electric Ry. Ord.	1¼	3 0 0	Jan, July
St.	4%	Do. 4% Pref.	6⅛	6 3 1	Mar, Sept.
St.	4%	Do. 4% Deb.	87	4 14 2	Jan, Jly.
St.	5%	Metropolitan Ry. Con. Ord.	77	6 9 9	Feb, Aug
St.	5%	Do. 4% Pref.	71½	4 19 0	Feb, Aug
St.	5%	Do. 4% Deb.	74½	4 14 3	Feb, Aug

† Ex dividend for interest

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name.	Price, Wed., May 12.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*	£ s. d.		
St.	3½	Metropolitan Electric Tramways A Ord.	82½	4 5 0	Jan. July
St.	3½	Do. B Ord.	84	4 3 10	Jan. July
St.	..	Metropolitan Dist. Ry. Ord.	11½	.. ..	Feb. Aug.
St.	4½	Do. 4% Pref.	95	4 7 0	May Nov.
St.	4½	Do. 4½% First Pref.	103½	4 7 0	Feb. Aug.
St.	6½	Do. Def.	12½	4 12 0	Jan. July
St.	4½	Do. 4% Debs.	103½	4 9 11	Jan. July
St.	4½	Do. Do.	103½	4 11 11	Jan. July
St.	4½	Do. Do.	103½	4 11 11	Jan. July
St.	4½	Do. Do.	97½	4 6 4	May Sept.
..	..	Underground E. Rys. of London Shares	..	.. ..	..
1	..	Do. A Ord.	..	.. ..	..
St.	6½	Do. 6% Inc. Debs.	115½	5 4 1	May Sept.
..	..	Do. D	107½	5 12 6	May Sept.
..	..	Do. E	107½	4 7 6	Jan. July
..	4½	Do. 4½% Pref.	103½	.. ..	March
5	..	Yorkshire W. Rys. Ord.	..	.. ..	..
		Electric Manufacturing, &c.			
1	1½	Babcock & Wilcox Ord.	23	.. ..	April Oct.
1	1½	Brit. Aluminium Ord.	23	3 11 11	May
100	5½	Do. Prior Lien Debs.	103	5 7 11	Jan. July
1	5½	Do. 6% Pref.	103	5 7 11	Jan. July
5	1	Brit. Insulated & Helsby Ord.	11½	4 11 4	Aug. Feb.
5	3½	Do. Cum. Pref.	74	4 16 9	Jan. July
1	6½	British L.M.Ericsson Mfg. Cm.6% Pref.	14	4 12 11	May Sept.
2	7½	Brit. Westinghouse Pref.	16½	4 12 6	April
1	..	Do. A Def.	1½	4 4 0	..
..	..	Do. B Def.	3½	4 5 8	Jan. July
5	5 0	Callender's Cable, &c., Co. Ord.	11½	4 7 0	Jan. July
5	2 0	Do. Pref.	..	4 17 7	Feb. Aug.
1	15½	Castner Kellner	3½	4 3 11	May Nov.
1	6½	Dick, Kerr & Co. 6% Pref.	..	6 17 ..	Sept.
5	..	Edison Swan U.E. Ltd. A £5	5	.. ..	Feb. Aug.
1	6½	Elec. Construction Ord.	8	4 11 7	May
St.	4½	Do. 4% Debs.	99½	5 1 0	Jan. July
10	6½	General Electric 6% Pref.	15½	5 1 4	Jan. Dec.
5	20½	W. T. Henley's Telegh. Wks. Co. Ord.	44½	4 15 4	Feb. Aug.
5	3½	Do. 4½% Cum. Pref.	..	4 13 9	..
St.	4½	Do. 4½% Deb.	99	4 13 9	Jan. Dec.
10	5½	India Rubber, G. P. &c., Ord.	9½	5 11 1	Feb. Aug.
10	5½	Do. Pref.	..	5 11 1	April Oct.
100	4½	Do. 4½% Debs.	97½	4	April Oct.
12	3½	Telegh. Con. & Main. Co.	37	4	May July
100	4½	Do. 4½% Debs.	96	4 4 3	Jan. July
1	12½	Vickers Ord.	13½	4 13 7	May Aug.
1	6½	Do. 6% Pref.	14½	4 11 1	May Aug.
St.	4½	Do. 1st Debs.	99½	4 .. 7	Jan. Dec.
100	4½	Do. 4½% 2nd Debs.	104½	4 .. 3	Jan. Dec.
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	135	5 12 ..	Feb. May. Aug. N.
St.	30/0	Do. Def. Ord.	24½	6 13 4	Feb. May. Aug. N.
St.	4½	Commercial Cable 4% Debs.	97	5 3 11	J. A. J. O.
10	5½	Cuba Submarine Ord.	9½	5 13 10	May Nov.
10	10/0	Do. 10% Pref.	17½	5 14 10	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4½	Direct Union Debs.	74½	5 3 8	J. A. J. O.
St.	25/0	Eastern Tel. Co. Ord.	34½	5 4 0	J. M. J. O.
St.	17/6	Do. 3½% Pref.	71½	4 13 1	J. M. J. O.
St.	4½	Do. 4% Debs.	92½	4 6 0	May Nov.
St.	4½	Eastern Extension Tel. Co., 4% Debs.	92½	4 7 0	Feb. Aug.
10	2/6	Do. Ord.	3½	5 6 6	J. A. J. O.
10	2/6	Gt. Northern Tel. Co. Ex Coup. 6	24½	7 11 ..	J. M. J. D.
25	13/0	Do. Pref.	17½	7 14 1	May Nov.
1	2/3	Marconi's Wireless Tel. Co.	3½	11 11 ..	April
1	1/4	Do. 7% Pref.	3½	10 .. 11	July
10	7½	West India & Panama Ord.	11½	7 .. 10	May Nov.
10	6½	Do. 1st Pref.	9½	7 3 3	May Nov.
10	3/0	Western Telegh. Co.	13½	5 .. 11	May Nov. D. Dec.
St.	4½	Do. 4% Deb. St.	94	4 5 5	Jan. Dec.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	124½	6 8 9	J. A. Jn. O.
..	5½	Cuban Telephn. Co. 5% Bds.	97½	6 4 7	Jan. July
1	7½	Mexican Telephone Ord.	7½	5 12 5	Nov.
..	4½	New York Telephone 4½% Bds.	103½	4 11 1	May Nov.
1	..	Oriental Telephone Ord.	2½	.. ..	April Oct.
St.	4½	Do. Db. St.	103½	4 12 6	Jan. July
St.	4½	Telephn. Co. of Egypt Db. St.	89½	5 .. 5	Jan. July
5	3/0	United River Plate Ord.	8½	6 .. 6	April Oct.
St.	5½	Do. Pref.	4½	6 .. 6	April Oct.
St.	4½	Do. Deb. Stk.	93½	4 16 3	Jan. July
		Financial and Investment.			
10	6½	Globe Telegh. & Trust	11½	5 9 7	S. D. Mr. Jn.
1	3½	Do. 6% Pf.	11½	5 .. 0	D. Mr. Jn.
1	5½	Mercantile Trust Ord.	7½	7 .. 0	J. A. J. D.
..	4½	Do. £10 Pref.	10½	5 14 3	J. A. J. O.
100	6½	Submarine Cable Trust Certs.	12½	4 14 6	April Oct.
		Colonial and Foreign Railways, Tramways, &c.			
St.	5½	Anglo Argentine Trams. 5% Debs.	97½	5 9 11	Jan. Dec.
St.	4½	Do. 4% Debs.	87½	5 3 3	Jan. July
St.	4½	Do. 4% Debs.	93½	4 12 7	Jan. July
5	2/9	Do. 5½% 1st Pref.	4½	6 .. 0	Jan. July
5	2/9	Do. 5½% 2nd Pref.	3½	7 1 11	Jan. July
100	5½	Brazilian Traction Ord.	104½	5 13 1	J. M. A. S. N.
100	4½	Do. 4% Pref.	87½	5 2 3	J. A. J. O.
5	4/0	Do. Def.	7½	5 6 8	May
5	5½	Do. 5% Cum. Pref.	4½	.. ..	May Nov.
St.	4½	British Columbia 4½% Con. Debs.	81½	5 9 11	..
..	..	Calcutta Elec. Trams. Ord.	3½	5 13 3	Mar, Sep
..	5½	Havana Elec. Ry. 5% Bds.	87½	5 14 3	Feb, Aug
5	6½	Madras Elec. Trams 6% Cum. Pref.	6½	5 .. 0	..
100	5½	Manaos Trams 5% Debs.	87½	7 4 11	Jan. July
..	..	Mexico Trams Common St.	20½	.. ..	F. M. A. S. N.
..	5½	Do. Pref.	7½	.. ..	May Sept.
St.	4½	Montreal Street Ry. 4½% Debs. (1922)	96½	4 .. 4	Feb. Aug.
100	5½	Rio de Janeiro Tram, L. & P. 50 yr. Bds	87½	5 .. 0	Jan. Dec.
100	4½	Do. Do.	87½	4 14 3	Feb. Aug.
		Colonial and Foreign Electric Supply, &c.			
5	3½	Adelaide Elec. Supply 6% Pref.	7½	5 .. 11	May. Sept.
St.	5½	Do. 5% Debs.	103½	4 17 7	Jan. Dec.
1	..	Barcelona Tr. Lt. & Pr.	1½	5 .. 0	..
5	4½	Do. Pref.	3½	6 .. 0	..
5	3½	Do. Def.	3½	5 .. 0	April, Oct.
..	..	Canadian Gen. Elec. Common St.	3½	5 11 1	J. A. J. O.
St.	6½	Melbourne Elec. Supply 5% 1st Mt. Debs.	102½	5 11 4	Jan. July
St.	5½	Do. 5% Cons. Deb. St.	103½	5 .. 0	April Oct.
..	..	Nanking & Pukow Ry. 6%	10½	5 14 1	Jan. July
..	..	Nanyang Bros. Tobacco	13½	5 13 4	J. A. J. D.
St.	4½	Toronto Power 4½% Debs. St.	89½	5 .. 11	Jan. July
St.	4½	Do. 4½% Debs.	89½	5 .. 11	May Nov.
1	..	Victoria Falls & Transvaal P. Co., 6% Pf.	1½	.. ..	Jan. July
..	4½	Do. 5½% 2nd Mort. Debs.	97½	.. ..	Jan. July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date May 12, the following as the present prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	11½d.	Antimony	£100 0 0
Solid Drawn Copper Tubes	13½	English Lead	£21 0 0
Brazed Copper Tubes	13d.		
Brazed Brass Tubes	13½d.		
Brass Wire	12½d.	Old Metals.	per ton.
Copper Wire	12½d.	Clean Scrap Copper	£73 0 0
Rolled Brass	12d.	Brazierey Copper Scrap	£65 0 0
Brass Sheets	12½d.	Clean Scrap Brass	£50 10 0
	per ton.	Old Lead	£18 10 0
Copper Sheets	£100 0 0	Old Zinc	£45 0 0
Spelter	£21 0 0	Hollow Pewter	£120 0 0
		Black Pewter	£85 0 0
		Gun Metal	£62 10 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date May 11, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£65 0 0	Lead Pipe	£19 0 0
Clean Mixed Brass	£55 10 0	Tea Lead	£17 10 0
Clean Copper	£72 0 0	Old Zinc	£47 0 0
Brazierey Copper	£66 0 0	Hollow Pewter	£120 0 0
Gun Metal	£63 0 0	Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS

Line.	Week ended.	Amount	Inc. or dec. (a)	No. of weeks.	Aggregats. Amount.	Inc. or d (a)
		£	£		£	£
Aberdeen Corporation	May 1	1,254	+ 42	44	80,328	+ 2,2
Anglo-Argentine	..	54,791	+ 3,891	18	922,187	+ 96,9
Ashton-under-Lyne	..	474	+ 39	5	2,809	+
Ayr Corporation	..	292	+ 17	51	16,819	+ 1,2
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	..	1,315	+ 65	6	7,202	+ 2
†Birmingham Corporation	..	12,934	+ 565	6	70,115	+ 1,4
Blackburn Corporation	..	1,187	+ 88	6	7,319	+ 1,0
Bolton Corporation	..	2,736	+ 34	6	15,130	+ 1,8
†Bournemouth Corporation	..	1,988	+ 153	5	11,012	+
Bradford Corporation	..	6,131	+ 272	6	35,263	+ 1,4
Brighton Corporation	..	970	+ 100	68	5,520	+ 6
†Bristol Trams & Carriage	..	9,357	+ 1,242	13	157,623	+ 14,2
Burmah E. Trams & Ltg.	..	R3,641	R758	18	..	+ R40,0
Burnley Corporation	..	1,555	— 31	6	9,470	— 1,0
Burton Corporation	..	281	— 14	6	1,558	— 1
Bury Corporation	..	1,000	+ 65	68	7,689	+ 6
Calcutta Tramways Co.	..	R61,897	— R1,907	18	R1,061,081	— R3,5
Camborne-Redruth	..	139	— 9	18	2,238	— 1
Cardiff Corporation	..	..	..	..	..	..
Central London Railway	..	..	..	..	..	..
Cork Electric Trams Co.	..	621	+ 30	18	8,176	—
Croydon Corporation	April 30	1,172	+ 86	4*	7,786	+ 6
*Derby Corporation	May 2	1,000	+ 53	5	5,574	+ 3
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	..	142	+ 7	18	2,326	+
Dublin United	..	4,141	+ 263	18	104,495	+ 5,7
Dundee Corporation	..	..	..	..	..	..
East Ham Council	..	1,317	+ 336	5	7,289	+ 1,8
Erith Urban Council	..	..	..	..	..	..
Exeter Corporation	..	369	+ 42	5	1,892	+
Glasgow Corporation	..	20,000	+ 1,000	53‡	997,000	+ 7,0
Glossop Trams	..	437	+ 8	19	2,129	—
Gloucester Corpn.	..	314	+ 9	5	1,578	—
†Halifax Corporation	..	1,111	— 136	5	10,948	—
Hastings Elec. Trams Co.	..	3,000	+ 28	18	13,901	—
Hong Kong	..	..	..	..	..	..
Huddersfield Corpn.	..	2,200	+ 300	6	14,414	+
Hull Corporation	..	3,000	— 110	5	16,751	— 1,1
Ilford District Council	..	..	..	..	..	..
Ilkeston Corporation	..	141	— 5	5	601	—
Ipswich Corporation	..	444	+ 24	5	2,403	—
Isle of Thanet Co.	..	..	..	..	..	..
Kilmarnock Corporation	..	161	— 9	51	8,142	—
Lanarkshire Trams Co.	..	..	..	..	..	..
Lancashire United	..	1,640	+ 30	18	28,139	—
Leeds Corporation	..	8,525	+ 438	6	47,179	+
Leicester Corporation	..	3,097	+ 67	13	52,349	+
Leith Corporation	..	716	— 1	51	35,762	—
Lincoln Corporation	..	141	— 1	6	789	—
LiverpoolCorporation	..	1 13 1..	101	17½	217,981	— 5
Liverpool Overhead Rly.	..	..	..	..	..	..
Llandudno&ColwynBayR	7	511	40	22	5,371	+
London County Council	April 29	17,000	+ 3,000	4	1,46,166	+ 17
London Elec. Ry. Co.	..	..	..	..	..	..
London United	..	..	..	..	..	..
Lowestoft Corporation	May 8	1,1..	— 12	31	8,138	—
Maidstone Corporation	..	..	..	..	..	..
Manchester Corporation	..	8,1..	+ 67	8	60,811	— 2
Metro'y Railway	..	..	..	..	..	..
Nelson Corporation	..	1..	..	51	1,030	..
Newcastle-on-Tyne Corpn.	..	4,000	+ 400	5	32,879	+ 7
Newport (Mon.) Corpn.	..	..	..	..	..	..
Northampton Corporation	7	5..	+ 207	4	3,728	+
Oldham Corporation	..	2,1..	+ 32	7	14,673	— 1
Perth (N.B.) Corporation	..	..	..	..	..	..
Perth (W.A.) Elec. Trams.	..	..	..	..	..	..
Portsmouth Corporation	..	2,400	+ 212	5	11,113	—
Preston Corporation	5	922	+ 44	5**	4,621	—
Rotherham Corporation	..	1,044	+ 103	5	5,255	+
Salford Corporation	..	..	..	..	..	..
Stalybridge	..	..	..	..	..	..
Sheffield Corporation	..	11,0..	+ 800	6	53,728	+ 1
Singapore Trams	..	..	..	..	..	..
Southampton Corpn.	..	1,0..	+ 109	5	6,343	—
Southend Corporation	..	7,1..	+ 69	5	4,201	—
Stlybridge, Hyde, &c., Jt. B.	..	..	..	..	..	..
Sunderland Corporation	..	9,0..	+ 1,3..	6	7,871	—
Sunderland District	..	1..	+ 16	27	14,417	— 1
Swindon Corporation	..	1,376	+ 13	..	..	..
Tynemouth Trams Co.	April 28	962	+ 37	17	8,793	—
Wallasey Corporation	May 1	1,212	+ 53	5	6,530	—
Walsall Corporation	..	704	+ 90	19	12,334	+
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	..	3,186	+ 406	5	15,899	+
Wolverhampton Corpn.	..	1,0..	+ 100	5	5,331	—
Yorkshire W.R. Trams	..	1,1..	+ 90	19	28,176	—

(a) These comparisons are with the corresponding period last year. * Partly electric
† Includes omnibuses &c. ‡ Minus 2 days. § Minus 3 days ¶ Plus 3 da
§ Plus 2 days. ** [illegible] last year.

THE ELECTRICIAN:

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NOTES.

Electronic Valves and Relays.

DURING the past three or four years the double anode vacuum valve has been coming to the front in telegraphy, especially wireless telegraphy, because it offers the long-sought solution of the problem of the sensitive and quick-acting relay. It is claimed for several forms of the valve that they can be arranged in cascade to amplify inaudible radiotelegraphic signals some hundreds, or even thousands, of times while preserving the wave form of the high-frequency current; so that delicacy and speed seem to be ideally combined. Perhaps the most familiar form of this gas relay is the audion amplifier of DE FOREST. In this, as in other valves, the vacuum tube has as cathode an incandescent filament of carbon or metal; it has as one anode a plate or cylinder, and as the other a grid mounted between the plate and the filament. The function of the filament is to keep emitting electrons or negative ions. The voltage pulse or wave to be amplified is applied between the filament and the grid; this alters the number or distribution of the free electrons or ions in the space round the filament, and in consequence the current produced between the plate and the filament by an auxiliary constant voltage is altered also. As this "side" voltage can be made fairly high the possibility of magnifying the primary alteration of ionic density is evident. Moreover, the higher the side voltage the greater the magnification.

IN a Paper that appears in this issue, Dr. IRVING LANGMUIR shows very strikingly how greatly this side voltage and magnification can be increased by means of extreme evacuation of the tubes. This is easily understood; for the complete removal of gas removes the opportunity of the formation of ions by collisions between electrons and gas molecules, which is the limiting factor in ordinary tubes. In LANGMUIR's tubes, in short, the ions are electrons, and consequently the "side" voltage may be raised to thousands of volts. Extreme exhaustion, however, is not the best state of tubes that are to be used as rectifiers or detectors, a matter also discussed in the Paper, which has long previously been discussed and utilised by Sir OLIVER LODGE in his valve for obtaining high voltage direct current from a transformer. These things, perhaps, are not the most remarkable features of Dr. LANGMUIR's work. Two others are of outstanding importance. In the first place, the improvements described in the Paper have enabled the Author to build tubes that will generate by well-known methods continuous high-frequency oscillations up to powers not before attained, so far as we are aware. In the second place, the valves can be used for controlling the delivery of high-frequency energy to an antenna. Put briefly, this control is effected by altering in the desired manner the potential of the grid, while the plate is connected to a point of high potential on the antenna. Trifling alterations of the grid potential compel great variations in the plate circuit, and in the antenna current. Here we have a most promising solution of the problem of the high-power microphone for wireless telephony. In conclusion, we may remark that the wonderful work which is already being performed in telegraphy by the aid of these ionisation instruments constitutes one of the most magnificent tributes to the ultimate wisdom of prosecuting the most abstract, and at first sight useless, branches of physical science that has ever been witnessed in the whole history of science.

The L.C.C. Tramway Strike.

IT is difficult to write in anything like temperate terms on the subject of strikes at the present time of national stress. The Empire is in the midst of a life and death struggle, the greatest in the history of the world, and yet certain sections of the community appear to think that the present is a time in which they should indulge in strikes. The latest movement of this kind is the strike of the London County Council's tramway employés. If the conditions of

the men were exceptionally bad it might be felt that there was some justification for their action. This, however, does not appear to be the case. The average wages paid to motormen is £1. 19s. 9d. per week, and that paid to conductors averages £1. 16s. 7d. Also, those men who are normally paid less than £1. 10s. 0d. per week are receiving a war bonus on account of the increased cost of living. Notwithstanding that the wages appear to be good, the men struck first of all for a war bonus throughout; this has, however, now been changed to the more ambitious demand of 1s. per day extra. This would involve an additional expenditure of £216,000 per annum, and is altogether out of the question for an undertaking which is already not paying its way.

It should surely be understood that no section of the community has the right to demand that it shall feel no effects of the war, due to increased cost of living or otherwise. Although everyone will admit that a large proportion of the workers have responded nobly to the call of their country, this very response has left behind a residue of men who seem to be deficient in all sense of patriotism, and who are willing to take advantage of the occasion for their personal ends alone. With this idea in view they are prepared to break through any agreement and to act without the support of their union officials. The effect of the strike on the L.C.C. tramways, apart from the inconvenience caused to hundreds of thousands of individuals, is to cause a diminution in Government work. It is true that an effort has been made to maintain the service to Woolwich, but this has been only half-hearted; and it must be remembered that Woolwich is not the only centre of Government activity in the metropolis. The whole thing shows a most regrettable state of mind. At the conclusion of the meeting of the Council on Tuesday Mr. G. H. Hume, Chairman of the Highways Committee, read a letter from an ex-motorman, now serving with the Army at the front, in which the writer said that if he had his way he would put Service uniform on everyone who had come out on strike. This is a common-sense point of view, and drives us to the conclusion that the only solution of difficulties of this kind is the adoption of compulsory military service so that these industrial stoppages may cease. This would be a grave step to take, but it seems to be inevitable if the war is to be protracted and to be carried to a successful conclusion with a minimum of loss in men and treasure. The only satisfactory feature of this disgraceful move of the L.C.C. tramway employés is that the public seems prepared to support the Council in compelling the strikers to ask for forgiveness and to be allowed to return to their work on the old terms. We hope the Council will be equal to the occasion.

A "Question-Box" Convention.

It is a common experience in arranging technical meetings that there is difficulty in obtaining a suitable selection of Papers for reading and discussion. Engineering matters have a way of becoming standardised so that they no longer offer points which are open to great differences of opinion. On the other hand, there are many minor points which, although not sufficiently important to form the subject of a Paper, are of considerable interest and even importance. The difficulty of dealing with such points has been overcome in a novel way in the United States by holding what is called a Question Box Convention. The exact procedure is not indicated, but presumably members who are willing to raise questions on which they desire information put their questions into a box, and the queries are drawn from time to time as the discussion flags. As to who has the privilege of expressing the first opinion on any of these topics is not stated, and we can quite imagine that there might be some difficulty in inducing members to take on this task. Be this as it may, the idea seems to have worked in a very satisfactory way in Boston, where an informal discussion of this kind took place among an audience of some 300 members. One advantage, which should not be overlooked, is the cheapness of the procedure, the cost in this particular case not exceeding £20. From the account given of the proceedings it is evident that the discussion took a very practical line and had reference to all sorts of topics. We can also imagine that the discussion had a certain freshness about it which is often wanting in the discussion of a serious Paper. We commend this new method of conducting a meeting to the Incorporated Municipal Electrical Association if that body should find any difficulty in arranging a programme next year.

Locating Shell Fragments in Wounds.—A method of localising shell fragments or other pieces of magnetic material in the human body, which has recently been tested in France, is noted in the "Engineer." A powerful alternating current electro-magnet is brought near the region affected, and the presence of a magnetic body within the flesh is indicated by a perceptible trembling of the surface at the immediate locality. By feeling the flesh the surgeon can easily find the spot where the trembling is strongest, and can thus locate the fragment of projectile with considerable accuracy.

Pacific Cable.—The following categorical account of the alleged visit of an armed raider to the Bamfield Creek station (British Columbia) of the Pacific Cable Board appeared in the "Yorkshire Post" and "The Times" (London) during the week:—

"A telegram from Vancouver, British Columbia, announces that yesterday morning armed raiders made an attack upon the Pacific Cable Station at Bamfield Bay, Vancouver Island. Several men landed from a boat, and made a hasty attempt to cut the cable which connects Canada with Australia. The sentry on duty immediately fired at them and the men in the guard out. The guard rushed to the beach, but the men by that time had jumped into their electric launch and were making off. Shots were fired after them, but it is not known whether any of the raiders were hit. Owing to the promptness of the sentry, no damage has been done to the cable. It is thought that the raiders were Germans from the adjoining State of Washington. The Government has now ordered a patrol boat to guard the station from the sea."

On applying to the Pacific Cable Board in London for verification, or otherwise, of the above report, we are informed that the incident is entirely without foundation.

Differential Gearing and Corrugation.—An interesting experiment is being tried on the Huddersfield Corporation tramway system to prevent corrugation of the rails. According to the "Electric Railway and Tramway Journal," Mr. R. H. Wilkinson, the general manager and engineer, has devised a differential gearing which has been fitted to 11 of the Huddersfield cars, his view being that by thus endeavouring to eliminate the slip and skid of the wheels the cause of the formation of corrugations will be removed. These 11 cars are running with a section from which the corrugations have been carefully ground out. So far sufficient time has not elapsed for any definite results to be obtained, but it is stated that the indi-

tions up to date are of a favourable nature. It had been anticipated that the use of differential gears would have led to some small reduction in the consumption of current, but this economy has not materialised, although, on the other hand, there is evidence of a distinct increase in the life of tyres.

Government Assistance for Industrial Research.—As briefly mentioned in our last issue, a joint deputation from the Royal Society and the Chemical Society was received by the President of the Board of Trade and the President of the Board of Education on May 6th. The deputation, which was introduced by Sir William Crookes, consisted of Prof. A. W. Crossley, Dr. H. J. H. Fenton, Dr. M. O. Forster, Prof. W. H. Perkins, Prof. W. J. Pope, Prof. Arthur Schüster, Prof. A. Smithells, Prof. J. F. Thorpe and Mr. R. W. F. Harrison representing the Royal Society; Dr. A. Scott, Prof. F. G. Donnan, Prof. P. F. Frankland, Prof. J. C. Philip, Sir W. A. Tilden and Dr. S. Smiles representing the Chemical Society; Dr. A. Chapman (President of the Society of Public Analysts), Dr. G. G. Henderson (President of the Society of Chemical Industry), Prof. Jackson and Mr. E. W. Voelcker representing the Institute of Chemistry.

Prof. W. H. Perkins, Sir W. Tilden, Prof. P. Frankland, Prof. W. J. Pope and Dr. M. O. Forster spoke in support of memorials from the Royal Society and the Chemical Society which had been submitted to H.M. Government on the position of the chemical industries, and the steps which might be taken to improve their status and efficiency in the United Kingdom. The speakers drew attention to the fact that the comparatively backward state of certain industries in this country is due to a failure to realise that modern industry to be successful must be based on scientific research, and to the lack of association between manufacturers and science combined with a want of scientific knowledge and appreciation of the importance of scientific work amongst the public generally, and the lack of organisation among the various chemical and allied industries. The deputation advocated Government assistance for scientific research for industrial purposes, the establishment of closer relations between the manufacturers and scientific workers and teachers, and the establishment of a National Chemical Advisory Committee for these purposes. Mr. Runciman, in reply to the deputation, pointed out that the Board of Trade fully appreciated the extent to which national industrial progress is dependent upon the utilisation of the services of men of science, and the importance of provision for the thorough training of a very much larger number of industrial chemists than are at present available. He agreed with the views expressed as to the need of closer co-operation between manufacturers and scientific workers and teachers. The war had shown the weakness of our position in certain important respects, and he was in full sympathy with the general views expressed by the deputation. The actual proposals would receive careful and sympathetic consideration. Mr. Pease informed the deputation that the particular problems to which they had drawn attention had been present to the Board of Education for some time past, and that a scheme had been approved in principle by which substantial additional assistance would be given by the Government to scientific education and to industrial research. He hoped that though the funds immediately available might not be large they would be sufficient to enable an organisation to be brought into being at an early date, which would be capable of expansion subsequently. Mr. Pease further expressed his appreciation of the offer of assistance and advice by members of the two societies represented at the deputation.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Dr. C. C. Garrard contributes the first part of an article on "Balance Systems of Protection" (p. 236).

An article on "Electric Bells," by Mr. C. Turnbull, appears on p. 249.

Dr. H. F. Parshall contributes an appreciation of the late Dr. F. S. Pearson (p. 248).

We publish an abstract of the President's Address to the South African Institute of Electrical Engineers, by Mr. B. Price, on "Power Supply on the Rand" (p. 231). Our leading article deals with this subject (p. 246).

A description of the electricity supply undertaking just started at Karachi, India, appears on p. 234.

The new gas-driven electric supply station at Wood Green is also described (p. 239).

A Paper on the "Pure Electron Discharge and its Applications in Radio Telegraphy and Telephony," by Dr. I. Langmuir, is abstracted (p. 240).

We abstract a Paper on "The Use of Gaseous Power in White Light," by Messrs. C. C. Paterson and B. P. Dudding (p. 251).

Companies' Meetings and Reports. Meetings of the Anglo American Telegraph Co., Lisbon Electric Tramways, Penarth Electric Lighting Co. and South Wales Electrical Power Distribution Co. are reported; and the directors' reports abstracted include those of the Brisbane Electric Tramways Investment Co., Canadian General Electric Co., Electric Construction Co. and United River Plate Telephone Co. (pp. 260-261).

PERSONAL.

At the meeting of the Great Northern Telegraph Co. at Copenhagen, recently, the chairman announced the early retirement of Mr. F. C. C. Nielsen, the Company's representative in London.

Mr. Nielsen is one of the best-known men in the telegraph service in London, having since Oct. 1, 1883, been manager for the Great Northern Company in the metropolis. Since 1890 he has acted as the Company's representative in England, and was present on behalf of his Company at the International Telegraph Conferences at Berlin (1885), Paris (1890), Budapest (1896), London (1903) and Lisbon (1908). He entered the service of the Great Northern, China and Japan Extension Telegraph Co. as far back as March 1, 1870, and soon after saw service in China and Japan. He was agent in Yokohama in 1875, and became superintendent at the Amoy station in 1877. From there he passed on to Hong Kong, returning to Europe in 1878 to take up an appointment as secretary of the Great Northern Company at Copenhagen, from which position he was transferred to London, as above mentioned. Mr. Nielsen retains his connection with his old Company in a consulting capacity. His many friends in England will be glad to know that his convalescence from his recent ill-health is almost complete, and will wish him long enjoyment of his well-earned retirement. Mr. Nielsen has been the recipient of many distinguished appreciations from the Danish, Russian and Japanese Governments for valuable services rendered. He was born at Copenhagen in 1851, and matriculated at the University of that city in 1869.

His many friends in the electrical and allied industries will sympathise with Mr. C. Orme Bastian on the loss of his only son, Second-Lieut. Stanley Bastian, of the 4th Battalion Seaforth Highlanders, who was killed in action in France on May 9. Lieut. Bastian, who joined the forces at the outbreak of war as a private in the "Artists," was granted a commission as recently as April last. He had been out at the front since early in November, and was a platoon sergeant at the Battle of Neuve Chapelle. He was born in 1892, and when war broke out was with Messrs. Dick, Kerr & Co. He was the grandson of Dr. Charlton Bastian, F.R.S.

Mr. J. H. Cardew, electrical engineer, North-Western Railway, India, has resigned from the Government service, and Mr. D. A. Petruse, foreman electrician, has been placed in charge of the office of the electrical engineer of the Railway.

Mr. H. M. Taylor, the borough electrical engineer of Middlesbrough, has tendered his resignation in consequence of his having received a commission as first lieutenant in the Royal Marines (Submarine Miners).

Mr. C. L. Faunthorpe, an assistant electrical engineer at Blackburn, has accepted a commission in the West Kent Regiment.

Mr. Percy Taylor, assistant electrical engineer at Darwen, has enlisted in the motor transport service.

APPOINTMENTS VACANT AND FILLED.

A linesman is required for electrical department in India; thoroughly qualified in h.t. three-phase transmission line work and capable of attending to motor repairs. Salary £275 first year, £300 second and third years, with bungalow accommodation and allowances. *See advertisement.*

A works manager is required for important cable works. *See advertisement.*

Messrs. Pellew, Harvey & Co., 62, London Wall, London, E.C., advertise for a mechanical electrical engineer.

Electrical fitters, scientific instrument makers and armature winders are wanted in H.M. Dockyard, Portsmouth. Wages 39s. per week, plus 3s. war bonus. Applications to Electrical Engineer, H.M. Dockyard, Portsmouth, stating experience, age, &c.

An advertiser requires an instrument maker for the supervision and repair of standard instruments in large works.

The Commissioners for the Port of Calcutta require an assistant to the superintendent of machinery. Candidates must have had thorough mechanical and electrical training. Salary Rs.450 per month, rising by increments of Rs. 50, to Rs. 600, with free quarters, &c. Applications to the consulting engineer and London agent (Mr. J. Angus, M.I.C.E.), 17, Victoria-street, S.W., by May 28.

A shift engineer and a switchboard attendant are required for electricity supply works. *See advertisements.*

The Secretary of State for India has appointed Mr. C. C. T. Eastgate to be electrical inspector to the Government of the Punjab, Lahore.

Fulham (London) Electricity Committee recommend the Borough Council to appoint Mr. H. Woolgar, fourth engineer, to the position of temporary shift engineer, during the absence of Mr. A. Ardern on military service, at £3 per week. Mr. L. Float, junior engineer, will take Mr. Woolgar's place, at £2. 2s. per week.

INSTITUTIONS AND SOCIETIES.

Benevolent Fund of the Institution of Electrical Engineers.—The seventeenth annual general meeting of the contributors to the benevolent fund will be held at the Institution of Electrical Engineers, Victoria Embankment, London, W.C., on Thursday, May 27, 1915, at 7:45 p.m., immediately preceding the annual general meeting of the Institution, to receive the report of the committee of management and the statement of accounts and balance-sheet to Dec. 31, 1914. At this meeting the names of the committee of management for 1915-1916 will be declared.

Electric Vehicle Committee.—A meeting of this Committee was held in London under the chairmanship of Mr. R. A. Chattock on May 11. The Committee considered and passed the draft for the Committee's annual report and accounts. These will be incorporated in the annual report of the I.M.E.A. The secretary submitted the draft of the report to be submitted for discussion at the annual meeting of the I.M.E.A. on June 17, entitled "The Uses of the Electric Vehicle in Municipal Service." The report was provisionally approved and ordered to be submitted to the Council of the I.M.E.A. The arrangements were discussed for the proposed parade of electric vehicles on June 17, and the time was provisionally fixed for 5 p.m. The secretary is now to obtain the permission of the police to the parade being held on the Embankment. A number of matters relating to details connected with the publication of the "Journal" and publicity matters were dealt with. It was reported that, as the result of the circular letter sent to electric supply undertakings, a number of undertakings had purchased publicity material. The secretary, however, reported that he had received several letters which indicated apathy on the part of some undertakings in regard to the electric vehicle business. The technical sub-committee have now completed the preparation of the report upon "Methods of Charging and Charging Equipments," and this is to be circulated to all members of the Committee for consideration at the next meeting. As to further standardising of details appertaining to lead plate batteries, the Committee has decided to ask the Accumulator Section of the B.E.A.M.A. to consider the desirability of bringing about standardisation in regard to: (*a*) The clearance for the accumulation of sludge between the lower edge of the plates and the bottom of the cell container; (*b*) the size of the filler plug hole and a design of plug for same; (*c*) the distance between the top of the lip of the plug hole and the top edges of the plates so that one gauge may always be used in a garage for fixing the proper level of the electrolyte, measuring from the top edge of the filler hole lip; (*d*) details of connectors between cells and method of connecting these to the plate terminals.

Junior Institution of Engineers.—In a Paper before this Institution on the subject of cranes, Mr. C. H. Woodfield said that in the comparison of steam or hydraulic cranes with electric cranes, there was not a single feature in favour of the two former, either as regards first cost of installation, durability, economy in working and upkeep, or facility of control. Hydraulic and steam cranes were being converted into electric ones, and some of the reasons why this was being done were the considerable saving obtainable from power generated at a common station over a separate generator, such as a steam boiler for each crane, the greater risks from fire in the employment of the steam boiler, the inconvenience of getting the fuel and water to the several cranes and keeping the pressure ready in the boiler for use as required. For cranes where great force was required through a comparatively short stroke, hydraulic power possessed advantages. Hydraulic engineers claimed for this type that there were fewer working parts, with a minimum of movement and wear, and that there was an entire absence of revolving shafts or gears to break when the crane was overloaded, as the hydraulic power could be exerted to the maximum extent with impunity, whereas in the geared crane, overloading led to breakages. The disadvantage with the ordinary hydraulic crane was that it cost as much to lift the minimum load as the maximum, and when the crane was running on light loads for a period, the power was uneconomical. There was practically no flexibility in the use of hydraulic power, and to obtain even a limited flexibility, costly hydraulic rams and operating valves had to be employed. For cases where the cranes or hoists were required to be worked from a position away from the cranes or hoists, an electric control was a distinct advantage. Another feature in favour of electricity was that with the use of series wound motors varying speeds could be obtained according to the load being raised, so that for light loads a quick speed was obtainable, whereas for heavy loads the speed of the motor adjusted itself to a lower rate. The life of the electric motor being about 25 years compared favourably with the life of any other machine.

Institute of Radio-Engineers.—A meeting of this Institute was held on Wednesday, May 5, in New York, when a Paper on "The Pupin Theory of Asymmetrical Rotors in Unidirectional Fields, with Special Reference to the Theory of the Goldschmidt Alternator" was read by Mr. B. Liebowitz.

Iron and Steel Institute.—At the annual meeting of this Institute, which was held in London on Thursday and Friday of last week, it was resolved, on the recommendation of the council, that the names of all enemy aliens should be removed from the list of members, and that steps should be taken to amend the bye-laws, so that they provided for the future that, in the event of war existing between this and other countries, citizens or subjects of those countries, who were members of the Institute, should *ipso facto* cease their membership. Out of a total membership of 2,086 there were 632 foreign members, and of these 101 were of German, Austrian or Hungarian origin, and their names were accordingly removed from the list of members.

EDUCATIONAL NOTE.

University of Manchester.—Particulars of the lecture and laboratory courses in physics, preparing for both the ordinary and honours degrees, will be forwarded on application to the Registrar. Prof. Sir E. Rutherford will meet intending students on Thursday, Oct. 7, at 10:30 a.m.

ARRANGEMENTS FOR THE WEEK.

THURSDAY, May 27th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Annual General Meeting at the Institution, Victoria Embankment, London, W.C.

FRIDAY, May 28th.

PHYSICAL SOCIETY.

5 p.m. Meeting at King's College, Strand, London, W.C. Agenda: Papers on "Numerical Relations between Electronic and Atomic Constants," by Dr. H. S. Allen; "A Method of Calculating the Absorption Coefficients of Homogeneous X-Radiation," by Mr. H. Moore; "Two Experiments Illustrating Novel Properties of the Electron Currents from Hot Metals," by Prof. O. W. Richardson, F.R.S.; and on "High Permeability in Iron," by Prof. E. Wilson.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Discourse on the "Engineering Problems of Mesopotamia and Euphrates Valley," by Sir John Jackson, C.V.O., M.P.

THE NATIONAL RELIEF FUND.

(Treasurer, H.R.H. The Prince of Wales.)

This great National Fund, for the relief of those amongst the needier classes who are widowed, orphaned and otherwise affected by the fighting in which our troops and ships are now taking part, urgently seeks contributions however small. These can be sent with the following note, which can be cut out, filled in, put in an envelope and sent *unstamped*, addressed H.R.H. The Prince of Wales, Buckingham Palace, London.

Date .....

I enclose £ s. d. *to assist the Prince of Wales*

NATIONAL RELIEF FUND.

Name .....

Address .....

.....

POWER SUPPLY ON THE RAND.*

It may perhaps be of interest if I submit a few notes on some general aspects of electric power supply to the mining industry in the Johannesburg district, and in doing so I shall confine myself to a description of the main features of the power companies' business, drawing a comparison between its salient characteristics and those of other typical schemes. The business is controlled by two companies—the Victoria Falls & Transvaal Power Co. and the Rand Mines Power Supply Co.—the latter company being a subsidiary of the former, and the combined system being operated and managed by the Victoria Falls & Transvaal Power Co. For present purposes, therefore, the business may be treated as one complete scheme, and as such it ranks as one of the largest in the world. The following general description of the system is necessary for a proper appreciation of the statistics which follow.

Typically, the scheme is one which supplies a single industry, comprising a relatively small number of relatively large consumers scattered over a compact area. The area takes the form of a narrow strip about 45 miles long, stretching from east to west. There are three generating stations along this strip—namely, Brakpan at the far eastern end, Rosherville at about the centre and Simmer Pan between the two. There is also an outlying station on the Vaal River at Vereeniging, situated about 35 miles due south of Johannesburg, which feeds into the area at Robinson Central, a point about 5½ miles west of Rosherville. It will be seen, therefore, that there are four points of supply along the narrow area, and, as the density of the load is greatest in the neighbourhood of these four points, the

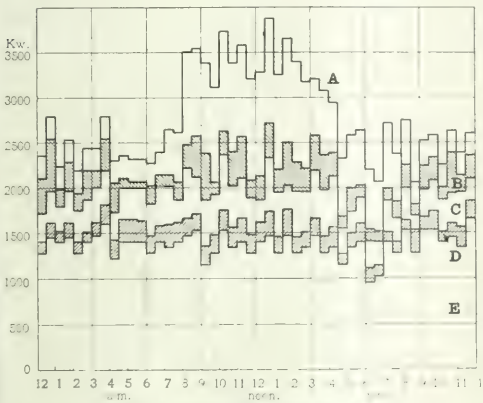


FIG. 1. TYPICAL SINGLE SHIFT MINE.

A Compressors. B Hoists. C Surface. D Underground. E Mills and tubes.

average distance of distribution is small compared with that which would be necessary in many schemes. Distribution is carried out at 20,000 volts overhead or underground over all sections of the area, excepting that in the neighbourhood of Simmer Pan and a small portion of that fed from Brakpan, where the pressure is 10,000 volts. The choice of these relatively high pressures has been determined by considerations of economy in capital cost of lines, cables and switchgear, rather than of pressure drop. The main transmission system virtually consists of overhead interconnections at 40,000 volts between the four points of bulk supply, and of two similar lines running west from Robinson Central to feed the relatively small section of the load at the extreme western end of the area. The power generated at Vereeniging is transmitted to Robinson Central at 80,000 volts. The railway charges on coal from the Middleburg colliery district (which lies some 70 miles to the north-east of the area of supply) are heavy, and the supply of cooling water within the area is restricted. It has, therefore, proved advantageous to expend capital upon transmission lines from an outlying station situated favourably as regards water supply and in close proximity to a colliery, and to transmit energy therefrom in the form of electricity rather than in the form of fuel. Under these conditions, the stations at Vereeniging and Brakpan, which are nearest to the source from which their fuel is drawn, are operated at the highest possible load factor, and Simmer Pan and Rosherville are left to take the remainder of the load at a lower load factor. The following table gives particulars of the demand and consumption of the three classes of consumers served by the companies:—

* Extract from the Presidential Address to the South African Institute of Electrical Engineers, by Mr. Bernard Price.

Table I.—*Particulars of Consumers Connected to the Power Companies' System.*

Class of consumer.	No. of consumers.	Aggregate of non-simultaneous maximum demands at points of delivery, January, 1915.		Units consumed per annum.	
		Kw.	Per-centage of total.	Millions of units.	Per-centage of total.
Mining	65	95,000	98·0	514·5	99·00
Industrial	8	1,100	1·1	2·8	0·55
Bulk supplies to municipalities	5	900	0·9	2·3	0·45
Totals	78	97,000	100·0	519·6	100·00

It will be noted as an outstanding feature that no less than 99 per cent. of the business is represented by supply to the mining industry.

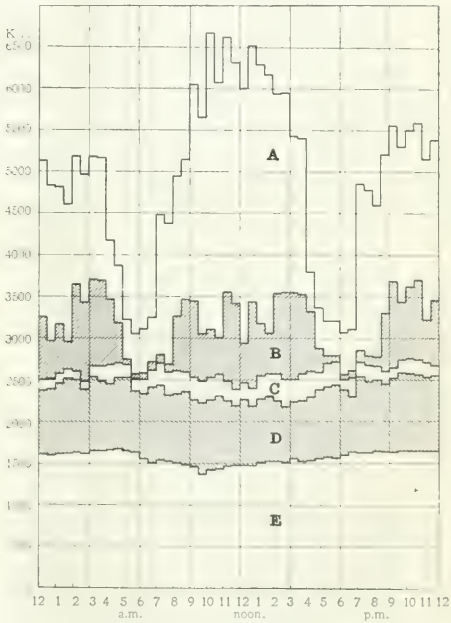


FIG. 2.—TYPICAL DOUBLE SHIFT MINE.

A=Compressors. B=Hoists. C=Surface. D=Underground. E=Mills and tubes.

Figs. 1 and 2 give a general idea of the type of supply taken by such mining consumers as have completely electrified their mine. Fig. 1 is for a mine working single shift and Fig. 2 for one working double shift. The compressor load for this latter mine is probably somewhat higher than that for an average case, but otherwise the charts may be considered typical. I shall return to these diagrams later, but in the meantime it may be noted that the load in both cases is at its highest between the hours of 8 a.m. and 4 p.m. in the daytime. Fig. 3 shows certain load curves of the power companies' system, including only the electric business proper. As you are aware, the Rand Mines Power Supply Co. also supplies upwards of 2,000,000 tons of compressed air per annum at a gauge pressure of about 100 lb. per square inch, and a portion of this air is compressed by means of electrically driven compressors at Robinson Central. As I am now dealing solely with the electric power actually sold as such, the power used for driving the power companies' compressors has been excluded.

A similarity between the shapes of the load curves of typical consumers and of the power companies' system will be at once apparent, the similarity being due to the fact that the cycle of operations is virtually the same on all mines. Whilst no doubt a certain number of consumers work double shifts, this does not

influence the fact that the periods of maximum demand for all consumers overlap. The shape of these curves is of first importance, because upon it depends to a very large extent the cost of furnishing the supply. The load factor of the combination of a number of individual supplies may be influenced by both the load factor and the diversity factor of the individual supplies, and the inter-relationship between these two factors is not always easy to follow. The complexity of the subject is, however, reduced when dealing with a very large system such as that under consideration, because the effect of all short-time fluctuation may then be ignored. Standard plant of the type and size now in use, when fully loaded by the hourly average rate of supply, is capable of meeting the short-time peaks without undue strain. Large generators and transformers absorb a considerable quantity of heat for a relatively small increase in temperature, and consequently respond but sluggishly in temperature to the fluctuations of heat generated within them. Similarly, the boiler plant has a considerable storage capacity for energy, and one of the special characteristics of a steam turbine is its ability to meet heavy overloads without distress.

It may in fact be said that, as the size of a system increases, the percentage short-time variation in load tends to decrease, whilst the ability of the plant to deal with such variations increases owing to the increase in the size of unit of plant which can be usefully employed. Although some of the winders in this district are unusually large, the largest of them represents a momentary peak of only about 3½ per cent. of the system peak, and at times, when two such winders happen to synchronise, the variation will be only about 7 per cent.,

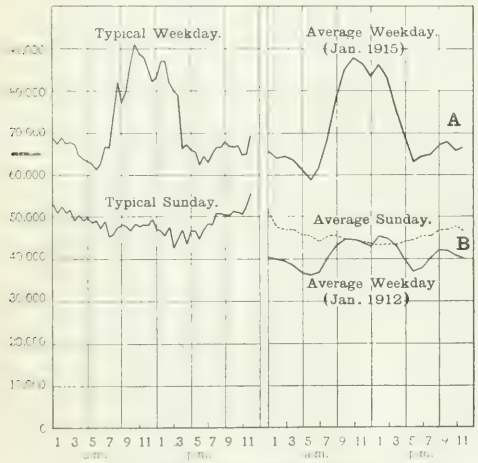


Fig. 3.—Daily Load Curves.
Combined system, V.F.P. Co. and R.M.P.S. Co.
A = Units for day, 1,892,600; load factor, 1 for 90+
B = Units for Sunday, 1,090,000; load factor, 1912, 90·0.

lasting for a couple of minutes at the most. The average rate of supply taken over an hour is, therefore, a satisfactory guide as to the amount of plant required for meeting the service, and for this reason statistics regarding loading are taken on the basis of units per hour. I will refer to load curves made out on this basis as "smoothed load curves"—that is, curves on which the short-time fluctuations have been averaged over an hour. This basis is very convenient in everyday practice, because integrating instruments have to be provided in any event for measuring station output and consumer's consumption, and such instruments are very reliable and accurate. Moreover, it is a simple matter to provide attachments to the sub-station integrating instruments, which will record on a dial the maximum of the hourly consumptions, thus rendering it unnecessary to record each of the many hundred hourly figures and to then select the maximum therefrom. The installation of such apparatus at every point of supply throughout the system enables accurate and complete data to be obtained regarding the load factor and diversity factor of the smoothed curves of the various supplies.

The diversity between any given selection of supplies may, I think, be considered as being of two independent types. Firstly, there is such diversity as may be due to a fundamental difference in the shape of the smoothed load curves of component supplies, having due regard to time (I will refer to this as "fundamental diversity"); and, secondly, there is the diversity which is due to irregularities in that portion of each of the smoothed load curves which falls within the period of the maximum demand on the system (I will refer to this as "general diversity"). In most large schemes the general shape of the load curves of individual supplies differs more or less for the several classes of consumer served, on account of differences in the type of business carried on and differences in the cycle of operations peculiar thereto. In other words, most schemes derive considerable benefit from fundamental diversity between the demands made by several different classes of consumers, whereas there is virtually no fundamental diversity on the system of the power companies in this district at present date. The diversity here may be attributed entirely to general diversity—that is, to the interleaving of the fluctuations on the smoothed load curves of individual consumers during the period of maximum demand of the resultant supply. Reference to Figs. 1 and 2 will show, however, that this general diversity will not be inconsiderable, as the amplitude of the hourly fluctuations on the smoothed load curves of individual consumers during the period of the peak is by no means small. To my mind, the clearest way to express diversity is to take the ratio between the aggregate of the individual maximum demands (which are *non-simultaneous*) and the maximum aggregate of *simultaneous* individual demands taken at the points of delivery in each case. The aggregate of the non-simultaneous maximum demands is arrived at by adding together the readings of the maximum demand attachments of the sub-station watt-hour meters described above. The maximum aggregate of simultaneous individual demands cannot be conveniently measured at points of delivery which are scattered all over the area, but is arrived at by selecting the maximum number of units sent out from generating stations during the successive hours of the period in question, and then correcting this figure for loss in transmission and distribution.

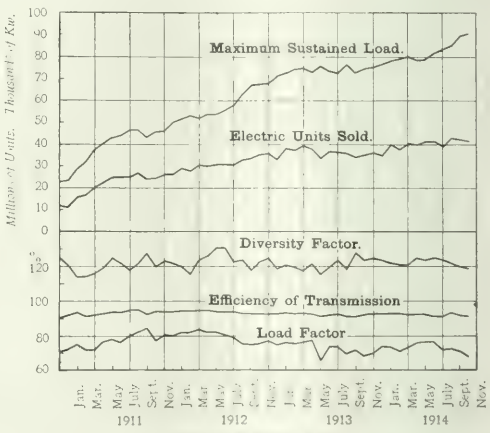


Fig. 4.—Electric Load.
Combined system, V.F.P. Co. and R.M.P.S. Co.

In Fig. 4 statistics are given regarding the load factor, diversity factor and losses for the power companies' system in the form of monthly figures extending over the last four years. It will be observed that the diversity factor (which is calculated as above described) varies between 1·2 and 1·25, which means that 20 to 25 per cent. more plant would have been required to meet the supplies if there had not been diversity between the hourly humps and hollows on the shape of the smoothed curves of the individual supplies. This factor, being obtained from smoothed curves only, eliminates the very much greater amount of diversity which must exist between the short-time fluctuations on the charts obtained from curve drawing wattmeters. Such short-time fluctuations of the individual supplies are almost entirely due to the winders and haulages, and there are so many of these that very complete diversity takes place between them. Table II. is interesting in this connection.

It will be noticed that the system supplies no less than 143 winders (excluding haulages), aggregating 55,000 kw. at continuous rating. I do not think there is another scheme in the world which is supplying such a large capacity of this class of load.

An intermittent supply of this type, involving as it does a very heavy momentary peak, which is often taken at relatively low power factor, is generally considered an unfavourable type of supply from the power companies' point of view; but this is only partially true. The reduction in power factor is undoubtedly most objectionable,

Table II.—*Particulars of Winders Connected to the Power Companies' System.*

	Type of winder.	No. of winders.	Total installed capacity at continuous rating.	Average size at continuous rating.
			H.P.	H.P.
Underground winding	A.C. winding motors ...	62	17,600	284
"	A.C. geared hoists	52	22,300	430
Surface winding	A.C. direct-coupled hoists	10	12,700	1,270
"	Ward-Leonard hoists ...	19	21,400	1,130
	Totals.....	143	74,000	517

	H.P.
Continuous rating of largest Ward-Leonard hoist ...about	5,000
Present momentary peak demand for ditto ... ,,	9,000
Continuous rating for largest a.c. hoist..... ,,	1,600

The above figures are specification ratings.

ut whereas a small number of such loads connected to a relatively mall system would necessitate an increase in both the kilowatt and ilovolt-ampere capacity of the system plant for the sole purpose meeting the momentary demand caused by synchronisation of e individual peaks; and whereas such loads would prejudicially

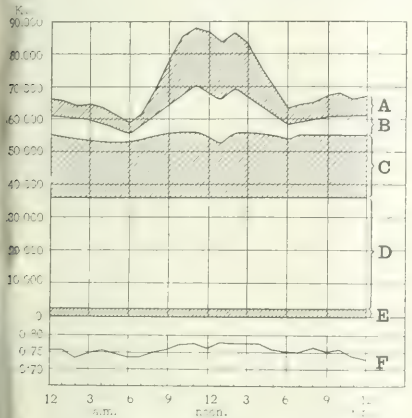


FIG. 5.—COMPOSITE LOAD CURVES (APPROXIMATE).
Combined system, V.F.P. Co. and R.M.P.S. Co.

A=150 winder and winder (55,000 kw. installed).
B=27 compressor (17,600 kw. installed).
C=Miscellaneous load, underground and surface.
D=4,000 stamps and 200 tubes.
E=Industrial and municipal supplies. F=Power factor.

ct the voltage and speed regulation of the system, a large number ich supplies connected to a large system diversify very fully, and e no prejudicial effect other than the reduction in power factor. ay, in fact, be said that, once having connected a few winders large system, it is beneficial, so far as the diversity and regulation the system is concerned, to add as many as possible. Under the litions obtaining on the power companies' system to-day, the ition of a new large winder has no more effect upon the load curve the system than the addition of a load having a smoothed curve milar to that of the winder.

Fig. 5 an attempt has been made to show how the power com- ies' system load curve is built up. To do this accurately would ve the collection of an enormous amount of data; in fact, it ld be necessary to obtain the actual smoothed load curve of each on of each component supply. A sufficiently close approxima- can, however, be obtained by assuming certain diversity factors the several components and by calculating the maximum demand the particulars of the total installed capacity of each class of om consumers' premises. Certain assumptions have also been with regard to the shape of the load curves of individual ons of the supply; but I think the following conclusions may be drawn from this diagram: (1) If it were not for the load taken compressors and winders the system load curve would be very flat, and would probably have a week-day load factor of over per cent. As a corollary, the miscellaneous load on the surface underground has a relatively high load factor. (2) There is a pronounced valley in the system load curve between the two shifts on the mines—that is, about 6 a.m. and 6 p.m. The relatively small rise in the load after 6 p.m. and until 6 a.m., as compared with the large rise between 6 a.m. and 6 p.m., shows that a large majority of the mines now work single shift. This point is brought out very clearly when comparison is made between the week-day load curves, shown on the right-hand side of Fig. 3, for 1912 and 1915.

In January, 1912, the height of the night peak (taken from the mean of the bottom of the two valleys) is about 65 per cent. of the height of the day peak taken from the same point, whereas in 1915 (that is, three years later) the percentage had fallen to about 25 per cent. This increase in the proportion of day peak to night peak is largely due to the fact that many mines have changed from double to single shift working since 1912.

The week-day load factor of the system for January, 1915, as calculated from the six day average curve in Fig. 3, is 80·6 per cent., and it will be observed that the monthly load factor, as shown in Fig. 4, now varies between 70 and 75 per cent., depending largely upon the proportion which the number of Sundays bears to the number of week days in the month. In January, 1912, the week-day load factor, calculated from the curve in Fig. 3, is 90 per cent., and the monthly load factor at that date, as shown in Fig. 4, was about 80 per cent. If the load factor had remained at this figure of 80 per cent., instead of falling to the present average of 72·5 per cent., the plant capacity required on the power companies' system would to-day be reduced by about 8,500 kw., together with a corresponding reduction in the margin of spare plant of 2,100 kw., making a total reduction of 10,600 kw. This means that one of the large generating units at Rosherville or Vereeniging could have been dispensed with,

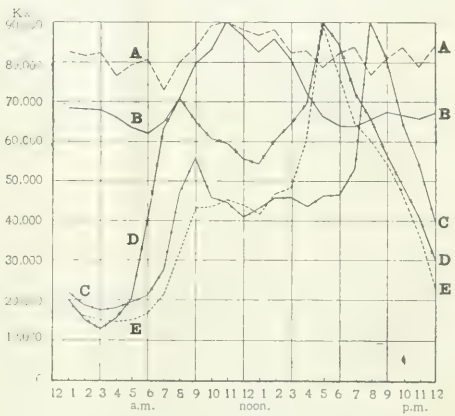


FIG. 6.—PRO-RATED LOAD CURVES.

A=Randfontein Estates, 5/2/1915. C=Johannesburg Municipality, 5/2/1915.
B=Power Co.'s., 5/2/1915. D=Chicago, 3/1/1912.
E=New York Edison, 21/12/1911.

and this is roughly a measure of the extent to which the electric business of the power companies has already been affected by the adoption of single shift working as a general policy by the industry.

The position as regards load factor and diversity factor may, therefore, be summed up by saying that the load factor of the power companies' system is high, because each and every consumer has a relatively high load factor. As compared with most schemes, diversity plays a very minor part.

The third curve in Fig. 4 shows the variation in efficiency of transmission and distribution during the last four years. This factor is the ratio which the total number of *high-tension* units delivered to sub-stations bears to the total number of units sent out from generating stations during each month. Although the units taken by consumers are measured at the low-tension 'bus bars in the sub-stations, 2 per cent. is allowed to the power companies in their use of mining consumers to cover transformer losses, and the over-all efficiency down to the low-tension meters in sub-stations is, therefore, about 2 per cent. less than the figure shown on this curve. It will be observed that the efficiency has fallen slightly during the last two years, and now averages about 92 per cent. (that is, about 90 per cent. to low-tension 'bus bars). This fall is due to the increasing proportion of the output generated at the distant station at Vereeniging, and the fluctuations on the curve are accounted for by changes in the relative loading of the several stations, and the consequent change in the distribution of load over the transmission system. Fig. 4 also shows the growth of the maximum sustained load and

of the total output of the system since January 1, 1911. The maximum sustained load means the maximum number of units sent out from all generating stations during the successive hours of the month, or, in other words, the maximum hourly average load.

It may now be interesting to draw a comparison between the power companies' business and that of one or two other schemes. Fig. 6 shows the smoothed load curves of the Chicago, New York, Johannesburg and Randfontein systems for a single week day pro rated to that of the power company. By pro rated I mean that the curve for each scheme is proportioned up or down, so that it may have the same summit as the power company's curve. It will be observed that the load factor of the power companies' system is higher than that of either of the three companies which supply a miscellaneous collection of different types of consumers, whilst the load factor at Randfontein is higher than that of the power companies' system. I should mention, however, that the curve for Randfontein is not strictly representative, as Mr. Butt informs me that the conditions obtaining on the date in question were somewhat abnormal. The week-day load factors calculated from these curves are approximately as follows: Chicago, 56; New York, 44; Johannesburg, 47·5; power companies, 79·5; and Randfontein, 91·5.

The characteristics of the power companies' loads may be compared with that of, say, Chicago, on another basis—namely, by taking the number of hours of use of various percentages of the full amount of plant in service during the peak. From such curves it can be seen that the power companies use 90 per cent. of the peak capacity of plant for 1,000 hours per annum, as against less than 100 hours for Chicago, and that 50 per cent. of the plant is used for about 8,400 hours and 2,700 hours respectively. In other words, the power companies use 90 per cent. of their plant 10 times, and 50 per cent. of their plant for three times, as long as Chicago. It will be clear from these comparisons that conditions here on the Witwatersrand are unique. The present method of operating the mines results in a load curve having a peak of considerable duration, but this peak occurs at an unusual time, and would not overlap the peaks on the curves of a traction or a city lighting and power supply if these latter were added to the power companies' system.

As engineers we desire to get the best possible results out of our work; as business men we want to supply the greatest possible amount of service at the lowest possible cost to the consumer and the greatest possible profit to our own particular concern; but whether we be engineers or business men, or both, we all desire to avoid unnecessary waste of capital and of the world's resources. Mr. Ferranti, when addressing the Home Institution in 1910, boldly outlined a scheme for the generation and distribution of electric power for the whole of Great Britain, and showed the enormous saving in capital and fuel which would result if electricity were to become the universal medium for supplying all heating, lighting and power requirements. I personally believe that some day this vision will materialise, in a broad form if not in detail, and that even in the more sparsely populated continent of Africa the conservation of the country's resources by the aid of electric power will be deemed to be matters of national import. The difficulty is that changes of this order can only mature gradually, and small advances do not permit the large economies which would be secured if it were possible for the ideal scheme to be laid out from the beginning. There is, nevertheless, a vast field for conservation within immediate grasp. The power problem in London is an outstanding instance, and it is gratifying to see that there is at last some prospect of a combination of interests in that important field. America is already leading the way, as witness the rapid development of the Chicago Edison Company within recent years.

ELECTRIC SUPPLY AT KARACHI, INDIA.

Karachi, the most western of the four great ports of commerce in the Indian Empire, has during recent years been growing in importance at a phenomenal rate. It is not impossible that it will loom large in the future map of the world, as the Government have intimated that it will be the Indian terminus of the proposed great

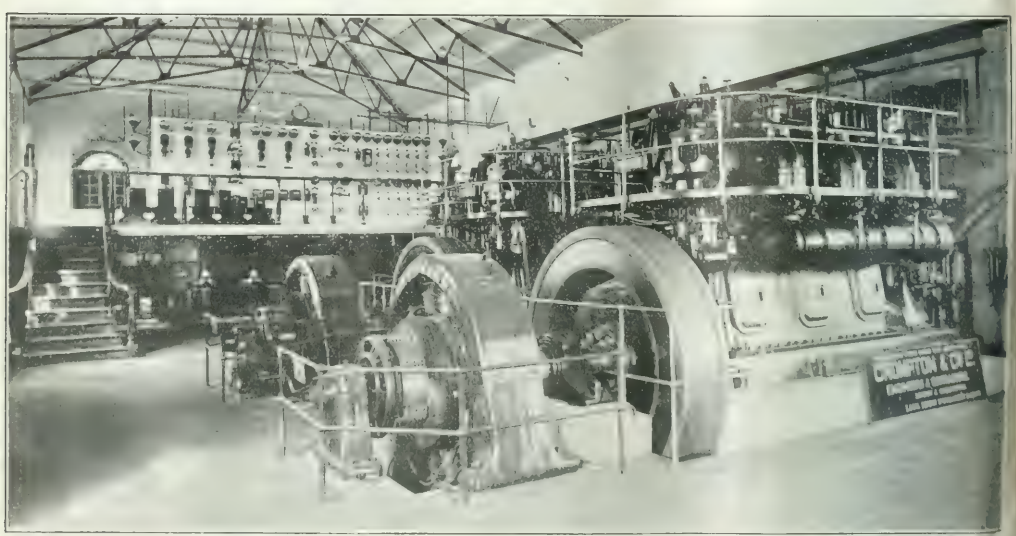


Fig. 1.—General view of Power House, showing Generating Sets and Switchboard.

Trans-Persia Trunk Railway, connecting Europe with India through Moscow and Baku, and surveys of the first part of the route from Isfahan have already been made. It is the chief outlet for the products of the Punjaub (wheat, oil-seed, cotton, &c.), and has considerable commerce with Afghanistan and Beluchistan.

The total trade of the port has increased by leaps and bounds during the past 10 years, as it amounted to £21,600,000 on private and Government account during the year 1905, in 1912 it reached the phenomenal figure of £40,725,000, while in 1914, despite the war, it was still £34,000,000. The population between the census of 1901 and that of 1911 jumped from 115,402 to 159,270, or an increase of 38 per cent. The commerce of the port overshadows everything else, but there naturally follow in its wake industries established there that pertain to commerce, among which are extensive local flour mills, ironworks, printing presses, soda water factories, &c.,

with land and facilities all ready for the considerable increase in the number that is sure to result from the general trend of events and the importance of the district.

Some years ago the port authority installed their own electric undertaking, but up to a month or two ago there was no public supply of electrical energy or of gas. The Hon. M. de P. Webb, C.I.E., of Messrs. Forbes, Forbes, Campbell & Co., was responsible for the preliminary steps in initiating a supply of electrical energy

Karachi. With the assistance of Messrs. Crompton & Co. the Hon. M. de P. Webb investigated the prospects of a public electric supply undertaking, as a result of which Messrs. Forbes, Forbes, Campbell & Co. decided to apply, under the Indian Electricity Act of 1910, for a Government licence to supply electrical energy in Karachi. This was granted in due course, and in 1912 the licensees retained Messrs. Handcock & Dykes, of Westminster, as their consulting engineers.

After some negotiations a very suitable site was selected in the Elander-road, with ample space for extensions, and with access to the railway. As a result of full consideration it was decided, having due regard to contingent circumstances, to install a direct-current Diesel-driven plant, with a three-wire system of distribution throughout the district, and early in 1913 the Karachi Electric Supply Corpn. was brought into existence for the purpose of taking over the rights conveyed by the licence and of putting them into effect. A contract for the complete equipment of the power house and distributors was entered into with Messrs. Crompton & Co., and shortly after that a start was made on the foundations. These in themselves were a matter of considerable magnitude in proportion to the works, as, owing to the nature of the soil, it was necessary to excavate to some considerable depth, the work being also impeded by tidal waters and land floods. All difficulties of this nature were gradually overcome, and a substantial armoured concrete bed put in position to receive the machinery.

The outbreak of the war caused considerable delay in the works, as the licensees from patriotic motives decided to transfer part of the staff to the wiring of troopships, while at a somewhat later stage the consulting engineers' representative and also some of the contractors' representatives on the spot joined His Majesty's forces. The work originally was to have been completed by the end of 1914, and, despite delays and other difficulties due to current events, on February 1, 1915, the completed station was formally opened by the Commissioner-in-Sind, Mr. R. P. Barrow, in the presence of a large gathering of the principal inhabitants. In a city like Karachi it was necessary to give very careful consideration to the relative merits of overhead and underground distribution, and the engineers ultimately decided in favour of the former.

The first section of the generating plant as at present installed consists of two 240 B.H.P. and one 100 B.H.P. Diesel engines, of Messrs. Mirrlees, Bickerton & Day's well-known pattern, direct coupled to Crompton 440 and 480 volt dynamos. These are illustrated in Fig. 1, which shows a general view of the power house.

The cooling of the circulating water was a question calling for careful consideration, and the engineers finally decided on using Messrs. Heenan & Froude's coolers, two of which have been provided, either being capable of dealing with the circulating water required at full load. The coolers are fixed in a cooler house opening out from the engine room, a 10,000-gallon water storage tank (fed from the town mains) being fixed above to provide the necessary "make up" water.

The main switchboard, consisting of 14 white marble panels—viz., three generator, two battery, two booster, two balancer, one summation, one earth and three feeder panels, complete with moving coil measuring instruments and switchgear—is mounted above the battery room, being thus raised some 7 ft. above the engine-room floor, as can be seen from Figs. 1 and 2. The battery consists of 276 Tudor cells, having a capacity of 653 ampere-hours at the 10 hours' rate.

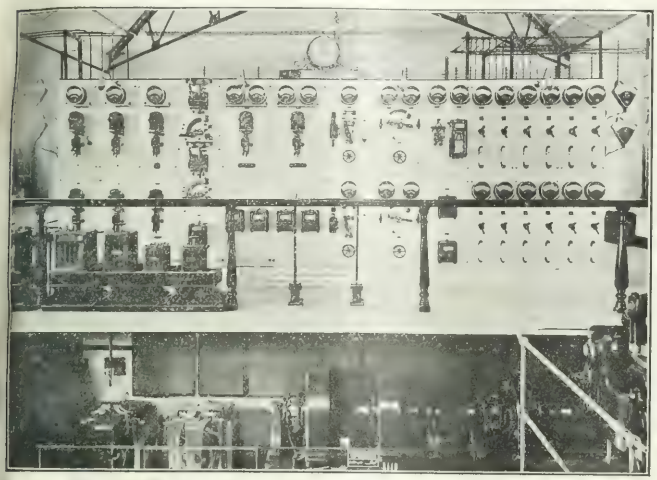


Fig. 2.—View of Switchboard, showing Booster and Balancer Sets below the Gallery.

The voltage of supply is 220 on either side of a three-wire system, 440 volts across the outers, but at full load the station voltage will rise to about 512 volts, to compensate for the drop in the feeders. This necessitates battery regulating switches having a large number of contacts. These switches are of the horizontal pattern, and are fixed in the floor above the battery room, behind the main switchboard, being operated by levers similar to railway signal levers, fixed in front of the board. Fig. 3 illustrates the back of the switchboard. Battery regulating switches are seen in the foreground.

There are two automatic balancers, each capable of dealing with an out-of balance current of 75 amperes, and three motor-driven boosters, each capable of a continuous output of 150 amperes at 0 to 115 volts. These are seen under the switchboard gallery in Fig. 2.

It was thought wise to start in the first place with direct current, as tending in the earlier stages to bring the undertaking more quickly to a remunerative stage, but it is not impossible that as the area and the scope of the operations is extended, a mixed system will be adopted to meet the probably large demand for energy for power purposes that is sure to grow up. The station has been built with a loose end to allow future extensions to be easily made. In the present building there is room for another 200 kw. set to be laid down.

The whole of the overhead work has been carried out in strict accordance with the regulations of the Indian Government, and is most substantial throughout, with a considerable margin in the strength of the poles for additions as the undertaking develops. The weight of copper installed with the first section is 35 tons.

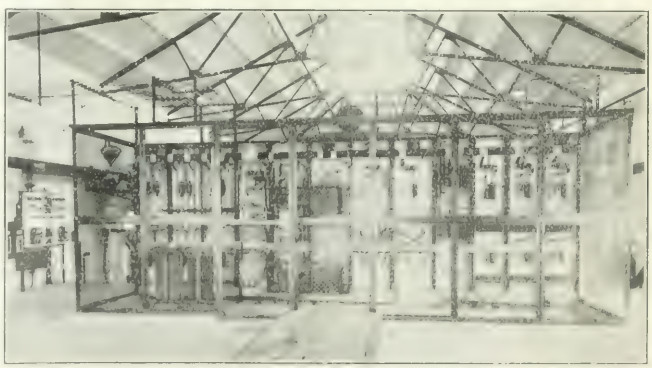


Fig. 3.—Back View of Switchboard, showing Battery Regulating Switches.

A considerable number of consumers have already been connected, and the licencees have made arrangements by which all consumers who so wish may have their wiring work carried out at a reasonable price under their supervision. Considerable extensions of the system are already in hand, the two very important contracts entered into with the municipality for public lighting. Not the least interesting circumstances in connection with the undertaking is the

[illegible] the directors who have given influential support to the project no less than seven are Indian gentlemen.

The work of the contractors, Messrs. Crompton & Co., under the supervision of their representative, Mr. T. F. Raven, has been executed in a manner as to give every satisfaction to those concerned, while mention must also be made of the consulting engineer's representatives, Messrs. F. N. Menzies and H. Frazer Nash, who have contributed largely to the success of the scheme. Credit is also due to Mr. G. W. T. Squires, the Corporation's architect, who has been responsible for the station building.

BALANCE SYSTEMS OF PROTECTION.*

BY C. C. GARRARD.

Synopsis. The author deals in some detail with the Merz-Price systems of protecting cables, generators and transformers, and concludes with observations on the use of split conductors so as to avoid the employment of pilot wires.

A number of schemes for protection have been suggested, or put into use, whereby the currents in different parts of the circuit are balanced against each other under normal conditions. A fault causes an unbalancing which unbalancing is arranged to trip the circuit breaker. Thus, for example, if we consider any electric circuit the current going in should, under normal conditions, equal the current coming out. If two appliances, one at either end of the circuit, be connected together by a pilot wire, the circuit can be arranged so that under normal conditions there is a complete balance. A leak to earth, however, causes the in-going current to differ in value from the out-going current, which difference can be caused to operate the tripping device. It is obvious that such an arrangement is independent of the direction of flow of power, and is therefore especially suitable for the protection of ring-mains. The principles just enunciated underlie the best known of balance protective systems, viz., the Merz-Price, and this system will be considered in the following paragraphs.

THE MERZ-PRICE SYSTEM.

The balance obtained in the Merz-Price system may be either a balance of voltages, a balance of currents, or an electro-

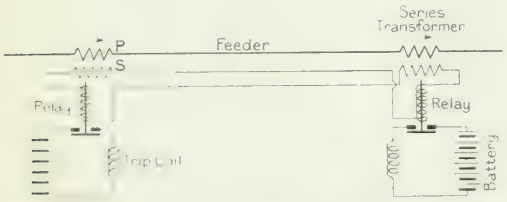


Fig. 1. Diagram illustrating Feeder Protection by the Merz-Price Balanced Voltage System.

magnetic balance, and theoretically it is possible to use either one of these three for any given case. Different requirements, however, have in practice met special solutions, and it is only proposed here to deal with actual installations and not to describe the alternative theoretically possible, but not so satisfactory methods. The widest sphere of application of the Merz-Price system is for the protection of cables, and the principle is the same, whether these cables are feeders, duplicate feeders or portions of a ring-main, although the special advantages of this system are best seen when considering the last mentioned problem, viz., the ring-main.

Merz-Price Cable Protection. The system which has been developed for cable protection is a voltage-balance, and depends upon the balancing of E.M.F.s in the secondaries of current transformers situated at either end of the cable. The connections required for a single cable are illustrated in Fig. 1. It will be noticed that two pilot wires are necessary. The secondaries of the two current transformers are reversed with regard to each other, so that with the current flowing straight through the cable, in either direction, the secondaries buck against each other and no current flows through the relay. Should, however, the currents at either end become unequal, due to a leak somewhere in the feeder, then the secondary voltages no longer balance, and a current will flow through the relays, and, if large enough, trip the circuit breakers at both ends. It is usual to set the relay so that a leakage current equal to 100 per cent. of the normal full load of the cable causes the relays to operate.

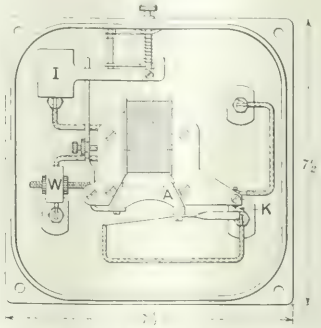


Fig. 2. Relay used by the British Westinghouse Co. with Merz-Price Protective Gear.

The relays used in the scheme of connections, shown in Fig. 1, are very simple. The one manufactured by the British Westinghouse Company is illustrated in Fig. 2, and that made by the British Thomson-Houston Co. is very similar (*see* Faye-Hansen & Harlow "Proceedings" Inst.E.E., Vol. XLVI., 1911, p. 701). Referring to Fig. 2 it will be seen that the weight of the armature A is counter-balanced by the adjustable



Fig. 3. Merz-Price Relay made by Messrs. Reyrolle.

weight W, and the trip coil circuit is closed at K. I is an indicator which falls when the relay operates. With the balanced voltage system (except perhaps with very short feeders, relays are always necessary.

Messrs. Reyrolle & Co.'s relay is illustrated in Fig. 3. It consists of an electromagnet with a very light armature and a

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small air-gap. When the armature is raised, contact is made in the trip coil circuit, and a heavy contact weight is released, which in falling, makes a parallel contact to that already made, thus ensuring certainty of operation.

Current Transformers for the Balanced Voltage System.—A little consideration will show that the current transformers used in the balanced voltage system must be of special construction. In the first place they must be capable of running with open-circuited secondary; and in the second place the secondary voltage characteristics of the two transformers which normally oppose each other must be exactly similar under all conditions of load, even up to short circuits of 20 or 30 times full load current. This necessitates each pair being specially balanced with extreme accuracy against each other. Generally such transformers are made with an air gap and have to be specially strengthened to prevent the dimensions of the air-gap changing under working conditions. The transformer, made by Messrs. Reyrolle & Co., is illustrated in Fig. 4.

The method for testing for balance is shown in Fig. 5. Each transformer must be tested back to back against a standard, in order that not only are the numerical values of the secondary voltages equal, but the phase differences are made equal. The necessity of this is illustrated in Fig. 5. The line AB represents the phase of the primary current, and AZ the secondary voltage of the standard, and AX and AY the secondary voltages of the two transformers tested. Now all three secondary voltages are numerically equal to each other, but the vestorial difference in voltage between X and Y may be sufficient to trip the relay. Thus it is necessary to measure this vectorial voltage XY, and adjust the transformers until it is sufficiently reduced.

In Fig. 6 are given the connections for balanced voltage protective in a three-phase cable with earthed neutral. It will be seen that a three-core pilot cable is necessary. If the

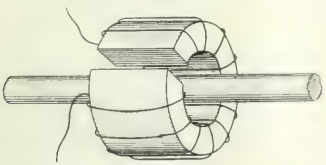


Fig. 4.—Current Transformer by Messrs. Reyrolle for use with Merz-Price Balanced Voltage Protective Gear.

neutral be insulated, the pilot wires can be reduced to two with two transformers at each end of the cable instead of three, and only one relay at each end instead of three. These economies are, however, attended by a loss of sensitiveness, and are not to be recommended. The three-core pilot cable should be regarded as the standard for three-phase working.

Merz-Price Protection for Generators and Transformers.—In considering the Merz-Price system as applied to the protection of cables, it was seen that a balance of the E.M.F.s in the secondaries of current transformers situated at either end of the cable was obtained. As against the balanced-current system the balanced-voltage system requires a less number of pilot wires, and for this reason the latter is the system generally used for cable protection (compare Favez-Jansen & Harlow, "Proceedings" I.E.E., Vol. XLVI., 1911, 675). Naturally with an E.M.F. balance the current transformers cannot be used for any other purpose than the operation of the relays, such as for example, to work the instruments on the switchboard. In the application of the system to the protection of machines, however, long pilot cables not being necessary, a system of current balancing and not E.M.F. balancing is used. That is to say, a current always exists in the secondary of the current transformer of a magnitude proportional to the load. A current transformer is situated at either end of the winding of the generator (or in the primary and secondary if the machine protected be a transformer). The secondary currents of the current transformers under normal conditions are, of course, equal, and are arranged to exert equal and opposite effects upon the relay or tripping coil; only in the event of a fault inside the protected machine is the balance upset and the switches tripped. As with current balancing, the secondaries of the current transformers have, under normal conditions, closed circuits, it follows that these transformers can also operate the ammeters, &c. It is, however, just as necessary to see that the transformers balance on very heavy overloads as with voltage balancing; moreover, in order that the balancing should not be upset, it is necessary to arrange that each current transformer of each pair has the same secondary load. Thus if one of the transformers feeds an ammeter and the other does not, then an impedance equivalent to that of the ammeter must be inserted in the secondary circuit of the latter.

Mention might here be made of the magnetic balance system. This is somewhat similar to the current balance method, except that the secondary windings of the two current transformers flow through the two primary windings of an auxiliary balancing transformer, the secondary of which feeds the tripping coil.

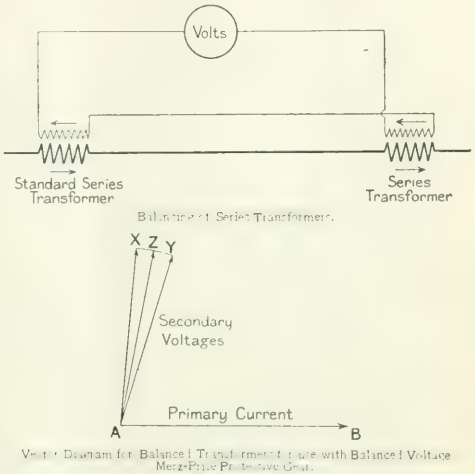


Fig. 5.—Testing Current Transformers for Voltage Balance for Merz-Price System.

With no fault no E.M.F. is generated in the secondary of the auxiliary transformer; a fault, however, results in the two primaries of the auxiliary transformer not balancing, and the switches are tripped. The magnetic balance system has, however, given place to the current balance system, and this latter can be worked either with or without relays.

Merz-Price Current Balance Protection—*Generator Protection without Relays.*—The connections are shown in Fig. 7, these being for a star wound generator. It will be seen that a current transformer is connected at each end of each leg of the machine winding. The three current transformers at the star point of the machine can be located adjacent to the alternator, or the three leads can be brought from the star point of the generator to the switch cubicles. It will be seen that current is only diverted through the trip coils in the event of unbalancing being caused by a fault.

Generator Protection with Relays.—When relays are used the connections are exactly the same as in Fig. 7, except that relays are inserted in the place of the direct connected trip coils.

The advantage of using relays is that smaller current transformers can be used, and it is, moreover, simpler to predetermine at which current the switches will be tripped.

It must be remembered that Merz-Price protection on generators only protects against a fault to earth or between phases, but does not take care of breakdowns between different parts of one phase, or loss of field, or trouble with the prime mover. In order to protect against sustained overloads, Messrs.

Reyrolle recommend time limit overload protection in addition to the balance protection. This is obtained by connecting fuses in series with the secondaries of one of the sets of three

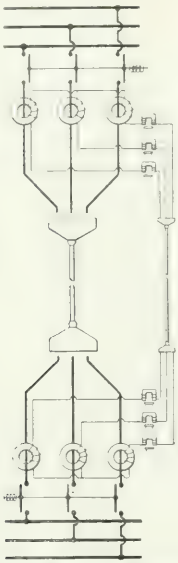


Fig. 6. Merz-Price Balanced Voltage Protection for three-phase feeder with earthed neutral, adopted by the Power Supply Undertakings in Northumberland and Durham.

current transformers. On one or more of the fuses blowing on overload the current from the other set of series transformers is diverted through the relays and trips the circuit breakers. In the present author's opinion, Merz-Price generator protection does not offer any advantage over reverse-power relay protection. This is specially so if the reverse power relays have an adjustment to render them, but little affected by variations in the bus-bar voltage.

In Fig. 8 is given a diagram of connections for generator protection on the current balance Merz-Price system, as recommended by Messrs. Reyrolle & Co. This is self-explanatory in the light of the foregoing remarks.

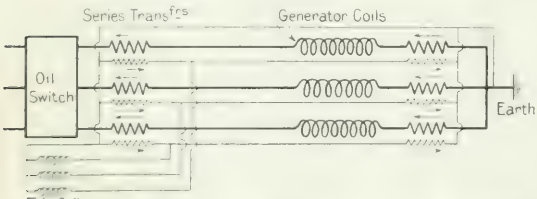


Fig. 7.—Merz-Price Current Balance Protection of Star-Wound Generators without Relays.

Current Balance Protection for Transformers. The Merz-Price system applied to static transformer protection depends upon the current balance principle. A diagram of connections is given in Fig. 9. According to Messrs. Reyrolle & Co., the Merz-Price system does not offer alone adequate protection for transformers, and it is desirable in addition to include protection against a sustained overload, such as would be occasioned by short circuit on the low-tension bus-bars. Time limit fuses (F_2) are shown, therefore, in series with the current transformers in Fig. 9. It is obvious that, if these blow, the currents from the other sets of transformers are immediately diverted through the relays and trip the circuit breakers. It will also be noticed that fuses (F_2) are shown in parallel with the relays. This is to prevent the switches being tripped when switching in. At the instant of switching in an abnormally large magnetising current may occur, depending upon the phase relationship of the residual magnetism of the core with the voltage at the instant contact is made at the switch. Trouble from this source is often experienced, even when simple overload circuit breakers are used, for which reason a time lag is desirable on transformer switches. The provision of the fuse

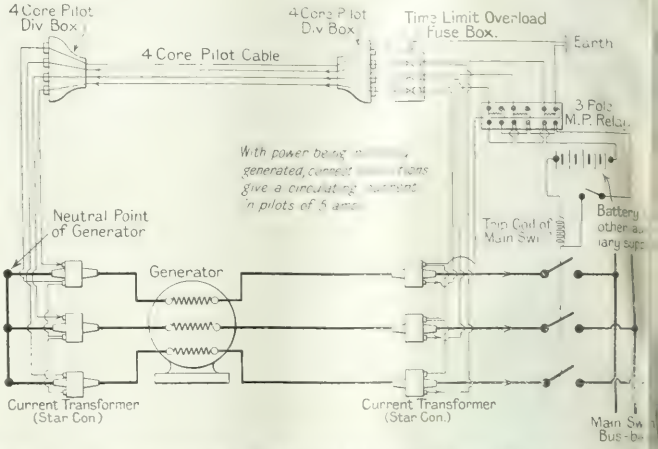


Fig. 8.—Diagram of Connections for Current Balance Generator Protection, Merz-Price System, with Relays.

shunting the Merz-Price relay takes away from the system one of the chief advantages claimed for it, viz., instantaneous operation. It will be seen that for transformer protection the

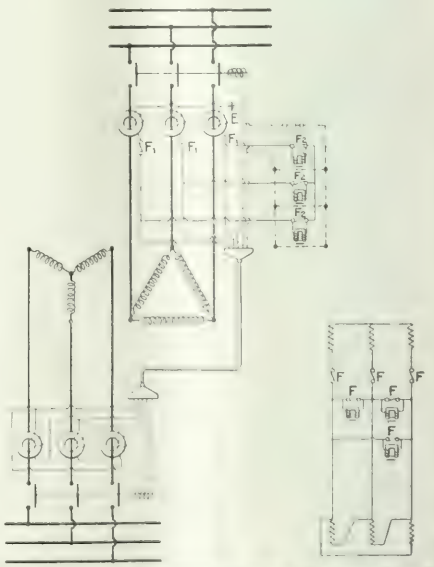


Fig. 9. Transformer Protection on Current Balance, Merz Price System.

system is somewhat complicated, and in the present author's opinion for transformer protection its installation is not warranted.

(To be continued.)

GAS DRIVEN ELECTRICITY WORKS AT WOOD GREEN.

Statutory powers for the supply of electrical energy in Wood Green, London, were conferred upon the District Council by the Wood Green Electric Lighting Order of 1902, and transferred by the Tottenham and Edmonton Gas Act of 1913 to the Tottenham District Light, Heat & Power Co., the new title given by that Act to the Tottenham & Edmonton Gas Light & Coke Co. As soon as the Act received the Royal Assent in August, 1913, the company instructed their consulting electrical engineers, Messrs. May & Hawes, of Westminster, to proceed with the scheme which had been prepared for Parliamentary purposes, and within a few months constructional operations were started. The progress of the work was somewhat delayed by the builders' strike and the war; but the generating works and mains were ready for the preliminary trials in December, and on Christmas Eve, 1914, within 16 months from the passing of the Act, the supply was officially commenced.

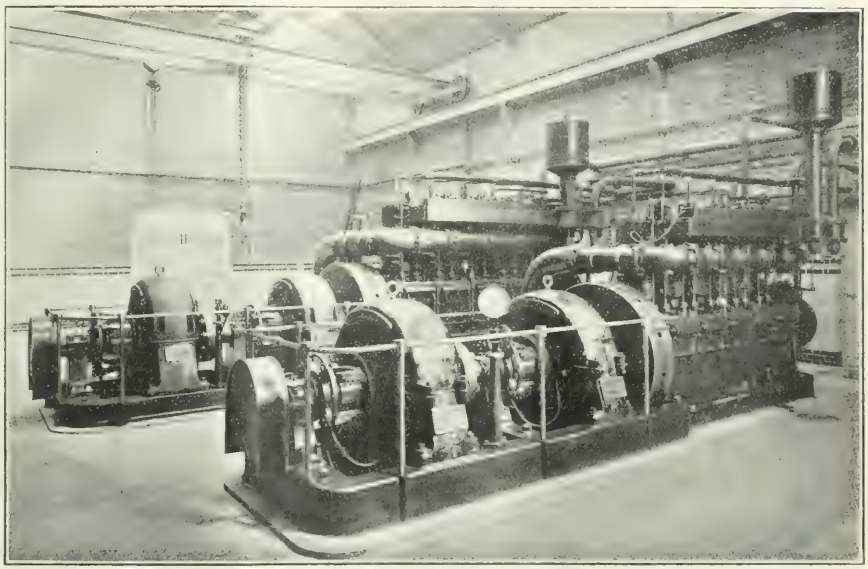
The area of supply under the order embraces the whole of the urban district of Wood Green. It has an area of 1,625 acres, with a population of 50,000 inhabitants. Wood Green is the shopping centre of a large suburban residential area, its High-road—the old Green-lanes—containing many important business establishments. The supply is on the direct-current three-wire system at a pressure of 240 volts for lighting and heating purposes, and 480 volts for power and special purposes. For small power requirements, where the demand does not exceed 3 kw., the consumers have the privilege of taking the supply at 240 volts.

The generating station is situated in Ringslade-road, in close proximity to the depot of the Metropolitan Tramways. Town gas supplied from the Tottenham works of the company furnishes the power by which the generating plant is operated. The gas is delivered through a 12 in. main into a holder erected on the site. This holder, which has a diameter of 40 ft., performs the dual role of providing a substantial storage of gas and of maintaining [illegible] at the required pressure at the engine valves. For the registration of the gas used in the generating station a special meter of a capacity of 20,000 cubic ft. per hour has been provided in a separate building.

The generating station comprises three bays, the centre forming the engine house. The ground floor of one of the side bays provides accommodation for the switchboard and electrical control gear, and at the necessary fitters' workshop, above which the [illegible] room has been constructed. Water cooling plant and [illegible] occupy the other bay, the water softening plant, [illegible] and boilers having been situated on the upper floor.

Two sets of generating plant have already been installed, one of 100 kw. and the other of 200 kw. capacity, and provision has been made in the engine house for two additional sets of still larger capacity, which are to be erected later on as the demand develops. The battery has a capacity of 300 kw.-hours at a three-hour rate, or 200 kw.-hours for one hour. The gas engines are the modern high-speed vertical type, built by Messrs. Hindley & Sons, of Bourton, of 170 B.H.P. and 340 B.H.P. respectively. The smaller runs at a speed of 450 revs. per min. and the larger at 350 revs. per min. Both have five cylinders and are equipped with forced automatic lubricating arrangements and double magneto ignition. The principal working parts are enclosed and lubricated under pressure. The engines are extremely compact, require but little attention, being practically automatic in working, and can be started up and put on full load in less than a minute. There is no noticeable vibration, specially designed foundations having been provided to assure this; and, as complete combustion of the gas is effected, there is no risk of any objectionable smell from the exhaust. The silencing of the exhaust has been carried out in a very effective manner. Compressed air is used for starting the engines, this being taken from a battery of four receivers, which are charged by a motor-driven air compressor.

The circulating water for the engines is supplied by gravity from a tank of 1,600 gallons capacity situated on the first floor over the cooling plant. By means of interlocking gear between the compressed air valves and the water valves the starting up of the engines without first turning on the water is rendered impossible. From the engine jackets the water flows into two "Heenan" rotary water coolers capable of dealing with 4,000 and 2,000 gallons of water per hour respectively. The water is returned to the storage tanks by means of electrically-driven centrifugal pumps. The make-up water is controlled by a ball valve on the tank, and all the water used is first treated by a "Boby" water-softening plant of 300 gallons capacity.



General View of Gas Driven Generators at Wood Green.

The engines are directly coupled to "tandem" direct-current dynamos, made by the Electric Construction Co. The dynamos are of the multipolar shunt-wound type fitted with interpoles, each pair being mounted on a substantial box baseplate with two pedestal bearings. The armatures of each set have been made strictly inter-[illegible] the [illegible] of a coupling [illegible] the outboard bearing, this coupling being protected by a cover of planished steel. The dynamos are designed to generate current at any voltage from 240 to 280, and [illegible] show very little temperature rise in any part.

The battery, which is supplied [illegible] by the Chloride Electrical Storage Co., consists of 270 [illegible] cells. Each cell has 29 plates, which are specially [illegible] to withstand [illegible] The battery is supplied [illegible] and is [illegible] The battery room is arranged in a single tier, with aisle gangways between the different

rows, which enables each individual cell to be readily inspected. There is also a gangway across the middle which divides the two halves of the battery, thereby reducing the danger of shock to a minimum. The whole of the regulating cells range along one side of the room, and the copper rod connections are carried on insulators on the wall to the centre, where they are carried down through insulating tubes in the floor to the regulating switches, which are immediately below. For charging the battery there is a double-ended booster of the Electric Construction Co.'s make in the engine room, placed on one side of the switchboard. The two boosting dynamos each have a capacity of 19 kw., and are driven by a 58 B.H.P. 500-volt motor running at a speed of 1,200 revs. per min., all three machines being mounted on a combination baseplate. The starting panel is fixed close at hand on the wall, and consists of a double-pole ironclad switch fuse and starter, fitted with overload and no-volt release, together with an ammeter.

The switchboard, for which the Electric Construction Co. were also responsible, consists of two generators, one battery and booster, one integrating watt-hour meter and three feeder panels, all of black enamelled slate. The panels are divided horizontally at the centre by an enamelled slate shield, the top half being devoted entirely to the positive side of the system and the lower half to the negative. The switchboard has an overall length of about 12 ft., and is placed 6 ft. away from the wall, thus leaving ample room for the battery regulating switches and also for access to the back connections, which are so designed as to be easily traceable. All circuits are protected by automatic cutouts, and, where suitable, time lag attachments are provided. The whole of the instruments are of the "Cirscale" type, manufactured by the Record Electrical Co., of Manchester. On the right-hand side of the board three illuminated dial voltmeters are fixed on swing brackets; the top one of these indicates the 'bus-bar pressure and the two lower ones are connected to voltmeter switches by means of which the pressure at the several feeding points can be ascertained. Paralleling has been made a simple matter by the provision of a portable horizontal pattern voltmeter, which is provided with plugs to fit sockets on the generator and battery panels. On the top of the board there are the battery meters and two pedestal-type voltmeters. The regulating gear has been kept entirely separate from the board. The resistances are placed in a cellar, into which all the cable connections from the generators and boosters come and also the feeder cables. Immediately above the resistances the control pillars, eight in number, including two for the battery regulating switches, are mounted on the engine-room floor. By this arrangement it is possible for the switchboard attendant to have control of all generating plant and at the same time to be able to see the whole of the switchboard instruments. An earth panel, with an Everett-Edgcumbe disc recording ammeter, short-circuiting relay and overload breaker, is fixed on the wall at the back of the board.

To facilitate the erection and overhauling of the plant, a 10-ton hand-operated travelling crane, by Messrs. Herbert Morris, of Loughborough, has been installed on a runway which extends for the whole length of the engine room.

Under the contract, the consumption of gas by the generating sets working at ordinary full load, with gas of 500 net B.Th.U. per cubic foot at a normal temperature and barometric pressure, is guaranteed not to exceed the following: For the 200 kw. set 30·75 cubic ft. and for the 100 kw. set 31·35 cubic ft. per unit generated as registered by watt-hour meters. The official consumption tests have not yet been taken, but we understand that the trials of the plant and their general running on the load give warrant to the view that the guaranteed results will be excelled.

Under the Wood Green Electric Lighting Order, the streets scheduled for the compulsory mains were limited to High-road and Myddleton-road. It is scarcely necessary to state that the company recognised that so restricted a system of mains would be practically and economically unsound, and they were sufficiently enterprising to inaugurate the supply with a comprehensive system of distributing mains throughout the principal streets of the district. Mains will be provided in other streets from time to time as the demand for electricity arises, the feeding and distributing system having been laid out with a view of general extensions.

All cables are of the three-core type, insulated with impregnated paper, lead covered and steel armoured, made by the Western Electric Co. There are three feeding centres where the feeder mains serve the distributors, one situated near the Town Hall, one in the High-road adjacent to Noel Park station, and the other in the Alexandra Park district, near the junction of the Avenue and Alexandra Park-road. At these centres feeder pillars have been erected, and similar pillars will be provided at convenient points for dividing up the network of distributing mains into suitable sections.

The capital expenditure on the scheme, including Parliamentary costs, land, generating station and mains, amounts to about £30,000. The responsibility for the preparation of the scheme and for carrying it into effect is shared by Mr. A. E. Broadberry, manager of the Tottenham District Light, Heat & Power Co., and Messrs. May & Hawes, the consulting electrical engineers. The duties of directing and supervising the constructional operations have been performed by Mr. J. Fisher, for the company, and Mr. L. W. Ballard, for the consulting engineers. The prices charged range from 5d. to 1½d. per unit for lighting purposes and 2d. to 1d. per unit for power purposes. Meters for registering the supplies are provided and maintained by the company at a quarterly rental of 2s.

THE PURE ELECTRON DISCHARGE AND ITS APPLICATIONS IN RADIO TELEGRAPHY AND TELEPHONY.*

BY DR. IRVING LANGMUIR.

Summary.—After outlining the fundamental principles which govern the phenomenon of electron emission, the author shows how, through the medium of a hot-filament vacuum rectifier (called the "kenotron") and the "pliotron" (a new type of amplifier), both of which employ the pure electron emission from heated metals in extremely high vacua, a very simple and successful equipment has been produced to send and receive radiotelegraphic and radiotelephonic messages.

After reviewing the work of Elster and Geitel, Fleming, J. J. Thomson, Richardson, Soddy, Pringle, Parker and others, the author passes on to his own work on the subject. Richardson's equation for the thermionic currents is

$$i = a\sqrt{T}\,\epsilon^{-b/T},$$

in which i is the current per square centimetre at the temperature, T, and a and b are constants for the particular metal. According to

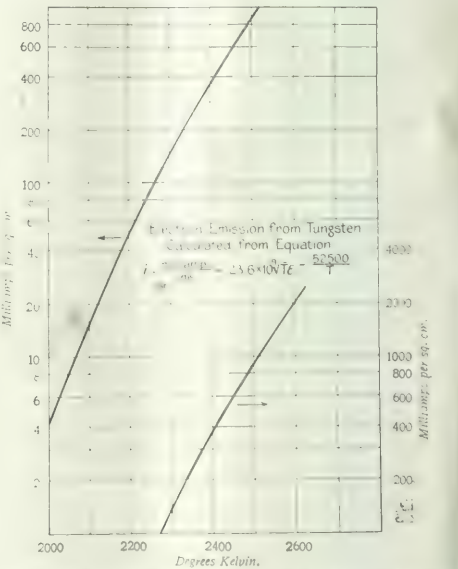


FIG. 1.—ELECTRON EMISSION FROM TUNGSTEN IN A "PERFECT" VACUUM

this equation the currents that might exist across the vacuous space in a tungsten lamp would be very large, but actually they are, of course, quite small. A study of the subject showed that the smallness of the current was not due to any failure of the filament to emit electrons, but to the inability of the space around the filament to carry the currents with the potential available in the lamp.

In one case, two single loop tungsten filaments were mounted side by side in a bulb. After the bulb was exhausted in the best possible way and the filaments were thoroughly aged and freed from gas, one of the filaments was heated while a positive potential was applied to

* Paper read before the American Institute of Radio Engineers, New York, April 7, 1915, abbreviated. Also published in the "General Electric Review," May, 1915.

the other through a galvanometer. The hot filament thus served as cathode in the discharge occurring in the lamp. As the current through the cathode was increased, the thermionic current as measured by the galvanometer increased at first, according to Richardson's equation as shown in Fig. 1; but beyond a certain point, the further increase in the temperature of the cathode produced no further increase in thermionic current.

The curve representing thermionic current as a function of temperature, therefore, consists essentially of two parts: first, a part in which Richardson's equation applies; second, a part in which the current is independent of the temperature. In the first part of the curve it is found that the current is independent of the voltage, or shape and size of the anode, but in the second part of the curve the current is affected by both of these factors and may also be either increased or decreased by placing the lamp in a magnetic field. It is thus evident that the only reason that the current does not continue to increase, according to Richardson's equation, is that the space between the electrodes is only capable of carrying a certain current with a given P.D. The explanation of this phenomena was found to be that the electrons carrying the current between the two electrodes constituted an electric charge in the space which repelled electrons escaping from the filament and caused some of them to return to the filament. The author gives a modified equation. Thus

$$i = 2{\cdot}33 \times 10^{-6} \frac{V^{3/2}}{x^2},$$

in which V is the P.D. between parallel plates, x cm. apart, and i is the current per square centimetre.

Extremely minute traces of gas, however, may lead to the formation of a sufficient number of positive ions to neutralise to a large extent the space charge of electrons and thus very greatly increase the current carrying capacity of the space. For example, a pressure of mercury vapour of about 1/100,000 mm. has, under certain conditions, been found to eliminate completely the effect of space charge so that a current of 0·1 ampere was obtained with only 25 volts on the anode, whereas, without this mercury vapour, over 200 volts were necessary to draw this current through the space. Besides this enormous effect on the current carrying capacity of the space, many gases have a great influence on the electron emission from the cathode. But in every case where the cathode is of pure tungsten, the effect of gas is to decrease, rather than increase, the electron emission. For example, it is found that a millionth of a millimeter of oxygen, or gas containing oxygen, such as water vapour, will cut the electron emission down to a small fraction of that in high vacuum. As a result of this work, we became firmly convinced that the electron emission from heated metals was a true property of the metals themselves and was not, as has so often been thought, a secondary effect, due to the presence of gas.

Further investigation showed that with the elimination of the gas effects, all of the irregularities which had previously been thought inherent in vacuum discharges from hot cathodes were found to disappear. In order to reach this condition, however, it was not sufficient to evacuate the vessel containing the electrodes to a high degree, but it was essential to free the electrodes so thoroughly from gas that gas was not liberated from them during the operation of the device. It was also necessary to free the glass surfaces very much more thoroughly from gas than had been thought necessary previously. The difficulty thus consists not in the production of the high vacuum, but in the maintenance of this vacuum during the use of the apparatus. As the voltage applied to the terminals was increased and as the current density in the discharge increased, the tendency for the gas residue to become ionised became very much more marked and the difficulties in maintaining a sufficiently high vacuum increased still further. However, by special methods of exhaust and by special methods of treating the electrodes, these difficulties have been overcome and it has thus been possible to construct apparatus in which a large current density can be obtained and P.D. of much more than 100,000 volts may be applied without obtaining effects attributable to positive ionisation.

In previous devices which employed discharges through vacuum, either with or without a hot cathode, there was always evidence of positive ionisation if the current density was increased above an extremely low value, or if potentials over 50 or 100 volts were applied while a current of as much as a few milliamperes was flowing. The effects of this positive ionisation manifested themselves in many ways. If the ionisation was sufficiently intense, a glow throughout the tube was visible. For example, in the Braun tube, with a lime-covered cathode Wehnelt states that a vacuum as high as possible should be obtained, but he speaks of being able to see the path of the cathode rays. It has apparently always been assumed that the cathode ray of sufficiently high intensity can always be seen, but, of course, such luminosity is direct evidence of ionisation. One of the most sensitive indications of the presence of positive ionisation is the failure of the current to increase with the voltage in a regular manner, as shown by the above equation.

With the higher voltages, perhaps the most troublesome features of positive ionisation is its tendency to disintegrate the cathode. The positive ions, moving under the influence of the electric field, acquire high velocity, and when they strike the cathode cause rapid disintegration and ultimate destruction of the electrode. With a pure electron discharge, however, there is no disintegration of the electrode caused by the discharge and the filament lasts the same length of time as if no current passed through the vacuum.

Another effect, produced by positive ionisation, is the emission of electrons from the cathode under the influence of the positive ion bombardment. These electrons, which constitute the so-called delta rays, escape from the cathode with considerable initial velocity, and are, therefore, capable of charging up a third electrode in this space to a potential of 10 or 15 volts negative with respect to the cathode.

With the pure electron discharge, none of these effects are present. The cathode rays are entirely invisible, the current voltage curve is a smooth curve, follows the 3/2 power law, in case the filament temperature is sufficiently high and the shape of the electrodes is such that the small initial velocities of the electrons from the cathode do not play too large a role. It is possible to obtain a very high current in this type of discharge, but in order to overcome the space charge effects, it is then necessary to use a very strong electric field close to the cathode.

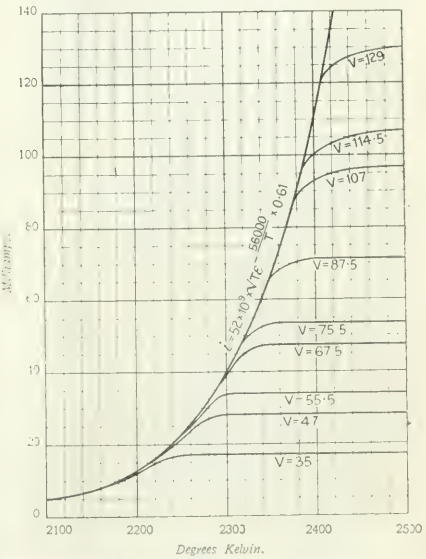


FIG. 2.—THE EFFECT OF SPACE CHARGE ON THE THERMIONIC CURRENTS.

Dr. W. D. Coolidge ("Phys. Rev." 2, 409, 1913) has used the pure electron discharge in the construction of a new type of X-ray tube, and several other types of apparatus have been developed making use of this pure electron discharge. These devices possess the same advantages over apparatus formerly used as the Coolidge X-ray tube possesses over the ordinary X-ray tube. In order to distinguish these devices from those containing gas and in most cases depending upon gas for their operation, the name "Kenotron" has been adopted. This word is derived from the Greek *kenos*, signifying empty space (vacuum), and the ending, *tron* used by the Greeks to denote an "instrument."

"KENOTRON" RECTIFIER.

The Coolidge X-ray tube is, of course, a rectifier for high voltage alternating current, but it is not suitably designed for this purpose. In an X-ray tube, the voltage applied must be consumed in the tube itself, whereas in the rectifier the voltage in one direction should be consumed in the load in series with the rectifier, although the voltage in the opposite direction should be taken wholly by the rectifier. In the X-ray tube, however, the space distance between the anode and cathode and the presence of a focusing device around the cathode, the space charge effects are very much exaggerated, so that it is necessary to apply several thousand volts in order to get even 10 milli-

amperes or current. This voltage necessary to overcome the space charge is completely lost when the tube is used as a rectifier.

To overcome this loss of voltage as far as possible, the anode and cathode in the kenotron are placed close together and everything is avoided which might tend to screen the cathode from the field naturally produced by the anode. In this way it has been possible to build kenotrons which have supplied pure electron currents of over an ampere, with a voltage drop of about 200 volts. This current, however, requires large anodes and cathodes, so that it is usually more convenient to build kenotrons with a current capacity of not over 250 milliamperes, and if it is desired to rectify larger currents than this, to place several kenotrons in parallel.

There seems to be no upper limit to the voltage at which a kenotron can operate. A kenotron has been built capable of rectifying 250 milliamperes at 180,000 volts, and there seems to be every reason to think that kenotrons could be used at very much higher potentials if desired.

Fig. 2 gives the characteristics of a typical kenotron designed for rather large currents. The curves show the current carried by the kenotron for different filament temperatures at given voltages between the electrodes. For example, if the temperature of the filament is 2,400 deg. the maximum current that can be obtained with any voltage is about 112 milliamperes. If, however, the resistance of the load is able to hold the current down to a value of, say, 54 milli-



Fig. 3.
Molybdenum Cap Type of Kenotron.

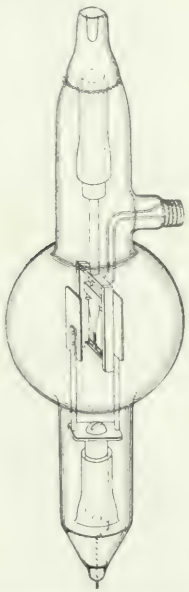


Fig. 4.—Kenotron with Filament between Two Parallel Plates.

amperes, then we see from the curves that the voltage drop in the kenotron would be 75 5 volts, the remaining voltage, which may be many thousands of volts, being consumed in the load in series with the kenotron.

Figs. 3 and 4 illustrate two forms of kenotrons, one for voltages up to about 10,000, and the other one suitable for use up to 50,000 volts. With voltages higher than about 12,000 to 15,000 volts, the kenotron of the type shown in Fig. 3 is apt to fail, because the electrostatic attraction of the anode pulls out the helically-wound filament and short-circuits the device. At the higher voltages, therefore, it [illegible] to support the filament and to locate it as far as possible, the electrostatic forces acting on it.

The characteristics of the kenotron are such that the current flowing through it is always perfectly stable, so that several kenotrons can be run in parallel and each one will take its proper share of the current. This is in marked contrast with the behaviour of mercury arc rectifiers, which have negative characteristics and, therefore, if [illegible] placed in parallel, one of them takes the whole of the current.

Owing to the absence of gas effects, the kenotron is a perfect [illegible] conductor in the reverse direction, even when voltages of 100,000 volts or more are applied. For similar reasons, it is capable of rectifying high frequency currents, as well as low frequency, there being not the slightest sign of any lag effects.

Amplifying or Controlling Devices: "Pliotrons."

In a pure electron discharge, as the temperature of the filament is raised, a point is always reached where the current becomes limited by the space charge between the electrodes. Under these conditions only a small fraction of the electrons escaping from the cathode reach the anode, whereas the majority of them are repelled by the electrons in the space and, therefore, return to and are absorbed by the cathode. From this view-point it is evident that if a negatively-charged body is brought into the space between the anode and cathode, the number

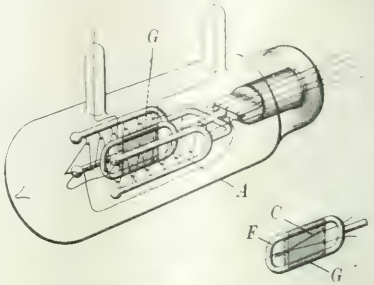


Fig. 5.—"Pliotron" for Amplification.

of electrons which then return to the cathode will increase, so that the current to the anode will decrease. On the other hand, if a positively-charged body is brought near the cathode, it will largely neutralise the negative charges on the electrons in the space and will, therefore, allow a larger current to flow from the cathode. In this way it is possible to control the current flowing between the anode and cathode by an electrostatic potential on any body placed in proximity to the two electrodes. This controlling effect may be best attained by having this controlling member in the form of a fine wire mesh, or grid, placed between the electrodes.

The term "Pliotron" has been adopted to designate a kenotron, in which a third electrode has been added for the purpose of controlling the current flowing between the anode and cathode. This word is derived from the Greek "pleion," signifying "more." A Pliotron is thus an "instrument for giving more," or an amplifier. A similar use of the prefix "plio" occurs in the geological term "Pliocene."

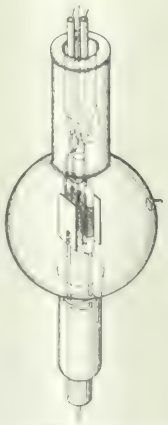


Fig. 6.—"Pliotron" for Radiotelephony

The three elements, hot filament cathode, grid and anode, are, of course, similar to the elements of the De Forest audion. However, the operation of the audion is in many ways quite different from that of the pure electron device operating in the way I have described above. In the audion, as well as in the Lieben-Reisz relay, the amplifying action appears to be largely dependent upon gas ionisation, even when the device operates well below the point at which blue glow occurs.

In the construction of pliotrons, it has been found desirable to make the wires constituting the grid of as small cross-section as possible. In this way, even when a positive potential is applied, to the grid, the current that flows to the grid may be made extremely small. The use of very fine wire is made possible by using a frame of glass, metal or other suitable material, to support the grid. Thus, in Figs. 5 and 6, the filament is mounted in the centre of a frame made of glass rods, on which the fine grid wire is wound by means of a lathe. The grid may thus consist of tungsten wires of a diameter as small as 0·01 mm. and these may be spaced as close as 100 turns per centimetre, or even more.

In Figs. 5 and 6 are shown two types of pliotron. Fig. 5 shows a pliotron such as used for amplifying radio signals in a receiving station. Fig. 6 shows a large pliotron which may be used for controlling as much as 1 kw. of energy for radiotelephony.

The characteristics of the pliotron depend upon the length of filament used, the distance between filament and grid, the spacing between the grid wires, the diameter of the grid wires, the distance between grid and anode, and the size and shape of the anode. The important elements in the characteristics of a pliotron are, first, the relation between the current flowing between anode and cathode as a function of the potential on the anode and of that on the grid: second, the current flowing to the grid, as a function of the potential of the grid and the potential of the anode.

Fig. 7 gives the characteristics of a small pliotron such as that shown in Fig. 5. Curve A gives the current flowing to the anode for different grid potentials, while the potential of the anode is maintained constant at 220 volts. Curve G gives the current flowing to

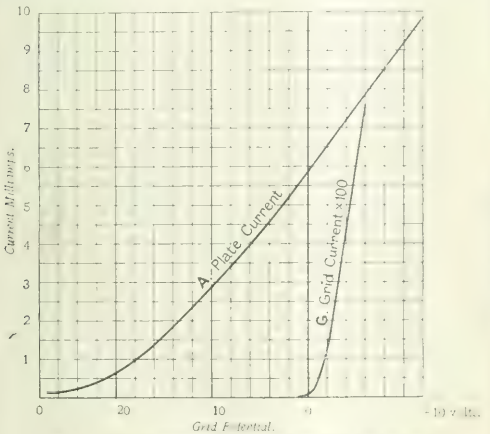


Fig. 7.—Characteristic Curves of small Pliotron.

the grid under the same conditions. For different anode potentials, these curves are shifted vertically, by amounts proportional to the change in anode potential. In fact, it is found that these curves can be represented with fair approximation by a function of the form

$$i = A(V_a + kV_g)^{3/2},$$

where i is the current flowing to the anode, V_a is the voltage on the anode, V_g the voltage on the grid, and k the constant which depends on the relative shapes and positions of the electrodes.

Fig. 8 gives similar characteristics for a large pliotron like that shown in Fig. 6. In this case, the anode potential was 8,500 volts.

By using a fine grid, the current to the anode can be stopped entirely by even a very slight negative potential on the grid. On the other hand, a rather low positive potential will then be sufficient to draw a large current to the anode. The amount of current taken by the grid would be only a very small fraction of that flowing to the anode, in case the diameter of the grid wires is small compared to the distance between them. On the other hand, with a coarse grid—that is, a grid in which the spacing is large—a rather large negative potential may be necessary in order to stop the current flowing to the anode. Similar results to those obtained by changing the spacing of the grid may be obtained by changing the [illegible] between the electrodes. The effects produced in this way may be expressed approximately by means of the constant k in the above equation, the effect of fine spacing thus being to increase the value of k, while coarse spacing decreases it.

By using a fairly coarse grid, consisting of two wires, it is possible to obtain a control of the current to the anode, always using a negative potential on the grid. Under these conditions, since there are no positive ions present, no current flows to the grid, except that necessary to charge it electrostatically to the required potential. It thus becomes possible to control very large amounts of energy in the anode circuit, by means of energy in the grid circuit.

There does not seem to be any upper limit to the voltages that may be used in the pliotrons. With voltages over 30,000 it is often necessary to space the electrodes further apart and to use heavier wires for the grid, in order to reduce the danger of breakage of the parts by the large electrostatic forces which then occur.

The current carrying capacity of the pliotron is limited only by the size of cathodes that it is found convenient to use and by the voltage available. Large currents cannot be readily obtained with low voltages because of the space charge effects described previously. With voltages above 500 volts, however, it is found practicable to use currents of 300 or 400 milliamperes for a pliotron of the type shown in Fig. 6.

It is evident from the characteristics of the pilotron that any number of these devices may be placed in parallel and that in this way, very large amounts of power may be controlled.

Pliotron in a Receiving Station.

If the antenna of a receiving set is coupled directly to the grid of a pliotron and a telephone receiver is placed in series with the anode, signals may be readily detected, but the results obtained in this way are usually very poor. Under these conditions, the sensitiveness of the arrangement is proportional to the curvature of the curve A, Fig. 7 (or, more accurately, proportional to the second derivative of the anode current with respect to the grid potential). This curva-

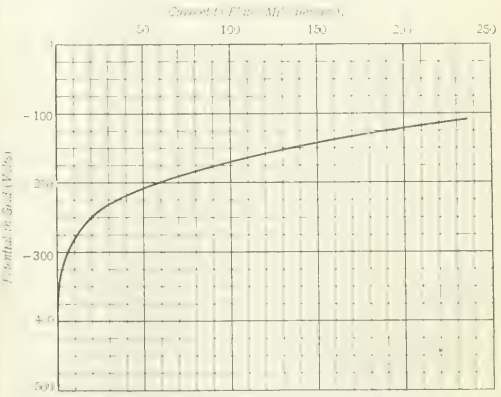


Fig. 8.—Characteristic Curve of a large Pliotron.

ture may be somewhat increased by applying a negative potential to the grid, but even under these conditions the sensitiveness of the arrangement is usually not very high.

If it is attempted to use a condenser in series with the grid and thus use the pliotron in the way that the audion is often used (as described, for example, by Armstrong, "Electrical World," December 12, 1909, p. 1149), it is found necessary to shunt the condenser with the resistance and often place a battery of a few volts in series with the resistance, in order to prevent a large negative charge from accumulating on the grid.

It has been found, however, by W. C. White, that a very minute trace of certain gases may very greatly increase the sensitiveness of this device as a detector. For example, by placing within the bulb a small quantity of an amalgam of mercury and silver, the characteristics of the tube show a kink, as illustrated in Fig. 9. With a detector of this sort, if the grid potential is adjusted so that its average value is approximately that at which the kink occurs, there [illegible] under these conditions either an increase or a decrease in the grid potential causes a decrease in the anode current. The sensitiveness of this detector is then very high. The quantities of mercury vapour necessary to give this effect are so low that anode voltages of 200 or more may be used without any indication of glow discharge.

Pliotron as Voltmeter.

The value of a pliotron as a voltmeter depends primarily upon the slope of the curve between anode current and grid potential;

for example, curve A, Fig. 7. A second factor of importance is the magnitude of the current taken by the grid. In order to get the greatest amplifying effect it is desirable to have this current as low as possible. In a pliotron of the type shown in Fig. 5, the current to the anode increases at the rate of about 1 milliampere per volt change in the grid potential.

By using larger anode potentials, the slope of the curve can be made very much greater, since it becomes possible to use grids of finer mesh. For example, in Fig. 8 it is seen that the slope of the curve corresponds to two milliamperes increase in anode current per volt charge in grid potential. It has been found that there is no sluggishness in the characteristics of the pliotron, even at the highest frequencies.

By connecting the pliotron as amplifier, as shown in Fig. 10, the high-frequency currents received from the grid may be amplified one hundred to six hundredfold. In this arrangement, it is the high frequency or radio frequency that is amplified, and not the audio frequency. This amplification of the radio frequency possesses the marked advantage that the detector circuit may be tuned to the same frequency as the amplifier circuit, and in this way a very marked increase in selectivity is obtained. In fact, it has been shown by Mr. Alexanderson that the resonance curve of an outfit consisting of amplifier and detector, both tuned to the radio frequency as shown in Fig. 10, may be obtained from the resonance curve for the detector alone, by squaring the ordinates. For example, if with a single detector, the signals from one station (A) are received 100 times as strong as those from another station (B), then, with the above

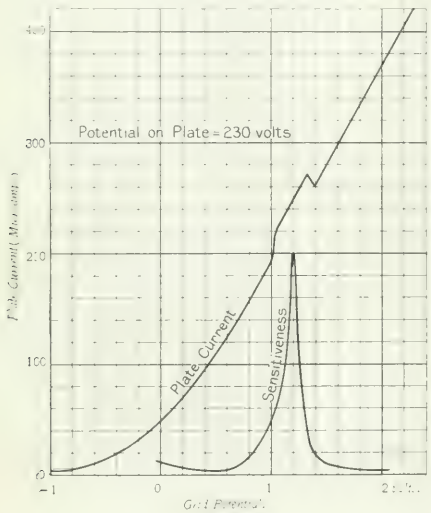


FIG. 9.

arrangement with the amplifier, the signals from A will be received 100 times squared, or 10,000 times as strong as those from station B. If two amplifiers be used in this way, the signals from station A could be obtained 1,000,000 (or 100^3) times as strong as those from station B. In practice, this arrangement has been found to give a wonderfully high degree of selectivity.

Of course, a pliotron may also be used for amplifying the audio frequency, coupling the circuits together by means of an iron core transformer. A single pliotron, under these conditions, gives an amplification of current of several hundredfold, when voltages of from 100 to 200 volts are used on the anode.

By placing inductance and capacity in the grid and plate circuits and coupling these two circuits together, it is possible to use the pliotron as a source of continuous oscillations. Small pliotrons of the type shown in Fig. 5 may produce oscillations up to a few watts, and these may be used in a receiving station, according to the Heterodyne principle, for receiving continuous oscillations. One pliotron may be used for both amplifying or detecting, and for producing oscillations. With the larger pliotrons, using voltages of a few thousand volts, up to a kilowatt of high frequency oscillations [illegible] be produced by [illegible] tube.

Use of the Pliotron in Radiotelephony.

[illegible] of the larger pliotrons, it has been found possible to control about 2 kw. of energy in an antenna, by means of the currents obtained from an ordinary telephone transmitter. There are many arrangements by which this may be accomplished. For example, a 2 kw. Alexanderson alternator (100,000 cycles) may be loosely coupled to the antenna and the anode of the pliotron may be connected to a point on the antenna where the potential is normally high. As long as the potential on the grid of the pliotron is strongly negative, no current flows to the pliotron and therefore the full energy is radiated by the antenna. If, however, the negative potential on the grid is decreased, a sufficient current may be drawn from the antenna strongly to damp the oscillations and thus greatly decrease the energy radiated. With sufficiently high potential on the grid, practically the whole of the energy may be diverted from the antenna.

It is thus possible to control the output of the antenna by varying the negative potential on the grid of the pliotron. Since the grid is always negative, no current flows between filament and grid and, therefore, practically no energy is required to maintain the charge on the grid. In this way, therefore, by connecting the secondary of the transformer between the grid and filament, and placing the primary of the transformer in series with telephone transmitter, it is possible by means of the variations in the currents from the telephone transmitter to obtain potentials on the grid of several hundred volts and thus to control the output of the antenna.

Instead of using an arc or alternator as a source of high-frequency current, the pliotron may also be used as generator of the oscillations. One pliotron may be used both for producing the oscillations and for controlling the amplitude of the oscillations, in accordance with the sound waves acting on the telephone transmitter. It is usually preferable, however, to use a large pliotron for producing the oscillations and connecting a small pliotron in the grid circuit of the large pliotron for controlling the output of the latter.

With the above arrangement an extremely simple and efficient radiotelephone outfit can be made. Since the pliotron for producing

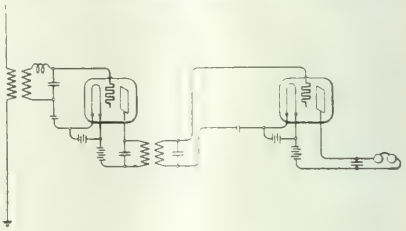


FIG. 10.

oscillations requires comparatively high direct-current voltages, it has been found convenient to combine the pliotron oscillator with a kenotron rectifier. Two types of apparatus of this type have been in use a considerable time, and it will be of interest to describe these in some detail.

In the first outfit, which is a small outfit having a capacity of about 20 watts in the antenna, the source of power is the local city supply, which is 118 volts 60-cycle alternating current. This is connected with the primary of a small transformer, having two secondary windings. One of the secondaries is designed to give about 5 volts and furnishes the current used for heating the filaments of the kenotrons and pliotrons. The other secondary of the transformer is wound to furnish a potential of about 800 volts. This is rectified by means of a kenotron and serves to charge a condenser of about 6 mfd. In this way a source of high voltage direct current is obtained in a very simple manner. The plate of the pliotron oscillator is then connected to one of the terminals of the condenser, while the filament is connected to the other. The plate of the second pliotron is connected to the grid of the first, while the grid of the second is coupled by means of a second small transformer to the microphone circuit. With this outfit, both pliotrons may be relatively small, and in order to obtain an energy of about 20 watts in the antenna, it is found that the current drawn from the condenser is so small that the potential supplied by it does not vary sufficiently to be audible in the signals sent out. The different parts of this apparatus may be made very compact and no adjustments are found necessary in operating the system unless it is desired to change the wave length. In this case, it is only necessary to change the inductance or capacity.

In the second outfit, which is suitable for use up to 500 watts or more, the high voltage direct current is obtained from a small 2,000-cycle generator. The current from this is transformed up to about 5,000 volts, rectified by kenotrons and smoothed out by means

of condensers. By the use of 2,000-cycle alternating current instead of 60-cycle, it is possible to store up large quantities of energy, and thus obtain as much as a kilowatt or more of power in the form of direct current with condensers of moderate size. This high voltage direct current is then used as before, to operate a pliotron oscillator, the output of which is controlled by means of a small pliotron connected to the telephone transmitter.

By means of this system of control the amount of energy in the telephone transmitter circuit need be no larger than those commonly used in standard telephone circuits. It has thus been found possible to connect up this radio-telephone outfit with the regular telephone lines, so that conversation may be carried out between two people, both of whom are connected with the radio stations by means of the regular land lines. It has also been found possible to communicate both ways over these lines.

THE EFFECTS OF INSULATION RESISTANCE ON ARMOURED CABLES.

BY A. GAVAND.

If an armoured cable forms part of a high-tension network, any fall in its insulation resistance may seriously affect the P.D. between the cable and earth. The matter becomes of great importance in high-tension three-phase installations with an insulated neutral point. In tests carried out at the maker's works, the insulation resistance of armoured cables often amounts to several hundred megohms per mile. But when a cable has been laid and a number of joints have connected it with other cables, figures of this order of magnitude are never obtained; it is not unusual to find an insulation resistance varying from 1 to 10 megohms per kilometre. But even with these figures, the variation in the difference of potential between the cable and earth is very slight, though this would not be the case if the insulation resistance fell to 100,000 ohms per kilometre. For instance, in a network carrying current of a periodicity of 50, let us suppose the voltage between the cables to be U, and between each of the cables and earth to be U/2. If, now, one of the cables is earthed through a resistance of 25,000 ohms, the voltage in this cable will fall by 44 per cent., while it will rise in the other by 30 per cent. Variations of voltage of this sort would be likely to affect any weak spots in the cable. In a three-phase system with a neutral insulated point, the maximum cut-outs may be brought into operation, and this is thought by some to be a weak point in the system. But let us suppose, on the other hand, that the maximum cut-outs are not affected. In this case, the supply of current through the network continues, unless some other disturbing factor arises; but the sound cables are submitted to an increased voltage which might after a time affect their insulation. An indication of this lack of balance would be obtained by connecting a lamp or a voltmeter to the secondary of a transformer, the primary of which is connected between each bus bar and earth. A remedy might be found in using an automatic cut-out, which comes into action when this lack of balance arises. An apparatus of this kind has been proposed by Wedmore, one of the engineers of the British Thomson-Houston Co. It consists of a small three-phase transformer, connected to each feeder; the secondary windings are connected in star fashion and are joined to a fourth winding which is in parallel. So long as the sum of the three currents is zero, no current passes between the neutral points and the star connections; but if, as the result of an earth, the sum of the three currents is not zero, a current flows in the fourth circuit, and causes a relay to act which opens the main cut-out.

It is now proposed to study the law connecting the voltage-difference between the armoured cables and earth with the insulation resistance. We must confine ourselves to the simple case of supposing the capacity and insulation resistance to be centred at a certain point. The product of these two quantities will be constant, as one is directly proportional, and the other is inversely proportional, to the length of the cable. This will allow us to apply the formulæ (1) and (2), as given below, to a length of 1 km. of cable. Moreover, the capacity c which enters into the calculations, is that with reference to the armouring and not the total capacity. Formulæ (1) and (2) cannot pretend to be rigorously exact; they do not take account of the variation of capacity, nor of the self-inductance which, according to the opinion of Boucherot, is not negligible for low values of ρ. Boucherot considers that in cases of dead short-circuit, this may be the cause of voltage-rushes, due to resonance, which might take place in certain well defined cases.

Let us now take two cables A and B between which there is a périodic voltage-difference, given by $U_m \sin \omega t$. Let us suppose the insulation resistance of A to be infinite, and of B to be ρ. If I_m is the current, it is possible to show that

$$I_m = \sqrt{\frac{U_m^2 c^2 \omega^4 \rho^2 + U_m^2 c^2 \omega^2 (1 + 2c^2\omega^2\rho^2)}{(1 + 4c^2\omega^2\rho^2)^2}}.$$

which can be written in the form

$$I_m = \frac{U_m c \omega \rho}{1 + 4c^2\omega^2\rho^2} \sqrt{(1 + 2c^2\omega^2\rho^2)\frac{1}{\rho^2} + c^2\omega^2}.$$

or, as a first approximation, we get

$$I_m = \frac{U_m c \omega (1 + 2\omega^2 c^2 \rho^2)}{1 + 4\omega^2 c^2 \rho^2}.$$

The voltage between A or B and earth is then given by the equations,

$$P_A = \frac{I_m}{\omega} \cdot \frac{U_m \omega c (1 + 2\omega^2 c^2 \rho^2)}{1 + 4\omega^2 c^2 \rho^2} = \frac{U_m (1 + 2\omega^2 c^2 \rho^2)}{1 + 4\omega^2 c^2 \rho^2} \quad \ldots \quad (1)$$

$$P_B = \rho \frac{U_m \omega c (1 + 2\omega^2 c^2 \rho^2)}{1 + 4\omega^2 c^2 \rho^2} \quad \ldots \quad (2)$$

Putting

$$\frac{1 + 2\omega^2 c^2 \rho^2}{1 + 4\omega^2 c^2 \rho^2} = \lambda.$$

and

$$\frac{\omega^2 \rho^2}{1 + \omega^2 \rho^2} \cdot \frac{1 + 2\omega^2 c^2 \rho^2}{1 + 4\omega^2 c^2 \rho^2} = \mu.$$

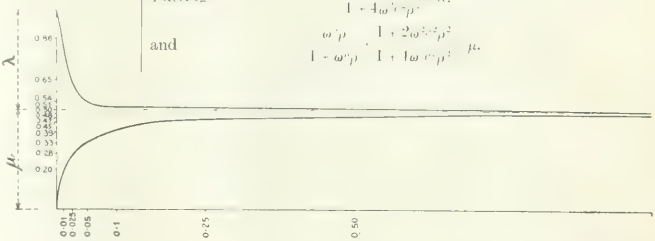


DIAGRAM SHOWING THE VALUES OF λ AND μ AS FUNCTIONS OF THE INSULATION RESISTANCE ρ, IN FRACTIONS OF A MEGOHM. ($c = 0{\cdot}1 \times 10^{-6}$ FARAD PER KILOMETRE.)

We have

$$I_A = U_m$$
$$P_B = \mu U_m.$$

The values of λ and μ, in a special case, are shown in the appended diagram.

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"Science Abstracts." Edited by the Institution of Electrical Engineers. (London: E. & F. N. Spon.) Vol. XVIII. No. 208. Part 4. Section A.—Physics. Pp. iv.+47. Section B.—Electrical Engineering. Pp. iv.+39.

"Proceedings" of the Koninklijke Akademie Van Wetenschappen Te Amsterdam. (Amsterdam: Drukkerij de Standaard.) Vol. XVII. Pp. 87.

"Journal" of the Washington Academy of Sciences. (Baltimore: Waverly Press.) Vol. V., No. 8. Pp. 27. $25.

"The Year Book of Wireless Telegraphy and Telephony, 1915." (London: The Wireless Press, Ltd.) Pp. lxvi.+800. 3s. 6d. net.

"Journal of the Institution of Electrical Engineers." Edited by P. F. Rowell. (London: E. & F. N. Spon.) Vol. LIII., No. 247. Pp. 883. 3s. 6d.

"The Philosophical Magazine." (London: Taylor & Francis.) Sixth Series. No. 173. Vol. XXIX. Pp. 111. 2s. 6d.

"Proceedings of the Royal Society." (London: Harrison & Sons.) Series A. Vol. XCI. No. A 623. Pp. 193-344. 2s.

"Improved Four-figure Logarithmic Tables." By G. C. M. Laton. (Cambridge: University Press.) Pp. 27. 1s. 6d. net.

"Memoirs" of the College of Science. (Kyoto: The University.) Vol. I., No. 2, December, 1914. Pp. 32; and Vol. I., No. 2, February, 1915. Pp. 35. Yen 0.50.

"American Journal of Science." Ed. by E. S. Dana. (New Haven: Tuttle, Morehouse & Taylor Co.) Vol. XXXIX. No. 233. Pp. 125. $6 per year.

* Abstract of an article in "La Lumière Électrique."

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POWER SUPPLY OVER LARGE AREAS.

The wonderful development of electrical power on the Rand during recent years has been brought strongly before engineers in this country by one or two Papers read before technical institutions during the last few months. One of these was Mr. J. H. RIDER'S Paper, in which the author dealt largely with the details of equipment, particularly from the point of view of the consumer. Another Paper is the presidential address of Mr. BERNARD PRICE to the South African Institution of Electrical Engineers. In this address, which we reproduce to some extent in another column, the author gives a more general survey than that of Mr. RIDER, dealing with the question of the power supply on the Rand as a whole. The electrical system on the Rand is now, we suppose, the largest power system in the world, with an output of approximately two million units per day, and it gives us an opportunity of looking at matters from the point of view of large networks as distinct from the comparatively small networks to which we are more accustomed in this country. Even the undertaking of the Newcastle-upon-Tyne Electric Supply Co. is smaller. An idea of the power available is gained when we read that the largest winder on the Rand (where, indeed, many large winders are used) only represents a momentary peak of about 3½ per cent. of the total load, and even if two such winders happen to synchronise in their operation the variation only amounts to about 7 per cent.

Very naturally the diversity between consumers is very effective in producing a comparatively smooth load curve, but the diversity factor on the whole cannot be very large; in fact, it only varies between 1·2 and 1·25, because the class of consumer is practically the same throughout. Even so, there is a very distinct gain by combination, for if each consumer generated electrical energy privately, 20 to 25 per cent. more plant would be required owing to the lack of diversity alone.

When reading of networks of this kind one cannot but regret that greater progress has not been made in this country by the various power companies, and that their

efforts have been so very largely thwarted by municipal opposition. The character of load obtained by connecting up the smaller English towns would not, of course, be anything like so good as the load on the Rand, but there would no doubt be a considerable gain in the saving of plant; and the diversity factor, although not so very high, would certainly be worth consideration. This would more particularly be the case if towns east and west of each other at a considerable distance could be connected up to a single network.

One of the most interesting parts of Mr. PRICE's address is where he gives a comparison between the loads obtained on the Rand and those obtained by the Johannesburg Municipality, by Chicago and by the New York Edison Co. Loads on the Rand have the great advantage of being worked continuously at high load factors, though this characteristic is not quite so marked as it was at one time, owing to the fact that some of the mines are beginning to work single shifts. Even so, there is a very marked superiority over the load obtained from large cities, although the latter may include a large proportion of power for traction purposes. This can be expressed in words by saying that the power companies on the Rand use 90 per cent. of the peak capacity of plant for 1,000 hours per annum as against less than 100 hours for Chicago. Even so, the load curve at Chicago is exceedingly good, and one that we should like to see as being characteristic of the London area. It is to be hoped that in due time this will come about. But we agree with Mr. PRICE that the difficulty is that a change of this order can only mature gradually, and that small advances do not permit the large economies which would have been secured if it had been possible for the ideal scheme to be laid out at the beginning. Now, however, it is no use talking about ideals; we must take things as they are and work for the desired end, which will be attained in due time.

REVIEWS.

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Boilers, Economisers, Superheaters: Their Heating Power and Efficiency. By R. H. Smith. (London: Crosby, Lockwood & Son.) Pp. viii.+128. 7s. 6d. net.

It is frequently stated that insufficient attention has been given to the economical production of steam, whereas considerable work has been done in bringing the steam engine to a high state of efficiency. Probably the reason for this is contained in the fact that engineers have been satisfied with the moderately high thermal efficiencies obtained with boilers. Also exact knowledge of the processes which take place in the transference of the heat energy of combustion to the working fluid has been wanting, and attempts to formulate any rational scientific method of design have not met with any great success.

Prof. R. H. Smith, has devoted much attention to the study of steam generation, and his latest work is very welcome. The author attempts the scientific treatment of boiler design, based on a new conception of the heating action in a boiler. There is nothing in the book to suggest any radical change in boiler construction, but the author endeavours to put boiler design on a sounder base and to systematise the calculations relating thereto.

Engineers are aware that radiation [illegible] fuel and from incandescent particles in the flame plays an important part in heat transmission in the furnace. The amount of the radiation is stated by Prof. Smith to be from 25 to 50 per cent. of the whole heat generated. Heating power cannot be conceived as depending only upon conduction and convection processes. The author, therefore, includes radiant action, and deals with the whole theory of heat transmission from the furnace end of the boiler to the outflow end of the economiser.

Certain empirical factors must of necessity enter into the formulation of this theory, and the author has been able to analyse a very large number of boiler and economiser records from which these factors have been extracted after laborious computation. Prof. Smith has successfully reduced the number of variables to a minimum, and wherever possible has simplified the work by the aid of diagrams and equivalent simple expressions. Thus, in the first three chapters, we find simple relationships between carbon percentage, calorific value, CO_2 percentage, air supply and integral specific heat of flue gas. In this connection the author gives very interesting explanations of the general nature of combustion.

The temperature of the furnace gas controls to some extent the subsequent heating action in the boiler flue and economiser. The author makes use of the fourth power law for a full radiator, and on somewhat novel lines proceeds to the determination of this temperature, obtaining results which, it is stated, closely agree with knowledge derived from actual experience.

The problem of heat transmission through the boiler flue next receives careful consideration. Prof. Smith does not introduce directly the velocity factor into the expression for the rate of heat transmission, but, instead, makes this rate depend on the product of gas temperature and temperature difference. The influence of hydraulic mean depth is also shown. The theory leads to important boiler constants, which can be derived independently from measurements taken during a boiler test. The theory is applied to economisers with like results. The nature of these constants and their dependence on other factors is carefully explained, and this should aid considerably in promoting further research into the subject. A chapter demonstrating the advantage of "contrary flow" is quite new in conception. Engineers will agree with the author in advocating a perfectly definite and scientific measurement of boiler power to take the place of the meaningless "nominal" horse-power.

Altogether we find this book most interesting and instructive, and can strongly recommend it to those who are concerned with the design of steam generators. E. C. M.

Magnetism & Electricity. New and revised edition. By S. S. RICHARDSON, B.Sc., A.R.C.S. (London: Blackie & Son, Ltd.) Pp. viii.+598. Price 4s. 6d.

The output of text-books being so great, one naturally expects to find in the newest example to hand some definite qualities which give the book a substantial *raison d'être*.

The book before us is described as a second year course, adapted to students either of applied electricity or of pure physics. The restricted use of mathematics is an evident characteristic. This will be considered a merit by the reader desiring a clear grasp of the simple conceptions of the subject. But it will not serve the more profound student. In place of a scientific progress of ideas the tendency to a degenerate recourse to mere statement is almost inevitable. For example, take the chapter on Thermo-electricity. The student is supplied with thermo-electric diagrams consisting of straight lines. He is told that there is a neutral point at which the thermo-electric power vanishes. He is told that the Thomson effect was discovered from theoretical considerations. But of the underlying theory he is completely deprived. His dissatisfaction would not be allayed by the discovery that even the books are completely [illegible] presented. Impressions [illegible] of a pair of metal and an alloy are generally used, and he ought at least to be told that the Thomson [illegible] E.M.F. and temperature does not apply to such junctions. It is true that this last omission holds of a great number of even [illegible]

often succumb to a too facile dependence on text-books for material.

Amongst qualities desirable in a text-book of science may be ranked accuracy of statement, and an expressed care for the inclusion of the fruits of recent investigation—in regard at any rate to well-established facts of first-rate importance. The present book is far from satisfying such standards. To take a few instances. It is stated (p. 149) that evaporation is accompanied by the development of electric charges. If so, this should find very prominent mention indeed—which it does not get—in the chapter dealing with atmospheric electricity later in the book; but the statement is not true. Again we find (p. 573) the statement that the southern magnetic pole has not yet been reached. This is a matter of no little importance in the history of discovery. It was at the instance of the British Association that the Antarctic Expedition under Sir James Ross was sent out in 1839, with a view especially to the precise determination of the south magnetic pole. He was unsuccessful, but the feat was accomplished for the first time by the British Expeditionary party under Sir Ernest Shackleton in 1909. The pole was then in Lat. 72° 25′S., Long. 155° 16′ E.

The chapter on "Conduction in Gases" contains many misstatements, some of which arise from a complete ignoring of the striking researches on X-rays, which began with Laue, in 1912.

D. O.

THE LATE DR. F. S. PEARSON.

AN APPRECIATION BY DR. H. F. PARSHALL.

The tragic death of Dr. F. S. Pearson through the sinking of the "Lusitania" brings to a premature close an engineering career of more than exceptional brilliancy. Both in North and South America, as well as on the Continent of Europe, Dr. Pearson had extensive transactions with the German manufacturers and financiers, and I have reason to believe, in so far as the Germans are capable of admiring genius other than their own, they recognised the exceptional abilities of Dr. Pearson. Undoubtedly, one way and another, the Germans have profited largely through his genius. It seems too much to expect that they should in any way regret having been the wilful cause of the death of an innocent man, who had no ill-will against them—at least, not until the breaking out of the war.

Dr. Pearson was about 50 years of age. He graduated at Tufts College, and had earned his way through that Institution by being local station-master while pursuing his engineering studies. My first acquaintance with him was in the early nineties. He had then finished the design of and had in operation the large West-End tramway station at Boston, Massachusetts, U.S.A. In order to secure the best economy, he had installed what were then very large horizontal cross-compound Corliss engines; but the largest railway generator available was a 500 kw. machine at 350 revolutions, in consequence of which the economies incident to the use of large steam plants were largely frittered away in the shafting and other arrangements incident to driving a number of small generators of high speed from a large engine of slow speed. Dr. Pearson, with his usual clear foresight, had decided that someone must be competent to design large railway generators which could be attached to the flywheel of the main engine. He had consulted a considerable number of manufacturers, but none of them were willing to undertake the task. I was introduced to Dr. Pearson by the late General Eugene Griffin. As a result of our meeting, I explained to Dr. Pearson that I had in my note-books particulars of the generator he wished, and had only been hoping that electrical matters might so far advance that before I terminated my career I might be able to build such machines. With his usual boldness and energy, Dr. Pearson was not long in persuading his clients to place an order with the General Electric Co. for six of these machines. They were at that time considered colossal. Dr. Pearson subsequently designed a large tramway power installation on similar lines for Brooklyn, and later on, when the Metropolitan Street Railway Company of New York electrified, Dr. Pearson designed the huge station at Ninety-six Street, and was responsible for the whole of the mechanical and electrical arrangements. In fact, it was through his indefatigable energy that the tramway conduit system was made a success in New York. Numerous attempts had been made before to make conduits work, but the results had been so disastrous that it required someone of Dr. Pearson's courage to undertake the problem again. He did this and with entire success.

Nothing was too big or bold to engage the attention of Dr. Pearson, and the bigger the venture, provided the result justified the means, the more he was interested and the more he would devote his whole energies to a solution. In practically every engineering undertaking he was successful, although there may in many cases have been a considerable wait for the industry to overtake the enterprise.

Dr. Pearson's general theory straight from the beginning was, no matter how big a view was taken of electrical engineering problems, the ultimate demands were sure to exceed the original arrangements, and the bigger the original arrangements the less likelihood of waste in the long run.

He designed the hydro-electric power installation in Necaxa, Mexico, which was one of the first and one of the boldest in the world. In a few years the installation had to be doubled, when, except for the presiding genius of Dr. Pearson, probably the undertaking would never have been begun.

He was adviser and designer of hydro-electric power installations not only in Mexico, but at Niagara and in Brazil, all of which have been engineering successes, and will be a lasting monument to his genius, which was beyond that of any engineer that I have ever met, in that he could comprehend the widest possible situation as a whole, and could see further into the future, and had the courage of his convictions in going ahead on a scale that other engineers would have baulked at.

In early life he had made a special study of marine and mechanical engineering, hence his special qualifications in designing steam power stations. His qualifications were more essentially mechanical than commercial, and in all of the hydro-electric power installations the dam and the general power-house arrangements are practically his own.

His paths were paths of peace. He was essentially and always interested in engineering problems, especially in the utilisation of the forces of Nature in the service of man. It seems only the irony of fate that war should have been to some extent both directly and indirectly the cause of his death. In Mexico he was president and the moving spirit in the Mexican tramways and the Necaxa power installation and of the Mexican North Western Railway. All of these undertakings were brought to a standstill through the Mexican revolutionary paroxysms, and although the financial situation of these undertakings was distressing to Dr. Pearson, no one could have foreseen the anarchistic condition into which Mexico had been allowed to drift.

At the breaking out of the present war the Barcelona enterprise was in an incompleted state, and the Continental banking houses who had agreed to finance the matter to a conclusion were unable to go further. For this reason a complete reorganisation was necessary, and Dr. Pearson, while having every right to be discouraged, put his shoulder to the wheel and gave every possible assistance to effect the reorganisation of the financial arrangements necessary to save the enterprise. He was returning from New York to attend a general meeting of bondholders and to assist the Committee of reorganisation when he met his death. The tragedy is a double one, in that he was accompanied by his wife, who was also drowned.

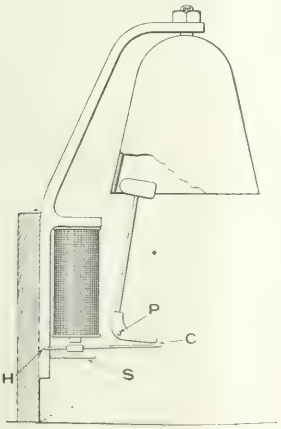
Like most members of our profession, Dr. Pearson was an optimist, in that he hoped civilisation had so far advanced by the teachings of science and improvements of engineering that the barbarities of antiquity could not be recurring, and that he should have met his death through an act of barbarity that would have put to shame the blood-thirsty pirates of old—since spite, not plunder, was the motive—and from a people who have every reason to be grateful to him, seems an irony beyond the power of comprehension or description. The

is one great fact, however, and that is that Dr. Pearson will always be remembered with deep affection by all who knew him, since, while he was a man of great force and energy, he was undoubtedly a man of perfect integrity, and a man who cherished ill-will towards no one and worked but for the betterment of mankind in general.

ELECTRIC BELLS.

BY C. TURNBULL.

Considering their importance, electric bells have received singularly little attention, and the design remains substantially as when originally invented. The operation of the ordinary bell leaves much to be desired both from the electrical, mechanical and user's point of view. The current is switched on to the magnets when the hammer is receding from them, and the circuit is broken before the armature has completed its stroke, so that the magnetic effect is far from being in phase with the movements of the armature. The hammer also remains too close to the gong, so that it damps the vibrations, and prevents the sound from carrying well while causing the discordant noise so nerve-racking in many a busy office. How much pleasanter would be the tone of a musical gong resounding to a series of rhythmic beats with a reasonable interval between. Such a change would surely help the amenities of life to a degree perhaps unsuspected by those who have come to think that hideous racket in some shape or form must necessarily accompany modern progress.



A properly designed electric bell should have a hammer arranged to swing through an appreciable arc, while the contact should be made when the hammer is right back and broken only when the armature has come against the pole-pieces. A bell on these lines was patented by the author many years ago, and it was then proved that it could have found a ready market had the firms who took it up not insisted on spoiling the design before putting it on the market. The General Electric Co. have recently introduced a large bell on similar lines, and, perhaps, we shall eventually see the pattern revived for ordinary sizes. The author's design is shown in the diagram. The armature is hinged at H, while the hammer is pivotted at P, the electric contact being at C. The armature rests against the stop S at the beginning of the stroke, while the hammer falls far enough backwards to make the contact C. Current flows through C when the circuit is completed, thereby exciting the magnets which draw up the armature and the hammer is thrown against the gong and the contact C is also broken. The armature then falls back on to the stop S, and remains there until the hammer falls back and remakes the circuit when the cycle is repeated. The stop S [illegible] which materially increases the force of the blows. Owing to the fact that the contact is made when the armature is right back and not broken until it is against the poles, this form of electric bell is very efficient, while the slow and rythmic stroke permits the use of musical gongs which ring out with pleasant tones. Laminated magnets give an appreciably sharper hammer blow, and should be used for large bells. The contacts may be made of nickel or similar metal, and are self-cleaning if the metal is thin enough to ensure that the pressure is concentrated on a small area where they meet.

Both the Post Office and the National Telephone Co. were willing to give this bell a trial, and there is no doubt that it would have sold well had it been possible to persuade manufacturers to put the original design on the market with some slight improvements. Unfortunately, the makers who took it up insisted on re-modelling the bell to make it more like the ordinary pattern, and this completely spoilt it. In the original design the stop S was made of a piece of wire shaped like a hairpin, pushed through from the back of the metal base. The action of this was perfect. It was easily adjusted and permanent after once being set, and the springiness was sufficient to help the rebound of the armature. The makers insisted on replacing this by an adjusting screw, which arrangement required that a spring should be fixed to the back of the armature to enable the hammer to work smoothly. This plan was expensive to make and inefficient in action, and the screw was liable to work back. But the most astonishing thing was that makers were absolutely unable to make workable pivots for the hammer and armature. They made them either so tight that the bell would not act at all, or else so slack that the action was destroyed by inordinate slogger. Yet it proved that there is a demand for such a bell, and, as the patent has run out, and there are no inconvenient royalties to pay on account of the work done to prove the practicability of the design, makers might find it worth while to revive it.

Large bells may be made on this system with a rotating armature instead of the ordinary type, the make and break being on similar lines. Even up to very large sizes such bells would work with small consumption of energy.

The hammer shaft should be of springy material, as this allows the hammer head to vibrate so that it does not interfere unduly with the vibration of the gong.

THE "LOCK-OUT" CONTACTOR.

The applications to which automatic control gear is chiefly adapted are three in number:—

1. The automatic starting and stopping of motors driving such gear as pumps, compressors, &c., in which case attendants are entirely dispensed with.

2. Where the scheme of control involves a number of complicated connections and changes in connections which must be rapidly and correctly made; for instance, in the control of lifts and bridges.

3. Where the use of hand-operated apparatus for large motors, for instance, becomes cumbersome and physically difficult in operation. In this case a small master controller, handling current of only a fraction of the amperage of the main current, controls a panel containing a number of contactors which handle the main current.

Where it is necessary to have automatic acceleration on direct-current circuits it may be obtained, broadly speaking, in three ways:

1. *By the use of a Solenoid controlled by a Dash-pot.* This method possesses all the disadvantages so well known in connection with dash-pots; for instance, the time of cutting out is the same in every case, and is independent of the starting load.

2. *By Counter E.M.F. Control.*—This also possesses numerous well-defined defects, such as uncertainty of operation on widely varying voltage.

3. *By Current Limit Control.*—This is the best system. It has formerly been necessary in this system to use series relays, the dropping of which are governed by the motor current, the results in the [illegible] being cut out just when the motor is ready for the change. The trouble in connection with this system is to have been that the relays which are used introduce a large number of extra con-

tacts, any one of which failing to work preventing the starter from operating.

The British Westinghouse Company have recently put on the market a system known as "The Series Lock-out Contactor System," which is claimed to have all the advantages of the series relays mentioned above, but which has entirely eliminated the one weak point—*i.e.*, relay contacts. This is already widely used in the States, and promises to revolutionise the applications of automatic control gear. Due to its special characteristic of "locking out" or not closing when the current is above a certain value, it has been called the Lock-out Contactor. It will be seen that an automatic

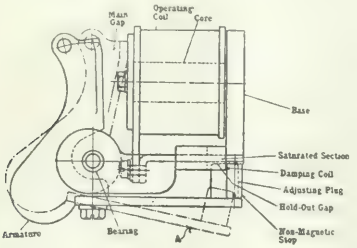


FIG. 1.—DIAGRAM OF "LOCK-OUT" CONTACTOR.

starter made up of a number of these contactors may have the contactors so adjusted that they will only close with a predetermined current on the motor. As long as the current is *above* the value at which the contactors have been adjusted to close nothing will happen, a step of resistance being cut out only when the current has fallen down to the predetermined value.

The operation of the contactor will be best understood from the following description, taken in conjunction with Fig. 1, the diagram of the magnet frame. It should first be noted that the motor current passes through the operating coil winding directly. With the contactor in the open position (shown in full lines), at the instant of applying current, assuming this current to be above the value at which the contactor should close, a flux will pass through the main air-gap, through the armature, and along the steel piece A fixed to

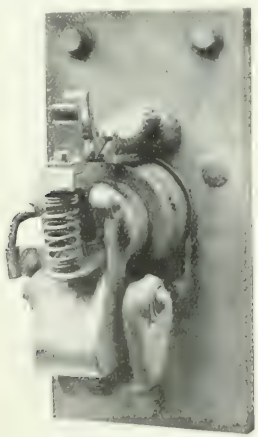


FIG. 2.—VIEW OF "LOCK-OUT" CONTACTOR.

the armature and carrying the adjusting plug, then through the main air-gap between the adjusting plug and on to the base. This flux tends to hold the contactor in the open position, due to the pull between the adjusting plug and the base of frame being greater than the pull at the main air-gap. For a fraction of a second current is prevented from passing through the part marked "saturated section," due to the very heavy damping coil which is wound round this. The necessity for this will be explained later.

As the current builds up on the motor, growing up, the flux through the saturated section remains the same. In consequence, the pull between the adjusting plug and the base of the contactor decreases, until a point is reached where the pull through the main air-gap overcomes the pull at the adjusting plug, and the contactor closes. Adjustment of the air-gap between the plug and the base of the contactor alters the figure at which the contactor closes. As will be seen, this adjustment is perfectly simple, and once adjusted the plug is locked in position.

Regarding the damping coil referred to earlier on, its use can best be followed by the effect on the contactor if it were absent. Without it the contactor would close as the current was rising upon it reaching the value at which it was set to operate. The damping coil sets up an entirely different condition in the magnetic circuit when the current rises very rapidly. Under these conditions the flux is prevented from passing through the portion marked "saturated section," and consequently it all passes through the adjusting plug. The increased "pull out" set up is so great that the contactor cannot close. In a fraction of a second after the current reaches the full value the flux divides between the two circuits as previously described, and the contactor is held out by the normal operation of the lock-out device. It is free to close when the current falls to the value for which the contactor has been adjusted.

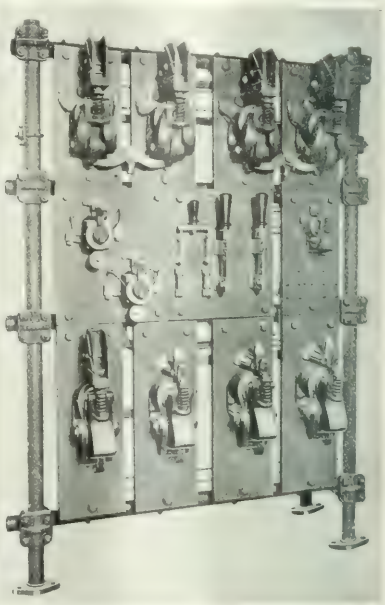


FIG. 3.—PANEL OF "LOCK-OUT" CONTACTORS.

An ordinary non-reversing automatic starter embodying this type of contactor would contain, firstly, a shunt-wound contactor, the circuit of which would be made from some distant point, or from a switch operated by the rise and fall of water in the tank, or rise and fall of air pressure in an air system, &c., as required. Secondly, a number of contactors of the type described above, which serve to short-circuit the resistance in the armature circuit. These contactors are so connected that without the use of any interlocking contacts each contactor is put into circuit, and consequently closes in the order desired. Also, the different contactors have their coils short-circuited, and consequently fall out as the next step of resistance to them is short-circuited, so that in the "full on" position only the shunt-wound line contactor and the last series-wound contactor are in circuit.

In order to keep the shunt coil as nearly as possible in line with the series coils as regards possibility, it is wound for a low voltage and a resistance is connected permanently in series with it. The coils are also impregnated with a special compound which renders them damp-proof, and at the same time capable of withstanding very high temperature without damage.

Fig. 2 shows the latest character of the contactor, and Fig. 3 illustrates a panel of the reversing type, in which the reversing co

tactors are shunt wound, as mentioned above, and the resistance contactors are of the lock-out type.

In comparison with other forms of automatic control gear, the following advantages are claimed for the series lock-out system :—

1. The number of shunt coils is reduced to a minimum. These coils are never subjected to the full voltage of the circuit, as is the case, at least momentarily, with most other types of control gear.

2. No clutch or retarders are used, the acceleration is explained above, being fixed by the load on the motor.

3. Small interlock contacts and switches for cutting in an economy resistance are not necessary.

CORRESPONDENCE.

THE HEAVISIDE LAYER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I read Dr. Lee de Forest's letter in your issue of the 7th inst., and hope I have not caused him and his friends any "amazed amusement." All that I have endeavoured to show is this, viz., that there is not at present the slightest reason for assuming that the cause of long distance wireless at night is due to reflection from an ionised layer.

The article reproduced in THE ELECTRICIAN is interesting in a way, but does not seem to me to contain anything that people here are not already familiar with. The fact that reflection may produce interference bands is very well known, but I fail to see what bearing this has on the existence of a *permanently ionised layer* as postulated by many engaged in practical wireless work. If Dr. Lee de Forest can explain how such a layer *comes into* existence and *permanently remains* in existence night and day I am sure many of us would be very interested and grateful to him. I am, &c.,

Mill Hill, N.W., May 15. W. H. F. MURDOCH.

ORGANISATION OF THE ELECTRICAL INDUSTRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have noted with considerable interest the recent proposals made by the Engineers' Club of Manchester, regarding the organisation of the engineering industry. The proposed association would undoubtedly be a step in the right direction and should have the support of the manufacturers generally.

I have previously advocated the formation of several large organisations (each to be formed by consolidating several existing firms) as a means for promoting the welfare of the electrical manufacturing industry, and am convinced that such concerns are not only advisable, but that they are necessary. The welfare of the individual is essential to the prosperity of the State, and whilst the combine may appear somewhat to cripple and handicap individual effort, the evil is more apparent than real. The sphere of the individual is limited and should be confined to specialities, whilst a combine must necessarily have an extended and general field. The specialist manufacturer can easily compete with the combine, because the large concern cannot possibly give so much attention and effort to one line of apparatus. There are obvious reasons for the existence of combines; Great Britain has lost a great deal of electrical business because there was no British firm sufficiently strong to compete with German combinations like the A.E.G. and the Siemens-Schuckert when very large [illegible] were involved. The Victoria Falls contracts illustrate the condition very forcibly.

The large organisation can manufacture and install complete plant, and accept the whole responsibility for the apparatus; it is undoubtedly true that many [illegible] prefer to have one firm responsible for everything, and [illegible] of business is obtained in this manner. This does not apply so much to the home trade, where consulting engineers are employed, as to foreign and colonial trade. The large combinations do their own consulting work and can furnish prospective customers with complete data and costs, and this information is more accurate than can be [illegible] a consulting engineer, inasmuch as the firms will accept contracts on the basis of their own proposals. If it were possible for every manufacturer to be a specialist and for all lines to be covered by such specialists, then the combine could not exist; such a condition is practically impossible, however, and as the large organisation tends towards high efficiency, it will be able to obtain business with less expense than the smaller manufacturer making the same class of apparatus.

The British manufacturer must realise that the German engineering industry is thoroughly organised, whilst the British industry is quite disorganised; and unless prompt steps are taken to organise properly and efficiently, the Germans will retain much of their past trade. Racial feelings are very strong now, but what will be the condition 30 or 40 years hence? The animosity between France and Germany as the result of the war of 1870 has never ceased to exist, but France has imported very largely from Germany for many years in spite of it. I am quite in favour of an Engineering Development Association, but combines must also be organised; otherwise the results will be disappointing, for the proposed bureaux cannot take the place of energetic salesmen.

A splendid opportunity has come to the British manufacturer, but no advantage will be gained without a thorough re-organisation.—I am, &c.,

Mass., U.S.A., May 4. CHARLES H. HADDRELL.

THE UNIT OF CANDLE-POWER IN WHITE LIGHT.*

BY CLIFFORD C. PATERSON AND R. F. DUDDING.

The principal object of this Paper is to describe and discuss the methods which have been used at the National Physical Laboratory, and the results obtained in the standardisation of high efficiency metal filament lamps in terms of the unit given by the 10-candle pentane lamp. Such a standardisation entails the comparison of two sources whose radiation in the visible spectrum, though continuous, differs appreciably in hue. The amount of this difference may be gauged by remembering that if the voltage on an ordinary carbon filament lamp is lowered until the hue of its light matches that from the pentane lamp, the carbon lamp will be found to be burning at a rate of consumption of about 7·7 watts per mean horizontal candle. The ordinary consumption of carbon filament lamps is in the neighbourhood of 4 watts per mean horizontal candle. A series of comparisons was carried out in order to express the hue of radiation from electric glow lamps in terms of the temperature of a black body whose radiation was identical in colour with that of the glow lamps in question. It has long been recognised that such colour comparisons can be made very accurately with a Lummer Brodhun photometer.† The methods used are those described in another Paper by the authors, which should be referred to for further details. From a diagram in this Paper it can be seen that a carbon lamp, the hue of whose radiation matches that from the pentane lamp, has the same coloured radiation as a black body at 1,610° C., whilst a tungsten lamp at 1·5 watts per mean horizontal candle matches a black body at 1,950° C. Now, between these extreme there exists a considerable colour difference, and this has to be bridged photometrically when defining the candle-power of the tungsten lamp in terms of the pentane unit. To do this, a set of metal filament [illegible] running at 1·5 watts per mean horizontal candle has been standardised, by the cascade method and values of candle-power in terms of the pentane unit have been assigned to them once for all. The method used and results obtained in standardising these tungsten lamps are the principal subjects of this Paper.

The Cascade Method. Briefly, the course followed has been to interpose between the pentane lamp and the high-efficiency substandard [illegible] additional set of lamps, each [illegible] one difference in the hue of their radiations constitutes a regular colour gradation in approximately even steps from the pentane colour up to that of the 1·5 watts per candle tungsten filament standards. If, now, each [illegible] below it—that is to say, the set whose light is one stage redder than [illegible] although perceptible, is too small seriously to trouble an observer [illegible]

* Abridged from a Paper read before the Physical Society.

† Lummer and Brodhun, "Contribution to Photometry," Trans. Illum. Eng. Soc., vol. IV., 1909.

It is assumed in what follows that in the measurements of lights of different colours the true basis of comparison is the perception of the average normal eye. The nearest approximation which it was possible to make to normal sight was to take the average of six different observers.

The photometric work involved has been laborious. In order to eliminate any uncertainties of individual lamps and to reduce the probable error, each of the six sets of lamps consisted of 10 or 12 individual lamps, and each set was compared with the next one, in order of colour, some six or eight times by each observer. This entailed in all between 2,000 and 3,000 standardisations, or between 10,000 and 15,000 observations. The work was started several years ago, but the difficulty experienced at first in obtaining metal filament standards which were sufficiently constant caused much delay in the early stages. For the cascade comparison six sets of sub-standards and 5 five comparison lamps were used.

Set 1 was a series of 11 sub-standards whose radiation matched in hue that of the pentane lamp, or the radiation from a black body at 1,610°C. Set 2 was a series of 11 Fleming-Ediswan sub-standards operating at an equivalent temperature of 1,700°C. Set 2 was compared against set 1 by the usual substitution method of photometry, using a Lummer-Brodhun photometer, and a comparison lamp, the colour of whose radiation lay midway between that of sets 1 and 2. In a similar way, set 3, with an equivalent temperature of about 1,750°C., was compared against 2 through another comparison lamp, which also divided the colour difference, and so on to set 6. It will thus be seen that by such a substitution method as this the colour difference between sets 1 and 6 is divided into 10 approximately equal steps—that is to say, at any one measurement there is only a colour difference of one-tenth that of the difference between sets 1 and 6. The difference of colour in the photometer throughout the investigation was, therefore, never greater than that resulting from a difference of temperature of about 45°C. All the measurements were made with an illumination at the photometer screen of 10 metre-candles. Finally, having by this means, and for each observer, assigned candle-power values to each of the lamps in set 6, the latter were compared in one step with set 1. It is of interest to note that the colour of the radiation from melting platinum is the same as that of set 3.

Before passing to the details of the work the authors desire to point out one of the advantages of the cascade system as applied to electric sub-standards. The possession at a standardising laboratory of a regular gradation of sub-standards ranging from the lowest to the highest efficiencies, enables a set of standards of suitable colour to be chosen for whatever test has to be undertaken. As gas-filled lamps develop and come more into use there would seem to be no reason why the system should not be extended to very high efficiencies with sub-standards eventually covering a range of from 1,600°C. to about 2,700°C. The authors are at present experimenting with gas-filled standard lamps with the intention of carrying the work a stage further should they prove satisfactory.

The authors then describe the types of lamps used in making these comparisons and give a table with full particulars of each set of lamps.

Absolute Value of the Unit of Candle-power.—The foregoing description deals with the method used to determine the ratio of the average value of one set of sub-standards in terms of another, and, therefore, deals only with relative values. The *absolute* values of candle-power of sets 1 and 2 have been assigned to them respectively by two independent comparisons with the Harcourt 10 candle-stand and lamp. Set No. 2 (consisting of Fleming Ediswan lamps) was compared against the pentane lamp in 1904 6. At the time that the determination was made their colour formed a suitable intermediate step between that of the pentane lamp and the usual light sources which had to be tested. After eight years' use of these lamps, and in view of some small unexplained differences between the N.P.L. unit and that determined in other quarters, it was considered desirable to realise the unit anew. Set No. 1 of the sub-standards was, therefore, prepared, whose light was identical in colour with that from the pentane lamp and compared against the pentane standard in the usual way over a period of about two years (1912-14). It is satisfactory to find from the subsequent inter-comparison of sets 1 and 2 that the unit of candle-power realised on these two different occasions separated by a period of eight years agreed with each other to within less than 1 part in 1,000 (0·1 per cent.).

The authors go on to discuss the order of agreement between different observers in the final candle-power value obtained for the high efficiency lamps (set 6), (*a*) by the cascade method; (*b*) by comparison in one step. They also deal with the accuracy to which photometric readings of this description are repeated by any observer and the probable error of the results. Table I. gives the probable errors of the various stages of the cascade and direct comparisons.

Table I.—*Giving the Probable Errors of the Various Steps of the Cascade and Direct Comparisons.*

Comparison.	Probable errors. Bench error.	Day-to-day error.	Error due to differences between observers.	Total probable error in mean of set.
	%	%	%	%
Pentane lamp against Set 1	0·01	0·05	0·00	0·05
Set 2 against Set 1	0·01	0·05	0·15	0·15
.. 2 .. .. 2	0·01	0·05	0·04	0·06
.. 4 .. .. 3	0·01	0·04	0·12	0·13
.. 5 .. .. 4	0·01	0·03	0·11	0·11
.. 6 .. .. 5	0·01	0·02	0·04	0·04
Total probable error by cascade method Set 6 against Set 1...	0·02	0·07	0·23	0·24
Total probable error by direct method, Set 6 against Set 1 .	0·02	0·06	0·22	0·23

Intercomparison with other National Laboratories of the Unit of Candle-power in White Light.—Having fixed the value of the unit in white light by the cascade method, it became of interest to know what order of agreement existed between it and similar units evolved at the National Laboratories of France, Germany and the United States.

The following table shows the value of the N.P.L. unit in terms of that of the Reichsanstalt, Bureau of Standards and Laboratoire Central, deduced from the mean of all the lamps tested :—

Table II.

	Ratio.	Difference from accepted value.
		%
Bureau of Standards N.P.L.	1·00$_3$	+0·3
Reichsanstalt N.P.L.	0·99$_{02}$	0
Laboratoire N.P.L.	1·00$_2$	+0·2

A higher accuracy than 0·25 per cent. cannot be claimed for these intercomparisons, and the results, therefore, show that within the limits of the experiment, the units of candle-power at the four laboratories realised in lamps operating at 1·5 watts per candle are in virtual agreement. The chief interest of the result lies in the fact that different methods were used at the several laboratories for carrying out the comparison.

The Redetermination of the Constants of the Pentane Lamp.—The second realisation of the unit of candle-power from the pentane lamp has afforded an opportunity of re-examining the constants of the pentane lamp in regard to changes of humidity and barometric pressure. As in the previous determination,* the comparisons extended over two summers and winters, and by this means as wide a range as possible of humidity was secured. The conditions for the use of the lamp were similar to those existing previously, except that a larger number of observers took part in the measurements, and there was no colour difference between the light from the pentane lamp and that from the sub-standards compared against it. From the results the authors conclude that if work of the very highest accuracy is to be carried out with flame standards under abnormal humidity conditions the combined humidity-temperature coefficient should be determined for the locality in which the work is to be conducted. It should be pointed out that the difference between the American and English determinations for the pentane lamp amounts to less than 1 per cent. in candle-power for a rise of humidity of 10 litres per cubic metre above the normal. Values have seldom been observed greater than this in Teddington. A table by Crittenden and Taylor shows the average humidities in Boston and New Orleans to be 9·9 and 19·1 litres per cubic metre respectively. Where such large differences exist in climatic conditions the question of the variation of the combined temperature-humidity coefficient might with advantage be further investigated.

The Constancy of the Unit of Candle-power held in Electric Sub-standards.—The continual use which has been made of electric sub-standards since the first determination of the unit of candle-power in 1904, has afforded opportunities of watching the behaviour of such lamps and particularly of observing their constancy. Several observers, amongst whom are J. A. Fleming, C. H. Sharp, P. S. Millar, E. B. Rosa and G. W. Middlekauff,† all witness to the constancy of

* C. C. Paterson, "Investigations on Light Standards," "Journ. I.E.E., Vol. XXXVIII., p. 274.

† Fleming "Proc." Brit. Assn., 1904. Sharp and Millar, "Trans." Ill. Eng. Soc., N.Y., June, 1910. Sharp "American Gas Inst.," Oct., 1913. Rosa and Middlekauff, "Proc." Amer. Inst. Elect. Eng., July, 1910, p. 1911.

properly prepared and seasoned electric sub-standards. Their observations have been mainly concerned with carbon filament glow lamps, and the present authors are able to endorse the views they express. In order to keep records of their behaviour, an annual analysis is made of all the photometric records where sub-standards have been used during the year. When an ordinary routine standardisation has to be made, three to six sub-standards are put on the bench in turn, and thus for each day's work a value is obtained for any one standard lamp in terms of others of the same set. The analysis of such results over a year's working indicates if any individual lamp shows signs of differing from the mean of the others. It has been unusual to find that a lamp has appeared to change during 12 months by more than 0·1 per cent., and the majority of them show no change which can be detected. If any lamp in a set shows a difference from the mean of 0·1 per cent. no change in the value assigned to it is made until such difference is repeated in the following year's analysis. Of the one or two lamps whose values have had to be adjusted in this way, some appear to have risen and some to have fallen in candle-power, and there is no sign that any fundamental set of lamps is undergoing a progressive change. This can be said equally of the tungsten filament lamps as of those with carbon filaments. A set of 1·5 watts per candle tungsten standards (set 6) has to be used nearly every day of the week, and a fundamental as well as a working set of these lamps is, therefore, kept. The working set fell in candle-power about 0·5 per cent. during the continuous use of the past two years. As the fundamental set will only be used perhaps two or three times a year, its constancy for very many years is assured. It could at any time be compared against set 5 (2 watts per candle), which has never to be used in ordinary routine work, and which, as a matter of fact, has not been used since the values of its individual lamps were first fixed by the cascade method. Similarly, the use of set 1 (matching the pentane lamp in colour) will never be necessary in ordinary work because of the redness of the light. When it is remembered that the filaments of these lamps are of tungsten operating at the low efficiency of about 7 watts per candle, and that they only require to be used for exceptional reference purposes at intervals of several years, there would seem to be every reason for expecting the unit of candle-power to be maintained constant by means of them for an indefinite period.

LEGAL INTELLIGENCE.

British Vacuum Cleaner Co. v. Jas. Bradshaw & Sons.

In the House of Lords on Monday the appeal by the British Vacuum Cleaner Co. (Ltd.) *v.* James Bradshaw & Sons (Ltd.) was dismissed. At the close of the arguments for appellants judgment was reserved.

The Lord Chancellor, in giving judgment, said that the action was brought to restrain infringement of a patent granted in 1901 to Hubert C. Booth for improvements relating to the extraction of dust from carpets and other materials. The defence was twofold: Firstly, non infringement, and, secondly, prior publication and user. The patent had been on several occasions before the Courts in other cases, and this House had decided that it contained a sufficient subject matter, and was to be construed in a particular sense. It was, however, open to defendants to prove anticipation as well as non infringement, and the Court of Appeal (by a majority), reversing the judgment of Mr. Justice Sargant, had decided in favour of defendants on the question of non infringement. The invention of appellants consisted of the combination of an extracting implement, a power driven suction pump, by means of which a considerable vacuum was obtained, and a dust collecting apparatus interposed between the place where the dust laden air entered the machine and the pump. Prior to appellants' invention there had been on the market and in actual use a vacuum apparatus for removing dust by suction, but in the present apparatus the vacuum was obtained by bellows, as distinguished from a cylinder pump, and the object of it was to remove dust from a surface, a process which required a moderate suction only, in the old apparatus there was a dust collecting receptacle in appellants' apparatus. The advance made in appellants' process was to introduce a nozzle which should press closely on to the surface to be cleaned, and to produce a vacuum behind the nozzle so considerable that the air should so powerfully force its way through the material to be cleaned as to carry the dust out of its structure. In the main the older apparatus only drew away the dust on the surface, and the current of air employed entered, but was meant to enter, under the edges of the nozzle. Otherwise no current of air would have been obtained. But the most powerful action of appellants' machine was directed to drawing air through the substance operated on. A close-fitting nozzle was, therefore, necessary. It was proved that the essential character of appellants' process was to produce a current of air so strong that it would draw in air by a nozzle which was applied all, or nearly all, the air which formerly came in under the edges of the nozzles; by practically sealing the gap between the nozzle and the surface, the current of air would be drawn from beneath and through the material to be cleaned. There was no doubt that appellants' process was a real advance in respect, at all events, that it met a practical want, and that the machine in consequence commanded a large market. It appeared to him that the appellants had limited their claim to an apparatus capable of maintaining a pressure of at least 5 lb. at this place, and that respondents' machines did not come within the patent so interpreted. For those reasons he was of opinion that the appeal failed.

Judgments to the same effect were read by all the noble and learned lords, except Lord Sumner, who merely expressed his agreement in the decision. Accordingly the appeal was dismissed, with costs.

Geo. Brown v. Lambeth Borough Council.

At Lambeth (London) County Court on Friday plaintiff brought an action to recover damages to a taxicab.

Mr. Lever (for plaintiff) said on January 6 a driver in plaintiff's employment picked up a fare at Brixton, which he was taking to Tulse Hill. When nearing Effra-road he came to a corner gas lamp which was shaded, and, as it was a very dark night and wet, as soon as he came from the glare of the lamp he was plunged into total darkness. A short distance away was a refuge, on which was an electric arc lamp, but at the time of the accident that was out, the result being that the driver ran into the refuge, smashing the lamp and damaging the taxicab.

Wm. John Saunders, driver of the taxicab, gave evidence in support of Counsel's statement, and added that when he approached the refuge he slowed down to eight miles an hour. Evidence was also called to prove that the arc lamp on the refuge was out at the time of the accident, and that it was practically impossible for the driver to see the refuge after he had come from the glare on the road caused by the shaded gas lamp.

Mr. Bruce Penny, Town Clerk of Lambeth, maintained that there was no negligence on the part of the Council, inasmuch as the lighting arrangements were carried out by the South Metropolitan Gas Co., and the South London Electric Supply Corporation. He also pleaded that the Council was not responsible for the damage, as they were acting under the instructions of the Chief Commissioner of Police, who was responsible for the street lighting under the Defence of the Realm Act.

The Borough Engineer (Mr. H. C. J. Edwards) stated that the lamps had been shaded at the instigation of the police, who approved of the measure taken by him and his staff. It was desired that the light from the lamps should be thrown on the ground, but that did not cause a "glaring light." In cross-examination, he said he did not know that hurricane lamps were placed on the ends of a refuge, nor that the Kensington Council had decided to place them on all refuges in the High-street. Evidence was also given that the arc lamp should have been in working order at the time of the accident and that it should have been alight, as it was found to be burning at 11 o'clock the morning after the accident.

Mr. Lever pointed out that under a recent judgment the Council was responsible for an accident of that nature, and his Honour, Judge Parry reserved judgment.

Electric Cables Under Streets.

In the Chancery Division on Tuesday Mr. Justice Eve heard an application for an injunction by the Chester Corporation to restrain the Chester Water Works Co. from pulling up streets in the city to lay electric cables to the river side. Mr. McMorran, K.C. (for the Corporation), said as Mr. Dighton Pollock (for the defendants) would give an undertaking not to proceed with the work for a fortnight, he would consent to a postponement of the trial for that time.

Gell Telegraphic Appliances Syndicate (Ltd.). Last week Mr. Justice Astbury confirmed the reduction of capital by cancelling 10*s.* each of 37,770 £1 shares.

PARLIAMENTARY INTELLIGENCE.

STALYBRIDGE, HYDE, &c., TRAMWAYS & ELECTRICITY BILL.

Last week a Select Committee of the House of Lords passed the Bill of the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board to authorise them to construct additional tramways, to extend the area of electricity supply, and to borrow £57,300 for the construction of tramways, £20,000 for the electrical equipment of the lines, and £5,500 for the purchase of lands for a new generating station, &c.

Mr. Balfour-Browne, K.C. (for the promoters), said that the population of the four towns was 92,577. The tramways, which were authorised in 1901, provided very great transit facilities in those districts, but owing to certain mistakes that were made in carrying two lines north and south, each of which took traffic for the other, and to having charged 1*d.* fares while other towns were in the habit of charging 1*d.*, the tramways had not been directly remunerative. The supply of electricity, on the other hand, had been a very considerable financial success, and in 1914 showed a profit of £8,257 3*s.* It was proposed to extend the tramways to serve additional districts within Saddleworth in the north and to other places to the outskirts of Stalybridge. The new lines and junctions would enable connection being made with Manchester. Stalybridge was the largest consumer of electricity, to the amount of 627,000. Hyde £11,000 Mossley and Dukinfield each £5,000. The Board's electricity undertaking was the eighth largest in Great Britain. They sold 205 units

[illegible] authorities concerned. The clauses were then adjusted.

ELECTRICAL ENGINEERS AND WAR BADGES.

[illegible] Mr. Everett [illegible] the Under Secretary of State for War whether he was aware that Mr. Harold W. Everett, electrical engineer to Clacton Urban District Council, had been refused a War Office [illegible] badge that he was entitled to wear as supplying power in connection with the preparation of munitions of war; would he say whether this represented a modification of the War Office regulations under which badges were offered to skilled employees of electrical services [illegible] and whether Mr. Everett, who [illegible], was he [illegible] had received badges without any stipulations; and would he explain whether uniformity of practice would be observed in future, and what the practice would be.

In a printed reply Mr. Harold Baker (Financial Secretary) stated that Mr. Everett was refused a War Office badge on the ground that "his company" was not supplying power for munitions of war purposes, and further, that the undertaking to enlist if called upon did not appear suitable to his case. It was suggested to him that he might apply for an Admiralty badge, which does not require this undertaking, as his work seemed to be connected with that department. There had been no [illegible] the War Office procedure which led to [illegible] badges to firms whose output was largely used for Government purposes. He had not [illegible] at the moment in the Midland [illegible] such badges had been issued by the War Office. Uniformity of practice was being observed as far as the complexity of conditions permitted.

L.C.C. (Tramways and Improvements) Bill.—A Select Committee of the House of Commons has been considering this Bill. The proposal to extend the tramways at Dalston has been dropped, but a point near Ludgate circus was thrown out, but the construction of a new tramway connecting Aldgate High-street along Mansel-street, with Mark-lane and Tower-hill, was approved. The clause to remove the restriction on the use of the Tower Street tram from the early forenoon until the evening was to [illegible] Monday.

Metropolitan District Railway Bill.—Opposition to this Bill has [illegible] and a new procedure, a non-opposed measure.

Second Reading.—The Rhondda Urban District Council (Tramways [illegible] Act, and the Aberdare Urban Council Bill were read a second time in the House of Commons last week. The Bills to confirm the Hull (Extension) and Tenby Provisional Orders have also been read a second time.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The [illegible] extracted from [illegible] specifications recently published have been [illegible] Messrs. Marks & Clerk, Chartered Patent Agents, [illegible].

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

[illegible]

9,035 Tucker & Crabtree. Electric switches. (Cognate application, 18,942/14.)
9,123 Simplex Conduits & Waterproof. Joints for metallic conduits for electric [illegible]

9,554 Beavis & Clarement. Electric cables.

An alternating-current commutator machine having commutating poles, each of [illegible]

9,856 B.T.-H. Co. & Carter. Return circuits of electric railways, tramways and the like. A continuous-current electric traction system provided with an insulated return conductor connected to the track at suitable intervals, and dynamotors or motor generators having their driving armature windings connected in series in the outgoing line and their generating armature windings connected in series in the insulated return conductor.
10,050 Pyrah. Commutators for dynamo-electric machines.
10,440 Stell. Electric cables.
10,532 Peter. Alternating-current track signalling.
A railway signalling system comprising track circuits constituted by block sections, the rails of which are cross-connected by means of inductance bonds in which the [illegible] sources in resonant or approximately resonant circuits for the purpose specified.
12,232 McGauran. Telephone call recorders. (22/7/13.)
12,233 McGauran. Telephone call recorders. (22/7/13.)
14,060 Goldstone. Portable electric battery lamps.
15,031 Girardeau & Bethenod. Spark gaps for radiotelegraphy. (25/2/14. Addition to 14,884/14.)
A double blower spark-gap wherein a winding for creating the magnetic field is supplied with continuous current by some source or by the excitation current of the alternator in stations in which the emission of the signal is produced by variation of the current, or is supplied with alternating current furnished either by the [illegible] antenna current.
15,155 Soc. Anon. Dite S.T.A.R. (Systems de Traction Auto-Regulateur.) Controlling arrangements for direct-current electric motors. (21/7/13.)
An arrangement for automatically starting direct-current electric motors, so that the motors are started at a maximum predetermined torque which diminishes as the motor speeds up, by providing a dynamo electric machine in series with the motor or motors across the mains.
[illegible]
16,308 Newton. (Mosler.) Spark plugs.
17,052 Carter, Maurice & Railing. Means for supporting electric lamps.
17,986 Beraud. Electric time switches. (Addition to 945/14.)
18,277 Myers & Myers. Means for connecting electric conduits to their fittings.
20,131 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Rheostats.
21,090 Thompson. Electro-magnetic perforators.
21,906 W. A. S. Benson & Co. & Ellwood. Reversible pin and socket coupling [illegible] electrical apparatus.
24,604 Midgley & Vandervell. Variable-speed dynamo-electric machines.

[illegible] tographic projections.
[illegible] N[illegible] & N[illegible] [illegible] A[illegible]/14.
[illegible] & Wa[illegible] [illegible]

APPLICATIONS FOR PATENTS

Note. *The undermentioned [illegible] except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

April 17, 1915.

5,774 Eidam. Method of coating copper. (13/6/14. Germany.)*
5,783 Marconi's Wireless Telegraph Co. & Franklin. Aerial conductors for wireless telegraphy.
[illegible] Wireless T[illegible] [illegible] small changes in the speed of a machine.
5,794 Edison & Swan United Electric Light Co. & Mullard. Electric arc forming device for use in electric valves or rectifiers or in oscillation generators.
[illegible] Rectifiers.
5,801 Keller. Current limiter to limit current used by consumer to a specified amount.
[illegible] N[illegible] V[illegible] N[illegible] [illegible] Manufacturers schappij. Manufacture of heating conductors for thermic telephones. (6/2/15. Germany.)*
[illegible] N[illegible] V[illegible] N[illegible] T[illegible] Telephoon Maatschappij. Sound chamber for thermic telephones. (8/2/15. Germany.)*
5,835, 5,842, 5,843, 5,844 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Construction of heating conductors for thermic telephones. (8, 9, 13/2 and 5/3/15. Germany.)*
5,836, 5,838, 5,840, 5,845, 5,846, 5,847 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Thermic telephones. (10, 11, 12/2 and 17/3/15. Germany.)*
5,837 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Thermic microphone. (11/2/15. Germany.)*
[illegible] N[illegible] V[illegible] [illegible] T[illegible]
5,843 Zimmerman. Commutators. (17/4/14. U.S.)*
5,850 Tebbitt. Electric ignition devices for internal-combustion engines. (2/5/14. France.)*
5,853 B.T.-H. Co. (G.E. Co., U.S.) High-speed rotating bodies.
5,866 Bosch. Lanterns for electric lamps. (15/6/14. Germany.)*
5,870 Perreur-Lloyd. Production of zinc or other metals by electrolysis. (Addition [illegible])
5,875 International Electric Co., Noir & Funecius. Portable telephone and telegraph instruments.

April 20, 1915.

5,879 Sturge. Combined electric switch and wall plug.
5,883 Wall. Method of obtaining a sparkless break of an inductive electric circuit.
5,897 Mapp & Lister. Electrical conductors.
5,899 Cable Accessories Co. & Reeves. Electric heating element.
5,909 Reid. Telephone call recorder.
5,918 B.T.-H. Co. (G.E. Co., U.S.) Windings for electrical machines.
[illegible] [illegible] n of zinc.
[illegible] [illegible]
5,938 Cowper-Coles. M[illegible] [illegible] trolytically-coated metal plates.
5,943 Giles. Electri[illegible] [illegible] 14. Germany.)*
[illegible] [illegible] high-frequency currents with polyphase [illegible]
[illegible] [illegible] A[illegible] [illegible]
[illegible] [illegible] [illegible] 14]
5,982 Henderson & Hunter. [illegible] currents.
6,003 Bachelet. Electromagnetic-driven pumps.

April 22, 1915.

[illegible] [illegible] [illegible] [

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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A NOTABLE HOTEL INSTALLATION.

The electrical equipment of the Regent Palace Hotel, Piccadilly Circus, London, may be said to mark a new epoch in this particular class of electrical and allied engineering work. Many problems are presented to the architect in the first place, and finally for complete solution in detail by the electrical and mechanical engineer, in the fitting out of a large modern hotel with the many accessory appliances which go to make up not only the creature comforts of the guests, but also to provide profits for the shareholders. Not the least troublesome of these problems is that of furnishing a readily controllable, efficient and safe method of heating in all the bedrooms. The ordinary steam or hot-air systems are something of a solution, but they contribute nothing from a purely asthetic point of view. It is true that they raise the temperature of a room to a comfortable degree, but in this respect they are crudely utilitarian. Not even the most ardent hotel resident would wish to sit by the side of one even for an hour. The coal fire and the gas stove introduce, in the first instance, difficulties in the way of attention, and in the second, difficulties with flues. In both cases the management can only sanction their use by an extra payment. The electric fire does not suffer from any of these disabilities, and in addition to furnishing a distinct and valuable element of novelty, at any rate at the present time, it is also a satisfactory heating unit and is quite pleasant to sit by. The electrical engineers who are responsible for the electrical installation at the Regent Palace Hotel have doubtless weighed the pros and cons of the situation, and ultimately decided to take what must undoubtedly be regarded as the bold step of installing no less than a thousand-odd 1-kw. modern electric fires. We shall give fuller details of the principal features of this portion of the installation at a later date.

In this issue we give a few preliminary particulars of the system adopted, and it is instructive to note that the supply authority have run two special cables from a neighbouring sub-station to the hotel to furnish energy to the heating circuits alone. Each of these has a cross-section of 0·8 sq. in. The copper in the heating circuits in the hotel proper has also been laid in of such capacity as to supply the whole of the fires should they all be turned on at one time. It should be noted that the management of the hotel having had experience of popular methods of catering, both in the restaurant and hotel business, have succeeded in fixing a tariff which is inclusive of the heating service to the bedrooms. Doubtless this will be looked upon, at any rate as far as electrical methods are concerned, as something of an experiment, but it certainly dispenses with a considerable amount of labour, and it has the distinctive psychological advantage of placing the patrons of the establishment quite at their ease; they feel that they are being catered for on an inclusive basis. The selection of the Belling type of fire is a matter upon which the manufacturer is to be complimented, if only for the fact that he carried out so large a proportion of the pioneer work in this important field. We anticipate that engineers and architects having new hotels in hand will seriously consider following the example of the Regent Palace Hotel in the matter of its bedroom heating installation. All too frequently developments are dependent upon the initiative being taken, and once some individual or company has made bold to take the first step others, who have stood by and watched the preliminary experiments, immediately become eager to follow. For the sake of the future of the electric fire movement in hotel circles, we hope that this will be the case.

Electric Smelting of Tungsten and Molybdenum.—The supply of certain compounds of chromium, tungsten and molybdenum, which are extensively employed in the manufacture of special steels, was quite insufficient to meet the demand at the outbreak of war owing to the stoppage of the Continental supplies. Since then the production of these compounds on a large scale has been undertaken at the works of the Thermo-Electric Ore Reduction Corpn., at Luton, where three 150-kw. three-phase electric furnaces are exclusively engaged in the production of ferro-tungsten, and a smaller single-phase furnace turns out about 35 cwt. of ferro-molybdenum weekly. A description of the method of manufacturing these products is given in "The Times Engineering Supplement," and shows how extensively electricity enters into their manufacture.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week May 10, 1915, to May 15, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]

phone material, £3,081 ; unenumerated, £1,056. *Denmark :* Machinery, £43. *Holland :* Elec. lamps, £1,616—50 pkgs. *Sweden :* Elec. machinery, £654 ; lamp parts, £466 ; unenumerated, £40. *France :* Lamp parts, £93 ; unenumerated, £51. *Italy :* Carbon parts, £21 ; unenumerated, £30. *Canada :* Unenumerated, £46.

EXPORTS.

To-Australasia.—*Auckland :* Unenumerated, £62. *Melbourne :* Elec. machinery, £1,377 ; wire and cable, £141 ; unenumerated, £972. *Sydney :* Elec. machinery, £12 ; unenumerated, £3,231. *Wellington :* Unenumerated, £529. *Adelaide :* Wire and cable, £48 ; machinery, £200 ; unenumerated, £385. *Brisbane :* Elec. machinery, £219 ; unenumerated, £66. *Freemantle :* Unenumerated, £43. *Dunedin :* Elec. machinery, £237. [illegible] machinery, £280 ; wire and cable, £10 ; unenumerated, £10. *New Plymouth :* Elec. machinery, £22. *Hamilton :* Machinery, £210.

Africa.—*Durban :* Machinery, £55 ; elec. glow lamps, £339 ; wire and cable, £512 ; unenumerated, £493. *Port Elizabeth :* Machinery, £166 ; unenumerated, £315. *Cape Town :* Machinery, £213 ; unenumerated, £92. *East London :* Wire and cable, £81 ; unenumerated, £17. *Delagoa Bay :* Elec. machinery, £39. *Beira :* Unenumerated, £207. Egypt.—*Port Said :* Unenumerated, £24. *Port Sudan :* Unenumerated, £70. *Alexandria :* Telegraph material, £26 ; wire and cable, £20 ; unenumerated, £25.

Fiji. Unenumerated, £23.

Russia.—*Archangel :* Elec. machinery, £170.

Portugal.—*Lisbon :* Machinery, £20 ; unenumerated, £122.

China.—*Tientsin :* Unenumerated, £327. *Hongkong :* Unenumerated, £11. *Shanghai :* Unenumerated, £11.

[illegible]

£735. *Calcutta :* Wire and cable, £81 ; elec. machinery, £326 ; unenumerated, £502. *Madras :* Elec. machinery, £17 ; unenumerated, £232. *Colombo :* Elec. machinery, £91 ; unenumerated, £39. *Karachi :* Unenumerated, £42. *Singapore :* Unenumerated, £473. *Bankok :* Unenumerated, £271. *Sourabaya :* Unenumerated, £17. *Port Swetenham :* Telegraph material, £168 ; unenumerated, £18.

Canada. *Montreal :* Unenumerated, £175. *Three Rivers :* Elec. transformer £100.

France. *Dieppe :* Machinery, £216 ; unenumerated, £93. *Boulogne :* Unenumerated, £128. *Bordeaux :* Wire and cable, £31. *Paris :* Unenumerated, £48. *Havre :* Machinery, £567.

South and Central America.—*Buenos Ayres :* Elec. machinery, £195 ; wire and cable, £163 ; unenumerated, £1,169. *Monte Video :* Wire and cable, £1,521. *Valparaiso :* Unenumerated, £674.

British Guiana. *Demerara :* Machinery, £340.

Italy.—*Genoa :* Wireless telegraph, £1,380 ; unenumerated, £242.

Holland.—*Amsterdam :* Telephone apparatus, £37 ; wire and cable, £2,457 ; unenumerated, £79.

U.S.A. *New York :* Machinery, £50.

Gibraltar : Telegraph material, £10 ; unenumerated, £34.

West Indies. *Grenada :* Unenumerated, £34. *Trinidad :* Wire and cable, £36.

FOREIGN GOODS (duty paid and free).

Wellington : Unenumerated, £37. *Madras :* Unenumerated, £34. *Stockholm :* Unenumerated, £381. *Cape Town :* Unenumerated, £350. *Calcutta :* Unenumerated, £185. *Auckland :* Unenumerated, £26. *Malaga :* Unenumerated, £61. *Melbourne :* Unenumerated, £73. *Sydney :* Unenumerated, £12. *Karachi :* Unenumerated, £35.

[illegible]

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

[illegible] A. Savage & Co. are removing to new and larger works at Burnham Approach, Pretend gardens, Chiswick, London, W., notify that their works will be closed from May 22 to 31 inclusive.

The Peninsular Engineering Co., Suffolk House, Laurence Pountney Hill, London, E.C., have been appointed sole agents for the firm of Los Hijos de Jose Casas, Barcelona, makers of high and low tension porcelains for the electrical trade.

Mr. J. Scrivener has resigned his position of director and manager of Messrs. Krupka & Jacoby (Ltd.), having been appointed to control the sales organisation of the "Z" Electric Lamp Mfg. Co. Mr. [illegible] have presented him with a gold watch. The staff have also presented Mr. Scrivener with a suit case.

[illegible] & Co. are to be unable to proceed to continue [illegible] owing to the requisitioning of their orchestra by the Army. They will [illegible] Service orders take precedence of everything.

[illegible] Lamp [illegible] Electric Works, Ltd., [illegible] Westminster, S.W.

Patent Development.—The proprietor of patent No. 11,154/1899, which [illegible] Applications to Messrs. Cruikshank & Fleet, Chancery Lane, London, W.C.

The proprietor of British patent Nos. 8,173 and 8,173 A/1907, which relate to "Improvements in induction alternators specially adapted for generating electric currents for ignition purposes in internal combustion engines," desires to make arrangements for exploiting same in Great Britain. Particulars from Messrs. Dicker, Pollock & Dearman, patent agents, 20-23, Holborn, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Batley. Councillor J. W. Turner [illegible] at the recent meeting of the Council that the restrictions [illegible] borrowing powers were going to delay the scheme for supplying electricity to the Heckmondwike, Staincliffe and Carlinghow districts.

He also said that there were a great many prospective consumers, both for household and mill purposes, in the districts named, and the Electricity Committee would have [illegible] to be patient until such time as they were enabled to proceed with the scheme. In view of the increased cost of coal, the committee found it was impossible to make any reduction in the charges for [illegible]

Gravesend.—Mains are to be extended to premises of prospective consumers provided the applicant guarantees a return of not less than 10 per cent. for three years in one case, and 15 per cent. for 10 years in the other.

Hove.—The Corporation propose to wire the Portland-road schools, which are shortly to be used as a military hospital, provided the War Office pays the cost.

GENERAL.

Aylesbury. At the last meeting of the Council it was reported that Mr. W. A. Turnbull's appointment as clerk of works had been terminated [illegible] from the date of [illegible] supply of current, and he was re-appointed as resident engineer on the same terms as his previous engagement.

Bermondsey (London). The Electricity Committee has again considered the proposal to close the [illegible] of the three Howden boilers at the generating station.

The committee has had before it [illegible] submitted by Messrs. Babcock & Wilcox for providing a [illegible] boiler, the cost of which would be £400 per boiler, plus £130 for the driving gear and motor for all three [illegible] £1,530 or £248 less than the cost of the [illegible] by Messrs. J. Brown & Co. The committee, the report [illegible] the scheme of Messrs. Babcock & Wilcox.

Blackrock.—The Urban Council have been notified that their application for the sanction of the Treasury to the raising of a loan of £15,000 for electricity supply [illegible] at present.

Burton-on-Trent.—At the recent meeting of the Council, Ald. T. E. Lowe, in moving the adoption of the report of the Gas and Electricity Committee, said he was glad to be able to state that the demand for electricity went on increasing.

He stated that last month was an excellent month, and they were able to show once more the value to the users of the low priced units. The total increase was over 30,000 units, and out of that nearly 27,000 units were for power on the three-phase mains. The actual net increased profit, compared with the same month in 1914, was £121. Those increases were the best demonstration [illegible] the Council could have, that although the price charged for power was low, it was profitable. The Belgian Engineering Co. had started [illegible] in Victoria-crescent, and were using a considerable quantity [illegible]

Cardiff Electricians' Wages.—At a conference last week between representatives of the Cardiff electrical contractors, the Building Federation and the Electrical Trade Union, the following agreement was arrived at :—

The rate for electricians, cable jointers and electrical fitters to be 9¼d. per hour as from May 15. On the first pay-day in November the rate is to be raised to 10¼d. per hour. Armature winders are to get 10d. per hour from the first pay-day after May 15 and 10½d. per hour in November.

Colwyn Bay. [illegible] the Local Government Board [illegible] a loan of £6,800 for the [illegible] Electricity undertaking at Rhiwlas, in connection with a new electricity [illegible], but the Board have intimated that, though [illegible] they would approve on the scheme, they were no [illegible] from the loan.

On grounds of public health, the Council consider that the erection of the electricity [illegible] should be proceeded [illegible] and the Board are being [illegible] under their [illegible]. The Board [illegible] deputation on Tuesday to [illegible] Mr. H. Scurfield [illegible] to the electricity works project.

Connah's Quay. The Urban Council's application for a provisional order has been granted [illegible] for the urban districts, as the outlying townships have been excluded.

Marylebone (London).—The Electric Supply Committee has decided to charge a special rate of 1d. per unit for all energy consumed at certain premises used in connection with Army work.

The Council is recommended to have certain electrical work carried out at the new Town Hall to meet the special requirements of the electricity department, at a cost of £360. The work includes special cables for the introduction of electrical radiators in the showrooms and other parts of the department, special conduits for wiring fittings, &c.

Poplar (London).—Many electricity undertakings must be envious of the electric supply department of the Borough Council, which is in the fortunate position of being able to announce a reduction in the price of current from 4d. to 3d. per unit for private lighting, after making a contribution to relief of rates equal to 2 pence in the pound and paying a bonus to the staff.

A representative of the "East London Observer" recently waited upon the manager and engineer (Mr. J. Horace Bowden) in order to obtain some particulars of the progress of the undertaking. The interview is reported in the issue of our contemporary of May 8. Mr. Bowden stated that 10 years ago the output of the electricity works was about 2,000,000 units, but it was now 17,000,000 units. Notwithstanding the difficulty in obtaining coal and its increased cost, the net profits for the past year had increased, whilst the total cost of production had been lowered. The total cost was 0·55d. per unit in 1913-14, and only 0·51d. last year, and the net profit had increased from £8,000 to between £13,000 and £14,000. Mr. Bowden attributed their success to improved machinery, to being able to buy coal very well, and to the increased power load. They bought coal cheaper in November than at any period during the last four years. There were 40 firms in the borough engaged on work for the Government to which they supplied electrical energy for power. As a set-off the department lost nearly £1,000 on public lighting since the street illumination had to be reduced, and they had also some loss from private lighting, and in other directions consumers were economising current. Mr. Bowden estimated that if there had been no war their profits would have been considerably better. As to the coming year, Mr. Bowden said he did not want to estimate any profit; he hoped to be able to meet all expenses, but with the coal market in its present condition he could not anticipate any net profit worth talking about, seeing that the increase on coal (based on current prices) would, if spread over a year, represent between £13,000 and £14,000, which was practically the amount of their net profit for the past 12 months. In spite of that, he was convinced that the advertisement which their undertaking would receive from the fact that they had lowered their prices whilst others were raising theirs, would bring them out on the right side.

The profit-sharing scheme was probably unique so far as the extent of it was concerned. Some undertakings paid a bonus to the foremen and senior members of the staff, but at Poplar every member of the staff, from the highest to the lowest grade in the permanent staff, would participate. The object was not to reduce labour by getting one man to do two men's work, nor to "speed up," but rather to create a feeling of individual responsibility amongst the employés. After all (said Mr. Bowden) it was the little things that counted. In the case of a stoker the saving of ¾ lb. of coal per unit generated, reckoned on the output of the station, would amount to £1,800. So it could be seen at once how desirable it was to encourage personal responsibility. A stoker could, by being a little careless, increase the cost of fuel, but when he knew that every ounce of coal he saved helped to increase the bonus which might pay for his summer holiday, he was going to be careful. About 86 per cent. of the whole output of the station was for power. It was owing to reduction in price that they had increased so rapidly. His predecessor reduced the price for power from 3½d. to 1½d., and the average price for power was now only 0·88d.

Shoreditch (London).—The Borough Council's electricity supply department have decided, in view of the increased cost of coal, to experiment with oil fuel at the generating station.

Southampton.—The Board of Trade have granted the Corporation's application for a provisional order for the parish of Bitterne, but it will not come into operation until after the war.

Southport.—The charges for electric current and gas have been increased by 10 per cent.

Woolwich. Owing to the unsettled state of the market, it is considered inadvisable to enter into any contract for the purchase of coal for the ensuing year, and the Electrical Engineer has been authorised to continue to purchase supplies as required.

Having regard to the fact that there is a considerable demand for electric supply being greater than their present plant can meet, and Mr. Snell's recent report, the Electricity Committee has been authorised to act without requiring the sanction of the Council in order that the completion of the plant at Globe-lane station may be expedited in every possible way.

LIGHTING, POWER & HEATING NOTES.

Chatham.—The Kent Electric Power Co. has asked the Council to agree to an increase of 20 per cent. in the charges for current supplied for public lighting owing to the increased cost of coal.

Electricity in Mining.—The report of the Mount Lyell Mining and Railway Co., for the half year to March 31, states that the Lake Margaret hydro-electric scheme was completed in November last and had been the main factor in the reduction of costs. The scheme had already justified itself. The expenditure was £164,000, including blower plant. Economies would be more fully felt during the current half-year. Machinery for the flotation plant had been ordered.

Swansea.—The Lighting Committee is considering a proposal for lighting a portion of Neath-road with 300 c.p. incandescent lamps at a total annual charge of £1,500.

The electrical engineer (Mr. J. W. Burr) has reported as to laying a new feeder from the electricity works to Morriston, but consideration of the matter has been deferred.

The Committee has decided to supply current for charging batteries for electric cars at 1½d. per unit, with a minimum of £2 per service per annum.

TRACTION NOTES.

Aberdeen. The Tramways Committee have decided to employ female conductors during the period of the war.

Croydon.—At a meeting of the Tramways Committee on the 10th inst. the following resolution, which was passed at a conference of the managers of the tramways undertakings within the metropolitan area held on the 7th inst., was considered:

(1) That tramways revenue cannot be improved by increasing fares generally; (2) that joint action should be taken by the tramways authorities in the metropolitan area to obtain more equitable treatment for tramways in respect of rates and the upkeep of the roads; (3) that powers should be obtained to jointly run omnibus services.

The committee decided to recommend the Council to approve the foregoing resolutions, and that the tramways managers be informed accordingly. At the meeting of the Corporation on Monday the recommendation was approved.

London County Council. On Tuesday it was decided to present a petition against the London Electric Railway Companies' Facilities Bill, which makes provision for the interchange of traffic between the underground tube lines and the London General Omnibus Co., &c.

The Parliamentary Committee point out in a report that as a result of working agreements entered into in recent years, various underground railway undertakings have been brought under the single control of the Underground Electric Railways Co. of London, and that company also controls the London General Omnibus Co., with which various omnibus companies work in agreement, and has large interests in the London & Suburban Traction Co. "Thus the position, as it exists to-day, is (says the report) that a limited liability company, not subject as regards its capital powers, or in other respects to the direct control of Parliament, has virtually obtained a monopoly of the privately-owned passenger-carrying undertakings in London. Although the working and control of the various undertakings has been brought under one management, complete unification of financial interests has not as yet been assured, and this is apparently to be brought about by the powers sought by the bill. The Underground Co. holds over £17,000,000 of the total capital of the companies concerned. The reference in the preamble to the adverse effect of the war upon the railway companies suggests that the companies desire to recoup themselves for the extra expenditure entailed by economies of working effected at the expense of the travelling public through the withdrawal of some of the existing facilities. The fact that the war is entailing additional temporary expenses upon the companies in common with other undertakings is not an adequate reason for fixing permanently their inter-relations and giving Parliamentary sanction to the pooling of their funds."

London Tramway Strike.—At the meeting of the London County Council on Tuesday, the chairman of the Highways Committee (Mr. Hume) reported on the strike of the tramway men and said their demands would involve the Council in an additional expenditure of £215,000. The principal feature of the discussion which took place was the recent consideration of the matter by representatives of all the parties.

Newcastle-on-Tyne. The Board of Trade have issued their award in the dispute between the Corporation and the tramwaymen, who demanded an increase of wages.

The award is that the rate of payment of the "war bonus" to tramway employees who are youths of 18 years of age or under 1s. per week. The [illegible] employees who are youths of 18 years of age or under 1s. per week.

Scarborough.—The Scarborough Tramway Co. has decided to [illegible] during the season.

Sheffield. [illegible] Electric Railway Co. [illegible] on March 31st [illegible] record.

Tramways and Vehicle Workers' Conference. The annual conference of the National Tramways and Vehicle Workers' Union opened at Blackpool on Monday.

Mr. [illegible] presided and in [illegible] referred to the [illegible]

the unpatriotic attitude of Corporations, who granted bonuses which were insufficient when compared with the increased cost of living.

Mr KERR, of London, moved a resolution calling upon the Executive Committee to meet in order to consider the question of the London tramway strike, which they should officially recognise.

The resolution was seconded, and carried unanimously.

The conference elected Mr. Bradwell, of Sheffield, to be president for the ensuing year.

TELEGRAPH AND TELEPHONE NOTES.

Constantinople Telephone Co. A correspondent of the "Morning Post" states that the Constantinople staff of this company has been replaced by Hungarians, the control of the enterprise being at present in the hands of an Austrian, Mr. Eugen Redl.

Wireless on Ships.—It has been decided to postpone until Jan. 1 next the putting into operation of the Merchant Shipping (Convention) Act, 1914. Under this Act all British ships carrying 50 or more persons, and also foreign ships entering British ports, must be provided with wireless telegraphy installation.

FOREIGN NOTES.

Argentina. The "Review of the River Plate" says the Cia La Electrica del Norte has sold its electricity works in the city of Jujuy to Messrs. Pasquini Bros. for £184,000.

Buenos Ayres Municipality has rejected the request of the Compañia Alemana Transatlantica de Electricidad for the re-opening of a current account which had previously been kept with the municipal authorities under an arrangement which expired on Feb. 15 last. The debt of the Municipality to the company in respect of various services amounted at March 31 last to $500,000 m/n. approximately. The settlement of this debt at present would be a difficult matter to arrange in view of the general financial situation, and the company accordingly proposed the re-opening of the current account. The Municipality refuse to accede to this proposal, on the ground that its acceptance would place the company in a privileged situation which could be objected to by other companies.

La Plata tramcars ran 3,746,244 km. in 1914 (compared with 3,807,594 in 1913), the passengers carried being 10,376,506 (10,958,356), and the receipts $1,159,059 ($1,177,094) m/n.

Electric Traction in Venezuela.—At the recent meeting of La Guiara Harbour Corpn. the chairman (Capt. W. B. McTaggart) said that the conversion to electric traction of the Macuto and Coast Line Railway of Venezuela had been completed, and the electric coaches commenced running on May 9, 1914. The new system had proved a success. The net result of the working of the railway for the year ended Sept. 30, 1914, after paying debenture interest showed a credit balance of £1,082, out of which a dividend of 3 per cent. on the ordinary shares was declared. The result was good, although the benefit of the electrification of the system was only felt during the last five months of the working year, and the traffics and profits since then had steadily continued to augment.

Russia.—A consular report on the Odessa district for 1913 says electricity is making gigantic strides there, as elsewhere in Russia, and there should be good openings for British firms interested in electrical appliances. There is an increased demand for electric power plants from abroad for use in the smaller industries.

The electric tramways in Odessa and all its suburbs have been greatly extended, and the cars are well patronised.

At Nicolaieff the construction of the new electric tramways was begun in the autumn of 1913.

At Kharkoff the municipal tramway was extended, and new Diesel engines were installed in the power station. A new loan was raised for the completion of those works, for the electrification of the horse tramways now owned by a Belgian company and for other public works.

Mariupol municipality has decided to issue a concession for the construction and working of an electric tramway in the town, and also for connecting the town with the port and metallurgical works—the former about 3½ miles distant and the latter about 5 miles in the opposite direction.

The Vice-Consul at Rostov-on-Don also says there is a splendid opening for British made goods in Russia, but he advises that negotiations should not be entered into with local agents or importers without first obtaining reliable information as to their character and standing. British goods have a reputation for superior quality, and will find a ready sale if terms as to credit are suitable. Reliable agents, each dealing with a large district, should be appointed, and dealing direct with small local commission agents in the provincial towns should be avoided.

There is a telephone line between Theodosia and Kertsch, and it is rumoured that telephone communication is to be provided between Theodosia, Simferopol, Karasoubazaar and Stary Krim.

MISCELLANEOUS NOTES.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade has issued lists 20 and 21 of articles which inquirers desire to purchase, and the sources of supply or markets of which have been interfered with by the war. Copies can be obtained by United Kingdom manufacturers and exporters of British goods from 73, Basinghall-street, London, E.C.

Presentation.—Recently Ald. J. Brown, deputy Lord Mayor of Hull, was presented with his portrait painted by Mr. Fred Elwell, and subscribed for by members of the Corporation and prominent citizens, as a token of their appreciation of the services rendered by him to his native city.

Mr. Arthur J. Atkinson presided, and others present were Ald. Brown, the Lord Mayor (Ald. Hargreaves), the Sheriff of Hull (Mr. E. Ohlson), &c. The Chairman referred to Ald. Brown as a distinguished citizen who had occupied the position of Mayor and Sheriff, and who had done an enduring work as chairman of the Telephones Committee. Largely owing to his efforts, he said, Hull held the unique position in this country of having full control of the telephone service in its own area.

The Lady Mayoress unveiled the portrait and then presented Mrs. Brown with a silver salver, a diamond necklet, diamond ear-rings and a pair of solid entree dishes.

The Lord Mayor formally presented the portrait to the alderman and paid a tribute to a colleague who had devoted 22 of the best years of his life to the service of his fellow-citizens.

Ald. Brown replied, and at his request the portrait was accepted by Ald. Larard on behalf of the Corporation for the new Guildhall.

Year Book of the Swedish Chamber of Commerce in London.—We have received a copy of this Year Book for 1914, which contains, amongst other interesting matter, trade reports on the iron and steel, timber, wood distillation, coal and other trades, the electrical and shipping industries of Gt. Britain, the utilisation of water power in Sweden, lists of Swedish Consuls, and a table of imports from Sweden to the United Kingdom, &c. The registered offices of the Chamber are at 5, Lloyd's-avenue, London, E.C.

TENDERS INVITED.

Turbo-Alternators and Condensing Plant.

EDINBURGH Corporation invite tenders for the supply and erection of two 5,000 kw. Turbo-Alternators and Condensing Plant at their new electricity supply station at Portobello. Copies of specification, forms of tender, &c., from the engineer, Mr. F. A. Newington, Dewar-place, Edinburgh. Specification, general conditions and drawings can be seen at, but not obtained from, the offices of the consulting engineers, Sir Alexander Kennedy & Messrs. Kennedy & Donkin, 17, Victoria-street, London, S.W. Tenders to the town clerk, Sir Eleanor Hunter, W.S., by noon on Monday, June 21. Specification deposit £1.

Turbo-Generators.

THE SECRETARY TO THE GOVERNMENT RAILWAYS AND TRAMWAYS, DELAGOA BAY, is to receive tenders by noon July 21 for supply and erection of a 250 k.v.a. Direct-coupled Turbo-generator. Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Coal Handling Plant, Stoker, Steam Feed and Water Pipes, &c.

MANCHESTER Electricity Committee want tenders (by noon June 2) for coal unloading crane, conveying plants, &c., at their Barton power station.

The Electric Supply Committee of DUBLIN Corporation invite tenders for the installation of an Underfeed Stoker in one of their Babcock boilers at the Pigeon House works. Specification from the city electrical engineer, Mr. Mark Ruddle, and tenders to the Chairman, Electric Supply Committee, Cork hill, Dublin, by noon Tuesday, May 25.

LEEDS City Council invite tenders for the supply and erection of Steam Feed and Water Pipes, &c., in connection with an extension of works, involving the addition of 18,000 kw. of plant. Conditions, &c., from the manager of the Electricity Dept. (Mr. C. Nelson Hetherd) and tenders to town clerk, Sir Robert E. Fox, Town Hall, Leeds, by 10 a.m. May 26.

Wiring and Fittings.

LONDON County Council require tenders by 11 a.m. June 4 for an Electrical Installation at the County Secondary School, South Hackney (about 260 wiring points).

FINCHLEY Urban Council require tenders by noon May 31 for wiring 100 workmen's dwellings. Specification, &c., from the Engineer, Church End, Finchley.

PORTSMOUTH Education Committee require tenders by 10 a.m. May 26 for the Electric Lighting, &c., at the Girls' Hostel now being erected in Milton-road, Portsmouth. Specification, &c., from the Town Clerk.

The Penrikyber Navigation Colliery Co. (Ltd.), PENRHIWCEIBER, Glam., require tenders by June 8 for three, six or 12 months' supply of Electrical Fittings. Forms of tender from the Secretary.

Cooling Towers.

SHEFFIELD Electric Supply Committee require tenders by 10 a.m. May 28 for the Supply and Erection of Two Natural Draught Cooling Towers, with all Fittings, Pumps, Pipework, &c. Specification, &c., from the General Manager and Engineer, Mr. S. E. Fedden.

Electrical and General Stores, Cables, Transformers, Switchgear, &c.

MANCHESTER Electricity Committee require tenders by 10 a.m. May 26 for 12 months' supply of Stores, including Cables, Asbestos and Rubber Goods, Acids, Dynamo and Carbon Brushes, Electrical Accessories, Lamps, Wire, Insulators, Pitch, Transformers, &c. Forms of tender from Mr. F. E. Hughes, Town Hall, Manchester.

WIGAN Electricity Committee invite tenders (by May 29) for h.t. three-core Paper and Lead-covered Armoured Feeder Cable, Transformer and Switchgear.

LAUNCESTON (Tasmania) Council want tenders by 4 p.m., July 26, for converter, switchgear, underground feeder cable, &c. Specifications, &c., from the City Electrical Engineer.

Excavations and Concrete Work.

SHEFFIELD Electric Supply Committee want tenders by 10 a.m. May 28 for Excavations and Concrete Work (contract No. 139). Specifications from the Engineer and General Manager.

DUNDEE Corporation want tenders by first post June 4 for Reinforced Concrete Floors and Jointless Flooring for Extension of Carolina Port generating station. Specification, &c., from the General Manager, electricity dept., Dundee.

Fire Alarms.

RANGOON (Burma) Municipality require tenders by Aug. 11 for the installation of a system of Fire Alarms for the town of Rangoon. Specification, &c., from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, London, E.C.

Railway Carriage Lighting, Track Transformers, Signals, &c.

The time for the receipt of tenders by the VICTORIAN RAILWAY COMMISSIONERS for the supply of Material for Railway Car Lighting and Electric Lighting Material for Car Repair Shops is extended to June 2. Specifications from the Commissioners' Offices, Spencer-street, Melbourne.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 2 for 300 Electric Train Stops and in each case such further supplies of similar goods as may be required during five years); and for Bogie Trucks, Wheels and Axles for 10 Electric Street Railway Cars. Specifications from Railway Offices, Spencer-street, Melbourne.

SYDNEY (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

Commutator-Grinding Lathe, Motor Generator, Motors, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 30 for 13 in. Centre Lathe for turning or grinding commutators (contract 28,737), and 9 kw. Motor Generator and Accessories (contract 28,760). Specifications, &c., from the Commissioners' Offices, Spencer-street, Melbourne.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 30 for supply of Four Electric Motors, varying from 7 H.P. to ½ H.P. (Contract 28,771). Particulars from the Commissioners' Offices, Spencer-street, Melbourne.

Telegraph and Telephone Instruments and Material, &c.

The Deputy Postmaster-General, Sydney (N.S.W.), will receive tenders until 2:30 p.m. June 16 for the supply of 400 pony pattern Morse Sounders to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specification, &c., from the Deputy Postmaster-General.

The Commonwealth of Australia Postmaster-General's Dept. give notice that the date for the receipt of tenders for a Telephone Switchboard for Warwick, QUEENSLAND, has been further extended from June 1.

Tram Rails, &c.

POSTMASTER-GENERAL, Cardiff, invites tenders by [illegible] for Steel Grooved Tram Rails, 6 feet lengths, and [illegible] Tie-bars. Tenders to Town Clerk by June 1.

Circuit-Breakers.

JOHANNESBURG Municipal Council require tenders by noon June 1 for the supply of 24 Double-pole Automatic Oil-immersed Circuit-Breakers of 200 amperes capacity. Specifications from the Controller of Stores, Plein-square, Johannesburg.

Submarine Cable.

The SPANISH POSTS AND TELEGRAPHS DEPARTMENT want tenders by June 22 for the laying of a submarine cable from Cadiz to Laraiche and for the repair of certain cables. The "Madrid Gazette" of April 23, containing the conditions of tender, &c., can be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

BERMONDSEY (LONDON).—The Electricity Committee recommends the acceptance of the tender of Babcock & Wilcox (at £1,330) for the supply of three chain-grate stokers.

LLANDUDNO.—The Urban Council have accepted the tender of Davidson & Co. (at £305) for induced draught plant for the electricity works.

REDDITCH.—Last week the Council ordered their seal to be affixed to contracts with C. A. Parsons & Co. for two turbo-alternators and condensing plant, and with the Electric Construction Co. for two synchronous motor alternators and accessories.

EDINBURGH.—The Electric Light Committee have accepted the tender of the Stirling Boiler Co. for water-tube boilers for £32,000.

HENDON.—The following tenders were received by the Guardians for wiring and fitting the Institution:—

Hendon Electric Supply Co., £350. 9s. 6d.; Strand Electric Co., £420. 17s.; A. E. Goodwin & Co., £469. 9s. 1d.; and Electra (Ltd.), £370. The following did not include lamps and shades: C. C. Pudney & Co., £310.; Napier-Kimber (Ltd.), £212. 2s.; H. J. Galliers, £334; C. H. Carbutt & Co., £475. The tender of the Hendon Electric Supply Co. provided for a 10 H.P. motor, which was larger than required for the institution. The firm were, however, prepared to supply a 7½ H.P. motor, and allow £1. 3s. and a further £6. 9s. 6d. discount on lamps, &c., which reduced their tender to £339. 14s. 10d. The company's amended tender has been accepted.

METROPOLITAN ASYLUMS BOARD.—The Board has accepted the tender of the London & Rugby Engineering Co. (at £32. 7s.) for an electric motor for driving workshop tools at the N.W. Hospital, and that of Lund Bros. & Co. (at £28) for accumulator charging plant at the South Eastern station.

SOUTHEND-ON-SEA.—The following tenders are recommended for acceptance:—

John Browne, five dozen steel tram tyres, £20 per dozen; F. Carrick & Sons, overhead travelling crane, £301.

EAST HAM.—The tender of Dick, Kerr & Co. is recommended for acceptance for re-equipping one of the Council's trucks with a 40 H.P. motor, new controllers, &c., for £275.

PONTYPRIDD.—The Urban Council have accepted the tender of Siemens Bros.-Dynamo Works for the supply of Wolfram and Tantalum lamps for the ensuing 12 months.

TOTTENHAM.—The Council is recommended to accept the tender of Keene & Co. (at £90. 10s.) for the supply of an electric motor.

MELBOURNE (VICTORIA).—The City Council have accepted the tender of C. Ekeling for supply and erection of hoists, electric motors, &c., in new beef house extension, at £1,169. 18s. 9d.

Meter Contracts.—Messrs. Chamberlain & Hookham (Ltd.) have received the following additional contracts for the supply of meters for the coming year, viz., from Battersea (London) Borough Council [illegible] Dundee and Swansea Corporations. They have also received [illegible] from Southend Borough Council for [illegible] meters.

Among the contracts recently secured by Messrs. Ferranti, Ltd. are [illegible] Bexley Urban District Council, Hebburn [illegible] Corporation, and Pontypridd Urban Council, [illegible] Corporation, and York Corporation (supplement [illegible] March 31, 1915).

Southport Borough Council have placed a contract with the Electric Appliance Co. for the supply of [illegible] up to and including [illegible].

Wigan Corporation have placed a contract with the Electrical Apparatus Co. (Ltd.) for the supply of [illegible] Thomson-Houston [illegible] 12 [illegible] having been awarded to the same [illegible].

Government Contracts.—The following contracts were placed by the British Government [illegible]:

War Office.—Bullers (Ltd.), telegraph pole arms, insulator brackets, &c.; Siemens Bros. & Co., electric cable and wire, electric cells, telegraph [illegible] parts, &c.; Accumulator Industries, and Houghton-Butcher Mfg. Co., battery boxes; T. W. Lench (Ltd.), insulator brackets, pole clips, &c.; [illegible] India Rubber Works, Johnson, Clapham & Morris, Johnson, Matthey & Co., Johnson & Nephew, Shropshire Iron Co., Frederick Smith & Co., Inc. in London Electric Wire Co. & Smiths, and Ward & Goldstone, electric cable and wire; Edison & Swan United Electric Light Co., telegraph commutators and vibrators and galvanometers; India Rubber Gutta Percha & Telegraph Works Co., galvanometers and electric lamps; A. Kershaw & Son, galvanometers; Gambrell Brothers, Muirhead & Co., Nalder Bros. & Thompson, R. W. Paul, W. G. Pye & Co., and Reid Brothers (Engineers), resistance coils; Gell Telegraphic Appliances Synd., telegraph commutators and vibrators; Babcock & Wilcox, electric cranes; Austin Motor Co., electric sets, &c.; Litholite (Ltd.), insulators; Brimsdown Lead Works, [illegible] Co., electric lamps and switches; London Electric Wire Co. & Smiths, electric cable and wire and telephone sets and parts; Walter's Electrical Mfg. Co., battery boxes and telephone sets and parts; Western Electric Co. and West London Scientific Apparatus Co., telephone sets and parts; Bayliss, Jones & Bayliss, steel telegraph poles; W. H. Beal, W. E. Chapple & Sons, Cutler's Steam Joinery Works, John Jaques & Son, Maple & Co., H. H. Martyn & Co., T. & S. E. Merredew, Venesta (Ltd.), and D. Wishart & Co., wood telegraph poles; Edmundson's Electricity Corpn., wiring at Codford, Sutton Veney and Warminster; Tredegar (Ltd.), ditto, Codford; Girdleston & Co., ditto, Sutton Veney; Ellis & Ward, electric light installation Cannock Chase, Mansfield, Oswestry and Rhyl; Cox-Walkers, ditto, Richmond.

India Office.—Marconi's Wireless Telegraph Co., wireless apparatus; Siemens Bros. & Co., and Callender's Cable & Construction Co., cable; Chance Bros. & Co., searchlights; Peel-Conner Telephone Works, telephone parts.

Post Office.—Creed, Bille & Co., telegraph apparatus; Automatic Telephone Mfg. Co., British L. M. Ericsson Mfg. Co. and Phœnix Telephone & Electric Works, telephone apparatus; Bullers (Ltd.) and E. Lewis & Sons, iron arms; Johnson & Phillips, Pirelli General Cable Works and St. Helens Cable & Rubber Co., telephone cable; Albion Clay Co., Doulton & Co., and Oates & Green, stoneware ducts; Western Electric Co., telephone cable and apparatus and extension of telephone exchange equipment, East (London); Bartlett, Bayliss & Co., and John Macdonald (Ltd.), poles; E. Austin & Sons, saddles; T. W. Lench (Ltd.), insulator spindles; Millar's Timber & Trading Co., insulating strips; Peel-Conner Telephone Works, telephone exchange equipment, Huddersfield and Salisbury.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Barnes. [illegible] year ended March 31 amounted to £92,081, against £89,040 [illegible] 1914.

The new lamps connected were 752 private and three public, against 314 private and four public, the cost per unit being 1·04d., against 0·79d.

Coun. KITLEY, chairman of the Electricity Committee, has submitted a report on the past year's working of the undertaking. The net profit was £1,765, against £3,214 for 1914, which was the best year. The decrease in profit has been brought about solely through the effect of the war. He paid a tribute to the electrical engineer (Mr. C. S. Davidson) and his staff for the efficient manner in which, in the absence of several members who had gone on active service, the work had been carried on.

Bournemouth. [illegible] Mr. L. Bidlake, [illegible] year ended March 31 [illegible] £102,240, [illegible] £2,062, [illegible] £24,705. After [illegible] £11,[illegible] [illegible] £106,787, and [illegible] £75,063, leaving a net balance of £12,921.

Receipts per car-mile were 13·52d. (12·83d.), and working expenses were 7·25d. (7·23d.) per car-mile. Car-miles run were 1,815,632 (decrease 146,720). Out of the net balance allowances to members of the staff on military service required £2,352, and the capital charges and deficit on the 'buses £1,075. Since October only one 'bus has been in service. The deficit amounts to £169. The two Daimler chassis were commandeered by the War Office in November, and £1,404 was received in compensation. Two Tilling-Stevens chassis were ordered to replace these vehicles, and they have been now delivered, and the old bodies have been fitted to them. Considerably over one-third of the staff have joined the forces, and with 20,000 troops in the town the extra work thrown on the staff has been considerable. Every member has volunteered to do extra work or duty in order to carry through and make the [illegible]

Bury. [illegible] year ended March 31 [illegible] £3,976, and sinking fund £5,752, and of the balance £5,000 is being devoted to relief of rates, £601 refunded to rates for previous loss on Radcliffe tramways, £2,472 carried to reserve and £1,000 to insurance fund. Passengers carried were 15,513,264 (compared with 15,831,487 in previous year) and car-miles run 1,613,357. Average total revenue was [illegible]

[illegible] the new method of repairing [illegible] can be adopted, the life of the permanent way will not be determined by the wear of the rails, as was at first anticipated, but by the condition of the rail joints. The net surplus on the Bury sections (after paying war allowances, £897) was £8,472, and on the Radcliffe tramways £319. The net profit of £8,472 compares with £9,124 in previous year. During the year the Limefield section has been extended 1,100 yds. (double track) and the Jericho section 770 yds. (single track). The rails used on these extensions are 60 ft. long, 7 in. deep, 7 in. across the flange, have a groove 1¼ in. wide and 1⅛ in. deep, weigh 105 lb. per lineal yard, and are of high silicon steel manufactured by the Sandberg process at the Leeds Steel Works. They are laid on 6 in. of concrete, carried to within 1 in. of the bottom of the rail, the remaining inch, as well as 1 in. above the flange, being run up with asphalte. The joints are welded by the Thermit process, and cross anchors of 6 in. by 4½ in. H-section have been inserted—three pieces 6 ft. 8½ in. long, and four pieces 2 ft. long in each pair of rails.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—At the meeting on Friday last Mr. Francis A. Bevan (presiding) said that during the past year they had received the rent payable under their lease with the Western Union Company, which sufficed to pay the dividends on the three classes of stock. They had also received the annual contribution of £20,000 to [illegible] renewal fund as stipulated in the [illegible] together with £2,487 as interest and dividends on investments, which, with the amount brought forward, gave them a total of £153,099. It had become necessary that the c.s. [illegible] should be replaced, and [illegible] for a new cable ship, costing about £81,000, had been entered into. Ordinarily the new ship would have been completed by now, but the shipbuilding industry had been interrupted by the war, and it was impossible to say when their new ship would be ready, but they hoped [illegible] autumn. In order to meet [illegible] for a new cable and [illegible] ship, they had had to realise investments, and to meet a loss on their realisation of £3,632. He estimated that they had an actual balance on the renewal fund of £55,000, of which £37,000 was required to complete the payment for the new ship. That would leave approximately £18,000 to the credit of that fund.—The report was adopted.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.) The revenue [illegible] for 1914, [illegible] received from the Brisbane Tramways Co. amounted to £143,904, [illegible] with sundry receipts and amount brought forward (£3,809), less charges in London and Brisbane (£3,649), shows an available balance of £144,063. The directors have allocated £50,000 to reserve, £7,000 to accidents insurance fund, £18,689 in payment of debenture stock interest, £17,305 in payment of preference dividend and £24,000 in payment of interim dividend on the ordinary shares. Out of the balance the directors now recommend that a balance dividend of 4s. per share (tax free) be paid on the ordinary shares (making 8 per cent. for the year), that £3,069. 12s. 11d. be carried forward

CANADIAN GENERAL ELECTRIC CO.—The report for 1914 states that the profit was $914,527 (against $2,029,899 in 1913), and after taking into account amount brought forward and paying interest, allowing for depreciation and paying the usual dividend of 7 per cent., the surplus is $[illegible] carried [illegible] Dec. 31 1915, as to $[illegible],932, and the [illegible] $2,700,000, [illegible] $3,040,492.

ELECTRIC CONSTRUCTION CO. (LTD.)—The net profit for the year ended March 31, after providing £6,800 for debenture interest and £5,000 for depreciation, is £35,567. 4s. 7d. The sum brought forward is £7,153. 7s. 3d., and the amount available for distribution is £42,720. 11s. 10d. Deducting the interim dividend of 7 per cent. per annum on the preference shares (£2,197. 6s.) there remains £40,523. 5s. 10d. The directors now recommend payment of a further 7 per cent. per annum on the preference shares for six months to March 31 (£2,197. 6s.) and a dividend of 6 per cent. per annum on the ordinary shares for the year to March 31 (£13,452), the transfer to general reserve fund of £17,402. 12s., leaving to be carried forward £7,471. 7s. 10d. The directors are pleased to be able to report a good general demand for electrical machinery, which has been enhanced by special orders arising out of the declaration of war. The extension of the company's works (reported last year) has enabled these orders to be executed promptly and economically. The volume of unexecuted orders is satisfactory. The directors report with regret the death of their colleague, Mr. William Bulloch, and Mr. David Willock, who has been in the service of the company for 18 years, has been elected to fill the vacancy on the board.

LISBON ELECTRIC TRAMWAYS (LTD.)—At the meeting last week the chairman (Mr. L. Breitmeyer) said that the war had increased the cost of fuel and other supplies, and the exchange had dropped, causing a decrease in the profit of about £20,000. It had not been possible out of the year's profits to make the usual appropriation of £35,000 to depreciation reserve; only £15,000 was set aside from that source, but £19,012. 12s., formerly standing to the "premium on ordinary share capital," had been utilised for that purpose. In addition, £5,000 had been placed to exchange reserve, bringing that account to £55,000. Two of the most important of the Ascensores lines were now open for traffic, and the conversion of the remaining three inclines of that system to electric traction was nearing completion. The extension of the power-house plant was finished, and, were it not for the high prices of fuel, a great saving over previous years would have resulted. The negotiations with the Lisbon municipality regarding the interpretation of some clauses in their concession had made no further progress. A new Council had recently been nominated by the Government, and they hoped that their endeavours in the future for effecting an equitable settlement would be met in a more reasonable spirit. From present indications he did not think he was too optimistic in anticipating a further increase in revenue during the current year.

PENARTH ELECTRIC LIGHTING CO. (LTD.)—At the recent meeting the chairman (Mr. G. J. Somervell) said the total [illegible] was £5,438. 18s. 4d., and the working expenses were £3,036. 10s. 8d. The balance was £1,633. 3s. 2d., and it was resolved to apply £700 to renewals fund and £250 to reserve; to pay a dividend of 1 per cent. on the ordinary shares, leaving to be carried forward £283. During the year the number of consumers increased from 529 to 606. He said the position of the company had greatly improved and they had now entered in the dividend paying stage.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—Mr. W. Gascoyne Dalziel presided at the meeting last week, and said that notwithstanding the serious dislocation of trade following the outbreak of war, the units sold during 1914 amounted to 26,510,198, against 25,812,031 units sold in 1913, an increase of 698,167 units, and, after paying all working expenses, interest on prior lien debentures (£4,182) and setting aside £4,361 for depreciation, there was a surplus of £5,347 to be carried to suspense account, compared with £2,915. The surplus (£15,754) was more than sufficient to cover the indebtedness of £13,500 due to certain consumers of the Treforest Electrical Consumers' Co., and any further surplus profits would accrue towards payment of interest on the debenture stock. During the year additional connections to the system amounted to 5,502 H.P., and agreements had been entered into with new consumers for over 2,000 H.P. The construction of the mains to connect the new business was in progress and there was considerable promise of further new supplies in various [illegible]. Provisional orders had been granted to Abercarn, and parts of Cowbridge, Penybont and Llantrisant, so that the power company were now the authorised distributors of electricity for all purposes in those districts, and the developments of the business under those orders could now be proceeded with. In February last the operation of a joint supply arrangement between the power company and Rhondda Council commenced. Under that arrangement the power company purchased in bulk all the electricity Rhondda Council could generate from refuse at their Porth refuse destructor station, and sold to them all the electricity they required at certain towns and villages in the Rhondda where the power company's mains were already laid. In order to [illegible] the necessary extensions of mains, &c., to connect up new consumers with whom contracts had already been completed and others with whom they were in negotiation it was necessary to provide further capital, and the assent of the Treasury had been obtained to [illegible] £80,000 of prior lien debenture stock.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The gross earnings for the year ended Dec. 31, 1914, amounted to [illegible] the gross maintenance and other charges to [illegible] £105,846. 1s. 5d., leaving a profit of [illegible] dividend on the preference shares and [illegible] shares (£58,600), and adding amount brought [illegible] the available balance is £101,067. 12s. 9d. After [illegible] appropriations of £2,000 to the [illegible] reserve fund, the directors recommend that a [illegible] be paid on the ordinary share capital, making [illegible] paid in November last, 8 per cent. for the year (tax free), and that the balance of £6,562. 12s. 9d. be carried forward. The board record with deep regret the death of Mr. David Smith, for many years Secretary and latterly managing director of the Company.

NEW COMPANIES.

BUFFALO FORGE CO. (LTD.) (140,300.)—Reg. May 12, capital £6,000 in £1 shares, to carry on the business of mechanical, heating, ventilating and electrical engineers, founders, ironworkers, manufacturers, of fans, blowers, &c. Private company. First directors are S. L. Groom and A. W. Sanderson (both life governing directors).

SIMPLEX SLEEPER SYND. (LTD.) (140,294.)—Reg. May 11, capital £3,450 in 2,850 preference shares of £1 each, and 12,000 ordinary shares of 1s. each, to take over certain patents for an invention relating to railway or tramway sleepers and the electrical installation of track rails, to adopt an agreement with C. P., O. F. A. and N. P. P. Sandberg to carry on the business of manufacturers, installers and users of, agents for and dealers in railway or tramway sleepers and devices for the electrical installation of track rails and similar appliances for use upon railways and tramways, &c. Private company. First directors are C. P. Sandberg (chairman), O. F. A. Sandberg, N. P. Sandberg, A. Spencer, T. Jowett and P. Wheeler. Reg. office, Palace-chambers, Bridge-street, S.W.

CITY NOTES.

MEMORANDA (May 19).—Bank rate 5 per cent. (since Aug. 8, 1914. Consols 66¾. Consols Pay Day June 1. Stocks and Shares Ticket Days May 27 and June 10. Pay Days May 28 and June 11. Dates of fixed [illegible]

CASTNER-KELLNER ALKALI CO. (LTD.)—An interim dividend at the rate of [illegible] per annum has been declared for the six months ended March 31.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—The directors announce an interim dividend at rate of 10 per cent. per annum (tax free) on the consolidated ordinary stock for the past half-year.

MIRRLEES BICKERTON & DAY (LTD.)—Dividends of 5½ per cent. on the preference and 7½ per cent. on the ordinary shares have been declared [illegible] March 31.

RIVER PLATE ELECTRICITY CO. (LTD.)—The net revenue for the year ended Dec. 31, 1914, amounted to £31,000, against £42,201 in 1913, and the directors recommend a dividend on the ordinary stock of 8 per cent., [illegible]

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—The [illegible] Hon. Sir Edgar Speyer, Bt., [illegible] on the board, the directors have appointed the Rt. Hon. Lord George Hamilton, the deputy chairman, to act as chairman of the company.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, May 19. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

	NAME.	Price, Wed. May 19.	Yield p.c.	Dividend Due.
	Electricity Supply.			
10 7%	Bournemouth & Poole E.L. Ord.	[illegible]	[illegible]	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	10½	[illegible]	Feb, Aug
5 10%	[illegible]	[illegible]	[illegible]	Mar, Sept
St. 4%	Central Elec. Supp. C. Deb. St ...	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] West Ham Elec. Co. [illegible]	[illegible]	[illegible]	[illegible]
5 2/3	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
St. 5%	Do. 5% Deb. St.....	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
St. 4½%	[illegible]	[illegible]	[illegible]	July
[illegible]	Kensington and Knightsbridge Ord. ..	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	5¾	5 9 10	[illegible]
[illegible]	[illegible] 6% 2nd Dbs ..	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] S.S. 5% 2 Mt. Db. St	[illegible]	19 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1st Mort. Debs. .	95	[illegible]	Apl, Oct
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Ord.	[illegible]	3 0 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Electric Railways & Tramways.			
[illegible]	[illegible]	[illegible]	5 15 7	Apl, Oct
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] 7	[illegible]
[illegible]	1st Deb. Ord. .	[illegible]	17 11 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	Mar, Sept.
[illegible]	[illegible]	[illegible]	[illegible]	Jan, Jly.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] [illegible]

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name.	Price, Wed., May 19.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	£ s. d.		
St.	3½	Metropolitan Elec. Tramways, A Debs.	4	4	Jan, July
St.	3½	Do. B Debs.	4	3 10	Jan, July
St.		Metropolitan Dist. Ry. Ord.	4	7	May, Nov
St.	4½	Do. 4½ Pref.	6	7	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	4	12	Jan, July
St.	4½	Do. 4½ Pref.	4	11	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	87	4 11	Jan, July
St.	4½	Do. 4½ Cons. Stock	77½	5 3	Mar, Sept
10	..	Underground E. Rys. of London Shares	..	..	..
1	..	Do. A Ord.	..	..	..
St.	6%	Do. 6% Debs.	113½	5 6	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 15	..	5 11	Mar, Sept
..	4½	Do. 4½ Bds.	..	4	Jan, July
5	..	Yarmouth & West Norfolk Ord.	..	..	March
		Electric Manufacturing, &c.			
1	1½	British Westinghouse Pref.	2	4 11	Apl, Oct
1	1½	British Westinghouse Def.	2	4 11	May
100	5%	Electric Lighting Debs.	100	5	Jan, July
1	..	Electric Propulsion	1	..	..
5	15	Brit. Insulated & Helsby Ord.	11½	13 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	6½	4 16	Jan, July
1	5	British L.M.Ericsson Mfg. Cm.6% Pref	1½	5 12	Mar, Sep
2	7½	British Westinghouse Pref.	14	8 0	April
100	6%	Do. 6% Prior Lien Debs.	102	5 17	Apl, Oct
100	4	Do. 4% Mort. Deb. St.	73	5 9	Jan, July
5	5%	Callender's Cable, &c., Co. Ord.	1	5	Jan, July
5	5	Do. 5% Pref.	4	17 7	Feb, Aug
1	15%	Crompton & Co.	3½	4 12 4	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	..	6 17 2	Sept
5	..	Edison Swan Elec. Ltd. A £5 Sh.	..	..	Feb, Aug
1	6%	Elec. Construction Ord.	..	5 11	May
St.	4%	Do. 4% Debs.	101	5 15 1	Jan, July
10	5%	General Electric 6% Pref.	10½	5 19 3	Jun, Dec
2	2%	W. T. Henley's Teleph. Wks. Co. Ord.	14½	6 15 4	Feb, Aug
5	2/0	Do. 4½% Cum. Pref.	..	4 10 0	..
St.	4½%	Do. 4½% Deb.	9½	4 13 9	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7	5 11 1	Feb, Aug
12	6	Do. 6% Pref.	8½	5 16 9	Apl, Oct
100	4%	Do. 4% Debs.	77½	5 3	May, Nov
12	36/0	Telegh. Con. & Main. Co.	37	6 9	Jan, July
100	6	Do. 6% Debs.	86	4 4 3	Jan, July
1	12½	Vickers Ord.	11	7 0 7	May, Aug
1	6d.	Do. 5% Pref.	1½	4 11 1	May, Aug
St.	4%	Do. 1st Debs.	93½	4 5 17	Jun, Dec
100	4½	Do. 4½% 2nd Debs.	101½	4 6 1	Jan, Dec
		Telegraphs.			
St.	3/0	Anglo American 6% Pref. Ord.	10	5 13	Feb, May, Aug, N
St.	3	Do. Def. Ord.	2	6 12 3	Feb, May, Aug, N
St.	4%	Commercial Cable 4% Debs.	87	5 3 7	Ja, Ap, Jly, O
15	..	Cuba Submarine Ord.	3	5 13 6	May, Nov
10	10/0	Do. 10% Pref.	1	6 9 0	..
5	..	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4	Direct United States	7	5 3 5	Ja, Ap, Jly, O
St.	..	Eastern Ord.	143½	5 5 3	Ja, May, Jly, O
St.	12½	Do. 3½% Pref.	7½	4 13 4	Ja, May, Jly, O
St.	..	Do. 4% Debs.	92	4 7 7	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	91	4 7 5	Feb, Aug
10	6/6	Do. Ord.	10½	5 ..	Ja, Ap, Jly, O
10	..	Gt. Northern Tel. Co. Ex Coup. 6	..	7 11	Ja, May, Jly
25	15%	Indo-European xd and bonus	..	5 9 4	May, Nov
1	2/0	Marconi's Wireless Tel. Co.	3½	11 17	April
1	1/4	Do. Def.	1½	3 14	July
10	..	Western & Pacific Ord.	11½	4 14	May, Nov
10	..	Do. Def.	11½	5 4	May, Nov
St.	4%	Western Telegh. Co.	13½	5 2 3	Mr, Jly, O. Dec
St.	4½	Do. 4½%	94	4 15 3	Jun, Dec
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap	1½	6 5	Ja, Ap, Jn, O
..	5%	Cuban Telephn. Co. 5% Bds.	..	6 ..	Jan. Jly
1	7½	Monte Video Telephn. Ord	..	5 12	Nov.
..	4%	New York Telephone 4½% Bds.	..	4 13	May, Nov
1	..	Oriental Telephone Ord.	..	.. 6	Apl, Oct
St.	4%	Do. 4% Debs.	..	4 12	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	..	5 2	Jan, July
5	..	United River Plate Ord.	..	5 6	Apl, Oct
4	..	Do. Pref.	..	5 3	Jan, July
St.	4½%	Do. 4½% Debs.	..	4 15 3	Jan, July
		Financial and Investment.			
10	..	Globe Telegh. & Trust.	11	5 9 1	Sp, Dc, Mr, Jn
1	..	Do. Def.	1½	1 1	Sp, Dc, Mr, Jn
1	..	Submarine Cable Trust Ord.	..	6 5 0	Ja, Ap, Jly, O
..	4%	Do. Certs.	..	5 14 3	Ja, Ap, Jly, C
100	..	Submarine Cable Trust Certs.	1..	4 14 1	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	..	5 ..	Jun, Dec
St.	4½	Do. 4½% Debs.	..	5 3	Jan, July
St.	4%	Do. 4% Debs.	..	4 17	Jan, July
		Do. 1st Pref.	4½	6 5	Jan, July
		Do. Def.	..	7 9	Jan, July
10	3½	Brazilian Traction Ord.	10½	11 4	Fb, M, Aug, N
100	$1½	Do. 6% Pref.	..	..	Ja, Apl, Jly, O
5	6%	Brisbane Trams Ord.	7½	..	May
		Do. Def.	..	4 ..	May, Nov
St.	4½%	Buenos Ayres Great Southern Debs.	81½	5 11	..
..	..	Calcutta Elec. Trams. Ord.	..	7 7	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	8½	5 13	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	..	6 ..	..
10	6	Manila Elec. Trams. Ord.	..	7 4 11	Jan, July
..	..	Do. Pref.	..	..	Fb, M, Aug, N,
..	..	Do. Def.	..	..	Mar, Sep
St.	4½	Montreal Street Ry. 4½% Debs. (1922)	..	4 .. 4	Feb, Aug
100	5%	Rio de Janeiro Tram. L. & P. 50 yr. Bds	..	5	Jun, Dec
100	4½	Do. 4½% Debs.	95½	4 14 6	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
		Adelaide Elec. Supply 6% Pref.	..	6 13	Mar, Sept
St.	..	Do. Def.	10½	4 16 7	Jun, Dec
1	..	Bombay E. S. & T 6% Pref.	10½	5 14 4	..
..	..	Calcutta E. S. Corp. Ord.	..	6 12 3	Apl, Oct
		Do. Def.	..	5 0	..
St.	5%	Melbourne Elec. Supply 5% 1st Mt. Debs	102½	5 17	June, Dec
10	..	Do. Ord.	10½	5 14	Apl, Oct
		Do. Pref.	10½	4 18	Jan, July
1	..	Do. Def.	1½	4 15	Ja, Apl, Jly, O
..	..	Montevideo Gas Co.	..	5 11	Jan, July
50	4½	Do. Pref.	..	6 ..	Jan, July
..	..	Do. Def.	..	..	May, Nov
..	..	Montevideo Tramways	..	..	Jan, July

† Ex dividend for interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date May 19, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	11½d.	Antimony	£100 0 0
Solid Drawn Copper Tubes	13½d.	English Lead	£21 0 0
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	13½d.	Old Metals.	per ton.
Brass Wire	12½d.	Clean Scrap Copper	£73 0 0
Copper Wire	12½d.	Brazierv Copper Scrap	£65 0 0
Rolled Brass	12½d.	Clean Scrap Brass	£50 10 0
Brass Sheets	12½d.	Old Lead	£18 10 0
	per ton.	Old Zinc	£45 0 0
Copper Sheets	£130 0 0	Hollow Pewter	£120 0 0
Spelter	£61 0 0	Black Pewter	£85 0 0
		Gun Metal	£82 10 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date May 19, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£65	Lead	£19 5 0
Clean Mixed Brass	£63	Tin	£117 15 0
Clean Copper	£70	Old Zinc	£46 0 0
Brazierv Copper	£6..	Hollow Pewter	£120 0 0
Clean Copper Wire	£75	Stamped Black Pewter	£85 0 0
Gun Metal	£82		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line	Week ended		Receipts for week		Net Mileage	Aggregate. Amount	Increase or decrease	
			£			£		£
Aberdeen Corporation	May	12	1,637	+ 13	50	81,967	+	2,284
Anglo-Argentine	..	13	53,137	— 440	19	965,334	—	96,023
Ashton-under-Lyne	..	15	463	+ 21	7	3,268	—	83
Ayr Corporation	..	15	340	+ 49	52	17,160	—	1,126
Bath Electric Trams, Ltd	..	..	..	..	..	..	..	..
Birkenhead Corporation	..	..	1,327	+ ..	7	8,528	—	211
† Birmingham Corporation	..	13	12,939	— 714	7	83,054	—	696
Blackburn Corporation	..	12	1,252	+ 33	7	8,572	—	973
Bolton Corporation	..	16	2,722	— 187	7	17,851	—	1,995
† Bournemouth Corporation	..	12	2,011	+ 236	6	13,023	+	324
Bradford Corporation	..	..	..	..	..	..	..	..
Brighton Corporation	..	16	985	+ 61	73	6,505	—	681
† Bristol Trams & Carriage	..	14	9,087	+ 1,044	19	166,711	+	15,264
Burnham E. Trams & Ltg.	..	..	R3,496	..	19	..	—	R40,546
Burnley Corporation	..	..	1,554	+ 90	7	11,034	—	1,183
Burton Corporation	..	..	..	+ 6	7	1,842	—	124
Bury Corporation	..	..	..	+ 101	7	8,983	—	717
Calcutta Tramways Co.	..	..	R52,152	— ..	19	R1,061,081	+	R84,163
Camborne-Redruth	..	..	141	+ 12	19	2,367	—	153
Cardiff Corporation	..	..	2,631	+ 31	5	14,042	—	2,079
Central London Railway	..	..	..	..	..	..	..	..
Cork Electric Trams Co.	..	13	..	+ 64	19	8,739	—	215
Croydon Corporation	..	..	1,815	+ 311	7	9,631	—	486
* Derby Corporation	..	..	1,021	+ 22	6	6,595	—	312
Dover Corporation	..	..	283	+ 6	6	1,851	—	274
Dublin & Lucan Railway	..	14	..	+ 14	19	2,476	+	73
Dublin United	..	..	6,035	+ 311	19	110,529	—	6,087
Dundee Corporation	..	..	1,332	+ 3	52½	65,960	—	1,396
East Ham Council	..	..	1,343	+ 367	7	8,633	—	1,900
Erith Urban Council	..	..	..	..	..	..	..	..
Exeter Corporation	..	13	..	+ 39	7	2,255	—	68
Glasgow Corporation	..	..	22,014	+ 1,113	119	1,019,104	—	8,013
Glossop Trams	..	15	123	..	20	2,252	—	201
Gloucester Corpn.	..	12	313	+ ..	6	1,891	—	142
† Halifax Corporation	..	11	2,182	+ 255	41	13,131	—	423
Hastings Elec. Trams Co.	..	17	902	+ 1	19	14,833	—	585
Hong Kong	..	..	..	..	..	..	..	..
Huddersfield Corpn.	..	15	2,512	— 349	7	16,956	+	1,250
Hull Corporation	..	18	2,881	+ 173	6	19,633	—	1,508
Ilford District Council	..	..	633	+ 175	6	4,079	+	832
Ilkeston Corporation	..	12	126	+ 8	6	728	—	70
Ipswich Corporation	..	15	427	— 21	6	2,830	—	52
Isle of Thanet Co.	..	..	323	+ ..	32	9,714	—	2,636
Kilmarnock Corporation	..	..	..	..	..	..	..	..
Lanarkshire Trams Co.	..	..	..	..	..	..	..	..
Lancashire United	..	13	1,832	— 17	19	33,816	—	2,001
Leeds Corporation	..	..	8,543	+ 354	7	55,773	+	931
Leicester Corporation	..	..	3,013	+ 131	7	55,363	+	168
Leith Corporation	..	..	717	..	7	36,480	—	263
Lincoln Corporation	..	15	128	— 8	7	917	—	69
Liverpool Corporation	..	..	13,340	— 167	134	231,321	—	4,914
Liverpool Overhead Rly.	..	..	..	..	..	..	..	..
Llandudno & Colwyn Bay & R	..	..	..	..	..	..	..	..
London County Council	..	..	50,155	+ 6,513	5	246,321	+	24,017
London Elec. Ry. Co.	..	..	..	..	..	..	..	..
London United	..	..	..	..	..	..	..	..
Lowestoft Corporation	..	15	152	— 11	32	5,290	—	586
Maidstone Corporation	..	..	..	..	..	..	..	..
Manchester Corporation	..	15	17,595	— 19	6	113,406	—	2,526
Mersey Railway	..	..	..	..	..	..	..	..
Nelson Corporation	..	..	1,213	— 19	51	1,213	—	232
Newcastle-on-Tyne Corpn.	..	..	6,092	+ 1	7	38,971	+	4,334
Newport (Mon.) Corpn.	..	..	804	+ 1	7	4,378	—	395
Northampton Corporation	..	..	731	+ ..	7	4,459	+	666
Oldham Corporation	..	..	2,223	— 11	8	16,896	—	1,246
Perth (N.B.) Corporation	..	..	..	..	..	..	..	..
Perth (W.A.) Elec. Trams	..	..	..	..	..	..	..	..
Portsmouth Corporation	..	8	2,501	+ 153	6	13,616	—	..
Preston Corporation	..	..	..	..	..	..	..	..
Rotherham Corporation	..	15	1,023	— 62	6	6,279	+	500
Salford Corporation	..	17	..	— 347	71	33,888	—	976
Shanghai	..	..	..	..	..	..	..	..
‡ Sheffield Corporation	..	16	8,437	+ 583	71	62,165	+	3,258
Singapore Trams	..	..	..	..	..	..	..	..
Southampton Corpn.	..	..	1,446	+ 155	7	8,290	+	121
Southend Corporation	..	..	764	— 96	7	4,928	—	948
St. Iyb'dge, Hyde, &c., Jt. B.	..	..	764	+ 16	7	5,132	—	361
Sunderland Corporation	..	..	1,426	+ 16	7	9,298	—	344
Swansea Corporation	..	..	..	+ 16	7	14,963	—	1,106
Swinton Corporation	..	..	178	+ 41	6	1,132	+	70
Tynemouth Tram Co.	..	..	570	+ 1	18	9,363	—	15
Wallasey Corporation	..	..	1,164	+ 45	6	7,694	—	731
Walsall Corporation	..	..	..	— 99	7	13,039	+	837
Warrington Corporation	..	..	..	..	..	..	..	..
West Ham Corporation	..	13	3,243	+ ..	6	19,142	+	1,329
Wolverhampton Corpn.	..	12	1,037	+ ..	6	6,368	—	204
Yorkshire W.R. Trams	..	..	..	+ 31	20	29,628	+	920

(*a*) These comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ‖ Plus 3 days.
¶ Plus 2 days. ** [illegible] with 52 weeks, same last year.

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NOTES.

The Gretna Railway Disaster.

AMID the horrors of war, events that would otherwise arouse attention pass almost unnoticed. Even so, the railway disaster at Gretna last Saturday morning was so terrible as to be the absorbing topic for a brief period. Our railways are rightly renowned for their safety, yet there seems a tendency at the present day for accidents, though less frequent, to be more serious in character. Thus, the accident at Gretna, involving three trains, is the most serious that has ever occurred on British or other railways, the loss amounting to about 160 killed and 200 injured, and most of these, unfortunately, were soldiers on their way to the front. Why is it that such an appalling loss of life should be possible? When we come to consider this question, the first weak link in the chain of safety is undoubtedly the signalman. He is apt to fail lamentably at times. It is sometimes thought that too much is required of the signalman, that his hours are too long and his responsibility too great; yet on the present occasion the signalman had had several years' experience at this particular signal box, had only just started his shift. He had arrived by the very local train which caused the disaster, and which remained in view of the signal box; yet, when [illegible] the position of this train, the only reply he could give consisted of the tragic words "I forgot." [illegible] forget under these circumstances, [illegible] to rely with any confidence upon the human element. Unfortunately, not merely is it forgetfulness which may have such terrible consequences, but there is also a disregard of, and even an apparent contempt for, rules which have been specially framed to ensure safety in certain operations. A rule of this kind is that which requires the use of lever collars when a train is shunted from one track to the other, and it appears from the evidence given at the inquiry not yet completed, that, if this rule had been observed in the present instance, the most terrible disaster in railway history would not have occurred. It is obviously useless to make rules if they are not observed. It is on account of forgetfulness and the disregard of rules that automatic means of signalling have come so very much to the front in recent years. Of necessity, however, it will be a long time before the signalman can be replaced, even to a limited extent, and at the best we must rely in many cases upon methods which will merely rectify his errors and omissions.

ANOTHER unfortunate feature about railway accidents of recent years is the way in which fire has almost always played a terrible part. In the present instance the loss of life would no doubt have been very much less but for the fact that an outbreak of fire at once occurred. It appears to us that much more might be done than is being done in the use of steel for the construction of carriages and the fire-proofing of materials of an inflammable character. Fire-proofing is not a costly matter, and although it may not render the materials absolutely uninflammable, it will make the difference between a fire that is smouldering and one that is raging. A still more important matter, however, is the employment of gas for the lighting of railway trains. We have frequently called attention to this matter, and the Board of Trade have also stated the desirability of discontinuing the use of gas. We understand that two of the three trains involved were so equipped, and in giving his evidence one of the engine drivers expressed the view that gas was the cause of the fire. It is certainly difficult to understand the fire's rapid progress except on this basis. If it is shown that the trains were equipped with gas, it is surely time that a more complete protest was made against the continued use of this illuminant. It would be unreasonable to expect a sudden transformation of the rolling stock of a large company from gas to electric illumination, but the matter has now been under discussion for a considerable time, and the public have a right to know what steps have been taken and are being taken to abolish gas lighting on passenger trains, so as to ensure that if an accident does occur it will be at least free from the horror of fire.

Metallic Conduction and the Electron Theory.

During the past 10 years physicists have been striving to interpret every electrical property of matter in terms of the electron or negative corpuscle, the indivisible unit of electricity. During many years previously they had been striving to explain everything without electricity—all phenomena were ascribed to a state called electrification, and were expressed in terms of the fields of force. The transition from one epoch to the other acquired its greatest velocity under an impulse from Sir J. J. Thomson when he first caught and measured up the negative corpuscles. To-day another discontinuity in thought, which, however, affects only a section of electrical theory, is brought before our minds by the same prophet. At a lecture before the Institute of Metals, which we report at some length in another column, Sir J. J. Thomson announced that he had abandoned the modern electron theory of metallic conduction, and had returned to a modified form of an early speculation of his own. Practically all modern work on metallic conduction assumes that the current is conveyed solely by electrons, that these exist loose in enormous quantities in metals, that they behave collectively somewhat like a gas among the molecules of the solid, and share those molecular motions which determine the temperature of a substance. The accumulating difficulties that have confronted these assumptions were discussed in the lecture, as our readers will see by referring to another column in our present issue. They have led Sir Joseph to discard all the electronic conduction theory except the single point that the current is carried by electrons.

Sir Joseph now postulates, first, that a conductor is capable of polarisation just like a non-conductor; that is to say, when an electric field is applied to it the molecules arrange themselves with positive ends pointing one way and negative the other—much as in the old Grotthus chain hypothesis of electrolysis. It is evident that the proportion of the whole number of molecules linked up in chains will depend on the state of molecular motion, that is, on the temperature. Second, he postulates that electrons can pass easily from one molecule to another when the negative end of the one is close to the positive end of the other, but not otherwise. The current through the metal is constituted of electrons skipping from molecule to molecule along chains of molecules. He shows by means of such premises that the startling discovery by Kamerlingh Onnes of the almost infinite conductivity of lead and mercury at the temperature of liquid helium can be explained. We believe that most physicists will welcome this revised metal theory, if only because it tends to unify their conceptions of the constitution of conductors, insulators and electrolytes. Meanwhile we await with interest the fuller working out on the new hypotheses of explanations of such phenomena as the Thomson thermo-electric effect and the anomalous resistivity of alloys, which have never been explained by the intramolecular gas theory; and also of the close connection between electric and thermal conductivity, the explanation of which was the chief glory of the electron theory.

Royal Engineers (T.F.).—The following appointments have been made:—

Electric Lights Company, Edinburgh (Fortress) Engineers: Sec. Corp. R. W. Stanfield to be second lieutenant.

London Electrical Engineers: Lieut. Hugh C. C. Tufnell is restored to the establishment.

Wireless Signalling on the London & South-Western.—Experiments are being carried out on the Hampton Court branch of the London & South-Western Railway on automatic train control by means of wireless signals. The experiments are purely tentative, and the system is not intended to replace or in any way interfere with the ordinary lock and block visual system.

Albert Medal Awarded to Sir J. J. Thomson.—The Albert Medal of the Royal Society of Arts for the current year has been awarded by the Council to Prof. Sir J. J. Thomson, O.M., F.R.S., for his researches in physics and chemistry, and their application to the advancement of arts, manufactures and commerce. The Albert medal was founded in 1863 to commemorate the Prince Consort's Presidency of the Society, and is awarded "for distinguished merit in promoting arts, manufactures and commerce."

Award of Barnard Medal to Messrs. W. H. and W. L. Bragg. The trustees of Columbia University, New York, have awarded the Barnard Gold Medal to Prof. W. H. Bragg, F.R.S., Cavendish Professor of Physics in the University of Leeds, and his son, Mr. W. L. Bragg, Fellow of Trinity College, Cambridge, for their work on X-rays and crystals. The medal is awarded every five years for meritorious service to science on the recommendation of the National Academy of Sciences of the United States. Previous recipients have been Lord Rayleigh, Sir William Ramsey, Prof. von Röntgen, Prof. Henri Becquerel and Prof. Sir Ernest Rutherford.

"The Central." We are glad to see that the war has not in any way damped the ardour of the editors of "The Central," and that the May issue of this journal in no way falls below the high standard set up by previous numbers of the journal. Perhaps the chief feature of interest, as in most other publications of this class, lies in the details given of Centralians who are serving their King and country in the present crisis. The Roll of Honour shows that there are 633 members of the Central Technical College now in His Majesty's Forces, of which number 341 have obtained commissions and 292 are serving in the ranks. It is hoped to publish in the next number a list of all Old Centralians who are engaged in the equally important duty of providing munitions of war, and a special request is made for all those so engaged to send in their names to the Hon. Sec., 4, Fairfield-road, Old Charlton, S.E. Apart, however, from this part of the issue, there are some excellent technical articles to interest the reader. These include an account of the visit of the British Association to Australia, contributed by Prof. G. W. O. Howe; an article on "Some Applications of the Mercury Arc," by Dr. T. M. Lowry; and a discussion of the future possibilities of Domestic Electricity, by Mr. H. W. Purle.

Coal Supplies Conference.—Arising out of the national conference on coal supplies to gas and electricity undertakings a deputation attended before the coal exports control committee on Thursday, the 20th inst., and laid the views of the conference before them. The deputation consisted of Sir Corbet Woodall, past-president of the Institution of Gas Engineers and Governor of the Gas Light & Coke Co.; Sir John Snell, president of the Institution of Electrical Engineers; Alderman Phillips, chairman of the Salford Corporation Gas Committee; Alderman Kay, chairman of the Manchester Corporation Gas Committee; Mr. Frank Bailey, chief engineer of the City of London Electric Lighting Co.; Dr. Charles Carpenter, chairman of the South Metropolitan Gas Co.; Bailie Smith, chairman of the Glasgow Corporation Electricity Committee; Mr. Regd. Neville, M.P., chairman of the Brentford Gas Co.; Mr. Hanbury Thomas, managing director of the Sheffield Gas Co.; Mr. J. S. Highfield, chief engineer of the Metropolitan Electric Supply Co.; and Mr. D. Milne Watson, general manager of the Gas Light & Coke Co.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Dr. H. W. Malcolm concludes an article on the "Future Progress of Cable Telegraphy" (p. 270).

Mr. S. F. Walker contributes an article on the "Gas Turbine" (p. 282).

We publish a communication by Prof. W. [illegible] "Currents in Bearings of Electrical Generators" (p. 266).

The first part of a Paper on "Methods of Measuring the Strength of Wireless Signals," by Prof. E. W. Marchant, is reproduced (p. 217).

We give extracts from the annual report of the Council of the Institution of Electrical Engineers, which was presented at the annual general meeting held last night (p. 272). Our leading Article deals with the work of the Institution (p. 280).

We give an account of the May lecture delivered before the Institute of Metals, by Prof. Sir J. J. Thomson, O.M., F.R.S., on the "Passage of Electricity Through Metals" (p. 274).

Some further details of the "Kenotron" are given from an article by Dr. S. Dushman (p. 276.)

A Paper on "Protective Reactors for Feeder Circuits of Large City Power Systems," by Messrs. J. Lyman, L. L. Perry and A. M. Rossman appears on p. 277.

An article on "Frictional Electricity on Insulators and Metals," by Mr. W. M. Jones, is abstracted (p. 283).

Companies' Meetings and Reports.—Meetings of Callender's Cable & Construction Co., Craigpark Electric Cable Co., Kalgoorlie Electric Power & Lighting Corpn., River Plate Electricity Co., and West London & Provincial Electric Supply Co. are reported, and directors' reports abstracted include those of the Anglo-Argentine Tramways Co., Havana Electric Railway, Light & Power Co., Lima Light, Power & Tramways Co., and Shanghai Electric Construction Co. (pp. 296 and 297).

OBITUARY.

Prof. Pieter Zeeman.—We regret to learn that Prof. P. Zeeman, professor of geometry and theoretical mechanics in the University of Leyden since 1902, passed away on May 8th. Prof. Zeeman was born in 1865 at Zonnemaire, near Zieriksee, Netherlands, and entered the University of Leyden in 1885, becoming assistant in the physical laboratory in 1890 under Profs. Lorentz and Kamerlingh Onnes. He obtained his doctor's degree in 1893, and in 1897 was appointed university lecturer on experimental physics in Amsterdam, afterwards becoming professor in that subject. This post he held till he returned to Leyden in 1902. His work has mainly been connected with magneto-optical phenomena, and various optical subjects; also with the propagation and absorption of electrical waves in liquids. He discovered the influence of a magnetic field on radiation phenomena, known as the Zeeman effect, for which he was awarded the Baumgartner Prize of the Imperial Academy of Sciences at Vienna and the Prix Wilde of the Académie des Sciences at Paris. He was elected a member of the Royal Academy of Sciences at Amsterdam in 1898.

PERSONAL.

Mr. W. Dubilier has again arrived in this country, being engaged with radio-telegraphic work.

APPOINTMENTS VACANT AND FILLED.

Machine testers, with experience in d.c., a.c. and turbo-generator work, and also men for small a.c. and d.c. motor testing, are wanted in Manchester district. *See advertisement.*

West Hartlepool Corporation invite applications for the position of borough electrical engineer. Commencing salary £400. Applications to the Town Clerk by June 9.

Mr. J. C. Cameron, who has been acting as [illegible] and engineer of the Northampton Corporation [illegible] been appointed permanent manager at £300, [illegible] £25 to £350 per annum.

"Indian Engineering" says that Mr. H. E. [illegible] electrical engineer in Mysore, and now [illegible] Tata hydro-electric scheme, has been appointed consulting electrical engineer to the Government of Mysore. Mr. [illegible] at chief engineer.

Mr. Robt. W. Holland, M.A., M.Sc., LL.D., of Palmers Green, London, has been appointed principal of [illegible] Municipal Technical Institute.

INSTITUTIONS AND SOCIETIES.

Diesel Engine Users' Association.—At the May meeting of this Association further engineers, having control of Diesel engine plant, were elected members of the Association. It was agreed that a member unable to attend a meeting on any particular occasion should be entitled to nominate a deputy to attend in his place, provided that such deputy be a member of his engineering staff, whose name has been previously submitted to, and approved by the Committee of the Association. The President reported that particulars of the scheme of insurance at Lloyd's against breakdown had been sent out to all members. The question of a suitable allowance to be made for depreciation of Diesel engine plant in connection with income tax assessment was discussed, and its further consideration was adjourned for the following meeting. The subject of lubrication of Diesel engines was further dealt with. Replies and information on several interesting points had been received from many members of the Association, and much valuable information had been obtained as to the various methods of lubricating, the costs per unit generated, comparative costs of lubrication as compared with fuel oil used, the practice in regard to withdrawal of pistons for examination, &c. It was decided to extend the time for sending in returns from other undertakings and to ask for some further information in certain cases so as to obtain results which would represent general practice as far as possible. These returns will then be tabulated and circulated among the members only.

Verband Deutscher Elektrotechniker.—It is stated in the "Elektrotechnische Zeitschrift" that the date of the annual meeting has been postponed, but whether it will take place in the autumn or not is still undecided.

EDUCATIONAL NOTES.

University of Manchester.—In the faculty of science complete courses of theoretical and practical training are given to students preparing for the higher positions in the electrical engineering profession. At the end of a three years' course students may obtain either an ordinary or an honours degree of B.Sc. in electrical engineering. There is also a special three years' course for a certificate in electrical engineering. The John Hopkinson laboratories, which have recently been extended, are well equipped with modern electrical machinery and testing appliances, and good facilities are afforded for educational and research work. Prospectuses from the Registrar.

University of London.—It was resolved at the meeting of the Senate held last week, that the science department of the Goldsmiths' College should be closed from the end of the present session.

Bristol University.—Considerable additions to Bristol University are to be commenced immediately owing to the generosity of Mr. G. A. Wills, chairman of the Imperial Tobacco Co., and Mr. H. H. Wills, who have given an additional £40,000 to the original £180,000 they gave for the purpose.

Manchester Municipal School of Technology.—Notice is given that the governing body propose to offer 10 research scholarships in technology tenable during the session 1915-16.

Of the scholarships, one is of the value of £80, three of the value of £75 and six of the value of £50, all with fees remitted. Research may be undertaken in electrical, mechanical or sanitary engineering, or in one of seven branches of applied chemistry (including general chemical technology and electrochemistry), or in the textile industries. Applications must be received by June 21, and forms of application, &c., from the Registrar.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 28th (to-day).

Physical Society.

7 p.m. Meeting at King's College, Strand, London, W.C. Annual Exhibition of Scientific Apparatus. Papers on "Numerical Relations between Electrons and Atomic Constants," by Dr. H. S. Allen. "A Mercury Lead Condenser for Absorption Coefficients of Homogeneous X Radiation," by Mr. H. Moore. "Lag Experiments Illustrating Some Properties of the Electron Current from Hot Metals," by Prof. O. W. Richardson, F.R.S., and on "High Permeability Iron," by Prof. E. Wilson.

Royal Engineers.

9 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Discussion on "The Engineering Problems of Mesopotamia and Lower Euphrates Valley," to be led by Major-Gen. Sir John Jackson, C.V.O., M.P.

FRIDAY, June 4th.

Royal Institution.

9 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Discussion on "Radiations from Exploding Atoms," by Prof. Sir Ernest Rutherford, F.R.S.

CURRENTS IN BEARINGS OF ELECTRIC GENERATORS.*

BY PROF. W. BUCHANAN.

It will be admitted that in a perfectly constructed alternator both practice and theory tell us that no such vagabond current exists, so that the cause must be looked for in constructive inequalities. The most likely causes are :—

(*a*) Magnetic leakage from the main poles to the bed-plate. In machines with a nearly saturated stator core some magnetism would be found in the air space behind the core, but very little could find its way through the solid iron frame ; the amount would be ascertained by laying an insulated conducting loop along the back of the stator, the sides parallel with the shaft and spaced equal to the polar pitch, the ends taking down to the shaft. An oscillograph would register *twice* the voltage available for producing current through shaft, bearings and bed-plate. I am of opinion that any such E.M.F. would be a small fraction of a volt.

(*b*) Short-circuit in a field coil, the magnetic circuit being otherwise symmetrical. Consider the simplest case—that of a two-pole alternator. Fig. 1 helps to explain the effects ; the parts marked *a* and *b* represent one side of the bed-plate and bearing, with magnetic connection to stator through the supporting frame. Let R represent the reluctance of each pole and air-gap, while that of bed-plate, shaft and bearings—both sides—is *r*, ampere-turns per pole is T, while (1—K) T turns on B pole are short-circuited, so that KT represents the ampere turns on the weaker pole, K is < 1.

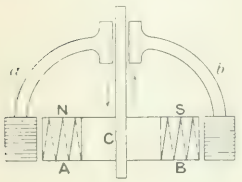


FIG. 1.

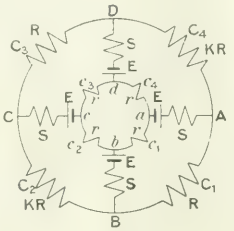


FIG. 2.

The flux that would be induced by the whole coil in circuit *Aac* is $0{\cdot}4\pi T \div (R+r) = F_A$, while that by the faulty coil would be $0{\cdot}4\pi KT \div (R+r) = F_B$ in the opposite sense, so the resultant flux due to both coils acting together is $F_A - F_B = \frac{0{\cdot}4\pi T}{R+r}(1-K)$ which gives the flux in the shaft.

(*c*) Unequal reluctances of main field circuit, due to unequal air-gaps, pole joints or permeability of poles. Referring to Fig. 1, in this case K = 1, but we may take the reluctance of the B pole and air-gap as *x*R, so that in this case $F_A = \frac{0{\cdot}4\pi T}{R+r}$, $F_B = \frac{0{\cdot}4\pi T}{xR+r}$, and shaft flux is $0{\cdot}4\pi TR(x-1) \div (R+r)(xR+r)$.

In the general case of a $2n$ pole alternator, all uniform except one having in case (*b*), KT ampere-turns, and case (*c*) *x*R reluctance, $n-1$ pairs of poles balance each other's effect on shaft circuit, and we are left with one whole and one defective pole exactly as in the two-pole case considered.

(*d*) Unequal air gaps, due to eccentricity of rotor relative to stator. Again, taking a two-pole alternator, when the N pole is nearest to the stator, the shaft flux is in direction from bearings towards the rotor, while after half a revolution of the rotor, when the S pole has least clearance, the shaft magnetism is in the reverse direction, it therefore reverses with the frequency of the armature E.M.F. It will be readily seen that when the internal surface of stator and external of rotor are both truly cylindrical, and neglecting secondary effects due to the [illegible] light eccentricity in alternators having more than one pair of poles.

In the frequently observed cases where the stator core is not quite cylindrical, but rotor quite true, an alternating flux is set up in the shaft. In the three cases, *b*, *c*, *d*, the presence of magnetism in the shaft can be ascertained with the rotor at rest but fields excited [illegible]

[illegible]

[illegible]

[

bility of about 1,200, an air-gap of 0·1 mm. has the reluctance of 12 cm. of core, in which case K is 1·12; even if it were only 9,000, it is at least 1,800, making K 1·18. Taking the smaller value, our equations show that

$$C_1 = KC_2 \text{ or } C_1 = \frac{2K}{1+K} = \frac{2\cdot24}{2\cdot12}$$

while $C_2 = \frac{2}{2\cdot12} c_2$, or $0\cdot94\, c_2$.

In order to determine the values of C_1 or c_1, by adding equations 1, 2, 3, 4, and noting that $C_1 + C_2 = C_3 + C_4$ [illegible], we get $8E = 16c_1S + 4c_1r + 2KR(C_1 + C_4)$; also, so on

$$C_1 + C_4 = 2C_1 = \frac{4K}{1+K} \text{ [illegible]} \quad \therefore 2E = c_1\left(4S + \frac{2KR}{1+K}\right)$$

Assuming a probable example with 20,000 ampere-turns per pole, $S = 25\times10^{-5}$, $R = 2\times10^{-5}$, $r = 1\times10^{-5}$, $K = 1\cdot12$ as above, we get

$$c_1 = \frac{0\cdot4\pi \cdot 20{,}000 \cdot 2}{100 + 1 + \frac{4\cdot48}{2\cdot12}} \cdot 10^{-5} = 48\cdot5 \cdot 10^{-6}, \text{ and } C_1 = 0\cdot94 \cdot 48\cdot5 \cdot 10^{-6}, \text{ the differ-}$$

ence being $2\cdot8\times10^{-6}$ lines maximum, being nearly 2·8 per cent. of the flux per pole. If we now consider any closed loop in position, say, OP to represent the circuit consisting of shaft, pedestals and bedplate, it appears that the stator core flux is always greater than the corresponding reverse yoke flux, so that as the poles rotate there is a reversing flux through this loop, whose maximum value is $2\cdot8\times10^{-6}$ lines. The E.M.F. induced in this circuit is readily calculated, assuming a sine wave of flux and E.M.F., thus: Let the flux wave be $\varphi = \varphi_0 \sin 2\pi\nu t$, the E.M.F. e at time t is $e = -\frac{d\varphi}{dt} 10^{-8} = 2\pi\nu\varphi_0 \cos 2\pi\nu t$, with maximum value $E_0 = 2\pi\nu\varphi_0 10^{-8}$ [illegible] $\cos 2\pi\nu t = 1$. Effective E.M.F. being $E_0 \div \sqrt{2}$ is thus $E = 4\cdot44\nu\varphi_0 10^{-8}$ volts. In above example we get $E = 4\cdot44\times50\times2\cdot8\times10^{-2} = 6\cdot22$ volts. If the joints are equal to 0·2 mm. gap, E becomes 11·5 volts.

(*f*) *Joints in Rotor Yoke.*—This case, which does not readily occur with turbo-alternators, produces a result similar to (*e*), there being no joints in stator, but two opposite yoke sections have reluctance r, those with joint Kr, the formulæ become $C_1 = C_2 = C_3 = C_4$, each $2E = \left(4S + R + \frac{2Kr}{1+K}\right)$. The effect in this case also is to produce an alternating current through shaft, &c.

In the example chosen, case (*e*), the simplest form is assumed in which the two joints have equal reluctance, but in practice this will not always be so, one joint making better contact than the other. The analytical investigation for such an example is rather tedious, but taking resistance in the C_4 quadrant as KR as before, but that in the C_2 quadrant as K_1R similar expressions to the above are obtained. It will be found, however, that the yoke flux is not now equal in all sections, nor is $C_1 - c_1 = c_2 - C_2$, &c., which means that a loop OP in the C_1 quadrant will register a different voltage when P is in the C_2 position.

The diagrams given by Prof. Dobson in the "General Electric Review," appear to be erroneous in three respects: (1) In showing two fluxes crossing each other, which since there can be but one magnetic force direction is impossible. (2) With joints, the yoke flux in any quadrant is shown equal to the corresponding core flux; if this were correct no E.M.F. could be obtained in any external circuit. (3) Another diagram shows the yoke fluxes unequal in different quadrants, while my investigation shows that such fluxes are all equal.

It is usual to prevent the current circulating through the shaft, bearings and bedplate by completely insulating one pedestal with its water and oil connections from bedplate; but the current could be reduced to a harmless amount by interposing a counter E.M.F. in the following manner: Round the shaft thread a circular laminated core wound with a fine wire coil, to the terminals of the latter apply an E.M.F. equal in magnitude, but opposite in phase relation to that observed when the coil is an open circuit, plus an allowance for magnetic leakage; the two E.M.F.s balancing, there can be no resulting current.

In practice, the phase of induced E.M.F. relative to that of the armature winding depends on the position of the stator joint, but one working phase will be found which, with a small additional inductance inserted to give the necessary lag [illegible] perfect opposition.

In one turbo-alternator (capacity 12,000 K.V.A., six poles, with stator in three segments) the author has observed 11 volts from pedestal to bedplate, the former being [illegible] current of 300 amperes, when the pedestal oil [illegible]

It is obvious that if the [illegible] equal to the number of field poles, then, provided the [illegible] had all the same reluctance, no shaft E.M.F. would occur, although there would be eddy currents in the magnet poles, due to the fluctuating field. In practice it would be nearly impossible to ensure all joints having equal reluctance, so that it would not be worth incurring the extra expense involved in having the extra number of joints.

In machines of such capacity that the stator cannot readily be constructed as a continuous ring, the manufacturers ought to arrange for complete insulation of bearing, an opposing E.M.F. coil, or impedance coil round the shaft.

METHODS OF MEASURING THE STRENGTH OF WIRELESS SIGNALS.*

BY E. W. MARCHANT.

Introduction.—The importance of accurate measurement of signal strength is generally recognised at the present time, as it is only by systematic measurements and careful observation of the corresponding atmospheric conditions that knowledge can be gained of the factors affecting the variations which are known to occur in the strength of signal.

Duddell and Taylor were some of the first to attempt accurate measurements of wireless signals. In their experiments, made over 10 years ago, the current used for transmitting from a small antenna was measured on a hot wire ammeter and the current received by a sensitive Duddell thermoammeter. Working over short range they established the relation (the form of which is now generally accepted)

$$I_R = \frac{KI_s h_s}{(56\cdot\ldots)}.$$

K being a constant, I_s the sending current in the antenna, h_s the height of the sending antenna, I_r the current received and r the resistance in the receiving antenna circuit.

The constant K depends on the height of the receiving antenna. It has been shown by Zenneck (the calculation being elaborated by Austin) that the electrostatic field at a distance, D, from a linear oscillator is given by

$$R = \frac{2\pi \ldots}{\lambda D \ldots 10^{-9}}$$

where l_0 is the length of the linear oscillator, I_0 the current in the oscillator, and λ the wave-length. It follows that the received current will depend on the length of the receiving oscillator l_r and on the resistance of the receiving circuit R. Thus, for two linear oscillators,

$$I_R = \frac{I_0 l_0 l_r}{\lambda D R \ldots 10^{-9}}$$

When the antenna is earthed, the aerial can be regarded as having half the length of the corresponding linear oscillator, and that only half the length of the oscillator is effective in emitting energy. Since the energy varies as l^2, the effective length of the oscillator is $\sqrt{2}l$. Thus [illegible] and the equation for the received current takes the same form with h_0 and h_r substituted for l_0 and l_r. This formula cannot be accepted without modification, but the calculation gives a probable form for the equation of received current.

Howe has calculated the received current on the assumption that the transmission is between two conducting surfaces, one formed by the earth and the other by the conducting layer of ionised air that exists at high altitudes.

The equation for the received current has been verified experimentally by Austin, between a shore station and a ship, and he has modified the original form by introducing a term representing absorption by the atmosphere. He has given the formula

$$I_R = \frac{1\cdot2\ldots}{\lambda D \ldots}$$

where currents are in amperes, and distances and lengths in kilometres, [illegible] a constant which [illegible] Howe's or another formula of the same form (but using different units), which is based on observations made between the Arlington station and the S. S. Salem, gives

$$I = \frac{\ldots}{\ldots}$$

In the formulæ [illegible] D is in kilometres and λ is in metres. These attempts to [illegible] of absorption are only approximate, and of value in giving us an idea of the order of magnitude of the current that may be expected to be received. It is well known that signal strength

* Paper read before the Wireless Society of London.

undergoes rapid and large variations, which indicate that absorption (if, to avoid circumlocution, one calls the effect that is produced by that term) is something that varies very largely, and it is these variations which, it is hoped, may be examined and discussed further.

As examples of the kind of variations that have been observed, I have some diagrams, obtained with the measuring appliances we have in Liverpool, which exhibit large and sudden changes in signal strength. The most marked difference is that between day and night. This difference varies with the time of year, and also from day to day; generally speaking the difference is smaller in summer than in winter, and it differs in all probability with latitude. In any given month the sunset effect varies with the weather conditions, and a study of the variations occurring during a complete 24 hours is likely to throw much light on the extent and cause of these changes.

One of the most remarkable phenomena that have recently been emphasised is the difference between the Pacific and the Atlantic as areas for wireless transmission, the Pacific area being apparently much more favourable than the Atlantic area. This result, if it is to be examined scientifically, will necessitate absolute measurement of signal strength as well as comparative measurement at isolated stations.

Receiving Aerial and Earth.—Before attempting accurate measurements it is necessary that the conditions at the receiving station should be as constant as possible. To obtain the best results the aerial should be of standard form, and as free as possible from surrounding obstacles, such as trees and houses. This is not necessary except when absolute measurements are to be made. The second factor which is important, whatever kind of measurement is to be attempted, is the resistance between the aerial and earth. In order to get good results it is essential that the earth resistance should be as constant as possible. The ordinary form of earth recommended in connection with lightning conductors or in power station work is a plate of copper buried in a damp place and surrounded with coke. This forms an excellent earth for wireless work also. In our measurements we have used a water-pipe system as our earth, connecting it to a fairly large capacity area; this has been found quite satisfactory. Recently we have excavated a trench about 25 yds. long close to the laboratory, and are laying copper strip in this, connected to a plate of copper about 6 sq. ft. in area. The important point is that the strip should extend over as large an area of ground as possible. Another earth with which we are experimenting is formed by driving twelve 2 in. pointed cast-iron pipes into the ground. One rather surprising fact we have noticed in connection with the excavations, is that the amount of moisture in the sandstone, completely covered by buildings and paving, is very large. In sand taken from a concreted yard, which has not been opened for 10 years and which was surrounded on all sides by buildings, the sand was found to contain over 10 per cent. of moisture. This leads one to expect that the earth resistance, even in this soil, which might have been expected to be fairly non-conducting, will actually turn out to be quite small and constant. For a given aerial and tuning arrangement it is evident that, with a given amplitude of wave, the received antenna current will, on a tuned antenna, depend solely on the resistance of the aerial system, including the resistance to earth; if this is constant, then the aerial may be regarded as one which will enable energy measurements to be made with considerable prospect of accuracy.

Direct v. Indirect Measurement.—The most obvious way of measuring the received signal is by using an instrument which will read the actual antenna current or the voltage on the receiving antenna circuit. This method was used by Duddell and Taylor, and Howe has recently employed a sensitive thermo-ammeter for measuring the current received in London from Brussels, Paris and elsewhere. The difficulty in this method of measurement is the sensibility of the instrument. The power available for operating the instrument at Liverpool, for example, with the signals from Paris amounts to less than 1 microwatt, and these are very powerful signals. Many of those which it has been possible to record by using a rectified current have given no more power than 250 micro-microwatts, and records could be taken with even smaller powers. A continuous-current instrument, where a local magnetic field can be used, such as is employed in the Einthoven galvanometer, can operate with one micro-microwatt; but this sensibility is out of the question for an alter-

been accomplished by Wulf, but in his experiments he has used a heterostatic type with a powerful auxiliary field in conjunction with a detector. Another type of receiver which might be used direct in the aerial is the hot-wire barretter, but this detector is so fragile and easily burnt out that it would not stand much chance of success.

One of the greatest difficulties in making accurate measurement is the elimination of "atmospherics." During the summer these are very frequent, even in the latitude of Liverpool. It is impossible to get rid of them altogether. Where a condenser is used in series with the aerial, as is done in many cases (and the arrangement is one which gives excellent tuning), it is desirable to have an inductive leak from the aerial to earth. This plan is adopted in the standard Marconi receiving station, and there is no novelty about it, but it saves trouble. We found a choking coil with an iron core, with comparatively small resistance (10 ohms.) quite satisfactory, and its connection or disconnection produced no appreciable effect on the strength of the signal which was being measured. The special double-valve arrangement now used by the Marconi Company to prevent interference was not tried, as the Fleming valve was not found suitable for accurate work in measurement. A weak coupling assists in eliminating atmospherics, and with 2,000 metres tuning we did not find them troublesome under any but the most unfavourable circumstances. The arrangement recently described by Austin seems to be a useful contrivance. This consists of an arsenic silicon crystal combination shunted across the receiving inductance; the resistance of this falls rapidly with increasing current, and heavy atmospheric discharges are thus diverted direct to earth.

Measurement by Coupled Secondary Circuit.—For many reasons, a coupled secondary circuit for receiving the signal is greatly to be preferred to direct measurement. There is, of course, a certain loss in power by the use of this arrangement; but the advantage to be gained in greater selectivity far outweighs any small loss in efficiency which is entailed. The antenna current flowing in the aerial can be estimated from the constants of the circuit in a manner which I explained in my I.E.E. Paper. This estimation necessitates the employment of an auxiliary circuit, which gives out a series of waves of the same wave-length as those which are being measured, produced by a current flowing in a local circuit, the value of which can be measured by a thermo ammeter. Provided the mutual inductions between the coils of the local circuit and the secondary circuit of the receiving system can be measured accurately, the measurement of the antenna current can be made as easily as if it is measured in the antenna. As stated above, the greater selectivity obtained by using two circuits, both of which are tuned, instead of using a tuned aerial circuit, is very advantageous, and enables signals to be read which differ comparatively little in wave-length from others that may be produced locally, even when the local stations are powerful. The coupling we have used between aerial and antenna is less than 4 per cent. and it was found necessary to weaken the coupling to this extent in order to avoid interference. With a tuned aerial and thermo-ammeter, work would have been impossible.

A very simple method of calibrating the secondary circuit has been adopted by Prof. Fleming. He induces in the primary coil of the antenna, after it is disconnected from the aerial, a current from a local circuit which is varied until it produces the same effect in the secondary circuit as the received signal; in this method the antenna current is replaced by a current produced locally, which can be measured indirectly by a thermoammeter. The measurement is simple, and involves no estimation from the constants of the circuit apart from that involved in the determination of the variable coupling of the auxiliary circuit.

Types of Detector.—It is difficult to decide on the type of detector which is most suitable for purposes of measurement. A considerable number of experiments were made in 1913, when the measurement of the Paris signals was first undertaken in Liverpool to determine which was the best for the purpose. We decided on a rectifying type used in connection with a sensitive galvanometer. The detector which we finally adopted was the Perikon, a combination of zincite and chalcopyrites, which gives great sensitiveness, and which, under favourable condition, is reliable. The drawback to this detector is that it follows a square law, and that it, therefore, becomes very insensitive for very weak signals. This point was tested with a number of different crystal pairs, but the result was always found to be the same. As I pointed out recently, this seems to show that the action of these crystals is thermoelectric rather than rectifying. For larger currents however, the rectification effect comes in and the rectified current in the local circuit becomes approximately proportional to the current in the local circuit rather than to the (current)^2. Another crystal pair, which has been much recommended and which was tried, was the zincite bornite (or erubisite) combination. A number of tests was made with this and the characteristic curve of the combination obtained. Some of these curves are shown in Fig. 1,

and it will be seen that the current (in the detector circuit) is proportional to the square of the current in the ... A number of investigators have used the Galena detector, notably Take and Vos, Abraham and others. Abraham has made a series of measurements on the Galena detector, and has shown that it also obeys the square law, although it has often been stated to ... type. ...

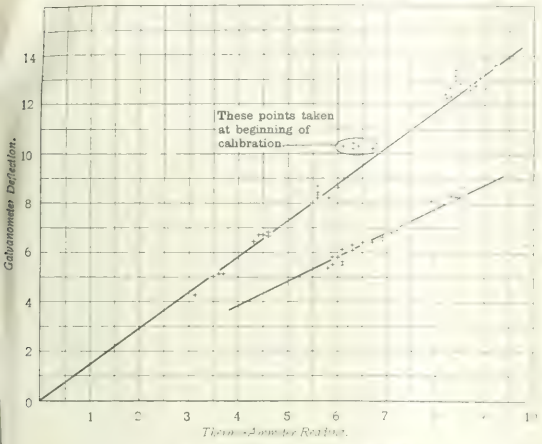


FIG. 1.—PERIKON CRYSTAL CHARACTERISTIC.

would seem that the majority of crystal detectors obey the square law quite closely for the small currents which pass through them when they are being used as wireless detectors.

One detector of great sensitiveness is the Fleming valve, in which the unidirectional conductivity between the filament of an incandescent lamp and, a metal plate arranged close to it, in an exhausted

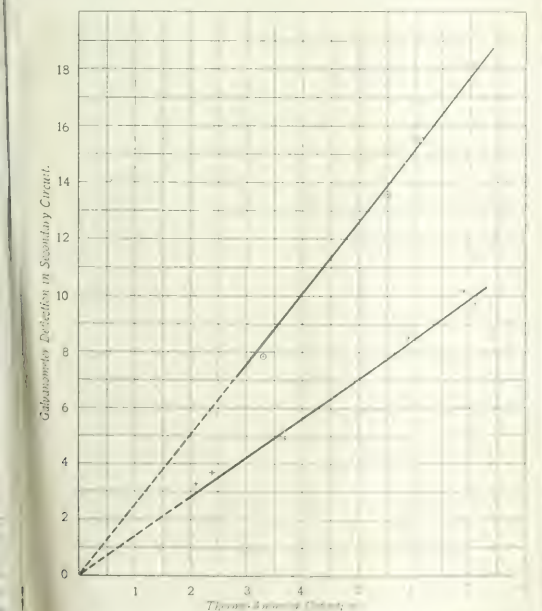


FIG. 2.—CHARACTERISTIC CURVE OF ZENITH DETECTOR. THERMO-AMMETER DEFLECTION ...

bulb, is employed to rectify the high frequency ... the oscillating circuit of a receiver. A number of ... made with this form of detector, ... it was ... prove more reliable than the crystal, and ... of not requiring resetting after a violent atmospheric ...

... type. Fig. 2 ... through such a valve when a variable P.D. is applied to it, first in one direction and then in the other. The current was never increased to the saturation point, as the object of the experiment was to determine what voltage would operate the valve without an auxiliary battery, and also what constancy of current could be expected under

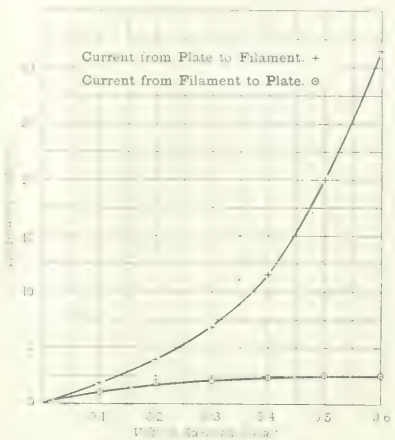


FIG. 3.—CURVE SHOWING RELATION BETWEEN CURRENT THROUGH LOCAL CIRCUIT OF FLEMING VALVE WITH VARYING VOLTS (BELOW SATURATION CURRENT). RESISTANCE IN LOCAL CIRCUIT 10,000 OHMS, VOLTS ON FILAMENT=12.

those conditions. The form of valve used in these experiments was a carbon lamp with V shaped filament arranged in a bulb with a nickel plate parallel to its plane. The filament was worked at a temperature corresponding with an efficiency of 1 c.p. for 3 watts, and, in passing, one may notice the well-known fact that the rectifying action is enormously greater as the temperature of the filament is raised. It is well known that tantalum gives better results than carbon, and it may be expected that tungsten would do even better, as it seems that the operation of the detector depends more on the gas inside the bulb and on the velocity with which the ions carrying the current are shot off than on the material of the filament. It will be noticed that in this valve a P.D. of almost 1 volt was required to bring the valve current to a value at which the current will change considerably for a comparatively small change in the P.D. applied to produce it.

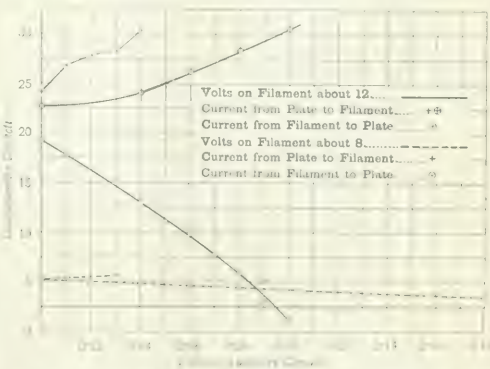


FIG. 4.—... RELATION BETWEEN CURRENT IN LOCAL CIRCUIT OF FLEMING VALVE WITH A P.D. ... OF ABOUT ONE VOLT IN LOCAL CIRCUIT (RESISTANCE 10,000 OHMS) AND P.D. ... FILAMENT ... VOLTS.

A ... bulb ... filament ... from the filament, in order to attempt to ... the valve effect ... bulb ... shown in Fig. 3. It will be seen that the current required to produce a rectified current

is much less, and the shape of the curve of current quite different from that in the other case. With the resistance used in the local circuit, however, the current due to the valve itself became much larger in comparison with the current due to the auxiliary battery, and with a positive current a P.D. of nearly 0·1 volt was required to neutralise the local E.M.F. Further, it was found that the current produced by the valve itself was very variable. Two curves obtained from the same valve within half-an-hour are shown in the figure. It was decided, therefore, not to attempt to use this valve for purposes of measurement.

(*To be concluded.*)

THE FUTURE PROGRESS OF CABLE TELEGRAPHY.*

BY H. W. MALCOLM, D.SC.

(*Concluded from page* 200.)

Summary.—An analytical study is made of the problem of increasing the speed of the submarine telegraph cable, and of rendering it, if possible, distortionless. The problem is attacked from first principles in order that clear ideas may be obtained. The discussion comes under three heads: (*a*) Distortion and how it is produced; (*b*) Present-day methods of reducing distortion; and (*c*) The loaded submarine telegraph cable. Tables and diagrams are given throughout so as to render the results readily available to those who have not the time to follow the processes by which they are obtained.

Cable with Less Loading.

It is interesting to examine the effect of a reduction in the amount of loading on Curve A of Fig. 50. From Fig. 44 it is clear that the height of the head of the signal is much dependent on the inductance, and a substantial reduction in the inductance may cause the sharp peak to vanish altogether. Keeping the condensers of the same size as before, let $L/R = KR^2/200$, and therefore L=47·6 m.h. Then $t/\sqrt{LK} = 0{\cdot}308$ second, and the height of the signal head is 4·826 mm.a. per volt.

The first and second terms of the series (32) are now hyperbolic, as is seen from Table XXXIX. They are contained in Table XL., from which curve A, Fig. 52, is plotted. The circular terms have been calculated for the instant $t=0{\cdot}4$, and also for $t=0{\cdot}5$, by which time they almost cease to count, owing to the rapid decay in $e^{-Rt/2L}$ due to the smaller value of L. Curve B is the same as Curve B of Fig. 48. The sharp peak is now gone and the curves closely resemble each other except that the front of Curve A is steep at 0·3 second, and resembles curve A of Fig. 17 for a single condenser with twice the loading. If the cables were replaced by meshes the discontinuities in the curvature of both these curves would disappear, and although steep they would not be absolutely perpendicular, but would be smoothed off as in curve A of Fig. 45.

To restore the sharpness to the head of curve A, Fig. 52, all that is necessary is to reduce the size of the condensers. The arrival current curve for the plain cable with condensers $K_s = K_r = Kl/20$, or half those of Fig. 52, is given in Fig. 18, curve B.* The general course of the loaded cable curve may easily be drawn from it without calculation by combining with it the steep front of curve A, Fig. 52.

When t is only slightly greater than $l\sqrt{LK}$, the series (32) is only very slowly convergent. A more rapidly convergent series may be obtained by integrating it with respect to t. The quantity of electricity still lacking in the condenser at time t after the steady E.M.F. has been applied at the sending end is

$$Q_t = \int_t^\infty C_t dt = 2EKl\,e^{-\frac{R}{2L}t}\,\frac{\sinh\frac{Rt}{2L}\sqrt{1-\frac{4x^2L}{R\,.\,KR^2}} - \sqrt{1-\frac{4x^2L}{R\,.\,KR^2}}\cosh\frac{Rt}{2L}\sqrt{1-\frac{4x^2L}{R\,.\,KR^2}}}{x^2\sqrt{1-\frac{4x^2L}{R\,.\,KR^2}}\left[\frac{2\sin x}{x} - \frac{1}{K_s}\frac{Kl}{K_r}\frac{Kl}{K_s}\frac{1}{x}\sin x - \frac{\cos x}{x}\right]} \quad (38)$$

which contains the rapidly-increasing factor x^2 in the denominator. For all values of t which are not close to the

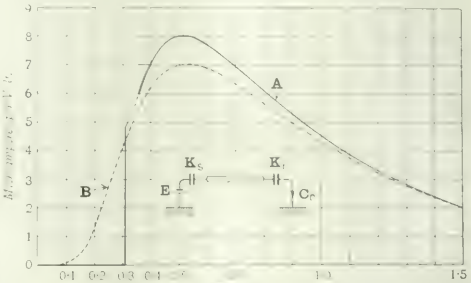


Fig. 52.—Cable with Small Loading.

Curve A, $K_s = K_r = \frac{Kl}{20}$, $L = \frac{KR^2}{200}$.

Curve B, $K_s = K_r = \frac{K}{L}$.

critical it is sufficient to consider only the first two or hyperbolic terms of the series. Thus, when $t=0{\cdot}4$ second, Q_t calculated from (38) is 6·765 microcoulombs per volt. Now the total charge in the receiving condenser at infinite time is $Q_\infty = \frac{Kl}{10}E$, or 7·289 microcoulombs per volt. Hence the charge accumulating between time $t = l\sqrt{LK}$ and $t = 0{\cdot}4$ second is the difference of these two, or 0·524 micro-coulomb per volt. Dividing this quantity by the time, 0·4 − 0·308 second, the mean current is found to be 5·67 mm.a. per volt at $t=0{\cdot}35$ second, which affords a confirmation of the portion of curve A shown broken because uncertain.

Table XXXIX.—R/2L = 22·98.

x.	$\frac{4x^2L}{KR^2}$. R	$\frac{R}{2L}\sqrt{1-\frac{4x^2L}{KR^2}}$	$\frac{4}{R/\sqrt{\quad}}$
2·6272	0·13804	21·338	47·084
5·307	0·56328	15·187	−231·14
8·067	1·30153	12·620	+515·00
10·909	2·38056	27·000	−340·57
13·819	3·81924	38·584	+294·06
16·782	5·6324	49·461	−261·89
19·786	7·8292	60·057	235·35
22·817	10·413	70·500	−212·95

Table XL.—*Fig. 52, Curve A.*

t (secs.)	0·3	0·4	0·5	0·7	1·0	1·5
$e^{-\frac{Rt}{2L}}$	0·001015	0·000102	0·000010	...	...	...
$\frac{Rt}{2L}\sqrt{\quad}$	0·4926	0·6570	0·8210	1·1494	1·6420	2·4631
$\cosh\frac{Rt}{2L}\sqrt{\quad}$	14·386	12·208	10·358	7·459	4·558	2·005
$\sinh\frac{Rt}{2L}\sqrt{\quad}$	7·338	5·417	3·897	5·456	7·794	11·691
$\frac{\sinh}{\quad}\sqrt{\quad}$	0·510	0·443	0·376	0·493	0·047	...
Q_t and Q_t (secs.) (mm.a. per v.)	0·005	0·005	0·517	0·966	1·511	2·006

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* "Theory," The Electrician, May 31, p. 317, 1912.

nearly 4 to 1. In other words, if the rate of signalling in the one case were 50 words a minute, in the other case the speed could be increased to 200 words a minute without sacrifice of legibility. The sharp dip in curve A could easily be removed by a curbing current of half the height or half the duration, put on at 0·08 second later. Moreover, the excess of height in curve A over curve B could be converted into increased sharpness of response, as illustrated fully in Part II., thus tending to a further increase in speed of transmission.

Principles Underlying the Design of a Loaded Cable.

As the conditions which determine the speed of a telegraph cable when loaded differ entirely from those that have hitherto prevailed, it may be well to outline here the process of thought which may be followed by the telegraph engineer when he is called upon to design a loaded cable. Instead of the "KR" law we have the formula

$$C_r = 2E\sqrt{\frac{K}{L}}\,e^{-\frac{Rl}{2}\sqrt{\frac{K}{L}}}$$

for the height of the signal head, which requires correction as explained for the presence of any apparatus with resistance or

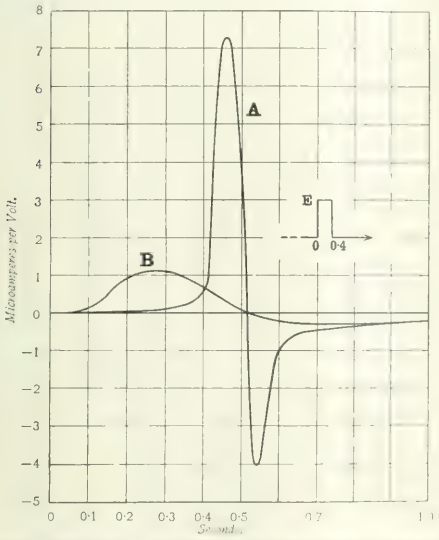


Fig. 53.—Elementary Dot Signal. Time of Contact 0·01 Second.
Curve A. —20 loaded meshes with condensers; K_1 K_2 KLL . LF $\frac{KR^2}{12}$
Curve B. —20 plain meshes with condensers: K K_1 K_2 [illegible]

impedance. The length of the cable and the speed at which it is to be worked are fixed by economic considerations. Now, instrumental limitations fix a certain minimum of current which the best available receiving apparatus requires if it is to work satisfactorily over long periods at the given speed. To make it more sensitive would lessen its reliability, and tests on the apparatus itself will determine this limiting current. Hence C_r is known; also E is fixed from considerations of safety of the dielectric. There remain only R, K and L. Of these three K can vary only within narrow limits, say from 0·3 to 0·4 mfd. per n.m. There are left, therefore, only R and L at disposal. The factor $\sqrt{K/L}$ in C_r is of small importance compared with the exponential $e^{-\frac{Rl}{2}\sqrt{\frac{K}{L}}}$; hence, for C_r to be great it is necessary to make $Rl\sqrt{\frac{K}{L}}$ as small as possible; or $\sqrt{\frac{KR^2}{LF}}$ [illegible] as possible—*i.e.*, the ratio of the conductor time-constant L/R as great as possible in comparison with the capacity time-constant KR^2.

Since $\frac{Rl}{2}\sqrt{\frac{K}{L}}$ is directly proportional to l and inversely proportional only to the square-root of L, it follows that a change in R makes itself felt in much greater proportion than one in L. But the magnitude of R fixes the weight of copper, and therefore of dielectric, and with these the cost of the cable is fixed. A trial value for R may be assumed, and the mechanically best available coils with the lowest time-constant may be supposed placed in the cable at suitable distances. Substituting these values in the formula, C_r is determined. If not satisfactory the assumptions must be readjusted. Alternatively, if continuous loading is adopted, one, two or three layers of iron wire may be placed round the wire; the increase in L which they produce is known from experiments on short sample lengths, and also the alteration to K. If these do not give a satisfactory value of C_r they must suffer readjustment—if necessary, R must be increased. Finally, the arrival curve must be calculated, and corrected for the spacing if coil loading is used. By means of the arrival curve typical signals may be constructed at the required speed, and a comparison of these with similarly calculated signals and with those actually obtained in practice will enable the designer to state with confidence whether his plan will meet the specification or not.

Conclusion.

From the foregoing discussion of the question of improved transmission it is evident that much may be expected from the present type of cable by advance along the lines which are indicated by theory for the improved formation of the signals at the sending end, and for their better detection at the receiving end. The principle of all these methods has been shown to consist in the sacrifice of the magnitude of the signal for the purpose of obtaining improvement in its shape. The natural corollary, and the complement to this process, is the restoration of size by reduction of attenuation, a result which is only to be attained by loading. In contradiction to the generally accepted opinion, it has been shown that the increase in inductance which can be attained in practice is far from being ineffective in the telegraph cable. But in order that the full significance of loading may be brought out the signalling conditions must be re-arranged. Hitherto signals have been formed exclusively by the extended "tail" of the arriving wave, the "head" being infinitesimal. By the use of loading the steep head may be given sufficient height to actuate the receiver, and the tail may be reduced to a convenient size by adjustment of the signalling apparatus. It is not merely a question of improved speed, but rather of a fundamental change in the method of transmission—a change which will bring submarine telegraphy into line with telegraphy on land and render available all the systems of signalling which are employed on land. It follows, as a first step, that if the design of a new cable is to make any pretence to scientific exactitude it is essential that all the cable constants should be specified and measured, for on the attenuation constant and not on the "K.R." of the cable will the speed of working—and, therefore, the value of the cable—increasingly depend. At least as great an advance may be hoped for as in telephony, where such an altogether disproportionate increase in efficiency has been attained without increase of cost, that it is now inconceivable for a new cable of any importance to be laid without loading of some kind.

It is probable that the loading of the first telegraph cable will be carried out on the continuous plan. In order to obtain from it the full speed of which it is capable it may be necessary at first to work the cable simplex. This objection would disappear if the cable were multiplexed, for then the allocation of the circuits could be arranged at will. Thus, it might be found convenient to work a type-printing multiplex system during the day, and high-speed automatic at night. Into the methods of multiplexing long cables it would be inadvisable to enter at this stage, but it may be predicted, in passing, that all will be found to depend for the degree of their success on the amount of inductance present in the cable.

Sooner or later the problem of coil loading must be faced. The difficulties of placing coils of fine wire [illegible] sheathing of a cable, and of maintaining their

insulation, are great, but within recent years they have all been overcome in telephony. The objection may still be raised that the problem of loading the telegraph cable is more difficult on account of the greater depth at which it must be laid. But it is probable that telephone coils could withstand the pressure unscathed, and if misgivings were felt on that score they could be specially constructed accordingly. Moreover, it may be pointed out that the telegraphic problem is more simple electrically and mechanically, because the coils need be (*a*) fewer in number and at greater distances apart, and (*b*) of a lower degree of electrical perfection, and, therefore, of greater robustness, since there is no requirement of balance, which must be accurately maintained, as there is in the twin cores of a telephone cable. Once laid there is no reason to apprehend more trouble at great depths than at present where the majority of faults occur in shallow water.

There is no difficulty, mechanical or electrical, in the way of laying a continuously-loaded cable. From both these standpoints the problem may be regarded as solved. At the same time it would be optimistic indeed to assume that telegraphic loading will soon become an accomplished fact. The student of cable history will recall the number of years that elapsed between the discovery by Oliver Heaviside* of the part played by inductance and its experimental verification abroad in the case of telephony and final acceptance here. But cable telegraphy is in a different category; there is much prestige to lose; its connections are international, and if events were allowed to follow the same course in cable telegraphy a blow would be struck at the supremacy which this country has long enjoyed.

There is another reason why the introduction of loading if long-deferred is in danger of coming too late. Interest in the problem has been quickened by the advance of radiotelegraphy. At present wireless acts as a feeder to cable telegraphy, but there is no reason why it should continue to do so indefinitely, and it is the manifest determination of its supporters that this state of affairs shall not continue. Unless its development should meet an unexpected check the indications point to the probability that it will ere long be fulfilling the functions of an economical high-speed transmitter of intelligence over long distances. The advantage of holding the field is on the side of cable telegraphy, and against wireless, which has to prove itself not only a success, but also preferable to the older method of communication. But no industry, however firmly established, can afford to wait until it begins to feel the stress of active competition. If this great advantage were lost by cable telegraphy the consequences could hardly fail to be serious, for it is probable that had wireless been in existence half a century ago long-distance cable telegraphy would never have come into being at all.

It is customary in discussing the relative merits of the two methods of communication unconsciously to compare cable telegraphy as it now is with radiotelegraphy as it will be when it has attained maturity. In so doing it is tacitly assumed that cable telegraphy, with its many years of greater experience, is already in close approximation to its final shape. Nevertheless, it must not be forgotten that the resources of modern electrical research were not available in the early pioneering days, when telegraphic practice was being established, and that progress was consequently slow. On the other hand, the growth of radiotelegraphy has coincided with, and has reacted upon, the development of these methods of investigation and forms of apparatus.

In proportion as radiotelegraphy has gained in the universality of its appeal, cable telegraphy has suffered in the difficulty which it presents to the experimenter. The novelty and fascination of the problems of wireless have enabled it to draw upon the best ability of every country; and to the zeal with which the discoveries of the physicist have been assimilated and applied its rapid advance is in great measure due. On the other hand, the difficulties in the way of research in cable telegraphy to other than those actually engaged in the pro-

* [illegible] "Electromagnetic Theory," Vol. I., p. 445.

cable telegraphy, while prolific in invention, has been relatively barren in discovery.

The possibilities in the future of wireless telegraphy are great and unquestioned in the field of communication between moving objects. For strategic reasons it may be of dominant importance; although such an occasion for its use fortunately arises but seldom, and the greatness of a modern nation is founded on its commercial prosperity built up in time of peace.* In high-speed transmission between fixed points the advantage of a metallic conductor, in guiding and localising the transmitted energy, cannot be overestimated. *once the obstacles of distortion and attenuation have been removed.*

The possibilities in the future of cable telegraphy are as brilliant in its own sphere as are those of wireless telegraphy. Although the difficulties in the way of their realisation must not be underestimated, none appear to be insuperable. Their speedy translation into fact is a task worthy of the greatest efforts of the engineers to whom it is entrusted. But much depends on the manner in which they are supported. Given the spirit of indomitable perseverance, the commercial large-mindedness and the scientific intelligence which alone made Atlantic telegraphy possible, there can be little question that cable telegraphy is about to enter upon a period in which all its past achievements will be excelled.

ANNUAL REPORT OF THE COUNCIL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

We give below extracts from the report of the Council of the Institution of Electrical Engineers, which was presented at the annual general meeting held last night. An account of the proceedings at that meeting, together with the result of the election for the new Council, will be given in our next issue.

Membership of the Institution.—At May 1, 1915, the total membership of the Institution was 6,811, compared with 7,045 on the same date in 1913. The total was made up of 8 honorary members, 1,328 members, 3,480 associate members, 568 associates, 357 graduates and 870 students. The corresponding numbers last year were 8, 1,548, 3,350, 646, 315 and 1,003. In addition, 60 candidates for associate membership have been approved by the Council for admission on condition that they pass the Institution examination or otherwise satisfy the examination regulations.

Roll of Honour.—Seven members were [illegible] to have lost their lives in the service of their country, and their names, together with their military ranks and the names of their corps, are set out in the following list:—

Died on Active Service.

Name.	Corps, &c.	Rank.
Josiah Alfred Donald.....	Divisional Engineers, R.N.D.	Sapper.
Henry Labour.....	French Army.....	...
Henry Herbert Stanley Marsh	2nd London Divisional R.E.	Major.
John Leeson Moffet.....	3rd Royal Scots Fusiliers...	2nd-Lieut.
William Walter Pullen....	Divisional Engineers, R.N.D.	Sapper.
Guy Lutley Sclater.....	H.M.S. Badger.....	Captain R.N.
Eric Western Wilson.....	West Yorkshire Regt.....	2nd-Lieut.

Premiums.—The following premiums for Papers have been awarded by the Council. In accordance with precedent, in deciding upon these awards the Council have not taken into account Papers contributed wholly or in part by Members of Council. The *Latimer Premium*, value £25, to Mr. C. J. Beavan, for his Paper, entitled "The *Ayrton Premium*, value £10, to Mr. J. H. Rider, for his Paper, "The Power Supply of the Central Mining-Rand Mines Group." The *Fahie Premium*, value £10, to Mr. H. G. Brown, for his Paper, "The Signalling of a Rapid-Transit Railway." The *John Hopkinson Premium*, value £10, to Mr. E. B. Wedmore, for his Paper, "Automatic Protective Switchgear for Alternating-current Systems." The *Kelvin Premium*, value £10, to Dr. S. P. Smith and Mr. R. S. H. Boulding, for their Paper, "The Shape of the Pressure Wave in Electrical Machinery." The *Paris Premium*, value £10, to Mr. C. P. Sparks, for his Paper, "Electricity Applied to Mining." An *Extra Premium*, value £10, to Mr. W. M. Selvey, for his Paper, "Power Plant Testing." An *Extra Premium*, value £5, to Mr. N. Shuttleworth, for his Paper, "Polyphase Commutator Motors and their Application." A *Students' Premium*, value £10, to Mr. H. Hobson, for his Paper, "The Utilisation of Waste Heat for the Generation of Electrical Energy." A *Students' Premium*, value £5, to Mr. A. Aspinall, for his Paper, "Modern Power House Condensing Plant." A *Students' Premium*, value £5, to

* Written before the War.

Mr. H. S. Marquand, on his Paper, "Some Notes on Modern Methods of Electric Welding and Their Application." The Council have awarded three Scholarships of £50 each, one to Mr. Leonard M. Barlow, of the City and Guilds of London Technical College, Finsbury, and one to Mr. Claude [illegible] of the City and Guilds of London (Engineering) College; and one David Hughes Scholarship of the value of £50 to Mr. Percy Davis [illegible] of King's College, London.

Wiring Rules.—A revision of the Wiring Rules is in progress, in connection with which 18 meetings of the Wiring Rules Committee have up to the present been held.

Model General Conditions for Contracts.—Of the revised Model Conditions approved by the Council and published on May 1, 1914, over 2,500 copies have already been disposed of. There is evidence that these conditions are being largely adopted by consulting engineers and others.

Research.—The Research Committee have made further progress with the work in hand in connection with (*a*) Magnet Steels, (*b*) the Heating of Buried Cables, and the (*c*) Properties of Insulating Oils. An investigation into the Maximum Current Densities which can safely be allowed on conductors of various cross-sectional areas is also under the consideration of the Committee. During the past year two Interim Reports ("Journal," Vol. LII., p. 779, and Vol. LIII., p. 328) on the Heating of Buried Cables, and one Interim Report ("Journal," Vol. LIII., p. 146) on the Properties of Insulating Oils have been published.

Sectional Committees.—There are at present five Sectional Committees which were appointed by the Council last year, namely: (1) Lighting and Power; (2) Electric Traction (including Railways, Tramways and other Means of Transport); (3) Telegraphs and Telephones (including Radio-Telegraphy and Railway Signalling); (4) Electro-Chemistry and Electro-Metallurgy; (5) Electricity in Mines. These Committees have held a number of meetings and have been engaged in obtaining Papers on subjects connected with the branches of Electrical Engineering which they represent.

National Service.—A few days after the outbreak of the war a special meeting of the Council was held at which it was agreed as follows: (*a*) That the Institution take action to assist the authorities. (*b*) To offer to the War Office free of charge and for immediate occupation, the available space in the Institution building. (*c*) To place the organisation of the Institution at the disposal of the Admiralty and of the War Office to select from its members available men trained in electrical engineering for any purpose the Admiralty or the War Office may indicate. (*d*) To take steps to assist in filling the vacancies occurring in the public services, electric power stations, tramways, &c. (*e*) To appoint a National Service Committee to deal with the above matters and with authority to take such further steps as they may deem advisable to utilise the organisation of the Institution in connection with the war or any emergencies that may arise therefrom. Under the authority given by the Council the National Service Committee immediately issued a circular letter, with reply form, inviting members to place their services at the disposal of the Institution in connection with the Army, the Navy, public services, &c., and in response to this circular over 1,600 offers of service from members and others recommended by members were received, among which were included some 500 offers for service in the Army or the Navy. The offers of service received were placed by the Council at the disposal of the various Government Departments. The Committee also sent a circular to the chief engineers of the [illegible] undertakings in the United Kingdom informing them of: (*a*) the offers of service received by the Council and placing them at the disposal of the various undertakings; (*b*) the precautions taken in London for the protection of the electric power stations and for the security of the public supply of electricity. A number of vacancies in power stations were filled by this means, but it soon became evident that there were practically no supply station men unemployed.

Early in September intimation was received from the Admiralty that about 670 engineers would be required for the Engineer Units of the Royal Naval Division, the formation of which had recently been sanctioned by the Admiralty, and it was agreed that in conjunction with the Institutions of Civil and Mechanical Engineers circulars should be sent immediately to all the members inviting applications to join the new units and that a special recruiting office for this purpose should be opened in the Institution's vacant rooms at No. 2 Savoy hill. The [illegible] of all classes of the three Institutions were [illegible] and the applicants were interviewed by a Committee of Selection consisting of Major-General R. M. Ruck, C.B., R.E., Mr. W. Duddell, F.R.S., Mr. R. Hammond, Colonel O. E. Ruck, R.E., and Mr. A. P. Trotter, together with representatives of the Councils of the Institutions of Civil and Mechanical Engineers. By the middle of October the corps had been recruited up to its full complement. Since the outbreak of the war the rooms of the Institution on the first floor have been continuously in the occupation of departments of the War Office, the Admiralty, [illegible] at present. At the invitation of the President, the Council decided to place the [illegible] from Major-General Ruck, C.B., R.E., on behalf of the War Office, asking him to nominate young electrical engineers for temporary commissions in the Royal Engineers and Artillery. The President [illegible] to the Members (M.I.E.E.) of the Institution [illegible] recommended suitable candidates. A large number of [illegible] by the President, assisted by Mr. W. Duddell, [illegible] number were recommended for commissions in the Royal Engineers, Garrison Artillery. The President had also [illegible] members for special temporary commissions in the Royal Engineers.

Members on Naval or Military Service.—[illegible] members it appears that there are at present some 925 members serving in the Navy, of the Army, viz.: 92 [illegible] 55 associates, 64 graduates, and 312 students.

Engineers' Volunteer Corps.—The Council received during February a letter from General Sir O'Moore Creagh, V.C., Military Adviser to the Central Association of Volunteer Training Corps, inviting the Council's co-operation in the formation of an engineers' volunteer corps affiliated to the Central Association. The Council accordingly issued in March a circular to the members residing in the London district, and replies have been received from some 150 expressing their willingness to join such a corps if formed. These offers have been communicated to the Central Association, and the matter is still under consideration.

[illegible] appointed by the Council to keep in touch with the British Electrical and Allied Manufacturers' Association in regard to the question of securing for British manufacturers the trade hitherto done by Germany and Austria-Hungary. A number of meetings of this Committee were held, at which representatives of the Manufacturers' Association were present, and the position was very fully discussed. Eventually after several suggestions had been considered the Committee came to the conclusion, with the concurrence of the manufacturers' representatives, that the continuance and expansion of British trade after the war will mainly depend on economic principles and on the commercial industry and initiative of British manufacturers, and that no useful action on the part of the Institution appeared to be possible. The Committee referred to above still remains in being for the purpose of advising the Council in regard to any questions which may arise in the future.

Powers to Borrowers of Municipal Loans.—Several meetings have been held of the Committee appointed by the Council last year to consider the question of the periods of repayment allowed by the Local Government Board for loans to municipal authorities for the purchase of electrical plant. Although the terms of reference were intended to embrace all kinds of such plant, the replies received from certain Associations representative of different sections of the electrical industry, who had been asked for their views, made it evident that on the whole the only alterations desired were in regard to cables and batteries. Inquiries were directed by the Committee to some 40 municipal supply undertakings for data as to the lives of cables laid down in various ways, the causes of their deterioration, and the residual value of old cables compared with the original cost. Opinions were also sought as to the desirability not only of extending the periods of repayment, but also of differentiating them according to the method of laying. From the replies received there appeared to be a consensus of opinion that cables possessed longer lives than those which were assumed in fixing the present loan periods, and the Committee concluded that good grounds existed for approaching the Local Government Board to sanction a period of 30 years in the case of underground cables, provided they are substantially constructed and laid with due regard to the nature of the soil. It seemed desirable also to treat substantially constructed conduits separately from cables, and to urge the adoption of a period of 60 years for such conduits. In view of the great improvements in batteries which have taken place in recent years, the Committee recommended that the repayment period for these should be extended to 15 years, in cases where the sanctioning authority was satisfied that adequate provision had been made for the proper maintenance of the batteries. In regard to reinforced concrete the Committee recommended an extension of the period to 30 years, so as to conform with that allowed by the London County Council. The Council will in due course make representations to the Local Government Board on the lines indicated above.

Smoke Abatement.—Towards the end of last session the Council received a letter from the Local Government Board Departmental Committee on Smoke Abatement inviting the Institution to give evidence. The Council accordingly appointed a Committee for the purpose of preparing and submitting to the Council the draft of the evidence to be given before the Departmental Committee, but the Council having since been informed by the Departmental Committee that in view of the war the Committee had adjourned its meetings sine die, the matter is for the present held over.

Legacies to the Institution.—The Council have to record the receipt of a sum of £500 in payment of legacies of £250 each to the Building and Benevolent Funds of the Institution made by the late Mr. Augustus Stroh, to whose executors the cordial thanks of the members have been conveyed for this mark of attention to the interests of the Institution.

Benevolent Fund.—The Committee of Management of the Benevolent Fund of the Institution report that on December 31, 1914, the Capital Account of the Fund stood at £4,642. 3s. The donations and subscriptions, to the Fund in 1914 amounted to £179. 19s. At the end of March, 1915, [illegible] to occur in the near future, the President was authorised by the Council to make an appeal to the members of all classes of the Institution (except students) for subscriptions and donations to the Fund. The result of [illegible] acknowledge their indebtedness to the generosity of the donors and subscribers who have supported the Fund, but in view of the inadequacy of this result, the Council venture once more to urge upon the members the [illegible] will be grateful for annual subscriptions even of quite small amounts.

[illegible] The total of the Life Compositions Fund on January 1, 1914, was £5,506. 19s. Out of this the sum of £97 has been transferred to the General Fund, in accordance with the Articles of Association, on account

of Life Compositions of members deceased during the year, leaving to the credit of the Fund £5,109. 19s. 0d., which amount, £5,032. 2s. 10d. is invested in Stock Exchange securities. The Building Fund has been augmented during the year by £709. 15s. 11d., of which £41. 18s. came from donations and subscriptions, and the remainder from Institution Revenue. The amount was utilised in reduction of the Economic Life Assurance Society's mortgage. Taking the Tothill-street property and the investments at cost, and the Institution building and lease, the library and furniture, &c., at the values standing in the books after writing off depreciation the assets amount to £114,929. 3s. 5d., against liabilities £43,359. 6s. 1d., leaving a margin to the good of £71,569. 17s. 4d. This margin set against the margin to the good in 1913 of £69,523. 3s. 9d., and shows an improvement for 1914 of £2,046. 13s. 7d.

Other matters referred to in the Report are members deceased, meetings, science abstracts, the library and museum.

THE PASSAGE OF ELECTRICITY THROUGH METALS.

The large audience which, on Wednesday, May 5, attended a meeting of the Institute of Metals to hear Sir J. J. Thomson, O.M., F.R.S., lecture on "The Passage of Electricity Through Metals," was probably not surprised to hear him abandon the theory of electronic conduction. But they had hardly expected that they would be able to listen to the first exposition of a new theory, simple certainly in its fundamental conception. It was a memorable evening.

In his introduction, Sir Joseph alluded to the strange fact that, though the quantity of electricity, which passed through metallic conductors every day was enormously greater than that which was sent through liquids and gases, our knowledge as to the mode of the passage of electricity through the latter rested on a much surer foundation. Since, in liquids, the electricity was carried by atoms or groups of particles, charged with either positive or negative electricity, all helping to carry the current, some physicists had believed that in metals electricity was likewise accompanied by matter. Experiments had not confirmed this view, however. Very heavy currents had been sent through alloys, and portions from the ends of the conductors had separately been analysed after the experiment; no indication had been discovered that the entrance and exit of the current had made any difference in the composition of the alloy. Again, large currents had been passed across the junction of plates of two metals (for example, lead and silver), but there had been no evidence of any transport of metal across the junction. Relief from the necessity of assuming the transport of atoms had come from the study of gases, in which very small particles—electrons—had been discovered to act as carriers of negative charges. That metals contained electrons was proved by their being emitted by hot metals, from the behaviour of the Coolidge tubes, which emitted electrons for months in the highest vacuum, and from other observations. The assemblage of electrons was supposed to be of the nature of a gas in equilibrium with the metal: that is to say, the temperature of the electrons was that of the metal, and the kinetic energy of the electrons that of the molecule of air at the same temperature, and as the mass of the electrons was exceedingly small their velocity must be very great. 10^7 cm. per second at 0°C. As long as there was no external force there was no flow of electricity through the metal. Under the influence of an external electric force the electrons drifted in a direction opposite to that of the E.M.F. (because electrons were negatively charged), the velocity of drift k being proportional to the electric force X, and the current was, therefore, $kneX$, where n was the number of electrons per unit volume, e the charge on an electron, k the drift or mobility, and kne was the specific conductivity of the metal.

The theory of metallic conduction at first appeared very promising. It explained many phenomena; *e.g.*, the close connection between thermal and electric conduction. For electrons would impart to the metal also the power to conduct heat; this power should be proportional to kn. At ordinary temperatures, at any rate, the ratio thermal conductivity/electrical conductivity was fairly the same for all [illegible] for copper, silver &c., [illegible] the temperature changes at the [illegible] percent. the absolute value was 6.3×10^{10} [illegible] at least to become [illegible] electrons [illegible] the [illegible] [illegible] with the [illegible] [illegible] to be proportional to their [illegible] density, the remarkable [illegible] of the [illegible] of the metal [illegible] [illegible] Other thermo-electrical phenomena [illegible] [illegible] on the view [illegible] the phenomena of contact potential [illegible] metal would contain different numbers of electrons, when the metals were brought into contact, the electrons would flow in the one direction until the pressures of the electrons were balanced.

But, Sir Joseph continued, the infant electronic theory had developed undesirable properties as it grew up. Numerical calculations had led to difficulties. The assumption of negative force electrons involved the assumptions, since metals were electrically neutral under ordinary conditions, of an equal positive electrification on the atom, and if, as would be seen, the phenomena seemed to require the presence of more electrons than atoms (*e.g.*, 20 times as many), then the atom would have to carry 20 positive charges, and that consequence was of grave difficulty. For there were strong reasons to believe that the number of + charges on an atom (or, what meant the same, the number of — charges that could be extracted from it) was not a large multiple of the atomic unit of electricity. It was true that the number of electrons per atom was about half the atomic weight; but most of those electrons were deeply seated, and they could only be liberated by a large expenditure of energy, and would not be affected in metals under normal conditions, where free electrons were produced by a kind of dissociation (by heat) of the neutral atom into an electron and a positively charged atom.

The specific conductivity kne could be determined directly; in the case of silver it was $3{\cdot}9 \times 10^{16}$. The unit charge e was known from other experiments; thus the product kn could be determined. To find the factors separately, indirect methods had to be applied; Sir Joseph referred to two. In flames the negative electricity was entirely carried by electrons, and the superior limit of the speed of the electrons in a flame at 2,000°C., under a gradient of 1 volt/cm., seemed to be 10,000 cm./sec; that estimate was probably too high. The k depended upon the effects of collisions between electrons and atoms; on Maxwell's law the speed of an electron through air at normal pressure would be 3,300cm./sec. Now air contained $2{\cdot}75 \times 10^{19}$ molecules per cm.^{3}, silver 6×10^{22} atoms, roughly 2,200 times the number of air molecules, per cm.^{3} Hence the velocity of an electron in silver should be 3,300/2,200 cm. or 1·5 cm./sec. That would make the k for unit force ($1/10^8$ of a volt per centimetre) only $1{\cdot}5 \times 10^{-8}$ cm., since $nk = 3{\cdot}9 \times 10^{16}\ n$ would have to be $2{\cdot}6 \times 10^{-4}$, or 40 times the number of silver atoms, and the atom of silver would have to carry a charge of 40 units. Such a number of electrons would exert a pressure of 100,000 atmospheres, and the specific heat calculations on that basis would give values many times greater than that observed. The second method dealt with the change of the electric resistance of metals under the rapidly alternating forces of light waves. Rubens found that this resistance was for wave-lengths λ greater than 2×10^{-3} cm., indistinguishable from the resistance for steady currents, and for the infra red rays $\lambda = 4 \times 10^{-4}$ only 20 per cent. greater; this consideration again required about 20 times as many electrons as atoms in the case of silver. All these arguments suggested that free electrons had little to do with the conductivity of the best conductors like silver and copper.

Another very important argument had been emphasised by the recent work of Kamerlingh Onnes. The resistance of pure metals was, roughly speaking, known to be proportional to the absolute temperature of the metal. That fact was so general that, one would expect, the electron theory should bring it out at once; but the theory did not even suggest it, and it was indeed difficult to reconcile the fact with it. At very low temperatures the conductivity of metals became very high; nk therefore must become very large. But we could not expect n to increase (the production of free electrons by heat should diminish very rapidly instead of increasing). Nor could k be expected to increase as the temperature was reduced so rapidly as to far exceed the diminution in n. Moreover, the recent experiments of Onnes, made with the aid of liquid helium, at about 4°C. absolute, showed that at very low temperatures phenomena occurred which previous low temperature research (with liquid air and hydrogen) had not suggested. The resistance of mercury and lead decreased steadily as the temperature was reduced; but at about 4 deg. there was a sudden drop of the resistance almost to zero, to a value far too small to measure: the value was less than one ten thousand millionth of the resistance at 0°C., instead of being 1/70 (4/273). The purity of metals was of the highest importance in this respect; the resistance curve of gold gradually bent round, becoming parallel to the temperature axis, but the purer the gold the smaller was the resistance at which this bending occurred. Further, when at 4 deg. absolute a current was started by Onnes in a ring of pure lead by moving a magnet near it, that current seemed to go on flowing almost indefinitely after removing the magnet; the current certainly kept its intensity for more than two hours, and Onnes calculated it would take four days to fall to half its value. Thus the temperature of 4 deg. absolute (or some such temperature) seemed to be a new kind of critical temperature, and the phenomena made the task of the electronic theory still more formidable.

Sir Joseph, therefore, brought forward a new theory, which he had first suggested in his "Applications of Dynamics to Physics and Chemistry" (1888). Electrons had not been discovered then, and he had had to suppose that electricity was carried by the atoms which lead to the difficulty he had already mentioned; later, in "The Corpuscular Theory of Matter," he had modified it by introducing the electron as the carrier of the electricity. He could best explain it, he said, by calling attention to the molecular theory of magnetisation. A piece of iron might be regarded as a collection of molecular magnets, grouped higgledy-piggledy, until an external magnetic force made them swing round to point in the direction of that force. The little magnets no longer neutralised one another then, and the iron behaved like a magnet, the intensity of its magnetisation depending upon the excess of the number of magnets pointing in the particular direction over the others. They might all swing round, if there were not forces at work knocking them out of line again as fast as they were pulled in; the effect was a compromise, and only a fraction of the magnets got into line. One of these disturbing forces was given by the movements of the molecules due to their tempera-

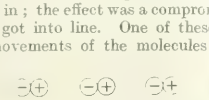


FIG. 1

ture; the higher the temperature, the fewer molecular magnets would remain in line. Langevin * had given a formula for the intensity of the magnetisation of a gas, based on this assumption and neglecting other effects. In this formula the intensity I was expressed in terms of the number of little magnets per unit volume N, their moment M, the magnetic force H′ (being the sum of two forces, the external force H and the force due to the little magnets in the neighbourhood which was proportional to I) by means of the equation

$$I = NM\left(\coth x - \frac{1}{x}\right)$$

when $x = H'M/R\theta$, θ being the absolute temperature. The graph representing this relation between x (as abscissa) and I was a curve. Again,

$$H' = H + kI$$

$$x = \left(\frac{H + kI}{R\theta}\right)M$$

or,

$$I = \frac{R\theta}{Mk}x - \frac{H}{k}.$$

This relation between I and x was represented by a straight line, and to find the value of I corresponding to any value of H, this line had to be drawn and its intersection with the curve to be determined.

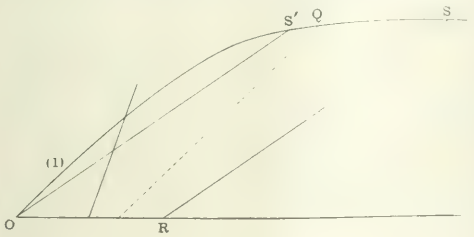


FIG. 2.

The electrical analogue of the molecular magnet, Sir Joseph suggested, was the dipole, consisting of a positive and a negative charge (an electron), the pairs being some distance apart in its atom, and setting themselves in chains (Fig. 1) under the influence of an external electric force. A certain fraction of the dipoles would point in that direction, the others indifferently in all directions. In this respect there was no difference between metals and non-metals and dielectric displacement, or polarisation could be explained by the setting of the dipoles.

The doublets or dipoles in the atoms would produce electric forces in their neighbourhoods, and these forces would tend to drag the electrons out of one atom into another. The difference between insulators and metals in a solid state was that the former parted easily with their electrons, and in metals the electrons would pass along the chain from one atom to another; in an insulator the electrons would not be dragged out. The force holding the electrons out in metals was due to the pull exerted by the atoms in the neighbourhood, and did not depend upon the external force. If p electrons passed along a chain per second, the quantity of electricity passing through unit area would be nep, n being the number of chains passing through a unit area drawn at right angles to the electric force; if I was the number of doublets pointing in the direction of the electric force and d the distance between two doublets, $n = Id$. Thus, other things being the same, the conductivity of the metal will be proportional to I. To find the current corresponding to any electric force we must take the Langevin curve, whose equation w

$$I = NM\left(\coth x - \frac{1}{x}\right) \quad \ldots \quad (1)$$

where x was now

$$\frac{M(X_0 + kI)}{R\theta}.$$

M was the electric moment of a doublet and X_0 the external electric force; kI was the part of the force due to the polarisation of the doublets. We saw from this that

$$I = \frac{R\theta}{kM}x - \frac{X_0}{k} \quad \ldots \quad (2)$$

Hence, the value of I would be got by finding where the straight line (2) intersected the curve (1). When the values of x were not large, the curve (1) might be represented by the tangent at the origin whose equation was

$$I = NM\frac{x}{3}.$$

This line intersected the line (2) at the point where

$$I = \frac{\frac{1}{3}M^2N}{\frac{1}{3}NM^2R - R\theta}X_0,$$

or if we took a temperature θ_0 defined by the equation

$$3R\theta_0 = kNM^2,$$

$$I = \frac{NM^2X_0}{3R(\theta - \theta_0)}.$$

The specific conductivity was proportional to I/X_0; thus, when the intersection took place in this region Ohm's law held, and the resistance was proportional to $\theta - \theta_0$. This held as long as θ was $> \theta_0$. When $\theta = \theta_0$ the line (2) was parallel to the tangent at O to Langevin's curve, it would intersect the curve at a place Q on the flat part of the curve; the value of I would be enormously greater than before, the resistance would be very small and Ohm's law would no longer hold. When the temperature was less than θ_0 a new effect would come in. The line (2), RS, now made a smaller angle with the horizontal than the tangent also to the curve (1). As the electric force X_0 diminished the line RS moved to the left keeping the same inclination to the horizontal. When the force was reduced to zero the line passed through O and intersected the curve at S′, where I had still a high value; thus though the electric force had been removed, a considerable fraction of the current remained, the effect which was so marked in Kamerlingh Onnes' experiment with the lead ring. This persistence of the current at these low temperatures after the E.M.F. was removed was due to the molecular bombardment at these temperatures being too weak to break up the chains when once they were formed. As on this theory the function of the E.M.F. was merely to form these chains, if the chains were there we should have the current even though there was no E.M.F. We might compare the effect with the permanent magnetism in a piece of iron when the magnetising force was removed. When the temperature was higher than θ_0, the line through the origin parallel to the line (2) would not cut the curve again; thus, there would be no current when the electric force was removed, now the bombardment was strong enough to break up the chains. Thus, on this theory the electrical properties of metals were very different on the two sides of the critical temperature θ_0: below this temperature a metal was almost a perfect conductor, and did not follow Ohm's law; above it it had the normal resistance and Ohm's law held. The difference in electric qualities changed as much on passing through this temperature, as those depending on the elasticity on passing through the melting point.

For the sake of definiteness Langevin's expression for I was taken, but the general result of the theory would be unaltered so long as I was a function of $NM/R\theta$: the particular form of the function was not of primary importance. It was possible that there might be other causes tending to break up the chains besides those of thermal origin. In the case we should expect I to be a function of $NM/R(\theta - D)$, where D was independent of the temperature, and if D were greater than NM^2/R ($= \frac{4\pi}{3}$ where $\sigma = NM^2/R(\theta - D)$ there

* THE ELECTRICIAN, Vol. LVI., pp. 108 and 148, November 19 and 26, 1905.

would be no critical temperature though the resistance would diminish as the temperature fell; at high temperatures we should expect the resistance of such metals to be proportional $R\theta + D$ and not $R\theta$.

This critical temperature, Sir Joseph concluded, thus appeared to be analogous to the temperatures at which changes in the state of aggregation took place. In the solid state the chains of atoms or molecules were held together by cohesion until thermal disturbances broke them up and the solid liquefied. There seemed to be an analogous change in the electric state. It was very remarkable that we had had no suspicion of these phenomena as long as we were limited to experiments with liquid air or even liquid hydrogen; the change made by the use of liquid helium was a most striking illustration of Browning's line—"The little more and how much it is."

THE KENOTRON.

In our last issue we gave extracts from a Paper read by Dr. Irving Langmuir before the Institute of Radio Engineers, in which the results obtained with a kenotron and a pliotron were described. In an article in the "General Electric Review" for March, 1915, Dr. Saul Dushman gives some interesting particulars of the construction of the kenotron.

In order to obtain the very high vacuum that is necessary, a Gaede molecular pump was used in series with two other pumps. With regard to the life of the kenotron, a 5-mil. filament is run at 2,400 deg. K., corresponding to 1 watt per candle, and has a life of about 4,000 hours. Where the current required is 100 milli-amperes or more, a 7-mil. or 10-mil. filament is used, and the temperature is varied accordingly. Some data in this connection are given in the

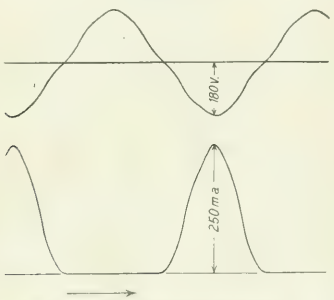


FIG. 1.—HALF-WAVE RECTIFICATION.

Upper curve gives voltage over kenotron; lower curve gives current rectified. Note the effect of voltage limitation.

following table, in which the "safe" temperature is that at which the life of the filament is likely to be about 2,000 hours.

Diameter of filament in mils.	"Safe" temperature.	Electron emission per cm. length.	Watts per cm. length
5	2,475	30	3·1
7	2,500	50	4·6
10	2,550	100	7·2
15	2,575	200	11·3

Owing to the existence of the space charge effect, it is evident that for any given current-carrying capacity i of a kenotron there will exist a voltage drop, V, in the rectifier itself. We can now consider the manner in which the kenotron operates when placed in series with a resistance across a source of high voltage. Let E denote the value of this voltage at any instant and i_a the current rectified. If V denote the voltage drop through the kenotron and R the resistance [illegible] it follows that

$$V = E - i_a R.$$

[illegible] of E, the current rectified increases as R is [illegible] the value corresponding to saturation [illegible] the temperature at which the cathode is [illegible] R [illegible] will [illegible] remain constant, [illegible] the voltage across the kenotron increases beyond [illegible] the equation gives the [illegible] when rectifying a given current [illegible] but when operating at [illegible] the voltage drop in the kenotron is that available above the $i_a R$ drop in load. In case of a short-circuit on the latter, where R decreases indefinitely, the total voltage of the source is taken up by the kenotron, thus liberating the whole of the energy Ei as heat at the anode, and the latter may be raised to a temperature at which it will melt or volatilise and ruin the tube.

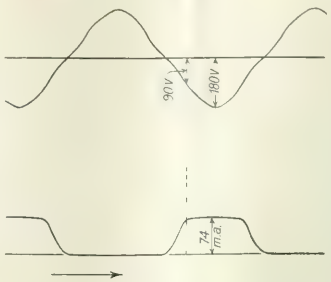


FIG. 2.—HALF-WAVE RECTIFICATION.
Note the effect of temperature limitation.

It is necessary to emphasise this characteristic behaviour of the kenotron, and in practice care should be taken to provide against short-circuiting the load, or some form of protective device should be used.

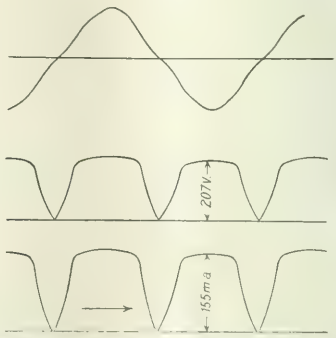


FIG. 3.—FULL RECTIFICATION, USING ARRANGEMENT SHOWN IN FIG. 5.

Upper curve voltage over primary of transformer; middle curve voltage over load; lower curve current rectified. The latter was limited by temperature of cathode on each side.

If the anode becomes too hot rectification tends to become imperfect. The rectifier must, therefore, be so designed that the space charge voltage is not great enough to cause heating of the anode

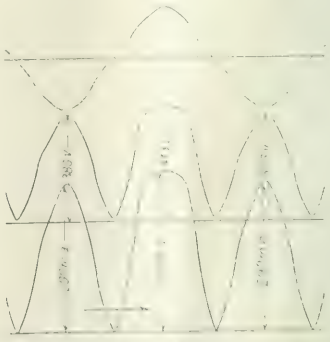


FIG. 4.—FULL RECTIFICATION, USING ARRANGEMENT SHOWN IN FIG. 5.

The current rectified was limited on one-half cycle by temperature and on the other half by voltage.

when the requisite current is being carried by the tube. About 10 watts per square centimetre of anode area is permissible, corresponding to a temperature of about 1,600 deg. K. At this tem-

perature the electron emission is still less than 0·02 milliampere per square centimetre.

Referring to the rectifiers illustrated in Dr. Langmuir's article as given in our last issue, Dr. Dushman gives the following conclusions:

1. For current-carrying capacities up to 500 milliamperes either a cylindrical anode with a filament down the axis or a W-shaped filament placed between two parallel plates may be used. The first-named type can apparently be made much more efficient as regards losses due to space charge effect.

2. Where currents of the order of 100 milliamperes or less have to be rectified, and the maximum direct-current voltage is not over 15,000, the molybdenum cup type is one that is simpler mechanically and also quite efficient.

3. For voltages up to 100,000 a cylindrical anode type has proved itself to be very practicable and efficient.

The oscillograms reproduced in Figs. 1 to 4 show the results obtained under different conditions of rectification. In Fig. 2 the

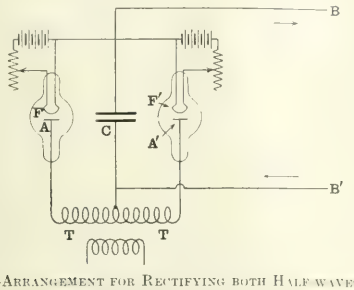


Fig. 5.—Arrangement for Rectifying both Half-waves, using Middle Point Connection on Transformer.

temperature of the filament is low. The oscillograms in Figs. 3 and 4 were obtained with the arrangement of apparatus shown in Fig. 5. The differences noticeable in Fig. 4 are due to the two kenotrons not being of the same construction.

PROTECTIVE REACTORS FOR FEEDER CIRCUITS OF LARGE CITY POWER SYSTEMS.*

BY JAMES LYMAN, LESLIE L. PERRY AND A. H. ROSSMAN.

Summary.—This Paper outlines the use and limitations of protective reactance coils in feeder circuits. Curves are given showing what the effects of feeder reactors are, with and without bus reactors, for generators of various reactances. The advantages that accrue to parallel operation of feeders are discussed.

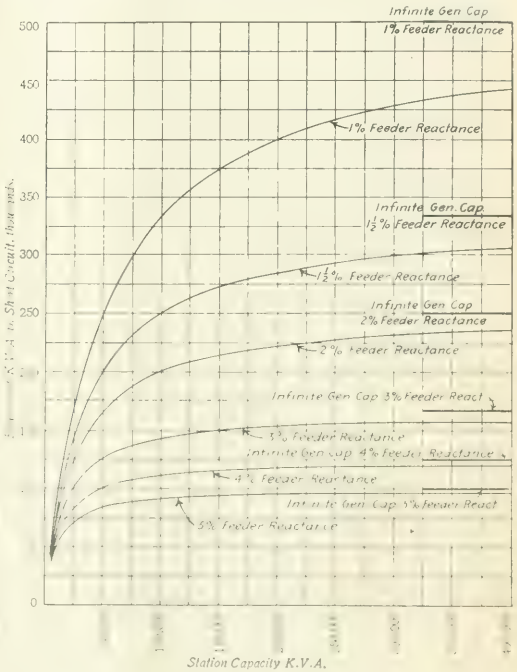
In a Paper entitled "Protective Reactances in Large Power Stations,"† the authors discussed the use and limitations of current limiting reactors in generator circuits and in power station 'bus bars. It is the purpose of this Paper to discuss, in greater detail, the use and limitations of reactors in the feeder circuits of large city power stations. Where reference is made to maximum values in this Paper this refers to maximum R.M.S. values and not to maximum instantaneous values. Transient effects are not taken into account by these curves. The transient effects can be derived from the R.M.S. values.

The authors point out the need for feeder reactances showing the breakdowns increase with greater rapidity as the capacity of the station and length of feeder cables gets bigger. Also, if no reactors are used in either the feeders or 'bus bars, heavy short-circuits occurring within a mile or so of the power stations would be felt over the entire system.

Curves.—In order to study the effect of different values of feeder reactance a number of curves has been plotted. Curve-sheet 1 shows the relation between the equivalent kilovolt-amperes in a short-circuit and the station capacity in kilovolt-amperes for six different values of feeder reactance when no 'bus reactance is used. The generator in this case gave 10 per cent. [illegible] Similar sets of curves are given for [illegible] reactance of 12 and 8 per cent. The points of special interest shown by these curves are: (*a*) With infinite generator capacity the equivalent kilovolt-amperes in a short-circuit vary inversely as the reactance in the feeder circuit. (*b*) The equivalent kilovolt-amperes in a short-circuit with infinite generator capacity are the same for the three sheets of curves. (*c*) The kilovolt-amperes in short-circuit increase more rapidly per kilovolt-ampere of station capacity for a small station than for a large one.

A comparison of similar curves on the three sheets shows that the variation in generator reactance does not greatly affect the curves. Curve-sheet 2 shows the four curves for 3 per cent. (of 5,000 k.v.a.) feeder reactance replotted on the same sheet for generator reactance of 12, 10, 8 and 6 per cent. respectively. By comparing the curve for 6 per cent. generator reactance with that for 12 per cent. generator reactance the small effect of the generator reactance on the curves is evident.

Curve-sheet 3 shows the relation between equivalent kilovolt-amperes in a short-circuit and station capacity in kilovolt-ampere with 10 per cent. generator reactance and 3 per cent. (of 5,000 k.v.a.) feeder reactors under two conditions. Under one condition no 'bus reactors are used. Under the other condition 12 per cent. (of 25,000 k.v.a.) 'bus reactors are used. The points of interest here are, that where 12 per cent. 'bus reactors and 3 per cent. feeder reac-



Curve Sheet No. 1.

tances are used, the equivalent kilovolt-amperes in a feeder short-circuit becomes practically constant at 125,000 k.v.a. station capacity, and any further increase in station capacity has no appreciable effect in increasing the short-circuit kilovolt-amperes. Where no 'bus-bar reactors, but 3 per cent. feeder reactors are used the short-circuit kilovolt-amperes increase until with infinite generating capacity they become 167,000 k.v.a.

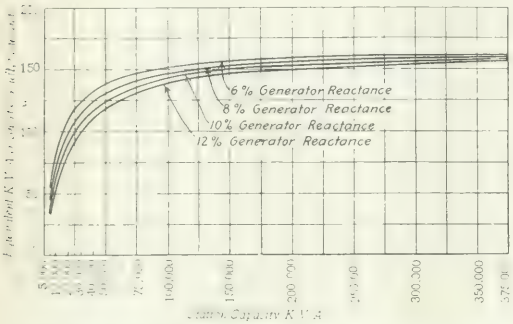
Interpreted in another way, when the 'bus-bar reactors are used the feeder reactors absorb 3 per cent. of the voltage and therefore, give a 25 per cent. drop in voltage on the section of the bus bars to which the feeders are connected under the worst conditions of short-circuit. The result that all feeders connected to that section will suffer a momentary drop in voltage of 25 per cent. Where no bus bar reactors are used, the feeder reactors on the defective feeder will cause the same conditions, about 100 per cent. of the voltage, and will cause [illegible] feeder reactors but the voltage on the other bus bars on the system will not be appreciably affected. If there are [illegible] short-circuits on the feeders or between the bus bars [illegible] the feeder reactors will not prevent failure of the generator windings or connections between windings and 'bus bars, it is evident that the use of feeder reactors alone is preferable to the

* Abstract of a Paper read before the [illegible] Institution of Electrical Engineers.

† The Electrician, Vol. LXXIII., p. 972 [illegible] 1914.

combination of feeder reactors and 'bus-bar reactors, but with the c live possibilities of trouble always present, 'bus-bar reactors should be considered. Whether or not they should be adopted depends upon the particular conditions of the system under consideration. It is evident that a very large power station without either 'bus reactors or feeder reactors is liable to short-circuits which will endanger apparatus and service, due to the practically unlimited concentration of power in the short-circuits.

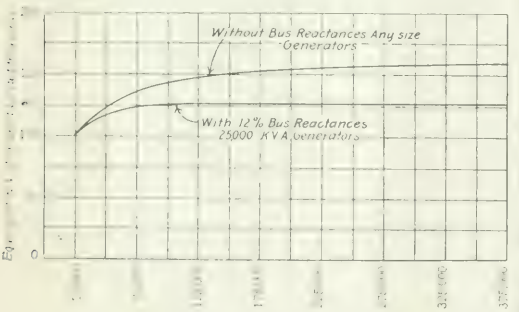
Effect of Feeder Reactors on Voltage Regulation. At 0·8 power-factor a 3 per cent. feeder reactor will cause a voltage drop of ap-



Curve Sheet No. 2.—Curves showing Values of Short Circuits in terms of K.V.A. with 3 per cent. Feeder Reactance and Various Generator Reactances without 'Bus Reactance—Three-Phase Short Circuits—5,000 k.v.a. Feeders.

proximately 1·8 per cent., at 0·9 power-factor a drop of approximately 1·3 per cent., at 0·95 power-factor a drop of approximately 1·0 per cent., and at 0·98 power-factor a drop of approximately 0·6 per cent. In large city power stations such as have been considered, there is always a considerable amount of synchronous apparatus in operation at a high power-factor, and the voltage drop due to 3 per cent. reactance in their feeders will be low.

The Parallel Operation of Feeders. The paralleling of alternating current feeders on a set of 'bus bars at the sub-station end and the tying together of the different sub-station 'buses by means of tie feeders between sub-stations would be highly desirable on most of our large city systems, if it could be safely accomplished. Such a method of operation would allow maximum facility in the inter-

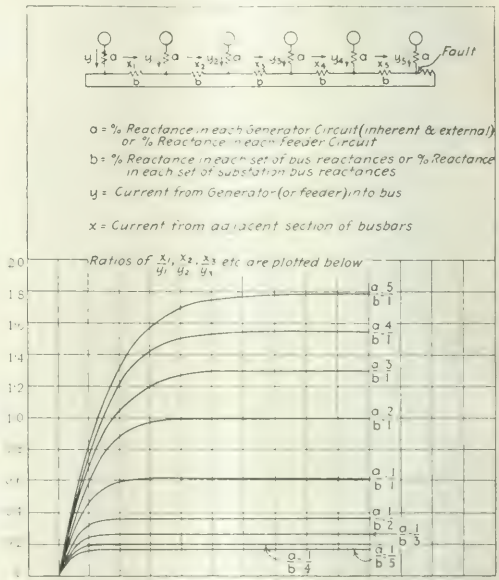


Curve Sheet No. 3.—Curves showing Values of Short Circuits in Terms of K.V.A. with 3 per cent. Feeder Reactances, 10 per cent. Generator Reactances with and without 12 per cent. 'Bus Reactances—5,000 k.v.a. Feeders.

generating capacities of 25,000 k.v.a.

[illegible] of power between various parts of the system, with a minimum amount of cable, the cables between the power station and sub-stations would be more evenly loaded and the total number of [illegible] would be reduced. Because of the cables between sub-stations, the reactance of the feeder cable between power station and sub-station would be eliminated. During the period of peak loads in the power station, power would flow in over the tie cables from sub-stations not carrying their maximum loads; and later, when the conditions of peak were reversed, the flow of power would be reversed.

The Effect of Reactance Coils on the Parallel Operation of Feeders.—To assist in the study of the amount of short circuit current which can flow into a fault, the series of curves on curve-sheet 4 was plotted. These curves can be applied to approximate the amount of short-circuit current into a fault on the 'bus bars of a power station where 'bus-bar reactors are used, or to approximate the amount of short-circuit current into a fault on or near the sub-station 'bus bars where several feeder cables are connected in parallel on the sub-station 'bus bars with 'bus-bar reactors between them. As applied to the case of a power station, assume the case where the ratio of generator reactance to 'bus bar reactance (a/b) equals 1/3. The corresponding curve is almost constant with three running generators. This means a short-circuit on any section of the 'bus bars is practically maximum when the generator on the same section and one generator on each adjacent section are in operation, and the addition of more generators to the system will not appreciably increase the amount of short-circuit current. In applying the curves to a sub-station consider the following concrete example: Consider a case in which the inherent reactance in each feeder equals 1 per cent., artificial reactance equals 3 per cent., and 'bus reactance equals 3 per



Curve Sheet No. 4.

cent., all based on 5,000 k.v.a. Then, if a short-circuit occurs on or near the sub-station 'bus-bars the kilovolt-amperes flowing in over the short circuited line equal $\frac{5{,}000}{0{\cdot}04}$, or 125,000 k.v.a. $a/b = 1/3 = 1{\cdot}33$.

From curves, by interpolation, $x/y = 0{\cdot}75$. Hence, the kilovolt-amperes flowing over each 4 per cent. bus reactor equal $0{\cdot}75 \times 125{,}000 = 93{,}750$ k.v.a., and the total kilovolt-amperes flowing into the fault $= 125{,}000$ k.v.a. $+ 2 \times 93{,}750$ k.v.a. $= 312{,}500$ k.v.a. The 93,750 k.v.a. flowing in over each 'bus reactor are composed of two components, one flowing in over the second reactor and the other over the adjacent line. These also bear the relation to each other of $x/y = 0{\cdot}75$. Hence, over the second reactor there flow in 40,180 k.v.a. and over the adjacent feeder 53,570 k.v.a. In this case with 125,000 k.v.a. flowing into the fault from the feeder on the same section with the fault, and 53,570 k.v.a. over each adjacent feeder, it is probable that all three of these feeders will go out at once, and these will be followed by the other feeders in the sub-station.

The authors go on to consider other cases, from which they conclude that even on feeders from a very large generating station, feeder reactors of moderate size effectively limit the amount of current flowing from the power station end into a short circuit on the feeder. On the other hand, if this feeder is one of a number of feeders connected in parallel at the sub-station end, a short-circuit

will have a back feed from all other feeders connected to the sub-station bus bars. The amount of kilovolt-amperes flowing over these other parallel feeders is likely to be sufficient to trip out part or all oil switches on these circuits.

Summary.—In a large city power system [illegible] of underground cable and consequently the cable faults increase at a faster rate than the generating capacity. The severity of short-circuits also increases with increased generating capacity. Feeder reactors are particularly effective in reducing and localising the effect of such short-circuits. When properly proportioned feeder reactors are used, an increase or decrease of generator reactance has only a limited effect on the amount of kilovolt-amperes flowing into a fault. Bus section reactors in the generating station in connection with feeder reactors still further reduce and localise these effects, even when it might be more desirable to distribute their effect if other conditions permitted. It would be desirable for many reasons to operate feeders in parallel at their sub-station ends, but such operation tends to increase greatly the kilovolt-amperes flowing into a feeder short-circuit and to cause other feeders besides the one affected to trip out when overload relays with the usual settings are used.

THE ELECTRIC COOKING PLANT AT THE HEAD OFFICE OF THE SIEMENS-SCHUCKERTWERKE AT SIEMENSSTADT, NEAR BERLIN.*

This large plant is designed to provide meals for 3,000 persons in four groups of 700 to 800 each, and up to May of last year has provided for 2,000 daily. The current is supplied at 6,000 volts polyphase from the firm's own power-station, and is transformed down to 2 × 220 volts direct current by a single armature rotary converter, the neutral conductor being earthed. The kitchen is on the sixth floor of the building, and contains the following apparatus: Four ovens each having four chambers of 600 mm. by 800 mm. by 360 mm. clear internal space, arranged in a horizontal row; 18 frying pans, each 400 mm. by 600 mm. by 65 mm.; six saucepans, each of 400 litres capacity; two saucepans each of 200 litres capacity (two more are to be added); three small tilting saucepans of 30 to 50 litres capacity; two heating cupboards of 2 by 0·8 by 0·8 metres external dimensions. There are also three serving tables with electrically heated water baths and plate-warming racks, four coffee machines of a capacity of 75 and 150 litres per hour, and one hot-water boiler of a capacity of 1½ cubic metres for cooking and washing. There are also electrically driven serving lifts, washing machines for the crockery, &c., potato-peeling machines capable of dealing with 500 to 600 kilos of potatoes in about 2½ hours. All apparatus is arranged for 220 volts. In each apparatus, the earthed neutral is connected without a cut-out to one pole of the heater and at the same time a connection is made with the metal frame of the apparatus. The outer conductor is connected to the heater through a cut-out and a controlling switch. In the large saucepans or boilers, the switches and cut-outs are mounted on separate columns. With the ovens, the tables for the frying pans, the heating cupboards, &c., the switches and cut-outs are built into the front wall in such a manner that only the switch-handles and heads of the fuse-cartridges are exposed. The supply mains extend from the main switchboard into the ceiling of the floor beneath the kitchen and pass up from the floor to the several apparatus in the kitchen through brass tubes. The ovens are covered with a wrought iron galvanised plate which can be also used as a warming plate. The inner chambers are thermally insulated by air-jackets. They are heated by upper and lower heater-plates, each provided with two separate circuits, and controlled by rotary switches. The heater-plates are provided, in a position which is inaccessible to the attendants, with three contact-knives that engage with contact-springs on the rear wall of the chambers, and permit of their being removed and replaced in a very simple manner. The loading of each chamber is 8 kw. The [illegible] frying pans used in the chambers are made with longitudinal ribs at the bottom, which prevent the bottoms of the pans from lying directly on the heater plates. The directly-heated frying pans are welded up from wrought iron, and are made very heavy. They are arranged in sixes on three tables, the electrical connections to the pans being made through plug-contacts. The conductors pass from distributing boxes on a shelf beneath to the [illegible] terminal sockets flexible metal tubing. The switches are arranged separately from the distributing boxes on the front wall of the [illegible]. The heater-elements are arranged on the underside of the [illegible] 2 the frying pans, and are pressed against the latter by [illegible]. The loading of each heater is 7 kw. Each [illegible] having 200 outlets per hour.

The large saucepans are made with the heater-elements arranged directly below the bottom. In order to facilitate the emptying of these vessels, and also the removal and replacement of the heater elements, they are mounted on trunnions, and are provided with worm-gearing and a hand-wheel for turning them. The cover is mounted on a separate support. In order to enable porridge and like foods to be cooked, some of these saucepans are provided with an oil-jacket, the heater elements being arranged on the outside of this jacket at the bottom of the saucepan. The efficiency of this arrangement when full during the heating up period is 82 per cent., as compared with 90 per cent. for the directly heated saucepan. This difference is, however, counterbalanced by the fact that the oil stores sufficient heat to keep the contents of the saucepan boiling for 1½ hour after the current has been switched off. Each saucepan has two separate main circuits of (for the 400-litre pans) 12 kw. and 24 kw., which are both distributed over the whole bottom of the pan, and are subdivided into subsidiary circuits. By means of two switches, 12 kw., 24 kw. or 36 kw. can be supplied to the pan. The 200-litre pans have a maximum loading of 18 kw.

The coffee machines, for 75 and 150 litres per hour and of a loading of 12 kw. and 18 kw. respectively, each consist of a continuous water-heater (93° C.), and an infusing vessel with a heated water-jacket. The consumption of energy for six months of last year (1914) is as follows:—

Month.	Mean daily consumption. Total consumption. Kw.-hours.	Total consumption. Kw.-hours. Per head.	For cooking only. Kw. hours.	For cooking only. Kw. hours. Per head.
February.....	731	0·534	532	0·387
March	770	0·517	571	0·384
April	568	0·350	368	0·220
May	661	0·430	476	0·306
June	638	0·450	480	0·311
July	599	0·411	405	0·273
August	592	0·422	427	0·305
Mean value...	651	0·430	451	0·312

The consumption per head was calculated according to the number of portions issued, averaging 1,579 per day.

The current was charged to the kitchen at 5 pf. (= 0·6d.) per kilowatt-hour, and amounted to about 2½ per cent. of the total budget for the kitchen (2·15 pf. = 0·258d. per head per day). In the Hennigsdorf Works of the A.E.G., where there are 130 persons to be catered for, and the current is supplied at the same price, the daily cost per head is 2·05 pf. (= 0·246d).

Similar plants, heated with coal, steam and gas, gave the following results:—

Kind of plant.	No. of persons catered for.	Heating agent.	Daily cost of fuel per head in pfennigs.
Officials' Dining Rooms	592	Gas and steam	1·61
	325	Gas.	2·47
	200	Gas	2·42
	797	Gas and steam	2·36
	1,096	Gas and coal	1·95
	624	Gas, coal & steam	1·87
Operatives' dinner room	528	Gas and steam	1·69
	500	..	1·26
	1,900	..	1·14

The price of fuel was as follows: Gas, 11 pf. per cubic metre (= 37·4d. per 1,000 cubic ft.); steam, 0·33 pf. per kilo (= 3·36s. per ton); coal, 4·8 pf. per kilo (= 48·87s. per ton).

* Abstract of an article in [illegible] E.T.Z., [illegible] 1026-1028.

BOOKS RECEIVED.

[illegible] Journal of the Institution of Electrical Engineers. London: E. & F. N. Spon.) Vol. LIII., No. 248. Pp. 665. 6s. net.

[illegible] Proceedings. London: Longmans, Green & Co.) Vol. IV., Part I. 1914. Pp. 70. Vol. Part IV., Index. 1914. Pp. 75. 18fr. per year.

[illegible] of the Washington Academy of Sciences. Baltimore: The Waverly Press.) Vol. V., No. 9. Pp. 415-502.

Bulletin of the Bureau of Standards. Washington: Government Printing Office.) Vol. 11., No. 2. Pp. 149-240. 25 cents.

The Physical Review. Lancaster, Pa.: American Physical Society.) Vol. V., No. 4. Second series. Pp. 79. $0.60.

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THE WORK OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The appearance of the annual report of the Institution of Electrical Engineers provides an opportunity for reviewing the work of this Society, and gives an insight, which is obtainable only once a year, into the Council's policy on certain questions, apart from the technical matters which come up for discussion when Papers are read. As might be expected, the present report, which was submitted at the annual general meeting yesterday, is somewhat unusual in character, owing to the outbreak of war during the period under review. This permitted a new and unexpected field of activity, and the Council took action without delay in order to assist the authorities as far as possible. What has since taken place in this direction is already fairly well known. Among other measures, a circular letter was issued inviting members to place their services at the disposal of the Institution in connection with the Army and Navy, public services, &c., and in response to this circular over 1,600 offers of services were received, including some 500 offers for service in the Army or the Navy. A circular was also sent to the electricity supply undertakings informing them of certain offers of services. A number of vacancies in power stations were filled in this way, but it was soon found that the supply of unemployed station men was very small. Later, in the recruiting of the Engineering Units of the Royal Naval Division, the Institution co-operated with the Institutions of Civil and Mechanical Engineers. Quite recently the Institution has assisted in the formation of an Engineers' Volunteer Corps, and this matter is still under consideration.

Turning to the more practical side of life, we find that soon after the outbreak of war the Council appointed a Committee to keep in touch with the British Electrical and Allied Manufacturers' Association in regard to the question of securing for British manufacturers some of the trade hitherto carried on by Germany and Austria-Hungary. A number of meetings were held with representatives of the B.E.A.M.A., but no very effective results seem to have been obtained. The conclusion was reached that the con-

tinuance and expansion of British trade after the war will mainly depend on economic principles and on the commercial industry and initiative of British manufacturers, and that no useful action on the part of the Institution appeared to be possible. The question was considered whether a Paper on certain aspects of foreign competition should be discussed; but the B.E.A.M.A. came to the conclusion that no useful result would be so obtained, and at their request the idea was abandoned. This episode, we think, serves to show how very difficult it is to make satisfactory headway on these ultra-commercial topics. If there had not been co-operation with the B.E.A.M.A., and if this conclusion had not been expressed by the B.E.A.M.A., we can quite imagine that the Council of the Institution would have been subjected to a good deal of criticism for not bringing forward some scheme, or taking some public action, in regard to German trade. We confess that we are in general agreement with the conclusion that has been reached, but we nevertheless consider that a good deal of useful work might be done by some of the engineering institutions combining to consider what is practicable in the way of trade organisation. If anything is ever to be done in this direction, surely now is the time.

Another subject which has been under consideration by the Council is the much-debated subject of periods for repayment of municipal loans. It is well known that the Local Government Board has shown a tendency in recent years to cut down these periods, and a good deal of complaint has justly arisen on this account in respect to certain kinds of plant. It may well be argued that it is a very mistaken policy to have loan periods exceeding the life of the plant for which the money has been borrowed; but, at the same time, it is certainly a hardship if the period is much less than the probable life. The types of plant which have come most under discussion in this connection are electric mains and accumulators. As a result of inquiries, the Council has come to the conclusion that the period for mains might very well be 30 years, provided the construction is substantial and that the mains are laid with due regard to the nature of the soil. It is suggested, also, that the period for substantial conduits might be 50 years, and that the period for accumulators might be extended to 15 years where adequate provision is made for proper maintenance. We are glad to note that the Council intend to make representations to the Local Government Board on these lines in due course.

Another line of activity relates to smoke abatement, in connection with which the Local Government Board Departmental Committee on this subject invited the Institution to give evidence last session. Although some evidence has been collected, the matter has now been adjourned indefinitely on account of the war.

From this brief summary it is clear that the Council has the needs of the industry at heart, but we think it would be well if they would take members more frequently into their confidence. When a statement of activities is made only once a year, members are apt to feel that nothing is being done during the intervals. This objection might be removed very readily (now that the "Journal" is published once a fortnight, not to mention the readiness of the weekly electrical journals to publish such details), and probably a useful purpose would be served if the Council were to give details in selected instances, after deciding not to deal with certain subjects, why this decision was reached. Such a procedure would tend to remove misapprehension, and would be quite as useful as an account of work actually carried out, and about which there is no question of its desirability.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Wireless Telegraphy. By W. H. MARCHANT. Pp. xi. 241. London: Whittaker & Co. 5s. net.

The preface states that "this book is intended primarily for the use of those engaged in the practical operation of radio-telegraph installations and for students who already possess some knowledge of electrical science." These words describe its scope well enough. The book is quite elementary in that it assumes no previous acquaintance with wireless, but it omits the experiments with rubbed amber and so forth, and proceeds in the first chapter to the subject proper, "Electric Oscillations and Waves."

The treatment is orderly, and a good table of contents is provided. After the introductory first chapter, there are chapters on the transmitter, the receiver, detectors and the testing buzzer. The next five chapters describe the special features of the Marconi, Poulsen, Telefunken, Lepel and Goldschmidt systems. Then follow a chapter on portable sets, another on various high-frequency measurements—a subject which can hardly be dealt with satisfactorily in a book of this character—and four chapters of a miscellaneous nature. It will be seen, therefore, that the book aims at being fairly comprehensive; and consequently, with only 238 pages of large print, including 154 figures, the treatment cannot be in any way thorough. In our opinion, such unproved devices as the Poulsen high-speed transmitter and receiver, and the Telefunken sound intensifier, might with advantage have been omitted to give room for an adequate treatment of more practical subjects, such as antennæ and crystal detectors.

Looking through the book in detail, we note that electric oscillations are described with reference to inductance some pages before the paragraph wherein inductance itself is explained; and in that paragraph, in likening the current opposing property of inductance and resistance, the distinction as to energy dissipation is unfortunately not made. The few lines on p. 15, describing the process of radiation from the antenna will, we fear, lighten no whit the black darkness encompassing most readers on this subject. "The charging current of an accumulator should not exceed 20 per cent. of the capacity of the cell" is an example of regrettable loose wording, and an astonishing paragraph referring to rotary converters states that "the relation between the direct voltage and current and the alternating current and voltage will be if the D.C. voltage and current are each 100–70·7 volts 141 amperes alternating." Such floundering is merely unpleasant to the initiated, but constitutes a terrible load to the latter. The [illegible] buzzer is shown only in the electrostatic arrangements to detector being made to the much more useful shunted buzzer method.

We have noticed a few cases of downright error. In describing the Marconi synchronous spark system the author states that the spark takes place when the alternator E.M.F. is a maximum; actually it is at or near the moment of zero E.M.F. Both description and diagram of the Fleming valve receiver omit the polarising E.M.F., and in Fig. 46, for the electrolytic detector, the common but fatal mistake is made of connecting up the potentiometer in such a way as to short-circuit the detector to the high-frequency P.D. In the

chapter describing the Poulsen system. Fig. 88 shows the operating key joined halfway up the jigger, instead of at the earthed end; and it is stated that the tikker is not able to receive spark signals, which is quite a mistake.

Fig. 82, consisting of a series of separate connection diagrams of the Marconi multiple tuner for different positions of the main switch, is likely to be helpful to operators. The ingenious logarithmic chart in Fig. 150, relating the inductance, wave-length and capacity in oscillating circuits, is an interesting feature in the chapter on measurements.

In any future edition we hope the irritating consistent misuse of the plural form, antennæ, to connote the singular will be rectified.

L. B. TURNER.

Graphical Determination of Sags and Stresses for Overhead Line Construction. By GUIDO SEMENZA and MARCO SEMENZA. Translated from the Italian by C. O. MAILLOUX. Pp. x. + 24 + 13 charts. (London: Hill Publishing Co. 12s. 6d. net.

In his preface the translator bewails the fact that the great majority of overhead lines are installed with an utter disregard of all scientific principles. The "instrument of precision" most relied upon is the "eye" of the lineman or foreman. The job looks well when done, which is usually when the weather conditions are very favourable. When storms rise and the lines fail it is put down to dispensations of Providence, when, strictly speaking, it should be put down to ignorance of the staff. The purpose of the present book is "to provide a method of determining sags and stresses which, while based rigorously and solidly upon sound scientific principles, is so simple in its application and in its practical use that an intelligent lineman or foreman can use it without difficulty." We have grave doubts, however, whether any lineman or foreman will be found who will appreciate the alleged simplicity of the process. A trained engineer, however, would find the charts very useful, and could readily draw up instructions as to sags and strains to meet various conditions. Without some guidance the book would be of little use to anyone who was not familiar with graphs, for, in the directions for using the charts, there are references to "intersections of the ordinate," "the hyperbola," "the scale of abscissæ," and so on, all calculated to bewilder even an intelligent lineman. The book contains only 23 pages of text and 13 charts; the textual matter is divided into five parts: (1) General considerations; (2) construction of the charts; (3) manner of using the charts; (4) the values of wind velocity, ice coatings, temperature limits, allowable stress, &c., including the regulations on these matters, issued in various countries (this fourth part contains a lot of useful data); and (5) a mathematical appendix.

The method employed is as follows: A coefficient is found from a chart giving the ratio in which the load on the span is increased, due to the assumed wind velocity and thickness of ice coating. Blondel's idea of a hypothetical span, equal to the real span multiplied by this ratio, is then introduced, and in order to simplify the treatment, the curve is assumed to be a parabola instead of a catenary. From the formulæ thus obtained the charts are plotted, and one can read off the sag at any temperature for any given values of the hypothetical span and the tension in the wire. Only copper lines are considered. There can be no doubt that to anyone who has to make such calculations, the charts would prove of great assistance, but we are sorry to have to say that anyone reading the book would be very liable to give it up in disgust before getting to the charts, for we have never seen a book containing so many printer's errors in such a small compass. There are many errors, too, for which the printer cannot be blamed, and although a loose errata slip is supplied it merely deals with about half-a-dozen of the errors. Even the list of symbols [illegible] that one can only find out what they really mean by working backwards from the equations in which they occur. Thus, on p. 2

[illegible]

we find equations on p. 3, containing X, the meaning of which is to be found on p. 17. Also, on p. 3, one reads: "When it is *not* desired to take the action of the wind into account," followed by a formula involving the velocity of the wind; the mystery is solved by omitting the word *not*. References are given to equations which have evidently been subsequently renumbered without readjustment of the references. Curves are said to be drawn for given *abscissæ*, meaning parameters. On p. 15 we read $P_r = xv^2ld$ (*see* p. 8), whereas on p. 8 $P_v = xv^2d$. On p. 18 we are informed that "$\beta > 0$, and, therefore, $\cos \beta \geq 1$." One would not object to such idiosyncrasies as "vaies with the diamere," but when one finds on p. 19 seven misprints in formulæ and things of numerical importance, one's sympathies go out to the "intelligent lineman," who, through this book, is to be initiated into methods of scientific accuracy.

Notwithstanding these defects, if one is engaged in this branch and cannot read the original, he will certainly find the charts of great use, and will understand them much better for having spent a few hours purging the text.

G. W. O. HOWE.

THE GAS TURBINE.

BY SYDNEY F. WALKER.

A considerable amount of discussion as to the possibility of running a turbine by gas has taken place from time to time. Among other pronouncements has been one which appeared fatal to the idea, viz., that the temperature of the resultant gases formed by the combustion of the fuel would be too high for any turbine to work in. Yet the gas turbine is an accomplished fact. It was worked out in Germany on a small scale some few years back; and just before the war an apparatus to furnish 1,000 H.P. was built. It was arranged in very much the same manner as the vertical Curtis turbo-electric generators, the dynamo being fixed above the turbine. An overall efficiency of 20 per cent. was claimed for the 1,000 H.P. plant when running on very light load, only furnishing the exciting current for the dynamo. The writer understands that in this plant some difficulty was experienced in the operation of the valves, and also that it was not found practicable to work the whole of the explosion chambers. Probably if it had not been for the outbreak of the war and the general disturbance which preceded it everywhere, these difficulties would have been overcome; possibly they may have been overcome by now; and the turbine would have been on the market.

The turbine is worked on the impulse principle, and the difficulty of the high temperature referred to above is overcome by causing the hot gases formed by the combustion of the fuel to expand down to 12 lb. per square inch absolute.

A completely new departure has been taken in the gas turbine, so far as the use of gas as a prime mover is concerned. In the internal-combustion engine it will be remembered that the working fluid is formed in the power chamber. The cylinder of the internal-combustion engine is an explosion chamber and a power cylinder combined. In the impulse gas turbine that has been worked out in Germany, the explosion chamber is separate from the power member. In the apparatus to furnish 1,000 H.P. there were 10 explosion chambers, grouped round the axle of the turbine. The explosion chambers were in the form of irregular ellipsoids, something like a number of bags of Scotch bag pipes, with the mouth-pieces all turned inwards towards the axle. The explosion chambers were nearly pear-shaped, with the neck of the pear, as it may be termed, turned inwards towards the axle of the turbine, and the necks carried the delivery valves for the hot gases. In each explosion chamber there was an entry valve for air, and another for gas or liquid fuel. The apparatus was tried with almost every kind of fuel from gas, producer gas, petrol of various specific gravities, gas oil, tar oil, and coal dust. The only form of fuel with which it could not be worked was coal dust.

Attached to the apparatus are air and gas pumps, on very similar lines to those of the two cycle gas engines that have

done such good work, and the cycle of operations is as follows: Air is forced in into each explosion chamber in turn under pressure, and when the air pressure inside of the chamber reaches a certain figure, the air entry valve is closed. The gas entry valve is then opened, and gas, or one of the other fuels mentioned, is forced in also under pressure. Where liquid fuels are employed a spraying apparatus worked by compressed air, on similar lines to that employed with the Diesel engine, is added. When the charge of gas or liquid fuel has been forced into the explosion chamber, the mixture is fired by electric sparks passing between contacts fixed in several portions of the chamber. With liquid fuel, the inventor prefers to force the fuel in in gusts, very much in the same manner as steam is forced into some of the earlier Parsons turbines. His idea is, that by forcing in the fuel in this manner, mixing with the charge of air is more thoroughly accomplished. The reason for the multiplication of sparking requires no explanation; it is merely a device to secure complete combustion of the charge. On the combustion of the charge the temperature is raised, the pressure following, and when the pressure has risen to a certain figure, the outlet valve in the neck of the explosion chamber is opened, and the hot gases forming the products of combustion are forced out through a conical nozzle, very similar to that used with the De Laval and Curtis turbines. The hot gases expand down in passing through the nozzles, very much in the same manner as the steam expands down in the nozzles employed with the impulse steam turbine. From the nozzle the cooled and expanded gases pass through the turbine rotor. The writer understands that the rotor of the 1,000 H.P. machine had only one disc, and that it ran at 3,000 revs. per min. A fan is employed at the other end of the exhaust, to assist in drawing the hot gases through the rotor of the turbine. When the hot gases have passed through the turbine, a blast of air is forced through the explosion chamber, to perform the same office as in the case of the Diesel engine, and the two cycle gas engine. It will be remembered that in both of these engines the air which enters the cylinder first, after the completion of the power stroke, is devoted to scavenging the cylinder; it sweeps out the remainder of the exhaust gases and cools the cylinder to a certain extent. The arrangement in the gas turbine, it appears to the writer, has a distinct advantage over that in the two-cycle engine. With the two-cycle engine, as is well known, there are considerable complaints of inefficiency due to the presence of a portion of the exhaust gases in the cylinder, at the commencement of the succeeding charge. The time available for scavenging is so small, it forms such a small fraction of the stroke, that except under very favourable conditions, complete scavenging is not possible. A small percentage of the resultant gases are left in the cylinder, and the efficiency of the succeeding stroke is lowered, owing to the dilution of the succeeding charge of gas, and to the raising of the temperature of the succeeding charge both of gas and air. With the gas turbine, as worked out in Germany, the scavenging air has a very much longer time to perform its work. The scavenging air does not pass through the rotor of the turbine. A by-pass is provided for it, so that the cooling effect of the air upon the explosion chamber is obtained without lowering the efficiency of the conversion at the rotor.

The outlet valve of the explosion chamber is kept open until the scavenging is complete; it is then closed and the air proceeds to fill the chamber to the required pressure, gas being forced in under pressure, and the cycle proceeding as before.

In the small model of the gas turbine with which the early experiments were made, and which furnished [illegible] horse-power, the valves were worked mechanically; but in the apparatus made for 1,000 H.P. they were worked by oil. A distributing valve, something on the lines of the distributor for the ignition current for automobiles, was employed. It consisted of two concentric cylinders, the inner one revolving. A pressure of oil was maintained by means of an oil pump in the inside of the inner cylinder, and a slot in the inner cylinder, as it revolved, came in turn opposite slots in the outer stationary cylinder. The slots in the stationary cylinder led to the different valves in the different explosion chambers that were to be worked in turn. As the slot in the inner cylinder came opposite the slot leading, say, to the air entry value of one of the explosion chambers, that valve was opened by the oil pressure delivered to it, and it remained open for the period during which the slots remained opposite each other. The valve was closed by the removal of the oil pressure, allowing a spiral spring to come into play. It will be seen that by a proper arrangement of the oil distributing valve the gas and air entry valves and the outlet valves were opened in turn, and kept open for the right time.

The ignition was by a magneto, which came into operation when the speed of the turbine reached a certain figure. For starting, an accumulator and induction apparatus was employed. The exhaust gases were also employed in the 1,000 H.P. apparatus to raise steam in an auxiliary boiler, the steam being used to drive a small engine for working the fan and the gas and air pumps. It will be remembered that the heat in the exhaust gases has already been employed to raise steam in connection with large gas engines in this country and on the Continent, particularly where the gas is obtained from a producer. In all forms of gas producer steam is used, and it has usually been found that the exhaust gases furnish sufficient steam, if properly applied, for the purpose. It is claimed that the gas turbine occupies only about one-third of the space required for a gas engine to furnish the same power, that it weighs only about a quarter, and that the maximum degree of irregularity is very much less than with the gas engine.

It goes without saying that if the gas turbine establishes itself, and if anything like the efficiency claimed for it in Germany is obtained, on extended trial, it should be very much more economical for driving electricity generating stations than either steam or the gas engine. A point that may perhaps be noticed is the pressure in the explosion chambers with the gas turbine is very much less than in the gas engine under ordinary conditions.

FRICTIONAL ELECTRICITY ON INSULATORS AND METALS.*

BY W. MORRIS JONES.

Summary.—The author has conducted a large number of experiments on the [illegible] with both insulators and metals. He describes the apparatus used, and gives the results of his work. A theory is outlined to account for the results obtained.

As there seems to be but little known about frictional electrification, the experiments described below were undertaken with the object of discovering new facts which might be of assistance in forming a quantitative theory. In these experiments, after the method adopted by Morris Owen,† measurements were made of the charge produced on a surface by friction and of the frictional work [illegible] in generating it.

The rubbing [illegible] consisted of a [illegible] wheel round the rim of which rubbers of various soft materials were placed. The wheel, of moderate moment of inertia and 0·8 cm. thick, turned in bearings fixed in a wooden framework, and could be set into rotation by a known weight falling through a measured height. The weight was attached to a cord passing over a light pulley in the ceiling and wound round a wooden drum fixed on the wheel. A vertical pole graduated upwards in decimetres gave the distance through which the weight fell. In later stages of the work the wheel was driven by an electric motor of variable speed. The specimens rubbed were usually discs about 1·2 cm. in diameter, and were of various insulating and metallic materials. They were mounted with an insulating cement on small T-shaped stems of ebonite, which could be firmly fixed to a ebonite holder. Fig. 1 illustrates the apparatus used. A rub was effected by releasing the wheel, which was then set rotating by the falling weight, the specimen being separated from the rubber just before the wheel came to rest. Immediately after a specimen was rubbed, the holder supporting it was quickly withdrawn from the socket and suspended by a string over a deep metal jar into which the specimen could be lowered. The jar was placed inside, and insulated by quartz from a larger earth-connected jar, which served to increase

* Abstract of an article in the "Philosophical Magazine."

† "Phil. Mag." XVII., p. 457 (1909).

the capacity and to shield the inner jar from outside influences. The inner jar was connected by a fine wire passing through sulphur plugs in the outer to the upper plate of a parallel plate condenser, and also to one of the terminals of a quadrant-electrometer, the lower plate of the condenser and the other terminals of the electrometer being permanently earthed. The deflexions of the needle were observed by a telescope and illuminated scale. The zero of the scale was obtained by earthing the terminal of the electrometer by means of a suitable mercury-cup key operated by a string. The whole measuring system was enclosed in a wooden box with a window for the electrometer, the inside of the box being covered with tinfoil and earthed. The box served to shield the whole apparatus from external influences, and by means of drying agents inside it kept the apparatus perfectly dry. The needle of the electrometer was suspended by a platinum wire 0·01 mm. in diameter, and throughout the experiments was maintained at a potential of 100 volts by a small battery of Weston cells.

In measuring the charge on a specimen after a rub, the zero of the electrometer was first observed, the earth connection removed, and the specimen lowered into the jar and the deflection noted. The insulation of the apparatus was frequently tested. Before each rub, the specimen, holder and rubber were completely discharged by exposure to radiations from radium.

The scale was calibrated by the difference of potential due to a known current passing through a known variable resistance. The capacity of the measuring system was determined by the method of mixtures, using a standard condenser. Knowing the capacity of the electrometer and accessories, and also knowing the potential of the insulated quadrants corresponding to any deflection of the needle, the charge producing that deflection was obtained.

In rubbing the specimens care was taken to bring the middle part of the specimen evenly into contact with the rim of the rubbing wheel. It this was not done, the deflection obtained with insulators was always too small owing to the smaller area of contact. It was also

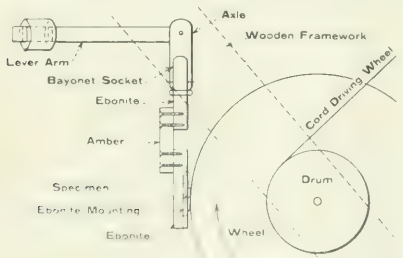


Fig. 1.

found necessary to give the insulators a rest after each rub, for if an insulator was rubbed a number of times in succession the deflections rose to the maximum, though the work done was the same for each rub and less than that required to give the maximum for a first rub. The insulators rubbed were fused quartz discs, quartz crystal, glass, polished ebonite, amber, sealing-wax, and crystals of fluorspar, Iceland spar, and heavy spar. The rubbers were bands of flannel, silk and chamois leather wound round the rim of the wheel, the axle of which was earthed, and the normal thrust between specimens and rubbers was in all cases 178 grams weight.

Tables are giving showing the charges in electrostatic units produced by various quantities of frictional work represented in joules, when four typical specimens were rubbed with flannel, silk and leather. The results are shown in Figs. 2 and 3. They show, as observed by Péclet* and Owen†, that with a sufficient amount of work, the charges reach a constant maximum. Results have been obtained for the other materials rubbed and have been plotted as curves, which show a similar form.

Table I. gives the values in electrostatic units of the maximum charges produced on the insulators by friction with the rubbers. It is interesting to note that the transparent insulators were positively charged when rubbed with the three materials, and that the opaque substances all became negatively charged.

[illegible] the experiments with the metals, the rubber [illegible] and electrometer, otherwise the charge [illegible] through the rubber to earth as fast as it was

* Ann. de Chimie et de Physique," LVII. p. 337. 1834).
† Loc. cit.

Table I.

Specimen.	Maximum charge in E.S.U. when rubbed with		
	Flannel.	Silk.	Chamois leather.
Quartz	10·950 (−)	9·761 (−)	7·557 (+)
Glass	8·818 (−)	10·725 (+)	2·212 (+)
Fluorspar	7·085 (+)	11·596 (+)	1·260 (+)
Iceland spar	8·817 (−)	11·818 (+)	1·236 (+)
Heavy spar	4·151 (−)	11·521 (+)	0·945 (+)
Ebonite	11·022 (−)	7·872 (−)	4·250 (−)
Amber	10·707 (−)	7·870 (−)	4·726 (−)
Sealing-wax	9·269 (−)	6·770 (−)	4·409 (−)

produced. For this reason the metallic specimens were rubbed only with silk bands. The insulation of the silk was frequently tested by bringing the cap of a charged electroscope into contact with the band when on the wheel, and observing the rate at which the leaves collapsed. In rubbing the metals, reversals of the sign of electrification were frequent, and appeared to be due to several causes. If the surface of the metal had become tarnished by oxide the charge generated was low and in some cases reversed in sign. This reversal was noticed in the case of zinc and iron. If the surfaces of these metals were rubbed when tarnished, the charge was positive for moderate amounts of rubbing and negative for greater amounts, whereas the surfaces when previously cleaned with fine emery-paper always showed a negative charge. Apparently the rubbing gradually wore off the film of oxide and ultimately produced a charge similar to that obtained on the pure metal. A reversal of the sign of electri-

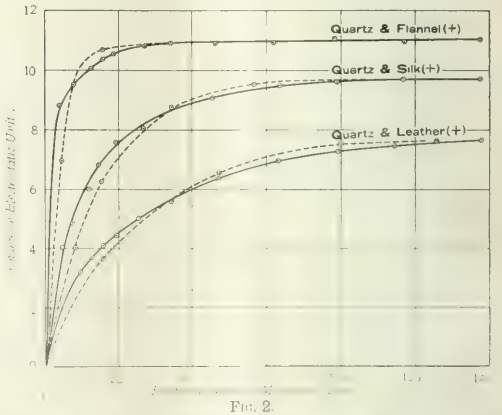


Fig. 2.

fication also appeared when the silk rubber had been used for some time, and was probably due to the silk having become smeared with oxide. A fresh silk band always gave an electrification of the proper sign when the cleaned specimens were rubbed.

When the metals were all cleaned with very fine emery-paper, all the specimens except thallium, lead and bismuth (which have the highest atomic weight) gave a negative charge at the first rub. Continued rubbing, however, produced a polish on the metals, and then it was found that the negative charges on aluminium, iron, copper, zinc and antimony became less and less and changed to positive, though the other metals, on continued rubbing, did not show this effect. Owing to these reversals and to the difficulty of preventing a roughened surface becoming smoothed out and polished by the friction, the specimens were, as far as possible, finally tested all with their surfaces at [illegible] degree of polish and with fresh silk bands.

The metals rubbed were [illegible], boron, aluminium, calcium, iron, copper, zinc, silver, tin, antimony, platinum, gold, thallium, lead and bismuth. The metals which could be obtained in the form of thin discs 1·2 cm. in diameter were soldered on brass cylinders [illegible] mm. thick, and second specimens were in some cases cemented on ebonite cylinders of the same thickness. Metals such as iron were made up to the same dimensions as the brass cylinders. All the above metals were rubbed for a maximum charge, and measurements of the charges produced by various amounts of work were also taken for a few typical specimens. In the case of the metals that readily tarnish in air, a few rubs were rapidly given immediately after cleaning their surfaces. The boron, supplied amorphous, had to be made up into a thick paste and allowed to set hard before it could be tested.

Some of the specimens employed were of the ordinary commercial grade of purity, those of the rarer metals being refined.

Fig. 4 shows the curves for some of the metals. In shape they are, as might be expected, very similar to those of the insulators. The maximum charge is, however, greater on some of the metals than on any of the insulators.

With the metals, capacity plays an important part in the value of the maximum charge generated. Three tin discs 1·2 cm. in diameter were mounted, one on ebonite and the other two on brass cylinders 3 mm. and 1 cm. thick. On being rubbed, the specimen mounted on the longer metal cylinder gave the greatest maximum charge, and the disc on ebonite gave the least, while the specimen on the short metal cylinder gave a charge of intermediate value. The three results in this case are shown in Fig. 4. Apparently, therefore, the charge generated on a metallic specimen by a given amount of work increases with the capacity of the specimen.

The following classification of the metals according to the sign of the charge shows that the metals examined can be divided into three groups :—

Au, Pt, Sn, Ag	Negatively charged when rubbed with silk.	Sb, Zn, Cu, Fe, Al	Positively charged if polished, negatively charged if rough, when rubbed with silk.
Bi, Pb, Tl	Positively charged when rubbed with silk.		

The sign and magnitude of the charge produced by the friction of the metals do not appear to be a well-defined physical property of

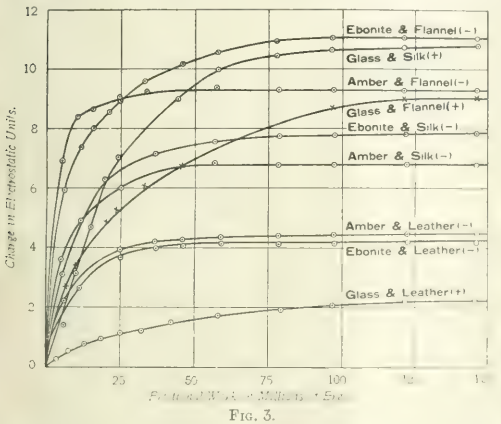


FIG. 3.

the metals. A possible relation between the maximum charges for different elements would thus be difficult to obtain, since, except with metals of high atomic weight, the sign of the charge seems to be largely determined by the physical state of the surface, and not merely by the nature of the material rubbed. If the maximum charge obtained by the friction of the surfaces of the metal, polished when possible, is compared with the atomic weight, examination shows some evidence of a periodicity in property with increase of atomic weight, and that, like some other physical properties of the elements, this property possibly conforms to the Periodic Law.

Some of the insulators and metals were rubbed in strong magnetic and electric fields, but no change in the maximum charge produced was noticed. The influence of temperature on the maximum charge was also investigated, and in this case also no change observed. In some experiments the rubbing wheel was driven by a [illegible] and the influence of pressure between rubber and specimen and that of velocity of the rubbing surface were investigated. From the results obtained, it appears that the maximum charge is independent of the pressure and of the velocity *

General Conclusions. It has often been suggested that frictional electricity is of the nature of contact electricity, the frictional work being expended in bringing the surfaces into contact.† It should, however, be noted that in Owen's experiments, mere contact without rubbing did not in any case produce the [illegible] charge on his specimens, and the same result [illegible]

* This result was stated by Péclet.

† Helmholtz, "Wissenschaftliche Abhandlungen," Erster Band, p. 860.

of the present experiments. Frictional electricity appears, therefore, to be an effect of a different order from that of contact electricity, and it is worth while considering whether the facts cannot be accounted for on some other hypothesis. Let us assume that the rubbing friction has the effect of removing electrons from either the rubber or the specimen at a rate proportional to the rate of working. Then if e is the total quantity of electricity liberated by a quantity of work w, we may write

$$\frac{de}{dt} = a\frac{dw}{dt} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where a is a factor depending on the nature of the materials and also upon the normal thrust between the bodies; a is a constant during any one experiment.

We now assume that during a rub, leakage of electricity takes place at a rate proportional to the total charge present, Q, and to the rate at which fresh surface of the rubber is coming into contact with the surface of the specimen, the total leakage being e'. The velocity of the rubber is proportional to the rate of working, so that this law of leakage may be written

$$\frac{de'}{dt} = b\frac{dw}{dt}\cdot Q. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where b is also a constant. The total charge existing on the specimen will now be

$$Q = e - e'. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

From these equations we find

$$\frac{dQ}{a - bQ} = dw,$$

which, on being integrated, gives

$$Q = \frac{a}{b}(1 - \epsilon^{-bw}). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

the constant of integration being determined by the fact that Q and w vanish together. On this theory the frictional electricity reaches a constant maximum value, a/b, when the generation of charge is compensated by the leakage.

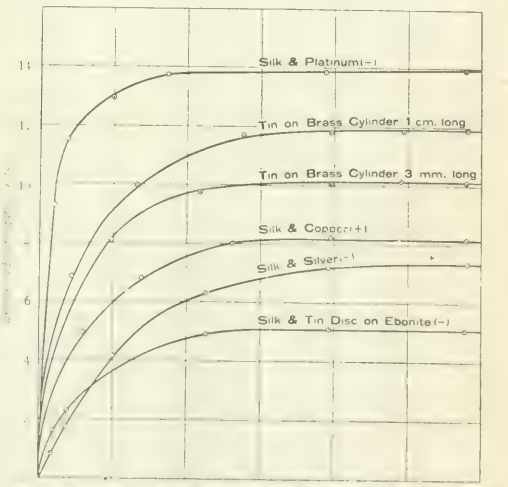


FIG. 4.

The constants a and b, of (4) can be determined by any pair of values of w and Q on the experimental curve, and Q can be calculated for other values of w. As a rule, the theoretical curves so obtained show fair agreement with the experimental curves, the chief difference being that the calculated curve is generally rather steeper in the middle part of the curve. [illegible] the way are shown in Fig. 2 for [illegible] and [illegible] all [illegible] the

In order to account for the result that the maximum charge is independent of the pressure, it appears that a and b must [illegible] the same function of the pressure. In the case of the metallic specimens, where $Q = CV$, if C is the capacity and V the potential of the specimen, the [illegible] in equation (2) should be assumed to be proportional to V, in other words, the coefficient b is

inversely proportional to the capacity. It follows by equation (4) that in the case of two specimens of the same material but of different capacities, the maximum charge should be greater for the specimen of greater capacity, and that the slope of the rising portion of the curve should be steeper for this specimen. Less work should be necessary, therefore, to produce any given charge in the case of the specimen of greater capacity. These results agree with the facts as indicated by the curves of Fig. 4. It seems probable, therefore, that a satisfactory theory of frictional electricity can be formed on the lines indicated, though in the form given above the theory is doubtless far from perfect.

AN ELECTROSCOPE FOR LECTURE TABLE USE.

In his recent lectures at the Royal Institution on photo electric phenomena, Dr. J. A. Fleming made use of an ingenious form of electroscope which he has devised for lecture purposes. The ordinary gold-leaf electroscope will not bear electrification to more than a few hundred volts, and the fragile nature of the leaf renders it liable to be destroyed by any incautious charging. In Dr. Fleming's electroscope a slip of brass about 0·25 in. wide and 2 in. long is fixed vertically on the top of a corrugated ebonite or sulphur pillar. The top of this metal slip is slightly bent over. A rectangle made of fine aluminium wire of nearly the same width and length as the slip of metal is attached by two very short cocoon silk fibres to the top of the rectangle, and these fibres are wetted with a solution of chloride of calcium to make them conduct. When the system is not charged the rectangle hangs vertically in contact with the metal slip. If a charge is given to it the rectangle stands out at an angle (*see* Fig. 1).

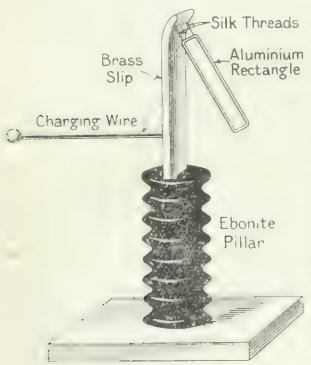


FIG. 1.—THE FLEMING ELECTROSCOPE.

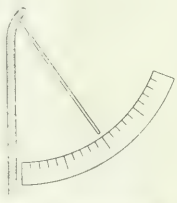


FIG. 2. SCALE FOR ELECTROSCOPE.

It is essential that all edges of the metal shall be carefully rounded so as to leave no sharp points. To the back of the metal slip may be attached a thin wire ending in a small ball, which is convenient for making contact with electrified objects. For lecture purposes the image of the electroscope can be projected on the screen by placing it in a parallel beam of light and employing a projecting lens and erecting prism. Dr. Fleming employs as a screen a large sheet of paper, on which a curved arc divided into degrees is drawn. The radius of this arc is adjusted to be the same as the length of the image of the aluminium rectangle, so that the end of that image moves over the arc (*see* Fig. 2). Such an electroscope will bear electrification to 10,000 or 20,000 volts, and is very convenient for exhibiting certain experiments in lectures.

Thus, one of Dr. Fleming's experiments in photo-electricity was as follows:—

A separate sheet of coarse brass gauze was placed on an insulating stand and connected to the above electroscope. A charge of positive electricity was given to the gauze. A beam of light from an arc lamp was thrown on the gauze. The electroscope maintained its steady deflection. It however, a sheet of recently polished zinc or magnesium was held closely behind the gauze, so that the light passing through the meshes fell on the zinc, the electroscope was very quickly discharged. This is because the light liberates negative electrons from the polished zinc, and these are projected on to the gauze and neutralise the positive charge.

To exhibit the relative photo-electric qualities of different substances Dr. Fleming made use of an arrangement of the following kind. On an insulating stand was placed a disc of the substance to be examined. This disc was illuminated by electric sparks taken between points of the alloy Invar, which yields a copious supply of ultra-violet light. This light is allowed to pass down a card tube, and fall on the disc. The top of this tube is closed by a very thin quartz plate to keep back any material particles.

Around the disc, but protected by the tube, and by a screen from the direct action of ultra-violet light is an insulated brass ring which can be connected to an electroscope made as above described. If then a positive charge is given to this ring and a disc, say, of polished zinc placed on the stand, the electroscope will hold its charge as long as the sparks are not passing between the Invar points. If, however, the zinc disc is illuminated by the spark light, and if the zinc disc is connected to earth, the electroscope will at once begin to lose its charge. This is because the liberation of negative electrons from the zinc causes a neutralisation of the positive charge on the adjacent ring.

In this manner discs of various metals, polished and unpolished, can be tested. Dr. Fleming showed the great effect of polish in promoting this photo-electric discharge, and explained the phenomena of photo-electric fatigue as being chiefly due to a film of air which is adherent to the surface of every solid body, but is for a short time removed by polishing at a high speed by an emery buff.

Amongst other interesting facts shown by Dr. Fleming was his discovery that in the case of the pairs of substances used as rectifying detectors in wireless telegraph receivers, such, for instance, as the zincite-chalcopyrite or galena-plumbago or molybdenite-copper rectifiers, one element of the pair is always highly photo-electric and the other is not. Thus, chalcopyrite and galena are highly photo-electric, and rapidly lose electrons under the action of ultra-violet light; but plumbago, zincite and molybdenite are very non-photo-electric.

This interesting fact may serve as a clue to some more complete elucidation of the reasons for this unilateral electric conductivity in the contact between certain pairs of substances.

PHYSICAL SOCIETY.

At the Meeting held on May 14th at the Imperial College of Science, London, S.W., Dr. A. RUSSELL, M.A., Vice-President, in the chair, a Paper entitled

"Precision Resistance Measurements with Simple Apparatus,"

was read by Mr. E. H. RAYNER.

The Paper describes methods by which the comparison of resistances can be made to an accuracy of 1 in 10,000 or higher by using simple apparatus usually available in electrical laboratories, or which can be easily constructed with little skilled assistance. The comparison of nominally equal resistances of 1 ohm and upwards by the usual method of shunting one side of a nearly balanced quadrilateral by a high resistance is mentioned, and variations on this when only part of one resistance is shunted are often useful. The great advantages of having resistances capable of carrying comparatively large currents is illustrated, especially for measuring changes of resistance of commercial apparatus under working conditions. The determination of errors in a volt box for use with a potentiometer is described at some length. This is of especial importance in precision photometry. If a sufficient continuous-current voltage is not available for testing such apparatus as high-potential dividers, it is shown that using sufficient continuous current to secure sensitivity the heating may be supplied by superposed alternating current. Resistances in common use are very generally of simple numerical value, and a Kelvin bridge specially designed for the comparison of such resistances is described. It consists essentially of two rows of 25 resistances of 20 ohms each.

Colonel SQUIER thought the Paper was very useful and likely to be generally helpful.

Mr. F. E. SMITH thought the Paper would prove of considerable service to many who were faced with the problem of measuring accurately resistances of indeterminate types. He might take exception to the lettering of the diagrams. Ever since 1861 all bridges had been lettered P, Q, R and S. The custom was practically universal, and it was advantageous to follow it in all cases. The author stated that when the current in a bridge is reversed the potential of the galvanometer is suddenly altered. This was not so in the case of equal ratio arms. Again, it was stated under Fig. 1 that A and B, when not equal to P and Q, should be in series as regards the supply current to obtain maximum sensitiveness. He worked out on the board a case in which this did not hold. The method of substitution, while of extreme usefulness, was not always the best to employ in a given case, and he showed an arrangement for use with a resistance with potential leads which was simpler and more convenient in practice. With regard to the measurement of

measurable resistances, he pointed out that in the type of bridge used for resistance thermometry we had ready to hand all that was necessary for the determination of any resistance to a very low to quote a high value with great accuracy. Moreover, no test could be calculated with ease, which was a considerable advantage.

Mr. DUDDELL said that with regard to the building up of resistances, he had in his laboratory a large number of 1,000 ω coils which were capable of carrying 0·1 ampere. By arranging these in series and parallel combinations he could readily obtain any ratio he wished, and the building up of a potentiometer with these coils was very easy and convenient. An advantage in the use of high resistance coils such as 1,000 ω for work of this kind was the relative unimportance of the connection errors, which were very small if the resistances had substantial plug contacts.

Mr. A. CAMPBELL said that he had introduced the system of non-inductive winding on a bimetallic frame about 15 years ago, and had been publicly in use in the National Physical Laboratory for many years. It appeared to have been patented recently by a foreign firm. The lessening of the inductance is obtained by winding a left and right-handed coil in the same set of channels and connecting them in series, tying the contiguous pairs of wires closely together. The capacity is well distributed it many channels are used. In a simple method which he has also used for many years, a single wire is taken through a large number of loops, in each of which the wires are very close together, and each channel carries a single loop.

Mr. C. C. PATERSON said that it was inevitable when working with ordinary resistances on a high voltage that a good deal of heat should be dissipated. In potential dividers one makes the coils all of the same wire, measures the ratios at low currents and relies on these remaining the same at high currents. This is not the case, however, the ratio altering by an appreciable amount depending on the precise position of the portion from which the voltage is picked off—*e.g.*, at the end or the middle of the coils—on account of unequal temperature distribution. He instanced a case in which errors of two or three parts in 10,000 were introduced from this cause, and said that the method of superposing an alternating voltage on a small direct-current voltage was very useful for determining the ratios under the working conditions of heat dissipation.

Mr. D. OWEN was surprised to observe that the author claimed to measure a resistance to 1 or 2 parts in 10 million. With coils of platinum-silver a change of temperature of 1°C. would change the resistance by about 260 parts in a million, yet no temperatures were stated in the examples quoted, nor was any reference made in the first method to the heating effect of the current in the various resistances. He thought that the Paper, therefore, gave a wrong impression of the precision which was possible in such measurements. In the method to which Fig. 2 applies the author requires four measurements to eliminate the resistance of the connecting piece. Could this not be much simplified by connecting the galvanometer to the middle of L, thereby reducing the measurements to two? As regards the 2·6 law connecting R and C, he failed to see how it was possible to neglect, as the author had done, the heating of the three-in-series three-in-parallel group. Each component of that group would carry one-third as much current as the single resistance, and would, therefore, have one-ninth as much heat dissipated in it. The neglect of this might account for the departure from the square law.

Dr. C. V. DRYSDALE, in a communication which was read by the chairman, said he was surprised that the author had adopted the method of shunting in place of the more convenient slide wire. In 1907 he had combined the principles of the Carey Foster and Kelvin bridges in a bridge which was simple to construct and susceptible of the highest accuracy. When the resistances compared are nearly equal their difference is given directly in millionths of their value. By means of a self-contained ratio bobbin it is possible to step up or down so as to obtain most of the uneven ratios which are required. The bridge forms an accurate series of standards built up from a single unit, and is, moreover, self checking. In Mr. Rayner's bridge contact errors in connecting his ratios do not seem to be eliminated, and it is not self checking. He was pleased to see that the author realised that contact errors can be minimised without great loss of sensitiveness by keeping the resistance of the ratio coils moderately high. In practice these need never be reduced below 10 or even 100 ohms.

Mr. RAYNER, in reply, said that it seemed easier in discussing bridges to use such letters as A B for the resistances to be compared and other letters well separated from them in the alphabet for the secondary resistances. He had often been troubled in lecturing by the awkwardness of methods by the difficulty of keeping in mind those [illegible] P, Q, R, S are used. Any criticisms by Mr. Smith on the arrangement of the resistances in the quadrilateral at right angles to the slide wire were welcome. He agreed with Mr. Duddell as to the size of unit to be used when a number of resistances are to be used in series and parallel. They should not be less than 1,000 ohms, unless errors are very carefully guarded against. He agreed with Mr. Owen that a sensitiveness to such a figure as, say, 1 in 10,000,000, does not necessarily imply similar accuracy of measurement, and the proof of the full use of the sensitivity lies in reproducing the numerical value on repeating the measurement. All the examples given here [illegible] in the paper. The author did not mean that identically the same shunting resistances have been required on repeating a series of measurements, as very small temperature changes in a few minutes will affect the result. [illegible] that it, for instance, on repeating a given experiment [illegible] resistance C required in the one position at one time was [illegible] is found in the other position, leaving out the [illegible] full advantage of the symmetry created. The [illegible] of connecting the galvanometer to the middle of L in Fig. 2 [illegible] of the resistance of the end contacts. He did not think he should call Dr. Drysdale's methods "simple" and available with apparatus ordinarily to be found in any laboratory or easily constructed with little skilled assistance. The other points he mentioned must wait till he could examine them in detail.

A Paper entitled

"Some Novel Laboratory Experiments,"

was read by Mr. F. W. JORDAN.

The experiments were the following:

Condensation Calorimeters for the Measurement of Latent and Specific Heats. It is shown how an ordinary vacuum jacket flask can be converted into a suitable condensation calorimeter. Errors arising from loss of heat and excess of the vapour are thus eliminated by making two experiments. Another condensation calorimeter is constructed on a different plan which also eliminates the same errors.

Thermal Conductivity of a Narrow Metal Bar. Gray's apparatus for the measurement of the conductivity of a narrow bar has been modified for the purpose of rendering the loss of heat relatively small, and reducing the time taken in the measurement, thus introducing the experiment to the elementary student.

Measurement of Poisson's Ratio for Rubber by the Lathe. The rubber is attached to opposite sides of the bed by the measurement of the anticlastic radius of curvature and Poisson's ratio is then deduced from the observations in the usual manner.

A Method of Measuring the Coincidence Period of a Kater and a Clock Pendulum. The Kater and the clock pendulums are electrically connected so that when at the centres of their swings a momentary current passes through a telephone receiver.

Differential Telephone Receiver. An ordinary receiver is connected to the secondary of a simple differentially wound transformer, and it is thus converted into a differential receiver for the purpose of electrical measurement.

Experiment on Interference Fringes. The fringes produced by a Lloyd's mirror in white light are nearly achromatised by a simple grating on smoked glass. Other suggestive interference effects with the grating are also described.

Mr. F. E. SMITH asked why in the thermal conductivity experiment four rods were used instead of one of four times the cross-section?

Mr. H. MOORE admired the ingenuity of the pendulum experiment, but thought that to make an experiment too simple and free from corrections made it much less instructive to students. He thought the eye and ear method of observing coincidences was one in which students should be trained as much as possible.

Mr. JORDAN, in reply to Mr. F. E. SMITH, said that the use of four thin rods rather than one thick one was advisable, as there was a smaller temperature drop between the end of the rod and the calorimeter when the former was thin than when it was thick.

A Paper entitled

"On Electrically Maintained Vibrations,"

by Mr. S. BUTTERWORTH, was taken as read in the absence of the author.

CORRESPONDENCE.

THE GYROSCOPIC COMPASS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the interesting article on gyro compasses published in your issue on the 14th inst. Mr. F. M. Denton seeks to show that there is with all such compasses an error due to latitude. As far as the Sea Star compass [illegible] mentioned he hurries to conclude the case of the latter [illegible] to show that he is incorrect. So that the demonstration should be clear a brief description of the compass will be useful.

The Sea Star compass consists of a wheel which can rotate about the horizontal axis of its axle and which is mounted in a casing which in turn is mounted in a frame so that the casing and the wheel can turn about a horizontal axis perpendicular to the axle of the wheel. The axle being also a diameter of the wheel. The frame is mounted in another frame in such a way that it together with the casing and wheel can rotate about a vertical axis which passes through the intersection of the axis of the wheel's axle with that of the casing. The wheel and the casing can turn freely about these respective axes, but the motion [illegible] of the outer frame about the

E

vertical axis is controlled in the way now to be described. A pendulum hangs from the casing so that it can swing about the horizontal axis of the latter but not about the axle of the wheel. The pendulum carries two strips of metal, insulated from one another and with a narrow gap between them. On the casing a roller is fixed so that for certain relative positions of the casing to the pendulum the roller is in contact with one or the other of the metal strips. Contact of the roller with either strip closes a circuit for an electric motor, the arrangement being that contact with one strip causes the motor to rotate in the reverse direction to that when contact takes place with the other strip. The motor turns the frame, &c., about the vertical axis. Thus motion about the vertical axis depends upon the position of the casing relative to that of the pendulum.

When the roller is in the gap between the metal strips there is no impulse to cause rotation, and the axle of the wheel is perpendicular to the plane of the pendulum. Except when it is being accelerated in the direction in which it can swing, the pendulum is always vertical. Hence, the roller being in the gap, the axle of the wheel is nearly always horizontal. When the roller is in contact with either of the strips, that is to say, when the axle of the wheel is not horizontal, there is, as explained above, motion about the vertical axis. The direction of this motion is arranged so that, by means of it, the axle of the rotating wheel tends to become horizontal. So far the description; it will now be shown that the Sea-Star cannot have any error due to latitude.

Imagine the compass to be stationary with respect to the earth, and the axle of the wheel to be placed perpendicular to the meridian. The wheel is caused to rotate about the axis of its axle. By the rotation of the earth the wheel is moved in space, but because of the rotation about the axis of the axle it tends to remain with the axle parallel to its original position. The pendulum, being under the influence of the earth, moves relative to the wheel. This brings one of the strips on the pendulum into contact with the roller on the wheel-casing. Movement about the vertical axis immediately takes place, and the axle of the wheel moves towards the meridian. Besides this, the casing and wheel swing about the horizontal axis perpendicular to the axle of the wheel. The roller moves into the gap and then into contact with the other strip. On contact being made, movement about the vertical axis again takes place, but in a direction opposite to the previous one. The axle of the wheel turns away from the meridian. The amount of movement, however, is less than the amount when it turned towards the meridian, because relative to the casing the pendulum is continuously moving in the direction of the swing of the casing and wheel about the horizontal axis. In other words, the time of contact is smaller for the second contact than it was for the first. The rotation about the vertical axis and away from the meridian causes the casing to swing towards and into contact with the strip it was at first in contact with. A movement about the vertical axis and towards the meridian results. The amount of movement is greater than the preceding movement away from the meridian; for the casing and pendulum are now moving in opposite directions, and the time of contact is, therefore, greater than the preceding one. Thus the axle of the wheel gradually turns towards and ultimately arrives at the meridian. Beyond this position the axle cannot permanently turn, for if it did turn in that manner the relative motion of the casing and the pendulum would cause it to return to the meridian; or, more correctly, keep it swinging about the meridian. For, when the axle approaches the meridian from either one side or the other its ends are moving in closed curves due to its swinging about the vertical and horizontal axes. It is only at the meridian where there is a balance of the turning influences, so that, once the axle is in this position there it remains with its ends moving in curves, symmetrical about the meridian.

This is true for all latitudes. The Sea-Star compass, therefore, does not require to be corrected for latitudes. Mr. Denton says it does. How does he fall into this error? In his article he describes the behaviour of a gyrostat which has its freedom suppressed about the horizontal axis perpendicular to the axle of the wheel's axle. The Sea-Star is free to turn about this axis. Its behaviour is, consequently, different from that which he discusses, and is, as has been shown, such that the axle points north-and-south at all latitudes.—I am, &c.,

London, May 21. WALTER LONGLAND.

BIBLIOGRAPHIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Many of the lecturers in our engineering colleges and schools are, for various reasons, unable to offer their services for fighting purposes, and the several Government Departments appear to have no openings, as yet, for such men. I am writing to you to suggest that the engineering colleges could perform invaluable service by preparing bibliographies of engineering literature.

I have in course of preparation such a bibliography, in card index form, of the literature of lifting and hauling machinery. This includes cranes of all kinds, hoists, lifts, conveyors, transporters, cableways, capstans, winders, haulage gears and allied subjects. When complete the work will be handed over to one of the engineering institutions, and it is hoped that we shall be able to make copies for the different engineering centres interested in machinery of this kind.

As it is desired to make the bibliography as complete as possible, I shall be grateful to any of your readers for copies of Papers, or for references to Papers and articles. The information given on each card comprises subject, title, author, nature of contribution, brief summary, source, length of contribution, number of arrangement, detail and line drawings, curves and half-tones.

A sample 6 in. by 4 in. card is enclosed for your inspection.—I am, &c.,

H. H. BROUGHTON.

The Hollies, Surrenden-road, Brighton, May 22.

HIGH-VOLTAGE WATER RHEOSTAT.*

BY L. L. CLARK.

Some time ago the writer had occasion to make an efficiency test on a steam electric plant under conditions that were somewhat out of the ordinary. The plant consisted of two 1,000 kw., three-phase, 2,200-volt alternators, with two banks of transformers for stepping-up the potential to 19,100 volts. It was desirable to include the entire station equipment, boiler, engine, generator and transformers of one entire unit in the test. It was necessary, therefore, to place the load on the high-tension side of the transformers, or at 19,100 volts. After numerous interesting experiments, load was secured by means of a water rheostat. The water available was limited in quantity. The supply consisted of condenser water, which originally came from an artesian well and from conservation of rain water. This water was collected in a cooling pond from which it was circulated through the condensers. The water in the pond had a resistance of approximately 100 ohms per inch cube. The artesian well supplied little more than enough water for boiler feed. This had a resistance of 200 ohms per inch cube. The low resistance (100 to 200 ohms per inch cube) as compared with approximately 1,000 ohms per inch cube for fresh water was due to the large amount of minerals, principally soda, which was present. The low resistance, together with the limited quantity available, is the feature controlling the design of a rheostat. The cooling pond covered about 3 acres and had a maximum depth of about 16 ft. An attempt was made to secure a load by placing electrodes at the points of an equilateral triangle suspended in the cooling pond. This plan was abandoned when it was found that the maximum spacing resulted in practically a short circuit. A very satisfactory load was obtained on a rheostat constructed according to the accompanying description.

Description of Rheostat.—The rheostat was designed for operation with the artesian well water. As it came from the well this water was collected in a pool having a capacity of about 10,000 gallons, and constructed with its top level with the ground. From this pool it was pumped to a tank of about the same capacity placed on the roof of the station. From this tank was obtained the water for the plant. To supply the rheostat with water two 2 in. lines were used to connect the plant water system to the boiler having three outlets, each of

* Article in the "Electrical World," slightly abbreviated.

which was provided with a valve. A separate outlet was used for feeding water to each leg of the rheostat. The water was conducted to each leg through 50 ft. of cotton fire hose and 20 ft. of open flume. It was allowed to cascade from the hose into the open flume, which was set with a very steep incline, then allowed to cascade again from the flume into the box constituting the rheostat. The hose and flume were well insulated from the ground. As will be noted by referring to Fig. 1, the feeder system forms a Y-connection with the header acting as an earthed neutral. In this feeder system the cross-section of water was made as small and the length of the path as long as possible, in order to introduce a high resistance. The calculated resistance in this water-feeder system was approximately 8,000 ohms per phase.

The rheostat consisted of three open boxes, about 21 ft. long and 18 in. square, Y-connected. These were separated at the points of the Y by about 5 ft. and came together in a common box which

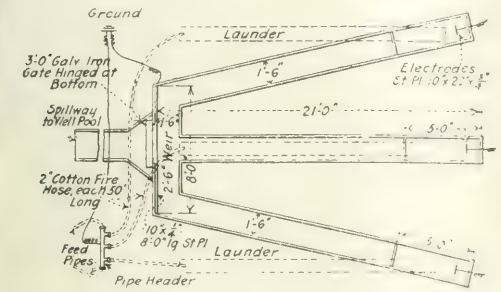


Fig. 1.—Plan of Water Rheostat

formed the neutral of the Y. In this neutral was placed a heavy steel plate which was permanently earthed. The whole rheostat was carried on 33,000-volt pin-type insulators. Feed water was introduced at the electrodes and circulated through each leg of the rheostat from electrode to neutral. A deep weir was cut at the neutral and a gate was inserted hinged at the bottom and arranged to open outward, the pressure of the water tending to open the gate. After passing over this gate the water was collected in a spillway and carried back to the well pool, from which it was again pumped into the piping system of the plant. This formed a complete circuit for the water, and none was lost save that due to evaporation.

The rheostat was constructed with an extra depth at the electrodes, as shown by Fig. 2, for the purpose of allowing for the use of greater

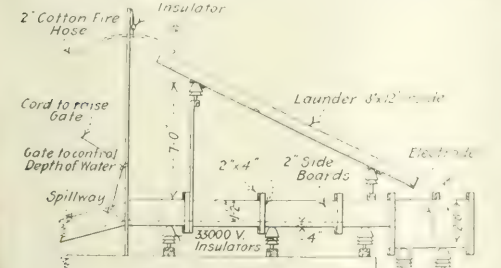


Fig. 2.—Side Elevation of Water Rheostat.

surface area of electrode and to provide for balancing the load by changing the position of the electrode with regard to the neutral. A cord attached to the gate was carried through the window of the power house to the table in it, where the meters for measuring the load were installed. The load was regulated by varying the height of the gate, thus varying the cross-section of the water in the rheostat.

The resistance of the water decreased very rapidly with evaporation. To maintain a uniform density the supply system was thrown wide open when the test was started. In this way evaporation was reduced to a minimum and the density of the water in the rheostat was held constant. It was found unnecessary to shift the electrodes in order to balance the load, as this was accomplished by varying the density of the water in the different legs of the rheostat by adjusting the supply of feed water admitted to that leg. This was done by adjusting the valves at the earthed neutral in the feed water system after the power had been switched on. During this test excellent control was obtained on loads ranging from 500 kw. to 1,200 kw., and it is believed that the load and control could have been secured for a load varying from 250 kw. to 2,500 kw. with the same apparatus. An interesting feature in connection with the control of the load developed during the test. Before the test was completed the supply of artesian well water showed signs of becoming exhausted. It was found necessary to introduce water from the cooling pond. This water had a resistance of only about one-half that of the well water. However, when introduced into the rheostat the load was readily held constant by emptying a part of the water from the rheostat, thus reducing the cross-section of the water in the boxes.

There is little doubt that this form of rheostat could be varied to take care almost any desired voltage and a very wide range of load.

LEGAL INTELLIGENCE.

Adams v. Thrift and others.

The Court of Appeal (the Master of the Rolls and Lords Justices Pickford and Warrington) recently dismissed the appeal of the defendant, Dr. Clarke, from a judgment of Mr. Justice Eve. Plaintiff, a shareholder in the Stolz Electrophone Co. (1913) (Ltd.), claimed damages against the directors (Sir J. Thrift, Lord Rosmead, Mr. R. A. Buddicom and Dr. G. F. Clarke) in respect of alleged false statements in the prospectus. The managing director and promoter (Mr. J. Holt) was a bankrupt. Plaintiff alleged that the prospectus contained several misstatements, that the shares were worthless at the date of allotment, and that he was entitled to recover the £300 he had lost by applying for his shares. Mr. Justice Eve held that plaintiff had made out his case of misrepresentation, but that Lord Rosmead, Sir J. Thrift, Dr. Clarke and Mr. Buddicom were the victims of the rascality of Holt. He held Dr. Clarke thought the promoters' statements were true, but the production of a prospectus signed by three colleagues did not afford a reasonable ground of belief for Dr. Clarke. He gave judgment for plaintiff for £300 and costs.

For defendants it was now contended that there was no suggestion that the directors (other than Holt) had been anything but entirely honest, or that they had been guilty of any fraud. What was alleged was that they had been negligent; but it was argued from the evidence that Dr. Clarke had reasonable grounds for believing that all the statements in the prospectus were true.

Without calling upon counsel for the respondent, their Lordships dismissed the appeal with costs, the Master of the Rolls saying that the prospectus contained a mass of misstatements which had been inserted by Holt. He thought Dr. Clarke had been negligent in accepting Holt's statements without proper inquiry.

Electrical Apparatus Co. (Ltd.) v. Canadian British Engineering Co. (Ltd.)

Last week in the City of London Court plaintiffs sued for £70. 18s. 6d. for goods supplied. The evidence showed that defendants ordered plaintiffs to send the goods to Canada. Plaintiffs had the goods specially manufactured, and then asked defendants' instructions about delivery, but as they did not receive instructions the goods were left on their hands. The secretary of defendant company said they could not pay at present. Ninety per cent. of their creditors in Canada and the greater part of the creditors in England had agreed to a scheme whereby they were to have six months' extension of time. If judgment was given against them defendants would have to go into liquidation. Plaintiffs said they did not wish to act vindictively and judgment was entered for them for £67. 3s. 6d.

Re W. T. Glover & Co. (Ltd.). On Friday last Mr. Justice Astbury sanctioned the proposed extension of the objects of the company. Mr. Peterson, K.C., said the company was a prosperous one, and for the economical and convenient working of the existing objects, as well as for the advantageous combination with other classes of business, it was proposed to acquire and work lead, copper and coal mines, and to smelt the ores and refine and treat the copper, lead and bituminous. The company also took power to sink wells, and with other companies to construct bridges across the Bridgwater Canal for the extension of its works.

PARLIAMENTARY INTELLIGENCE.

Provisional Orders. In the House of Commons on the 19th inst. a Bill was introduced to confirm the provisional electric lighting order granted by the Board of Trade (with the concurrence of the L.G. Board) constituting a Joint Board, consisting of the representatives of the urban districts of Wath-upon-Dearne, Bolton-upon-Dearne and Darfield-cum-West Riding of Yorks., for the joint exercise of powers under the Electric Lighting Acts in respect of their respective districts.

Electric Lighting Provisional (No. 1) Bill, which confirms the Clifden and Leenane provisional orders, has been read a second time in the House of Commons.

The Bill to confirm the Hartlepool Provisional Order has also been introduced and read a first time.

Electric Lighting Provisional Order (No. 2) Bill, which confirms the Haworth, Ilkley, Hull Extension, Kirkburton, Normanton, Litherland, Ryde (Amendment), Shipton, Stanley and Tenby provisional orders, has been read a third time.

London Electric Companies' Facilities Bill.—The Standing Orders Committee of the House of Commons have decided to dispense with the Standing Orders not complied with by the promoters so as to allow the Bill to proceed this Session.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1913 Specification.

1914 Specifications.

2,323 Cimingham. Electric arc incandescent lamps.

refractory substance, between on of the electrodes

4,220 De Lange & Fischer. Support for the heating conductor of thermic telephones and a method for its manufacture. (8/9/13. Addition to 4,184/14.)

8,842 Price & Callender's Cable & Construction Co. Electric cables.

9,558 Tucker & Crabtree. Electric switches. (Cognate application. 21,175 14.)

10,015 Parsons & Ball. Electric clocks.

10,504 W. R. Sykes Interlocking Signal Co. & Tarrant. Electric relay.

10,531 B.T.-H. Co. (G.E. Co. of America.) Electric motor control systems.

An electric motor control system comprising a single-phase source of supply, a phase converter and one or more polyphase motors, means for connecting the corresponding phases of the converter and motor or motors, first in series, then in parallel, and finally again in series if desired.

10,533 Alternating-current track signalling.

10,534 Peter. Electrically-operated point or signal actuating mechanism.

10,549 Davies & Railing. Relays connected with electric signalling in mines and the

10,775 Lyle. Telegraph transmitting apparatus.

10,807 Western Electric Co. Selective signalling systems for party lines.

A party line signalling system wherein the stations may be signalled from a source of current at each end of the line, in which means is provided at each station adapted automatically to taper the resistance of the line to the calling current, so that the electro-responsive devices at the stations will receive approximately the same amount of current irrespective of which of the two sources of current is used.

10,822 Collis & Crompton & Co. Operations on alternating-current distributing systems.

10,938 Alexander. (Union Switch & Signal Co.) Electrical control and operation of railway points and the like.

12,913 Kropp. Electric impulse-producing mechanisms. (29/7/13.)

13,538 Strohmenger. Electric welding and fusion deposition of metals.

13,706 Geb. Sulzer (Firm of). Centrifugal governors for internal-combustion engines of vehicles having electric power transmission mechanism. (16/9/13.)

14,861 Midgley & Vandervell. Manufacture and construction of commutators for dynamo-electric machines.

20,168 Bretteli. (Apple Electric Co.) Electric lighting and battery charging systems for automobiles and analogous purposes. (Divided application on 10,251/14. April 25.)

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

April 23, 1915.

6,114 Sheahan & Sayer. Inserts for tramway and like tracks.

6,135 Hall. Construction of insulated conductors for electrical purposes.

the like.

April 26, 1915.

6,178 Marr & Lister. Protecting electrical conductors.

6,197 B.T.-H. Co. (G.E. Co., U.S.) Controlling mechanism for automobiles.

6,217 Agner. Wireless telegraphy. (8/6/14, U.S.)*

6,222 Markt. Combined electric switches and plug couplings.*

April 27, 1915.

6,250 Adams & Adams. Meter.

6,253 Wall. Method of obtaining a sparkless break of an inductive electrical circuit.

6,259 Bachelet. Electro-magnetic projectile transmitting apparatus.

6,296 Mauclaire & Breon. Arc lamps.

6,302 Mellersh-Jackson. (Commonwealth Electric Tool Co., U.S.) Electrically-actuated tools. (Divided application on 21,143/14. Oct. 17.)*

April 28, 1915.

6,408 B.T.-H. Co. (G.E. Co., U.S.) Electric motors.

6,412 Jones. Electric-arc soldering.

April 30, 1915.

(1/5/14, Germany.)*

6,466 Ries. Combined electric light fitting and clock.

6,469 B.T.-H. Co. (G.E. Co., U.S.) Controlling mechanism for dynamo-electric machines.

Wireless Te tubes suitable for use in wireless telegraphy. (Divided application on 13,247 14. May 29.)

6,480 Turner. Telephone systems. (20/6/14, U.S.)

6,486 Lee de Forest. Wireless telegraph and telephone systems.

6,495 Svenska Turbinfabriks Aktiebolaget Ljungstrom. Rotary field magnets. (22/6/14, Sweden.)*

May 1, 1915.

6,499 Tiddeman. Railway signalling apparatus.

6,542 Mackenzie. Electric signalling system for railways.

6,551 Imray. (Samuel M. Kintner and Halsey M. Barrett, U.S.) Arrangements for transmitting and receiving signals by electromagnetic waves.*

6,558 Howard. Leakage protection device for electric cables.

3, 1915

6,592 B.T.-H. Co. (G.E. Co., U.S.) Lamps.

6,593 Pognon. Sparking plugs. (28/5/14, France.)*

Scott. Electric motors or dynamos. (Divided application on 16,093/14. July 6

May 4, 1915

6,635 Greenroyd. Carbon holder for arc lamps.

6,642 Moore. Combined electric switches and connecting plugs.

6,665 Leitner. Regulating electric circuits.

6,669 Hammond. Gaseous or vacuised detectors for radiant energy and method of controlling the action thereof. (Addition to 8,568 14.)*

6,671 Maglekilde Brondanstalt Radium Aktieselskab. Manufacturing radiaactive mineral water salts. (5/6/14, Denmark.)*

6,674 Beaver & Claremont. Leakage protection device for electric cables.

6,685 Wessel. Coin-operated electric supply apparatus. (4/5/14, Norway.)*

May 5, 1915.

6,699 Tateson & Roe. Illuminated advertising devices.

6,708 Kennedy-McGregor. Sparking plugs.

6,712 Grimaldi. Switch with rocking tongue for tramways and railways.*

6,715 Smyth. Electrical generators for lighting mechanically-propelled vehicles. (Divided application on 22,062/14. Nov. 5.)

6,723 Rosenberg. Equalising field windings for multipolar dynamo-electric machines.

6,727 Electro-Osmose Akt.-Ges. (Graf Schwerin Ges.) Manufacture of aluminium oxide. (8/5/14, Germany.)*

6,731 B.T.-H. Co. (G.E. Co., U.S.) Windings for electrical apparatus.

6,738 Mellersh-Jackson. (Commonwealth Electric Tool Co., U.S.) Electrically-actuated tools. (Divided application on 21,145/14. Oct. 17.)*

May 6, 1915.

6,753 Nussbaum. Microphones for wireless telephony.

6,805 Biles. Electric transmission of the energy of a heat motor to the driving wheels of a vehicle or the like. (Divided application on 10,275,14. April 25.)*

6,807 B.T.-H. Co. G.E. Co., U.S.) Stereoscopic X-ray apparatus.

6,813 Orling & Orling's Telegraph Instruments Synd. Amplifying the effects of small vibrations for telegraphic and other purposes.

6,818 King. Automatic switches of electric train-lighting systems.

6,820 Chaumont. Brake blocks for railway, tramway and like vehicles. (1/5/14, Belgium.)*

May 7, 1915.

6,846 Portway, jun. Switches for electric lamps and the like.

6,857 Schultz. Apparatus for forming insulation and like tubes.

6,859 Sharman. Electrical surveying instruments.

May 8, 1915.

6,895 Curtis, Mackley & Igranic Electric Co. Starting switches for electric motors.

6,898 A. P. Lundberg, G. C. Lundberg, P. A. Lundberg & Pegg. Electrical connectors.

6,930 Philip & Steele. Electrical measuring instruments.

May 10, 1915.

6,955 Brodie & Alison. Re-setting gear for signal indicators employed in mines and

6,979 Bassini. Transmission and reception of sound for use in submarine telephony.

6,980 Tanner & Claremont. Joint for an electric cable.

6,991 Landis & Gyr Akt.-Ges. Short-time switch. (23/5/14, Germany.)*

6,997 Siemens-Schuckertwerke G.m.b.H. Dynamo-electric machinery. (11/5/14, Germany.)*

7,006 Marks. (Landers, Frary & Clark, U.S.) Electrical toasting devices.*

7,013 Kettering & Chrysler. Dynamo-electric machines. (Divided application on 13,022/14. 14/7/13, U.S.)*

7,016 Capitani. Manufacture of tapes containing parallel electric wires. (9/5/14, Italy.)*

May 11, 1915.

7,080 & 7,081 B.T.-H. Co. (G.E. Co., U.S.) Electrical apparatus.

7,088 Midgley & Vandervell. Electric horns.*

7,092 Svenska Turbinfabriks Aktiebolaget Ljungstrom. Controlling means for electrically-propelled vessels. (17/9/14, Sweden.)*

May 12, 1915.

7,151 Cadenel. Switches.*

7,177 Grob. Switching-over apparatus for electrical lighting installations.*

May 13, 1915.

7,178 Kennedy. Sparking plugs.

7,206 Midgley & Vandervell. Electric starters for internal-combustion engines.*

7,211 B.T.-H. Co. (G.E. Co., U.S.) Electric circuit controlling devices.

7,212 Elektro-Osmose Akt.-Ges. (Graf Schwerin Ges.) Manufacturing aluminium oxide. (Addition to 6,727 15. 24/7/14, Germany.)*

7,213 Wahl. Electric cell, battery or refill for use in connection with portable electric lamps and for other purposes.

7,223 Aron & Hill. Control gear for electric starters for internal-combustion engines,

7,239 Bill. Electric switches.

7,244 Yarwood. Starting electric motors.*

problems arising in the transmission of electric power.

7,270 Fawssett. Electrical measuring instruments operating on the Ferraris or induction principle.*

7,271 Fawssett. Electric meters for the purpose of compensating for temperature variation.*

(Divided application on 6,102,14. March 10.)*

Electric

Dynamo-electric machinery. (11/5/14, Germany.)*

THE ELECTRICIAN COMMERCIAL & INDUSTRIAL SECTION.

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CHEAPER WIRING METHODS.

There has been a considerable amount of discussion recently in the American electrical journals on a suggestion which has been put forward in a number of quarters that some form of concentric wiring should be adopted in the United States. The subject has been discussed in that loose kind of way which would appear to be quite usual with technical, and for that matter, political affairs "on the other side." An impression appears to have been created by those who have conducted the correspondence and general discussion in the electrical press that concentric wiring and surface wiring generally are of necessity not only cheap but also nasty systems. The accepted methods of wiring in America and Canada which are sanctioned by the National Board of Underwriters are, in several cases, considerably below the standards of design and construction which obtain in this country. The knob and tube system, which appears to be quite common in American electrical installations, is not recognised in this country. Similarly, what is known as circular-loom duct, consisting of a tube of painted fabric, is not known over here. In fact, both these methods would be placed below the zero line of accepted British wiring standards. This fact does not in any way imply that they are not entirely satisfactory methods of wiring. Without an intimate knowledge of American wiring practice, and judging only from such literature as is available on the subject, we think that the standards of design and construction in American wiring practice are considerably below those which have been in vogue in this country for the past 10 years at least. Here again we make this comment in no disparaging spirit. In both cases the respective standards are mainly the product of indigenous conditions.

The development of what are known as concentric wiring systems in this country is undoubtedly the outcome of a desire to reduce the cost of installation. Both concentric and twin lead-covered wiring systems are now available with a standardised line of accessories and definite sizes of conductors suitable for the class of installation for which this method of wiring was primarily intended. Both the concentric and the twin lead-covered systems present neat forms of conductors which can be laid unobtrusively on the surface of the wall and ceilings, and in a general way can be installed with a minimum of labour and of cutting away at ceilings or under floors, &c. The chief economy effected by the use of this class of wiring material is obtained in its installation, and, so far as we are able to gather, this important fact has been overlooked by American installation engineers. They are inclined to condemn concentric and twin lead-covered systems on the score of cheapness not so much of installation but of quality of material. They appear to think that the introduction of concentric wiring would lower the standard of electrical installation in the United States below the level which the National Board of Underwriters has established as being safe from every point of view. We hasten to correct this impression. None of the special methods of surface wiring which has been developed in this country has been put on the market without an extended period of trial, and both the form of conductor and the design of the accessories for use in conjunction with it are the product of many minds and a great variety of practical experience.

Electric Pumping for City Water Supply.—Investigations made by the Baltimore Gas & Electric Co. have shown that electric pumping is the most economical method of pumping the entire water supply of Baltimore (U.S.A.). According to "Engineering News" pumps to the extent of 2,500 H.P. are to be installed and electric energy amounting to 6,500,000 units per annum will be required.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week May 17, 1915, to May 22, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

carbon electrodes, 60 pkgs.; elec. lamps, £347; unenumerated, £2,245—913 pkgs. merated, £136. *Sweden:* Elec. machinery, £484; elec. lamps, £19. *France:* Carbon candles, £200; elec. carbons and wire, 49 pkgs.; machinery, £855. *Canada:* Unenumerated, £13.

EXPORTS.

material, £16; unenumerated, £849. *Sydney:* Elec. machinery, £257; wire and cable, £110; unenumerated, £2,010. *Wellington:* Elec. machinery, £111; unenumerated, £63. *Adelaide:* Wire and cable, £1,100; machinery, £222; unenumerated, £100. *Brisbane:* Elec. machinery, £221; unenumerated, £220. *Fremantle:* Elec. lamps, £58. *Dunedin:* Elec. fans, £240; wire and cable, £85; unenumerated, £161. *Christchurch:* unenumerated, £18. *Hobart:* Unenumerated, £27. *Lyttelton:* unenumerated, £353. *Port Darwin:* Elec. machinery, £120. *Perth:* Unenumerated, £47.

merated, £121. *Cape Town:* Machinery, £136; wire and cable, £143; unenumerated, £519. *East London:* Wire and cable, £90; elec. machinery, £20; unenumerated, £49. *Delagoa Bay:* Elec. machinery, £32. *Beira:* Wire and cable, £21; unenumerated, £28.

EGYPT. *Alexandria:* Unenumerated, £116.

Petrograd: Wire and cable, £193; unenumerated, £764.

PORTUGAL.—*Oporto:* Unenumerated, £33.

CHINA.—*Hongkong:* Wire and cable, £194; unenumerated, £101. *Shanghai:* Wire and cable, £287; elec. machinery, £846; unenumerated, £243.

£2,300; telegraph material, £163; unenumerated, £1,500. *Calcutta:* Wire and cable, £1,187; unenumerated, £1,176. *Madras:* Elec. machinery, £41; wire and cable, £83; £593. *Bankok:* Wire and cable, £298; unenumerated, £49. *Port Swettenham:* Elec. cranes, 2,020; elec. machinery, £13. *Penang:* Elec. machinery, £480; wire and cable, £638; unenumerated, £201. *Rangoon:* Unenumerated, £201.

CANADA. *Montreal:* Unenumerated, £41.

£120. *Paris:* Unenumerated, £421. *Calais:* Unenumerated, £85. *Marseilles:* Unenumerated, £45.

merated, £408. *Rotterdam:* Wire and cable, £926; unenumerated, £83.

DENMARK.—*Copenhagen:* Elec. machinery, £125

U.S.A. *Philadelphia:* Unenumerated, £23

JAPAN. *Kobe:* Unenumerated, £197. *Tokio:* Unenumerated, £147. *Yokohama:* Unenumerated, £186.

GIBRALTAR: Unenumerated £36

MOLLENDO: Telegraph material, £34.

MALTA.—Unenumerated, £20.

FOREIGN GOODS (duty paid and free).

Lyttelton: Unenumerated, £75. *Auckland:* Unenumerated, £27. *Melbourne:* Unenumerated, £24. *Sydney:* Unenumerated, £74. *Paris:* Unenumerated, £542. *Dieppe:* Unenumerated, £30. *Barcelona:* £100; *Bombay:* Unenumerated, £21. *Yokohama:* Unenumerated, £2,500. *Hongkong:* Unenumerated, £85. *Petrograd:* Unenumerated, £164.

FOREIGN NEW GOODS (entered in Transit on through Bills of Lading).

Brisbane: Telephone apparatus, £2,150. *Calcutta:* Elec. lamps, £8; unenumerated,

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Messrs. Lyle & Freeman are moving to 40, Chancery-lane, W.C., [illegible] of the month. The telephone numbers will be Holborn [illegible] and the new telegraphic address will be "Potential, Holb, London." The firm will be glad to receive [illegible] catalogues [illegible] from those who [illegible] in their way of business.

[illegible] Messrs. A. Seager & Co. [illegible] approach [illegible] Hammersmith).

[illegible] H. Woodhouse [illegible] and manufacturing [illegible] has been acquired by the Fisher-[illegible] Co., Ltd., of Messrs. Lyle & Freeman [illegible] Electric [illegible] Speed [illegible].

Plant for Sale.—[illegible] Electrical Engineering Co., Ltd., Cathcart, [illegible] plant, consisting [illegible] sale [illegible] and electrical plant, including a Bellis steam engine and 75 kw. dynamo, 20 d.c. motors, 5 H.P. motor-driven electroplating set, motor-generator battery charging set, &c.

Alien Enemy Patents.—Messrs. W. T. Henley's Telegraph Works Co. have been granted a licence for Mirles patent, No. 5,198 of 1908. Messrs. Gilbert Gilkes & Co. have applied for a licence for Honold's patent No. 22,565, of 1912 for runners for Francis turbines.

Patent Development.—The proprietor of patent No. 11,154/1899, relating to "Galvanic Batteries," desires to make arrangements for working the patent in this country. Applications to Messrs. Cruikshank & Fairweather (Ltd.), 65 and 66, Chancery-lane, London, W.C.

The proprietor of patent No. 13,956 1909, relating to "Electric burglar alarm systems," desires to make arrangements for exploiting same in this country. Applications to Messrs. Wheatley & Mackenzie, patent agents, 40, Chancery-lane, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

A resolution has been passed to wind up voluntarily the Atlas Electrical Co. (Ltd.) and to appoint Mr. P. F. Hedges, 53, Cannon-street, London, E.C., as liquidator. A meeting of creditors will be held at 53, Cannon-street, London, E.C., on June 1.

An adjourned meeting of the creditors of Allen & Grosser (Ltd.), of Belfast, was held last week, when it was decided that the liquidation should be continued with Mr. Kennedy as liquidator. The committee appointed to look into the value of the assets recommend the sale of the assets to Mr. Allen (a director of the company) at a price which will give the creditors about 6s. 8d. in the pound.

Claims against Geo. Edwd. Hipkins, electrical engineer, 48, Wolverhampton-street, Dudley, are to be sent by June 1 to Mr. A. M. Fairbairn, 1, Priory-street, Dudley, preparatory to the payment of a dividend.

A first and final dividend of 9½d. will be payable on June 11 at 132, York-road, London, S.E., to creditors of Herbt. Jas. Godfrey, electrical engineer, lately trading at 188, Balham High-road, London, S.W.

Deed of Assignment.—A dividend is to be declared under a deed of assignment executed on Feb. 11, 1915, by Louisa Fellows, electric light contractor, 72, Victoria-road, Surbiton, and claims are to be sent by June 2 to Mr. G. F. Cotterell, Bolton House, Finsbury-pavement, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aldershot. As it is expected that the proposed new boiler plant at the electricity works should be installed at once, the money for carrying out the work on the basis of the accepted tender is to be taken temporarily from reserve, to be refunded if the new loan is sanctioned by the L.G. Board.

Manchester. An inquiry was held on Friday last, into the application of the Corporation for sanction to borrow £543,000 for the erection and equipment of a new electricity generating station at Barton.

The Deputy Town Clerk, Mr. P. M. Heather, said that as a consequence of the war very large demands had been made on the electricity undertaking, and, however much the previous necessity was, existing circumstances had rendered it imperative that the construction of the new station and the installation of the electric generating plant should be put in hand at once. The increased demands for electrical energy were entirely due to the increased current that was being supplied to engineering and other firms entirely for the purpose of the manufacture of war munitions. The municipal statutory area of supply, which was 46 square miles, had become absorbed in the industrial heart of England. Certainly within it were many large engineering firms with names known throughout the country, and those firms, with their smaller brethren, were [illegible] every possible effort to accelerate the output of munitions. In addition to those firms there were others also concerned with war [illegible] engaged in the manufacture of [illegible] cloth for uniforms, [illegible] and many things for the soldiers and sailors required. These firms were the largest consumers. With one exception, Manchester was supplying more current than any other undertaking for the manufacture of munitions of war. [illegible] could be reached at the end of the year, and one could [illegible] from [illegible] they had to tell their applicants to [illegible] they could have no more electricity. The Corporation Parliamentary Committee and other bodies had expressed support of the application.

Mr. Leo Electrical Engineer to the L. Passing, supplied technical details, and said that if the application were not granted the Electricity Committee would have to refuse all further increased supplies of current

Perth.—Last week the Electricity Committee made arrangements for laying the foundations for the new engine and dynamo recently purchased by them.

Willesden. The L.C. Board have sanctioned a loan of £1,112 for laying a feeder cable from Acton-lane sub-station to Craven Park.

It is proposed to substitute a feeder pillar to the present service boxes now in use on the cables at Craven Park. On the report of the electrical engineer (Mr. A. W. Blake) the committee recommend that deposits made on account of a supply of current be refunded to certain consumers after three years' satisfactory trading. Two applications for main extensions involving an outlay of £250 have been approved. It is proposed to interview the L.C. Board with a view to obtaining authority to raise part of the loans, amounting to £20,000, for prospective mains and services, sanctioned in August last. The committee is to hold a special meeting to consider the report of Mr. Blake on new terms for electrical bulk supply, estimates for new generating station, &c.

GENERAL.

Ashton-under-Lyne. The Council have decided to give a supply of electric current to Messrs. James Howe, of Hurst, subject to the consent of Hurst Council being obtained.

Glasgow. The following are the conditions for the exhibition and sale of electrical appliances at the showroom of the Corporation electricity department :—

The showroom shall exist primarily for the exhibition of electrical appliances. Electrical contractors and their customers shall be afforded all possible facilities for inspecting the stock of appliances kept in the central showroom. Any electrical contractor who shall request the Corporation to sell from the stock in the central showroom any fittings, accessories, lamps, or apparatus shall be entitled to receive out of the purchase price one-half of the discount which he would have received from the makers, had the contractor sold such apparatus to the customer direct. All fittings, accessories, lamps and apparatus sold from the showroom shall be at the usual retail selling prices current in the trade. All wiring work resulting from inquiries at the showroom shall be done direct by a contractor, and no undue preference shall be shown to any one or more electrical contractors. The hiring of apparatus shall not be undertaken from the showroom in the meantime, but the showroom management shall be free to lend apparatus for a short period to possible customers under exceptional circumstances, and make a charge, if they think fit, for the loan of such apparatus. All charges made to consumers by the showroom management shall be separately stated on the relative demand notes sent to consumers, and all sums paid to and obtained by the Corporation as a result of business done in the showroom shall be separately shown in the annual accounts of the Corporation electricity department, which accounts are audited by an independent auditor.

Stepney (London). The Council is recommended to limit expenditure on electric mains during the period of the war to giving a supply of current to consumers engaged on naval or military work.

It is only on the above condition that the L.C.C. will sanction the Council's application (which was made in November last) to borrow £15,000 for mains.

The plant, &c., necessary to enable the Council to give the Shoreditch Council the full supply of energy in bulk covered by the agreement between the two authorities will be available for use at the end of September next.

The Electricity Committee reports the purchase of 6,270 tons of coal at prices ranging from £1 1 6d to £1 4.

LIGHTING, POWER & HEATING NOTES.

Asylum Lighting. It has been decided to adopt the voltage of 220 for the electric installation at the new Park Prewett Asylum of Hants County Council. As regards the pumping machinery a double system of engines has been decided upon, one set of pumps to be worked by electricity and the other by a semi-Diesel oil engine. Electric driving will be adopted for the laundry machinery, the bakery and cold storage and for the auxiliary cooking plant.

Dundee.—The Cleansing Committee has decided to substitute electric for gas lighting in their premises in East Dock street.

Police Lamps.—Luton Town Council are recommended to equip the night police with electric lamps.

Stirling.—Mr. J. W. Papworth has been appointed consulting engineer to draw up the specification for wiring the new Municipal Buildings and to supervise the work.

TRACTION NOTES.

Birmingham.—The Tramways Committee report that it will be absolutely necessary to raise the [illegible] and loss of revenue due to the war.

A very heavy charge has to be met in respect of the [illegible] employees who have joined H.M. forces, and it is anticipated this will mean an addition to the expenditure for the year of about £22,000. Then increased wages will absorb another £16,000, and the [illegible] tax charges are put down at £10,000. In addition to [illegible] about £5,000 has to be taken into consideration [illegible] of electric current owing to the loss of experienced [illegible] drivers, and there is also the enhanced cost of materials, &c., and what is perhaps of more importance, the reduced revenue.

The increase in fares is about 10 per cent.

Bolton.—After a three days' strike, owing to a dispute about overtime, the Corporation tramway men resumed work on Tuesday.

The overtime rates at week-ends owing to the shortage of [illegible] by each motor, but the men have now agreed to undertake the work voluntarily, the Tramways Committee having promised to reconsider the question of a war bonus and other grievances of the men.

Halifax.—An accident occurred on the Corporation tramways on Saturday evening resulting in injuries to some passengers.

A tramcar, which was proceeding from Ovenden to Halifax, had got to the foot of a steep incline at Bee Bank when it [illegible] both tracks. Six passengers were admitted to Halifax Infirmary, their injuries, which were not serious, being mainly to the head, arms and [illegible]

London Tramway Strike.—The strike of L.C.C. and Metropolitan Electric Tramways men continues. On some routes there is a limited service, the number of cars running is being gradually increased, and it is stated that some of the men have returned to work.

Plymouth.—At the meeting of the Tramways Committee last week it was reported that, in pursuance of the minute passed at the last Council meeting, an agreement had been entered into with the Devonport & District Tramways Co. for the purchase of the company's undertaking on Tramway Act terms. It was stated that the company would transfer their lines to the Corporation on Oct. 2 next. The price to be paid for the property would be fixed by arbitration, the payment of the purchase money to be made within a month of the Corporation obtaining the necessary borrowing powers.

Women Tramcar Conductors.—At present there are 200 fully-trained women acting as conductors of Glasgow tramcars and there are many other women in training.

During the holidays women conductors were introduced on the Brighton Corporation tramcars.

At Accrington the manager has been empowered to engage women conductors if necessity arises ; women conductors will be paid at the same rate as the men.

At Preston a selection will be made from a large number of applicants. As an experiment 14 or 15 women will be put on Ashton-on-Ribble section and they will be paid the minimum rate for men (5d. per hour).

At Aberdeen "hundreds of applications" have been received from women who wish to act as conductors. A selection has been made by the tramways department, and these are being trained.

Women conductors are being engaged at Purley, Salford, Southend, &c.

York.—The Corporation have received an intimation from the Treasury that they have decided to sanction loans for the construction of the Hull road tramways, the Huxby road tramway extension and the building of the tramway [illegible] Fulford road.

TELEGRAPH AND TELEPHONE NOTES.

Radiotelegraph Note.—The Russian authorities have decided to erect and equip a radiotelegraph station at Novolandi, in the Odessa district, for receiving signals from the Eiffel Tower, Paris, with the object of time control.

EMPIRE NOTES.

Australasia. The "Australian Mining Standard" says Melbourne Tramway Trust recently decided to open negotiations with the Melbourne Tramway & Omnibus Co. with a view to purchasing the plant and rolling stock of the company, &c.

Wollongong (N.S.W.) Council received no regular tenders in response to a call for tenders for an electrical installation. Overtures were made by the Mount Pleasant Coal Co. and the Public Works Department's Port Kembla power house, and the Council are making further inquiries.

An Order in Council has been issued authorising the Barcaldine (Queensland) Shire Council to supply electricity in the town of Barcaldine.

Mr. T. K. Steanes, representative of Messrs. Heenan & Froude, recently wrote to Richmond (Victoria) Council stating that, owing to the [illegible] having been commandeered by the Perth Government in connection with war supply requirements, there was a doubt as to whether the company would be able to go on with the construction of the refuse destructor, and they asked that the signing of the contract be [illegible] The Council [illegible] £28 4s.

India.—"Indian Industries and Power" says important developments are to be expected in electric [illegible] India. A very favourable report has been prepared on the question of converting the [illegible] portion of the Bombay, Baroda & Central India [illegible] and the [illegible] and it is expected action will be taken up in the near future. [illegible] lead to the introduction of electric traction on other lines.

South Africa.—A Bill was read in the House of Assembly for the second time on April 12 providing for the expenditure of £13,604,800 by the Union of South Africa during the year ending March 31, 1916. Provision is made for railways and harbours, £3,000,000; public works, including buildings, &c., £130,000; and telegraph and telephone construction, £167,000. A further Bill provides for the expenditure of a further £443,161 on railways and harbours.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Sociedad Anonima Luz y Fuerza of Mendoza has brought an action in the Supreme Court of the Nation against the Government of the Province of Mendoza.

The company ask for recognition of the concession granted them under Provincial law No. 504 of Oct. 27, 1909, and for stay of the execution decreed on April 3 last relative to the construction of a dam on the river Mendoza, which execution would affect or impede the operation of the hydro-electric station of the company. The company also claims interest, damages and costs for the forfeiture of the concession.

The Supreme Court has given judgment in favour of the Compania Alemana Transatlantica de Electricidad in an action brought by them against the municipality of Moron, claiming cancellation of the municipal order of Oct. 13, 1913, which conceded the right of production and sale of electric energy in Moron to Messrs. M. Herlitzka & Co. The Alemana Company maintained that the order affected their rights, as the same authorities had previously conceded to them the exclusive privilege for 20 years from July 1, 1906, for the installation and exploitation of public and private electric lighting and other applications of electricity in Moron.

Chili.—The "Review of the River Plate" says the electric light and traction company of Valparaiso has demanded the rescission of its lighting contract with that municipality, owing to the non-payment of an account of a million and a-half dollars for public lighting.

France.—A consular report from Nantes states that the dock loading and unloading gear at that port includes 12 1½-ton, three 3-ton and one 30-ton electric cranes, and at the new Roche Maurice Wharf the Chamber of Commerce has erected 30 high c.p. electric lamps.

A report from St. Nazaire says that at the docks there are two 150-ton, two 1-ton and two 5-ton electric cranes

At Lorient the Chamber of Commerce propose to instal two 5-ton electric cranes on the new quay.

Electricity supply works are being erected by a company at Potée de Beurre, on the banks of the Scorff. Steam turbo-alternators of an aggregate of 750 kw. and generating at 6,600 volts will be used.

Spain.—A concession has been granted to Don Francisco T. Escoba, for the utilisation of the waters of the Rio Mundo (province of Albacete) for the production of electric power.

A concession for the construction and working of an electric tramway in San Cristobal de la Laguna (Canary Islands) has been awarded to the Sociedad de Trava's Electricos de Tenerife.

Swedish Trade Interests.—There is every indication that Swedish manufacturers and merchants are mobilising their forces with a view to taking the fullest advantage of the re-arrangement of trade organisation which must inevitably follow at the conclusion of the war. In all countries Swedish propaganda is militant, and British firms interested in Swedish trade are advised to keep themselves acquainted with the "Journal" of the Swedish Chamber of Commerce, published at 5, Lloyd's-avenue, London, E.C. (telephone, Central 6,338).

A table issued with the Year Book of the Swedish Chamber of Commerce in London shows that the electrical goods and apparatus (other than machinery and insulated wire) imported from Sweden to the United Kingdom in 1913 were of the value of £82,366, out of total imports of the same class, £1,587,294.

Swedish Exports.—The following articles are prohibited for exportation from Sweden:—

Wire ropes and cables, not insulated

Ditto, covered with lead or other metal, also in conjunction with other materials, and including electrical cables.

Ditto, with indiarubber or other insulating material not specially mentioned and including electrical cables.

Ditto, insulated, either wholly or partly with paper or asbestos or varnished, or any combination of these, including electrical cables.

Unmanufactured zinc and zinc scrap, zinc sheets, wire, pipes, anodes rods; also rolled zinc sheets (boiler zinc).

Frames for motor carriages and motor vehicles and for all vehicles for carrying merchandise; also wheels for automobiles.

MISCELLANEOUS NOTES.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade have issued lists 21 and 22 of articles which inquirers desire to purchase but whose sources of supply or markets have been interfered with by the war. Copies (by United Kingdom manufacturers and exporters of British goods) from 73, Basinghall-street, London, E.C.

London Fair and Market.—The Council of the Swedish Chamber of Commerce in London has offered to assist the International Trade Exhibitions (Ltd.) in making their London Fair and Market, to be held March 14 to 24 next, known to Swedish manufacturers, in the same manner as the French Chamber of Commerce in London is doing. In the "Journal" of the Swedish Chamber for June a translation in Swedish of the prospectus of the exhibition will be published.

Prohibited Exports.—Manufactures of aluminium have been added to the list of articles the exportation of which from the United Kingdom is prohibited, except to British possessions and protectorates.

The Electrical Supplies Business.—A lecture was delivered (in English and French) yesterday (Thursday) at the Cannon-street Hotel, London, under the auspices of the London Chamber of Commerce and the Belgian Committee for Trade with the Allies. The object of the lecture was to discuss (1) the question of bringing together British electrical supplies manufacturers and Belgian buyers; (2) the desirability of constituting a union of Belgian electricians to act as intermediary; and (3) to decide the selling and organising policy necessary to achieve the object on a co-operative basis.

TENDERS INVITED.

Switchboard.

REDDITCH Urban District Council invites tenders for a High-tension Three-phase Switchboard. Specifications from the consulting engineers (Messrs. Handcock & Dykes), 11, Victoria-street, Westminster, S.W. Tenders by June 14. *See an advertisement.*

Telegraph and Telephone Material.

Tenders are invited for the supply of Telegraph and Telephone Material to the AUSTRALIAN COMMONWEALTH Postmaster General's Department. Tender forms, &c., may be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W. *Further particulars are given in an advertisement.*

Crane, Coal Handling Plant, &c.

MANCHESTER Electricity Committee want tenders (by noon June 2) for coal-unloading crane, conveying plants, &c., at their Barton power station.

Foundations for Cooling Towers.

MANCHESTER Electricity Committee want tenders by 10 a.m. June 9 for Foundations for additional cooling towers at Stuart-street generating station. Specification, &c., from Mr. F. E. Hardie, Town Hall, Manchester.

Turbo-Alternators and Condensing Plant.

EDINBURGH Corporation invite tenders for the supply and erection of two 5,000 kw. Turbo-Alternators and Condensing Plant at their new electricity supply station at Portobello. Specification, &c., from the engineer, Mr. F. A. Newington, Dewar place, Edinburgh. Specifications, &c., can be seen at, but not obtained from, the offices of the consulting engineer, Sir Alex. Kennedy (Messrs. Kennedy & Donkin), 17, Victoria-street, London, S.W. Tenders to the town clerk, Sir Thomas Hunter, W.S., by 10 a.m. Monday, June 21.

The NEW SOUTH WALES GOVERNMENT RAILWAYS AND TRAMWAYS DEPARTMENT require tenders by noon July 21 for supply and erection of a 250 k.v.a. Direct-coupled Turbo-generator. Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

SYDNEY (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

Tram Rails, &c.

PORTSMOUTH Tramways Committee invite tenders for 100 tons Steel Girder Tram Rails, 6 tons Fishplates and 3 tons w.i. Tie-bars. Tenders to Town Clerk by June 1.

Half-watt Lamps.

KIRKCALDY Corporation invite tenders for about 100 Half-watt 1,000 c.p. Lamps and Lanterns. Tenders to Burgh Electrical Engineer by June 14.

Wiring and Fittings.

LONDON County Council require tenders by 11 a.m. June 4 for an Electrical Installation at the County Secondary School, South Hackney (about 260 wiring points).

FINCHLEY Urban Council require tenders by noon May 31 for wiring 100 workmen's dwellings. Specification, &c., from the Engineer, Church End, Finchley.

The Penrikyber Navigation Colliery Co. (Ltd.), PENRHIWCEIBER, Glam., require tenders by June 8 for three, six or 12 months' supply of Electrical Fittings. Forms of tender from the Secretary.

ECCLES Corporation require tenders by 10 a.m. June 9 for the Electric Lighting of Anson-street Council School, Winton. Specification, &c., from the Town Clerk.

Tenders are required by June 5 for Wiring and Fitting the Police Court, PORTH, Glam. Specification can be obtained at the Police Station or at County Hall, Cardiff.

Water Tank.

RHONDDA Urban Council require tenders (by noon June 4) for a Water-storage Tank of 30,000 gallons capacity at their electricity works. Specifications from the Electrical Engineer.

Fire Alarms.

RANGOON (Burma) Municipality require tenders by Aug. 11 for the installation of a system of Fire Alarms for the town of Rangoon. Specification, &c., from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, London, E.C.

EDMONTON Education Committee require tenders by noon June 1 for one year's maintenance of inter-communication Fire-alarms at schools in Edmonton. Particulars from the Architect, Town Hall, Lower Edmonton.

Armature Winding Machines.

The VICTORIAN RAILWAY COMMISSIONERS, Spencer-street, Melbourne, require tenders by 11 a.m. July 14 for supply of two Armature Winding Machines; and Voltmeters, Ampèremeters and Wattmeters. Specifications, &c., from Commissioners' Offices.

Telegraph and Telephone Instruments and Material, &c.

The Deputy Postmaster-General, Sydney (N.S.W.), will receive tenders until 2:30 p.m. June 16 for the supply of 400 pony pattern Morse Sounders to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specification, &c., from the Deputy Postmaster-General.

The Deputy Postmaster-General, Perth (W.A.) will receive tenders until 3 p.m. July 7 for 31,000 Porcelain (or Stoneware) Insulators (schedule 432 W.A.) for the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department. Samples may be seen at the offices of the High Commissioner for the Commonwealth, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Hobart, Tasmania, will receive tenders until June 21 for supply of 8 miles Paper-insulated Lead-covered Cable (schedule T175), 500 Glass Cells, 1,000 Zincs and 1,000 Porous Pots and 3 cwt. Sal Ammoniac (schedule T176), Telephone Instruments and parts (schedule T177), 27,000 Porcelain Insulators (schedule T180), Iron, Steel, Copper and Bronze Wire, Copper Tapes, Binders and Sleeves (schedule T181), 25 miles Insulated Copper Wire (schedule T182) and 50,000 Paper Jointing Sleeves, Soldering Solution, Insulated Staples and Linesmen's Equipment (schedule T184), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from Deputy Postmaster-General, Hobart.

Maximum Demand Indicators.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. July 19 for the supply of Maximum Demand Indicators. Specification from the City Electrical Engineer. (The Council have decided to grant 10 per cent. preference on British made goods and 5 per cent. preference on those of the allied countries during the war.)

Commutator-Grinding Lathe, Motor Generator, Motors, Cables, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 30 for 13 in. Centre Lathe for turning or grinding commutators (contract 28,737), and 9 kw. Motor Generator and Accessories (contract 28,760). Specifications, &c., from the Commissioners' Offices, Spencer-street, Melbourne.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 30 for supply of Four Electric Motors, varying from 7 H.P. to ½ H.P. (Contract 28,771). Particulars from the Commissioners' Offices, Spencer-street, Melbourne.

LAUNCESTON (Tasmania) Council want tenders by 4 p.m., July 26, for converter, switchgear, underground feeder cable, &c. Specifications, &c., from the City Electrical Engineer.

Circuit-Breakers.

JOHANNESBURG Municipal Council require tenders by noon June 1 for the supply of 24 Double-pole Automatic Oil-immersed Circuit-Breakers of 200 amperes capacity. Specifications from the Controller of Stores, Plein-square, Johannesburg.

Submarine Cable.

The SPANISH POSTS AND TELEGRAPHS DEPARTMENT want tenders by June 22 for the laying of a submarine cable from Cadiz to Laraiche and for the repair of certain cables. The "Madrid Gazette" of April 23, containing the conditions of tender, &c., can be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

HACKNEY (LONDON).—The Electricity Committee recommend the Council to enter into a sole-use contract with the Electrical Apparatus Co. for the supply of such meters as may be required up to and including 25 amperes capacity for one year.

The large majority of meters used on consumers' premises have (the committee reports) been supplied either by Messrs. Chamberlain & Hookham or Ferranti (Ltd.), and have, on the whole, given excellent results. These firms have practically the monopoly of the supply of direct-current house type meters and their prices (in the committee's opinion) are very high. About 12 months ago 60 meters supplied by the Electrical Apparatus Co. were installed, and these have given very good results. The difference in the prices of Chamberlain & Hookham or Ferranti meters compared with the prices of the Apparatus Co. is very marked in the case of small consumers, in which the cost per kilowatt of the service apparatus is always a heavy tax upon the undertaking. The Electrical Apparatus Co.'s meter is not recommended for sizes above 25 amperes, as the loss in the meters of larger capacities becomes serious. The special prices for the Apparatus Co.'s meters are conditional upon the Council entering into a sole-use contract, and each meter is guaranteed for two years from the date of delivery.

BRADFORD.—The Guardians have accepted the tender of C. Bell for wiring the Westbrook Lodge relief station, at £33. 10s.

BASINGSTOKE.—The tender of Johnson & Phillips (at £1,430) has been accepted by the Council for the supply and laying of electric cables for the extension to Audleys Wood and Hackwood House.

Meter Contracts.—The County Borough of East Ham have made a contract with the British Thomson-Houston Co., of Coventry, for 12 months' supply of their continuous current meters.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Blackburn.—The accounts of the electricity department for the year ended March 25, 1915, show capital expenditure £328,463 (increase £10,134), of which £132,495 has been redeemed.

Revenue was £48,100 (compared with £48,400 in [illegible]), and expenditure was £24,887 (£24,217), leaving gross profit £23,213 (£24,183). Interest required £7,203 (£6,968), loan instalments £10,000 (£9,000), and sinking fund £10,642 (£9,157), and the balance £2,368 (£2,058) has been transferred to depreciation and renewal fund. The number of consumers was 3,601 (a. 4,015 (a. Units generated were 7,193,023 (7,916,938) and sold 6,817,506 (7,291,870).

The engineer and manager (Mr. P. P. Wheelwright) says in his report an option to create a new generating station has been obtained, but further progress has been deferred owing to the refusal of the Treasury and L.G. Board to sanction loans for purposes not directly required for carrying on the war. The delay will affect the undertaking considerably, due to deferring indefinitely the provision of plant already agreed upon, thereby retarding, for the present, the steady growth of the department. The general increase in working expenses, although not pronounced last year, is likely to be a serious factor in the future, considering the ever-increasing price of all materials, particularly coal. There is little doubt

serious responsibility, taking alone at present the provision for making

Salford. The accounts of the electricity department for the year ended March 31 show net outstanding [illegible] expenditure £713,589 (net loss £12,331).

(1·36d.) per unit sold, coal stores, generation wages and repairs cost 0·49d. (0·56d.), and total working costs were 0·76d. (0·82d.). Units sold were 20,646,108 (19,652,015). The net profit (£8,406) has been placed to depreciation and renewals fund.

West Hartlepool. The [illegible] for the year show total receipts £19,505 (net [illegible] £17,612 in the previous year) and gross profit £7,934.

After providing £500 for the lease on the Hartlepool line, £2,569 for interest and £1,847 for redemption, the net profit was £3,018, which is to be [illegible]

COMPANIES' MEETINGS AND REPORTS.

ANGLO-ARGENTINE TRAMWAYS CO. LTD. The gross receipts for 1914 amounted to £2,850,995 4s. 11d., and after deducting working expenses (£1,880,996. 3s. 11d.) and adding interest on investments and deposits, transfer fees, &c. (£30,377. 8s. 11d.) and amount brought forward (£13,420. 14s.), the total is £1,013,797. 0s. 11d. Interest and charges absorbed £917,388. 6s. 2d., leaving £96,408. 14s. 9d. Having regard to the decrease in traffic receipts, compared with those of 1914, and the uncertainty of the outlook for the remainder of the year 1915, the directors have decided not to recommend any dividend on the ordinary shares, and the balance at credit of profit and loss (£96,408. 14s. 9d.) has been carried forward. The average number of miles of surface line open for traffic working throughout the year has been 361, against 348. The extension to Caballito of the first subway line from Plaza Mayo to Plaza Once was opened in April as far as Rio de Janeiro station, and the entire line on July 1, the whole length of the subway open (with extensions) being 4¼ miles. The construction of the second subway line between Retiro and Plaza Constitucion, which was to be completed by Dec. 31, 1914, has been postponed under [illegible] of the Municipality.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—Mr. T. O. Callender [illegible] for the past year was £14,624, against £16,119 in 1913. They had increased the allowance for depreciation from £8,989 to £9,967. The expenditure on contracts in course of execution amounted to £72,325 against £137,146. It was evident that owing to the war, and especially to the restrictions imposed on municipalities by the Treasury, that there could not be the same amount of contracting business for electric mains in the latter part of 1914 and in the present year as previously. Their debtors for goods supplied were £265,572, against £219,000, an increase of £45,000, which might fairly be set against the decrease in the [illegible] and profit, with that of the previous year. They had made the handsome profit of £162,254 or £3,020 more than in 1913. The general expenses at the London office came to £44,000, against £49,415. Hitherto, they had [illegible] done so on the present occasion the amount of those expenses would have [illegible] indication of what the results were. The board had, therefore, written off the commissions out of the profits. They had 300 of their permanent staff with the forces, and in addition at least a similar number of men who were in the company's service when the war broke out, but who were not permanent employees. Altogether they had in training or at the front [illegible] with. Their debenture interest was the same amount as last year, as was also the preference dividend, but they had slightly increased the provision for depreciation. Deducting those items left them with £189,419, or £38,578 more than in the previous year. It was proposed to pay the standard dividend and bonus of 15 per cent., which had been the distribution for many years, leaving £163,169 to carry forward. He thought it would be agreed that the results of the year's trading were satisfactory. It was hardly necessary to say that they had only been arrived at after [illegible] again into proper order. Owing to the action of the Treasury, and the [illegible] contract work had considerably decreased. The large telephone contract [illegible] they had every hope that, on the termination of the war, it would be [illegible] Apart from [illegible]

had enabled them to take advantage of work which had been offered to them by the Army and Navy, especially by the Navy. The amount of work done for the Admiralty was considerable. They were proud that so many of His Majesty's ships carried their cables and appliances, and it was a great satisfaction to the board to know that on several occasions when serious actions had taken place, the company's work had been reported on in such a way that they had every reason to be satisfied with it. There had been a good deal of trouble with regard to labour. Their own cable hands had stood by them loyally, but, like every one else with a large number of engineering employees, they had suffered considerable inconvenience. The report and accounts were then adopted.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—At the recent meeting the chairman (Mr. W. S. Brown) presiding said that, like other industries, [illegible] suffered owing to the war. At present they were doing very [illegible] principally for the Government. The accounts were pretty [illegible] and the outlook [illegible].

HAVANA ELECTRIC RAILWAY, LIGHT & POWER CO.—The gross earnings for 1914 were $5,396,713, [illegible] $3,417,954 in 1913; operating expenses and taxes amounted to $2,593,321 ($2,612,952), and net income was $2,801,392 ($2,804,101); other income, $102,119 ($140,087); gross income, $2,903,511 ($2,944,189); fixed charges, $1,094,140 ($1,096,086) and surplus $1,809,371 ($1,848,103). Dividends paid during year (6 per cent. on preferred and 5 per cent. on common stock) absorbed $1,647,431, and after various appropriations the balance forward is $1,291,557.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—Mr. E. Pope, who presided at the annual meeting on Tuesday, said that the general business had been [illegible] throughout the year, and the result was well up to the average of previous years. The old plant had been maintained in efficient running order, and formed a valuable stand-by plant, but owing to progress in engineering it was somewhat out of date, and could not be operated at a cost low enough to yield a satisfactory profit on the price at which they now had to sell current. There would be some increase in operating costs during the current year, but so far as the year had gone they had done a little better than during the corresponding period of last year. Some of their contracts had been recently renewed, and the aggregate of current sold showed but little variation. While the war lasted it would be impossible, in case of a breakdown, to get a supply of new plant or parts of plant, or even of material. Fortunately they had a fairly large stock of spare parts and supplies; still any breakdown even on a moderate scale might necessitate running the stand-by plant for a considerable time, and that would seriously reduce their profit.

LIMA LIGHT, POWER & TRAMWAYS CO. (LTD.)—The net profit for 1914 was £120,259, and £6,000 was brought forward. It is proposed to add £28,867 to redemption fund, £10,000 to reserve for bad and doubtful debts, and £16,814 to extraordinary repairs fund, and to provide £7,000 for losses in exchange. A dividend of 1 per cent. is recommended, leaving £50,077 to carry forward.

MEXICO TRAMWAYS CO. (LTD.)—In a circular to its bond and shareholders, as well as to those of its subsidiary concerns (the Mexican Light & Power, the Mexican Electric Light and the Pachuca Light & Power Companies), it is stated that since the date of the last annual reports financial and political conditions in Mexico have become steadily worse, and the country is now in a state of chaos, business being practically at a standstill. The control of the tramways has been taken out of the directors' hands and the board set out the events which have led up to the present position. When the tramway undertaking was seized, the salaries of many of the staff employed by the month was doubled and the remainder of the employees got a 25 per cent. increase in wages. The tramways have since been operated by officials appointed by the leaders temporarily in power. As a result operating costs rose speedily, while the character of the service and the condition of the equipment deteriorated rapidly, the new officials having had no experience in tramway operation or the handling of men. In addition, the maintenance of the cars was badly neglected, so that a very considerable proportion of the rolling stock is now laid up awaiting repair. For a short time the receipts were paid to the company's bankers, but subsequently the authorities directed that the earnings should be paid to the Government Treasury. It is now practically impossible to communicate (except after great delay) with the company's officials in Mexico, but the latest information states that when Carranza's representative was recently driven from the city of Mexico by Zapata he took with him the "controllers" off the cars, thereby rendering them unfit for service, and all traffic has ceased. So far the authorities have not taken over control of the businesses of the Mexican Light & Power, the Mexican Electric Light and the Pachuca Light & Power Companies, and the property of those undertakings has been very little injured. Their employees have, however, had to be given higher wages, while, as receipts are to a large extent in paper, there remains no available surplus after providing for maintenance. Great difficulty is experienced in collecting accounts, as many of the best residences have been commandeered by the authorities for the military officers and other Government purposes, so that, although electric light is still freely used, it has not been possible to obtain payment from the consumers. No bills for street lighting or power furnished to the Government have been met for a considerable time, and over 2,000,000 pesos are owing on this account. Meanwhile, the company has been compelled to import carbons and globes, &c., for the street lamps and to pay for them in gold. The business of the Pachuca Light & Power Co. has decreased [illegible] of the [illegible] Orizaba Electric Power Co. have been closed [illegible] Mr. Pope [illegible] the interests for the bondholders [illegible] further steps should be taken to protect the interests.

RIVER PLATE ELECTRICITY CO. (LTD.)—Mr. W. M. Mathieson, who presided at the meeting last week, said that the [illegible] past year was about £1,100 less than in 1913, nearly [illegible] being attributable to the war. There had been considerable [illegible] of supplies. As the export of carbon [illegible] by the British Government, they had had to buy supplies in the United States. Fuel had also cost more, while from motives [illegible] Municipal Government of Buenos Aires had requested them [illegible] used for the public lighting of La Plata with half-watt lamps. At the same time consumers of current for private [illegible] their expenditure though there was an increase in the [illegible] customers.

SHANGHAI ELECTRIC CONSTRUCTION CO. (LTD.) The accounts for 1914 show a profit of £33,602 compared with £34,526 in 1913, which, with £1,300 brought forward £34,903. There [illegible] reserve for renewals account £10,000, and applied £1,000 [illegible] of the preliminary expenses, and the directors [illegible] of 6 per cent. for the year (less tax) leaving to be carried [illegible] £4,703.

WEST LONDON & PROVINCIAL ELECTRIC SUPPLY CO. (LTD.)—Mr. H. Kahn, who presided at the meeting last week, stated that [illegible] sisted of the return from its investment in the Chiswick Electricity Supply Corpn., together with certain fees received for managing that undertaking. The balance available for distribution was £3,337, out of which the directors proposed to pay a dividend of 6 per cent. on the [illegible] preference shares for the year 1914, leaving £392. 11s. 1d. to be carried forward, against £26. 1s. 2d. In regard to the Chiswick Electricity Supply Corpn. (which supplied not only Chiswick but also Aberystwith with electric current) they had every reason to be satisfied with the results. The number of consumers increased by 111 (to 2,717 [illegible] to the lighting restrictions the increase in the number of consumers had only partly made up for the reduced consumptions of current for shop-front and similar lighting, the total revenue having dropped from £19,440 to £19,369. Nevertheless, owing to the saving in the cost of fuel resulting from the Diesel engine installed in 1913 coming into full use during the year, and in spite of the increased cost of coal and the increase in local rates, the balance carried forward to [illegible] revenue account was £248. 12s. 9d. higher than in 1913. After paying debenture interest, etc., the balance was £4,786. 11s. 11d., against £4,643. 7s. 5d. The [illegible] Corporation has utilised by paying a dividend of 6 per cent. on its ordinary shares and by transferring the balance (£1,018. 11s. 11d.) to depreciation reserve. As regards 1915, it was difficult to give any accurate forecast. The revenue from the Chiswick undertaking continued to show a considerable falling off compared with the corresponding months in 1914, owing to the lighting restrictions. To make up to a certain extent for the loss of revenue, the advance in the price of coal and other increases in the cost of production, the directors increased the charge for current by 10 per cent. from April 1. As regards Aberystwith, conditions were looking better, as the revenue had increased owing to the town being full of soldiers. The Corporation were installing a second Diesel engine at Aberystwith in place of the old steam set, and estimated that a considerable savin [illegible] in the cost of production would be effected.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ANGLO CHINESE ENGINEERS' ASSOCIATION (LTD.) (140,361). Reg. May 17, capital £53,750 in 5,000 6 per cent. cumulative preference shares of £10 and 75,000 deferred shares of 1s. each, to carry on in China or elsewhere the business of ironfounders, mechanica engineers, tool makers, metal workers, machinists, metallurgists, electrical and water supply engineers, &c., and to adopt agreements with A. J. Moore-Bennett. Private company. First directors are A. J. Moore-Bennett, J. Downs, S. Denison, H. J. Ward and W. W. Gibbs. Reg. [illegible] 9 & 10, Fenchurch-lane, E.C.

ECCO BATTERY CO. (LTD.) (140,389).—Reg. May 19, capital £12,000 in £1 shares, to adopt an agreement with T. Hill-[illegible] of the property referred to therein, to carry on the business of electrical engineers, agents, factors, manufacturers, importers and exporters, &c. Private company. First directors are M. West, A. J. M[illegible] M. H. Goldstone, T. H. Jones, T. M. Jones and T. A. Taylor (all permanent). Reg. office: Invicta Works, Bow Common-lane, E.

GENERAL CABLE MFG. CO. (LTD.) (140,379).—Reg. May 18, capital £6,000 in £1 [illegible] to carry on the business of [illegible] merchants, factors, dealers, agents, purchasers [illegible] and otherwise. No Private company. [illegible] W. [illegible] and C. E. Pullen.

MORTGAGES AND CHARGES.

BARBADOS ELECTRIC SUPPLY CORP. (LTD.)—Issue on March 3, 1915 of £500 debenture [illegible] part of series [illegible]

BRILLIANT SIGN CO. (1907) (LTD.)—Charge on certain book debts due from debtors in Belgium, dated May 6, 1915. [illegible] Capital £ Counsel: Bird.

PHŒNIX ELECTRIC HEATING CO. (LTD.) (1914) Mortgage on moneys payable under certain [illegible] to secure all moneys due from company to Parr's Bank [illegible]

CITY NOTES.

MEMORANDA [illegible] Bank rate 5 per cent. since Aug. 8, 1914. Consols to-day. Next Pay Day June 1. Stocks and Shares Ticket Days. June 10 and 24. Pay Days June 11 and 25. Price of silver, 23 7/8 d.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—The directors recommend a [illegible] and the ordinary shares at the rate of 6 per cent. per annum [illegible] the year 1914.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—Mr. Alex. Mackenzie has been appointed president of this company and its allied companies [illegible] by the death of Dr. E. S. Pearson through the "Lusitania" disaster.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—A petition to confirm an agreement [illegible] the company will be heard by Mr. Justice Neville on June 8. The proposed alterations will authorise the company to carry on the business of an electric lighting and supply company and to manufacture aircraft, armaments, munitions of war, &c.

BRUNNER MOND & CO. (LTD.)—The directors recommend a dividend on the [illegible] for the year to March 31, 1915, of 25 per cent. (less tax), placing £50,000 to suspense account and carrying forward £109,000.

DOULTON & CO. (LTD.)—A final dividend at rate of 5 per cent. per annum (6d. per share) on the preference shares is announced for the past six months [illegible] 5 per cent. for the year ended Dec. 31, 1912, and carrying forward £31,626.

LONDON ELECTRIC RAILWAY CO. At a Wharncliffe meeting last week the Parliamentary Bill authorising the company to [illegible] City & South London, the Central London and the Metropolitan District Railways, to make agreements with each other and with the London General Omnibus Co. for increased facilities for the interchange of traffic, &c., was approved.

MACKAY COMPANIES. The regular quarterly dividend of 1 per cent. on the preferred shares and the regular quarterly dividend of 1½ per cent. on the common shares of the Mackay companies will be paid on July 1, 1915, to holders of record at the close of business on June 9, 1915. The transfer books will not be closed.

NEW BRITISH EVER-READY CO. (LTD.) The directors recommend a final dividend of 6½ per cent. on the preference shares, making the maximum of 10 per cent. for the year to March 31, and 10 per cent. on the ordinary shares for the year, plus a bonus of 2 per cent.

TOPSHAM ELECTRICITY SUPPLY CO. (LTD.)—At the meeting last week the directors reported that they had a very favourable year's working. The profit to the year [illegible]

VERITY'S (LTD.)—A final dividend at rate of 6 per cent.(6s. per share) has been [illegible] on the ordinary shares, making 6 per cent. for the past year, and carrying forward £1,001.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, May 26. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Last Dividend	NAME.	Price, Wed. May 26.	Rate per cent. Yield p.c.	Dividend Due.
	Electricity Supply.		£ s. d.	
[illegible]	[illegible]	[illegible]	[illegible]	Mar., Sept
[illegible]	[illegible]	[illegible]	[illegible]	Apr., Aug
[illegible]	[illegible]	1	1/7	Jan., Apr.
	Brompton & Kensington Ord.	[illegible]	3 11 1	Mar., Sept
[illegible]	Central Elec. Supp. C. Deb. St.	[illegible]	4 8	
[illegible]	Charing Cross West End & City Debs.	[illegible]	4	Jan., July
[illegible]	Do. 4½% Pref.	[illegible]	5 12 6	
[illegible]	[illegible]	[illegible]	5 2 0	Aug., Feb
[illegible]	[illegible]	14	6 8	Feb., Aug
[illegible]	[illegible]	12½	4 15 0	Mar., Sept
[illegible]	Do. 5% Deb. St.	110½	4 10 0	Jun., Dec
[illegible]	[illegible]	11	6 7	Feb., Aug
[illegible]	[illegible]	[illegible]	4 12 1	May, Nov
[illegible]	Edmundson's Elec. Supp. 4½% Debs.	80	5 12 6	July
[illegible]	Kensington and Knightsbridge Ord.	[illegible]	6 4	Feb., Aug
[illegible]	[illegible]	[illegible]	5 14 3	[illegible]
[illegible]	[illegible]	[illegible]	5 11 11	[illegible]
[illegible]	Metropolitan E. Supp. Ord.	[illegible]	7 14	Mar., Aug.
[illegible]	[illegible]	[illegible]	4 15 3	Jan., July
[illegible]	Newcastle & Dist. E.L. 6% 2nd Dbs.	98½	6 1 11	Mar., Sept
[illegible]	Newcastle-on-Tyne E.S.5%2dMt.Db.St.	100[illegible]	4 19 0	Mar., Sept
[illegible]	North Metropolitan E. P. Supp. 6% Pref.	[illegible]	12 11	Apl., Oct
[illegible]	South London E.S. 1st Mort. Debs.	[illegible]	[illegible]	Jan., July.
[illegible]	Urban Elec. Supp. 4½% Db. St.	85	5 11	Apl., Oct.
[illegible]	Westminster E.S. Corp. Ord.	[illegible]	6 3	Mar., Sept
		[illegible]	4 14	Jan., July.
	Electric Railways & Tramways.			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Apl., Oct
[illegible]	Central London Guar. Assented Ord.	7[illegible]	[illegible]	Feb., Aug
[illegible]	Do. do. Assented Def. Ord.	[illegible]	7	[illegible]
[illegible]	[illegible]	[illegible]	4 15	May, Nov
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	5 17 11	Feb., Aug
[illegible]	[illegible]	[illegible]	[illegible]	Jan., July
[illegible]	[illegible]	[illegible]	[illegible]	Mar., Sept.
[illegible]	[illegible]	[illegible]	[illegible]	Jan., July.
[illegible]	Metropolitan Ry. Con. Ord.	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Aug
[illegible]	[illegible]	[illegible]	[illegible]	Feb., Aug

†Ex Dividend for Interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price, Wed., May 26.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*	£ s. d.		
St.	3½	Metropolitan Dist. Ry. 3½% A Deb.	80½	4 4 0	Jan, July
St.	3½	Do. 3½% Deb.	83½	4 3 10	Jan, July
St.		Metropolitan Dist. Ry. Ord.	16½	.. ..	Feb, Aug
St.	4½	Do. 4½% Pref.	92	4 7 0	May, Nov
St.	4½	Do. 4½% Cum. Pref.	94	4 15 0	Feb, Aug
St.	4½	Do. 4½% First Pref.	102½	4 12 8	Jan, July
St.	6%	Do. 6% Pref. Deb.	129	4 9 11	Jan, July
St.	4%	Do. 4% Deb.	87	4 11 10	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	87	5 0 0	Mar, Sept
St.	4½	Do. 4½ Deb. Stock	96½	.. ..	..
10		Underground Electric Rlys. of London Shares	1½	.. ..	..
1/0	..	Do. A Ord.	1	.. ..	..
St.	6%	Do. 6% Inc. Debs.	113½	5 6 4	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 15....	113½	7 13 10	Mar, Sept
..	6%	Do. 6% Inc. Bds., without coup. 15....	113½	4 6 10	Jan, July
..	4½%	Do. 4½% Bds.	..	.. ..	March
5	..	Yorkshire Ry. Pref. Ord.	8	.. ..	..
		Electric Manufacturing, &c.			
1	1/9	Babcock & Wilcox Ord.	21	5 12 0	Apl, Oct
1	1/0	Brit. Aluminium Ord.	1½	4 11 8	May
100	5%	Do. Pref. Cum. Deb.	95	5 2 0	Jan, July.
1	7½	Do. 6% Pref.	8	6 8 10	Jan, July
5	15	Brit. Insulated & Helsby Ord.	111	6 13 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	65½	4 17 0	Mar, Sept
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	1½	5 12 11	Mar, Sep
2	4½	Brit. Westinghouse Pref.	1½	7 14 10	April
100	6%	Do. 6% Cum. Pref.	101	5 18 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
5	5/0	Callender's Cable, &c., Co. Ord.	12½	5 18 3	Jan, July
5	2/0	Do. 5% Pref.	3½	4 17 7	Feb, Aug
1	15%	Castner Kelner	3½	4 12 4	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	8	6 17 2	Sept
5	..	Edison & Swan U.E.Ss. Ltd. A £3 pd.	4	.. ..	Feb, Aug
1	6%	Elec. Construction Ord.	7½	7 7 6	May
St.	4%	Do. 4% Debs.	84	5 15 1	Jan, Dec
10	6%	General Electric 6% Pref.	10½	5 19 3	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	14½	6 18 6	Feb, Aug
5	2/0	Do. 4½% Cum. Pref.	8	4 10 0	..
St.	4½%	Do. 4½% Deb.	96	4 13 9	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	5½	5 15 9	Apl, Oct
10	5%	Do. Pref.	9½	4 2 0	Apl, Oct
100	4%	Do. 4% Debs.	97½	6 8 0	Mar, July
12	3/0	Telegh. Con. & Main. Co.	37½	4 4 3	Jan, July
100	4%	Do. 4½% Debs.	95	4 14 1	May, Aug
1	12½%	Vickers Ord.	1½	6 6 4	May, Aug
1	6%	Do. 5% Pref.	1½	4 11 1	May, Aug
St.	4%	Do. 1st Debs.	93½	4 6 0	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	104½	4 6 1	Jun, Dec
		Telegraphs.			
St.	3/0	Anglo American 6% Pref. Ord.	10½	5 14 4	Feb,My,Aug,N
St.	3/0	Do. Def. Ord.	2½	6 10 8	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	78	5 2 7	Ja.Ap,Jly.O
10	5/0	Cuba Submarine Ord.	6½	5 13 6	May, Nov.
10	10/0	Do. 10% Pref.	15½	6 9 0	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	8½	5 1 10	Ja.My,Jly.O
St.	6%	Eastern Tel. Co. Ord. Xd	13½	5 3 10	Ja,My,Jly,O
St.	17%	Do. 31% Pref.	78½	4 12 5	May, Nov
St.	4%	Do. 4% Debs.	91	4 7 11	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs...	91½	4 7 5	Feb, Aug
10	5/0	Do. Ord. Xd	13½	5 5 8	Ja. Ap,Jly.O
10	5/0	Gt. Northern Tel. Co. Ex Coup. 6	31½	6 19 8	Ja, My, Jly
20	13/0	Do. Ex Coup. 6	5½	5 5 3	May, Nov
1	2½	Marconi's Wireless Tel. Co.	2½	11 17 0	April
1	1/4½	Do. 7% Pref.	1½	10 13 4	May, Nov
10	4/0	West Indian & Panama Ord.	11½	6 0 0	May, Nov
10	6%	Do. 1st Pref.	8½	7 3 4	May, Nov
10	3/0	Western Telegh. Co.	13½	5 2 7	Mr.Jly,O.Dec
St.	4%	Do. 4% Deb. St.	92½	4 7 8	Jun, Dec
		Telephones.			
..	$2	American Telephone & Telegh. $100 Cap	124½	6 8 9	Ja,Ap,Jn.O
..	5%	Central Telephone 5% Bds.	7½	6 6 2	Jan, Jly
1	7½	Mexico Video Telephone Ord.	1½	6 12 6	Nov.
..	4½%	New York Telephone 4½% Bds.	97½	4 12 11	May, Nov
1	10%	Oriental Telephone Ord.	2½	4 15 6	Apl, Oct
St.	4%	Do. Deb. St.	94½	4 12 6	Jan, July
St.	4½	Telephone of Egypt Deb. St.	88	5 2 3	Jan, July
..	4%	Telephone Invest Co.	8½	6 1 ..	Apl, Oct
5	3/0	United River Plate Ord.	4½	3 3 3	Jan, July
5	..	Do. 5% Cum. Pref.	4½	5 3 3	Jan, July
St.	4½	Do. 4½% Deb.	93½	4 16 3	Jan, July
		Financial and Investment.			
10	6%	Globe Trust & Trust	11½	5 7 ..	Sp,Dc,Mr,Jn
10	3/0	Do. 6% Pf.	11½	5 1 1	Sp,Dc,Mr,Jn
10	8%	Mackay Companies' Common	9½	8 5 0	Ja, Apl, Jly.O
	4%	Do. 4% Pref.	7½	5 14 3	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	127½	4 14 1	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	4%	Anglo Argentine Trams. 5% Debs.	94½	5 11 5	Jun, Dec
St.	4½%	Do. 4½% Deb.	84	5 3 ..	Jan, July
St.	4%	Do. 4% Deb.	84	4 15 ..	Jan, July
5	5%	Do. 5% 1st Pref.	4½	6 3 11	Jan, July
5	5%	Do. 5½% 2nd Pref.	4½	7 3 11	Jan, July
100	3½	Brazilian Traction Ord.	94½	11	Fb,M,Aug,N
100	3½	Do. 4% Deb.	73	5 9 0	Ja,Apl,Jly,O
5	5%	Brisbane Trams Ord.	7½	5 6 5	May
5	5%	Do. 5% Cum. Pref.	4½	5 9 8	May, Nov
St.	4½	Buenos Ayres and Belt 4½% Cum. Debs.	79½	5 .. 11	..
5	..	Calcutta Elec. Trams. Ord.	4½	7 10 6	Mar, Sep
5	6%	Havana Elec. Ry. 5% Bds.	84½	5 13 3	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	6½	6	..
100	6%	Mexican Tramway Common	7½	7 4 11	Jan, July
..	..	Mexico Trams Common St.	..	.. ..	Fb,M,Aug,N.
..	..	Do. Bds.	..	.. ..	Mar, Sep
St.	4½	Montreal Street Ry. 4½% Debs. (1922)..	100½	4 .. 4	Feb, Aug
1	..	Rio Janeiro Tram, L. & P. 50 yr. Bds	8½	6	Jun, Dec
10	4½	Tramways 4½% Bds.	98½	4 14 3	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
..	..	Anglo-Argentine Pref.	4½	5 13 7	Mar, Sept
..	..	Buenos Ayres Pref.	1½	4 16 7	Jun, Dec
1	..	Buenos Ayres Ord.	1½	1 .. 4	..
5	6%	Calcutta E. S. Corp. Ord.	4½	7	Apl, Oct
..	..	Do. Pref.	4½	7	..
..	..	Do. Def.	1½	7 .. 3	..
..	..	Do. Bds.	4½	7 1 ..	Ja,Apl,Jly,O
..	..	Do. Pref.	1½	1	June, Dec
St.	5%	Do. 5% Deb.	1½	4 18 0	Apl, Oct
..	..	Do. Pref.	1½	4 16 ..	Jan, July
..	..	Do. Def.	1½	4 15 3	Ja,Apl,Jly,O
St.	4½	Do. 4½% Deb.	1½	4 10 0	Jan, July
St.	4½	Do. 4½% Cum. Deb.	1½	5 .. 6	May, Nov
1	..	Valparaiso & Tramways Pref.	1½	5 .. 6	Jan, July
..	4%	Do. 4% 1st Mort. Debs.	1½	5 .. 6	Jan, July

† Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date May 26, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	11½d.	Antimony	£100 0 0
Solid Drawn Copper Tubes	13½d.	English Lead	£21 0 0
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	13½d.	**Old Metals.**	per ton.
Brass Wire	12½d.	Clean Scrap Copper	£73 0 0
Copper Wire	12½d.	Brazlery Copper Scrap	£65 0 0
Rolled Brass	11½d.	Clean Scrap Brass	£50 10 0
Brass Sheets	12½d.	Old Lead	£18 10 0
	per ton.	Old Zinc	£15 0 0
Copper Sheets	£130 0 0	Hollow Pewter	£120 0 0
Spelter	£64 0 0	Black Pewter	£85 0 0
		Gun Metal	£62 10 0

Mr A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date May 25, the following prices of SCRAP METALS:—

	per ton.		per ton.
Aluminium Cuttings	£66 0 0	Old Lead	£18 15 0
Clean Mixed Brass	£54 0 0	Tea Lead	£17 5 0
Clean Copper	£71 0 0	Old Zinc	£53 0 0
Brazier Copper	£65 0 0	Hollow Pewter	£120 0 0
Clean Copper Wire	£.. ..	Shaped Black Pewter	£80 0 0
Gun Metal	£.. ..		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ending	Receipts for week	Increase (+) or decrease (−) on week	Aggregates. No. of weeks	Amount	Increase (+) or decrease (−)
		£	£		£	£
Aberdeen Corporation	May	1,400	− 139	51	83,580	− 2,145
Anglo-Argentine	,,	20	2,175	20	1,029,517	− 95,106
Ashton-under-Lyne	,,	22	125	8	3,741	− 71
Ayr Corporation	,,	22	33	1	333	− 33
Bath Electric Trams. Ltd	..	..	..	..	..	..
Birkenhead Corporation	..	1,368	+ 134	8	10,004	− 108
†Birmingham Corporation	..	..	..	..	..	..
Blackburn Corporation	..	1,240	+ 134	8	9,812	+ 1,134
Bolton Corporation	..	1,711	+ 44	8	19,562	− 3,068
†Bournemouth Corporation	..	1,...	+ 1...	7	14,884	+ 1,...
Bradford Corporation	..	6,865	+ 1...	7	42,128	− 9...
Brighton Corporation	..	1,...	+ 1...	8½	7,...	− 6...
†Bristol Trams & Carriage	..	9,912	+ 33	..	176,623	+ 1,...
Burmah E. Trams & Ltg.	..	..	+ 1...	21	..	− 8...
Burnley Corporation	..	1,525	+ 1...	6	1,...	+ 1,305
Burton Corporation	..	..	+ 1...	5	2,...	+ 1...
Bury Corporation	..	..	..	..	..	..
Calcutta Tramways Co.	..	1,...	+ 1,...	21	1,32...3	+ 52,...
Camborne-Redruth	..	..	+ 1...	20	2,...	+ 143
Cardiff Corporation	..	..	..	..	..	..
Central London Railway	..	..	..	..	..	..
Cork Electric Trams Co.	..	..	..	20	9,234	− 3...
Croydon Corporation	..	1,816	+ 1...	6	11,447	+ 1...
*Derby Corporation	..	1,045	+ 1...	7	7,640	+ 282
Dover Corporation	..	..	+ 1...	7	2,152	− 4...
Dublin & Lucan Railway	..	1,...	+ 1...	8	2,615	+ 1...
Dublin United	..	..	+ 1...	21	116,297	+ 5,548
Dundee Corporation	..	1,...	+ 1...	21	66,584	+ 1,170
East Ham Council	..	1,...	+ 1...	13	9,847	+ 2,050
Erith Urban Council	..	..	..	..	..	..
Exeter Corporation	..	1,...	+ 1...	20	2,610	− 9...
Glasgow Corporation	..	..	+ 1...	21	1,041,919	+ 7,3...
Glossop Trams	..	..	..	21	2,379	+ 1...
Gloucester Corpn.	..	..	..	..	..	+ 1...
†Halifax Corporation	..	2,160	+ 1...	4	15,291	+ 1,...
Hastings Elec. Trams Co.	..	..	+ 1...	20	15,667	− 7...
Hong Kong	..	..	..	..	..	..
Huddersfield Corpn.	..	..	+ 1...	..	1...	+ 1,817
Hull Corporation	..	3,...	+ 1...	3...	2...	+ 1,471
Ilford District Council	..	..	..	..	..	..
Ilkeston Corporation	..	1...	+ 1...	11	853	+ 2...
Ipswich Corporation	..	1,...	+ 1...	9	3,342	+ 1,3...
Isle of Thanet Co.	..	1,...	+ 1...	8	10,171	+ 2,...
Kilmarnock Corporation	..	..	+ 1...	21	1...	+ 1...
Lanarkshire Trams Co.	..	2,001	+ 1...	1	35,817	+ 1,...
Lancashire United	..	1,703	+ 1...	14	31,555	+ 1...
Leeds Corporation	..	8,757	+ 1...	21	61,510	+ 1...
Leicester Corporation	..	3,065	+ 1...	21	58,430	+ 1,...
Leith Corporation	..	..	+ 1...	1	787	+ 1...
Lincoln Corporation	..	..	+ 1...	5	1,052	+ 2...
LiverpoolCorporation	..	13,402	+ 1...	21	258,057	+ 1...
Liverpool Overhead Rly.	..	..	..	..	..	..
Llandudno&Colwyn BayR	..	..	..	..	1...	+ 1...
London County Council	..	1...	+ 1...	11	2...12	+ 3,157
London Elec. Ry. Co.	..	..	..	..	..	..
London United	..	..	..	..	..	..
Lowestoft Corporation	..	1...	+ 1...	33	2...1	+ 612
Maidstone Corporation	..	..	..	..	..	..
Manchester Corporation	..	..	..	..	..	..
Mersey Railway	..	..	..	..	..	..
Nelson Corporation	..	1...	+ 1...	1...	1,393	+ 272
Newcastle-on-Tyne Corpn.	..	1...	+ 1...	21	45,293	+ 5,542
Newport (Mon.) Corpn.	..	1...	+ 1...	2	5,185	+ 365
Northampton Corporation	..	..	..	..	..	..
Oldham Corporation	..	3,...	+ 1...	21	1...3	+ 1,...
Perth (N.B.) Corporation	..	..	..	..	..	..
Perth (W.A.) Elec. Trams.	..	..	..	..	..	..
Portsmouth Corporation	..	1...	+ 1...	..	16,068	− 1...
Preston Corporation	..	1...	+ 1...	21	6,433	+ 633
Rotherham Corporation	..	1...	+ 1...	8	7,335	+ 524
Salford Corporation	..	5,810	+ 1...	21	39,397	+ 1,...
Shanghai	..	..	..	..	..	..
†Sheffield Corporation	..	9...	+ 1...	8	2...1	+ 3,...
Singapore Trams	..	..	..	..	..	..
Southampton Corpn.	..	1,1...	+ 2...	21	2...1	+ 1...
Southend Corporation	..	2,...	+ 1...	21	1...1	+ 1,1...
St'lyb'dge,Hyde,&c.,Jt. B.	..	..	..	..	..	..
Sunderland Corporation	..	1,...	+ 1...	21	10,759	+ 1...
Swansea Corporation	..	1,...	+ 1...	22	12,523	+ 1,...
Swindon Corporation	..	1,...	+ 1...	21	1,323	+ 1...
Tynemouth Trams Co.	..	1...	+ 1...	19	1...	+ 1...
Wallasey Corporation	..	1,...	+ 1...	21	1...	+ 1...
Walsall Corporation	..	..	+ 1...	..	1...	+ 1...
Warrington Corporation	..	1,...	+ 1...	7	3,104	+ 1...
West Ham Corporation	..	..	..	..	..	..
Wolverhampton Corpn.	..	1,...	+ 1...	21	2...3	+ 1,...
Yorkshire W.R. Trams	..	2,...	+ 1...	21	2...1	+ 1,...

(*a*) These comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses, &c. ‡ Minus 2 days. ‖ Minus 3 days. ¶ Plus 3 days.
¶ Plus 2 days. ** Compared with one week more last year.

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The Gyroscopic Compass (F. M. Denton).
The Range of Wireless Signals (Henry M. Sayers).
Measurement of the Logarithmic Decrement of Condensers (L. Isakow).
Electrical Supplies to Belgium 324
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The "Electrician" Commercial and Industrial Section ..327–338

NOTES.

The Annual General Meeting of the I.E.E.

THE annual general meeting of the Institution of Electrical Engineers is apt to be a formal function of no great interest. The meeting this year was, however, of greater interest than is sometimes the case, owing to the comments of the President, Sir JOHN SNELL, on the desirability of outside nominations for members of Council, and the discussion that ensued. There are, generally speaking, two courses which may be followed in this matter. One of these is for the nominations to lie, to all intents and purposes, simply in the hands of the Council. This is the course which was followed for many years; but it gave rise to dissatisfaction because it was felt that the nominations made did not represent the views of the members generally, and it was also probably felt that sufficient new blood was not introduced into the Council. In order to remedy this state of things the present system has been adopted, and accordingly the Council now nominate a larger number of candidates than the number of vacancies to be filled, so that there must in any case be a ballot; also outside nominations are encouraged. Undoubtedly this gives a very much greater popular control (which [illegible] opposed to Council control), but it is sometimes felt that outside nominations are a reflection upon the nominations proposed by the Council, and form, as it were, a vote of censure. We think the reasonableness of this view very much depends on the way in which the outside nominations are conducted, and that there need not be any such feeling, provided no aggressive means are adopted and that no particular member nominated by the Council is selected for attack.

NEVERTHELESS, the position is not altogether free from difficulty. By means of a popular ballot the smaller sections of the industry are liable to find themselves without representation. We think this is likely to occur at the present time, and that the central station part of the industry may be represented to the exclusion of others, such as the manufacturing, and also those sections, such as the electrochemical, whose representatives would not be so well known to the general body of members. From this point of view the system adopted by the Newcastle Local Section is to be commended. From the particulars given in another column it will be seen that for the forthcoming session the Committee has been divided up so as to have a certain number of representatives for seven different branches of the industry. In many ways we think it might be better if the outside nominations were made direct to the Council before any list is issued, so that they might be put forward by the Council. It will be unfortunate if the idea gets abroad that to be nominated by the Council is a disadvantage in the eyes of the general members, and it may be that members will in time feel a disinclination to accept nomination unless there is a fair prospect of election. Obviously what is desirable is that the most efficient representation should be obtained, but to obtain this result with the maximum of popular control is by no means a simple matter.

Wireless Telephony.

FOR several years the problem of wireless telephony has been handicapped by the need of a microphone which could handle considerable currents, and thus little progress was made in this direction until investigators began to get away from recognised paths. Various systems have been tried from time to time, such as the T.Y.K. system, of TORIKATO, the JANKE system with the Poulsen arc, that of DITCHAM, and that due to COLIN and JEANCE, and others, but without any very great success. The vacuum tube, however, has put a fresh weapon at the disposal of the investigator which promises to revolutionise present methods. Certainly, in one direction or another advances are being made very rapidly at the present time, and something in the nature of a revolution seems to be coming about. The reaction

vacuum tube is now being applied to wireless telephony by the Marconi Company, and in another column we are able to give a short account by Mr. H. J. Round of what is being done. The tube is partly used for the production of continuous oscillations, and partly for the magnification of the signals that are received. One of the most interesting points is the fact that extremely small aerial currents, such as 0·2 ampere, are sufficient to enable speech to be transmitted a distance of 70 km. Telephone sets on this principle, delivering 0·6 ampere to the aerial, are now sufficiently commercial to be guaranteed for a distance of 50 km. between ships at sea, and thus it seems that wireless telephony is at last in a fair way to make substantial progress.

The Belgian Market.

There has been a great deal of talk about capturing German trade, but, as far as we are aware, very little has been done in the way of seriously preparing the way to effect this desirable object. Undoubtedly one of the chief markets to be considered is that of Belgium, and we are glad to note that last week a meeting was held under the auspices of the London Chamber of Commerce and the Belgian Committee for Trade with the Allies, at which a lecture was given by Mr. R. Steylaers, outlining the position and proposing the formation of a society entitled the Union of Belgian Electricians. As will be seen by referring to another column, the lecturer gave an interesting account of how Germany succeeded in controlling the greater part of Belgian electrical supplies. By means of the large German organisations the position was gradually manipulated so that most of the electrical products came from the A.E.G. of Berlin, and although there were certain companies with Belgian names in addition to the Belgian Union Co. (which was in reality a branch of the A.E.G.), several of these were only Belgian in name and really were German in their constitution and in their aims. Against the powerful German companies Belgian concerns stood very little chance. Shortly before the war the A.E.G. began to approach the consumer direct, or if they did not quote direct they only withdrew quotations on the understanding that plant and apparatus of the A.E.G. was to be supplied. Reference was also made by the lecturer to the insidious system adopted by certain German houses of sending German clerks to firms in other countries under the pretence of learning the language, but in reality to obtain the names of potential customers. In conclusion, the lecturer suggested the formation of a large Union of Belgian Electricians, to act as a buying agent for the large number of Belgian customers which must arise immediately on the conclusion of the war.

The L.C.C. Tramway Strike.

We are glad to record that the discreditable strike of the L.C.C. tramway employés has at length come to an end, and has been forced to a termination by the simple expedient adopted by the Council of refusing to take back any men who are of military age and capable of military service. We desire to give hearty support to the step taken by the Council. It is most important, in the interests of the country at the present time, that disputes of this kind should be rendered impracticable. The industry of the country generally and the production of munitions of war are quite as essential as the carrying on of actual warfare. Many people have urged the importance of compulsory service from the point of view of military operations pure and simple. In our opinion, compulsory service is still more important in regard to industrial work, and we fail to see how the best can be made of our resources except by a step of this kind. Such a step would necessarily lead to very great economies, to much more efficient labour, and to the better utilisation of the energies of the whole country. Such advantages should far outweigh any minor inconveniences.

Royal Engineers (T.F.)—The following appointments have been made:—

London Electrical Engineers: Sapper I. S. Dalgleish and Second Corporal J. W. Mason to be Second Lieutenants.

1st Field Company, East Riding (Fortress) Engineers: Capt. P. De H. Hall (from Electric Lights Company) to be Captain; Second Lieut. R. Gaskell (from Electric Lights Company) to be Second Lieutenant.

Opening of the Aylesbury Electricity Works.—The inauguration of the Aylesbury Electricity Works took place on Thursday the 27th ult., when the members and officials of the Aylesbury Urban District Council attended at the works in Exchange-street for an informal inspection and opening ceremony. Two 150 h.p. Diesel engines, coupled to direct-current generators and a 600 ampere-hour battery have been installed.

Electric Pumping Plant in Cumberland Mine.—The Wyndham Mining Co., of Egremont, Cumberland, have recently decided to adopt electrical power for pumping purposes in their Helder Pit. In this connection two combined centrifugal pumps and motors, each capable of delivering 600 to 700 gallons per minute against a head of 1,300 ft., will be installed for the 214 fathom level. Two combined centrifugal pumps and motors, each capable of delivering 300 gallons per minute against a head of 360 ft., will be installed for the 58 fathom level. The whole of this pumping machinery will be in duplicate and also the cables in the shaft, so as to avoid any possibility of stoppage. Current at 3,000 volts, 50 cycles, for operating the pumps, will be taken from the Cumberland Waste Heat Co.'s supply station at Cleator Moor, and it will be used at this voltage for the large pumps and at 500 volts for the smaller pumps. The scheme is being carried out to the specification and under the direction of Messrs. W. C. and K. A. Mountain.

Telephone System at Panama-Pacific Exposition.—The installation of a telephone system at an exhibition involves the problem that standard rates are not applicable, owing to the short time during which the telephone has to earn sufficient to cover its installation, operation and removal expenses. For this reason the Panama-Pacific Exposition authorities decided to take over the telephone business within the grounds and to operate a private branch exchange connected with the local company. The Exposition grounds cover 625 acres, comprising 13 large exhibition buildings, in which there will be about 2,000 stands and about 450 buildings for other purposes. It was decided to lay out a 1,000 line system and to run the telephone cables underground in the same conduit as the light and power cables except for one end of the grounds, where weather-proof wires are run to the nearest feeder cable. The underground system required 41,000 ft. of cable, of which 4,500 ft. is 400 pair. The trunk line from outside to the private branch exchange contains 1,200 pairs. The exchange switchboard is made up of five sections or 15 positions, with a complete storage battery plant, charging generator and ringing machines. To provide the fullest telephone facilities at a minimum of expenses 36 pay stations are to be installed, each of which will consist of from 5 to 10 booths.

Palmer's Steel Works and Rolling Mills.—As mentioned in our issue of December 11th, a large plant, consisting of 15,000 B.H.P. of gas engines, driven by the waste gases from

the blast furnaces, is being put down at Palmer's steel works for the purpose of generating electrical energy. Further particulars have now come to hand, from which it appears that four gas blowing engines are being installed and six gas-driven electric generators, the gas engines being by the National Gas Engine Co. The gas for the latter will be treated on Fraser & Chalmers dry cleaning system. The horizontal double-acting gas-blowing engines will each have two gas power cylinders in tandem with one air cylinder between them. These engines, normally rated at 2,000 B.H.P. each, will be worked at reduced speed for blowing. The National gas engines will be of the high-speed vertical single-acting type, each unit having 12 cylinders on six cranks and driving a 1,000 kw. alternator. The blowing engines will supply air to the blast furnaces, and the electric power generated will be utilised throughout the Palmer works. The contract for the electrification of the heavy cogging mill and the conversion of the steel works auxiliaries from steam to electricity has been awarded to the British Westinghouse Electrical & Mfg. Co. (Ltd.). The scheme is being carried out to the requirements of Mr. A. B. Gowan, managing director, and under the direction of Mr. A. P. Pyne, works manager, of Messrs. Palmer's Shipbuilding & Iron Co., with whom Mr. William C. Mountain, of Newcastle-on-Tyne, is associated as consulting engineer.

Birthday Honours.—The King's Birthday Honours List this year contains the following names which will be familiar to our readers :—

New Baronets.—*Sir Henry Norman*, M.P. At one time Assistant Postmaster-General for a short period. He is interested in wireless telegraphy and is a Vice-President of the Wireless Society of London.

Sir Gilbert Parker, M.P., who initiated and organised the first Imperial University Conference in London in 1903.

K.C.B.—*Rt. Hon. Sir John Fletcher, Baron Moulton, F.R.S.*, for his services in connection with the British Dye Industry during the war.

New Knights.—*Lieut.-Col. William Forbes*, Commandant of the Engineer and Railway Staff Corps; is general manager of the London, Brighton & South Coast Railway, and a member of the Railways Executive Committee.

William Pearce, M.P. A director of William Pearce & Sons and of Spencer Chapman & Messel, chemical manufacturers.

William Napier Shaw. Director of the Meteorological Office since 1905, and Reader in Meteorology in the University of London since 1907.

William Slingo, Engineer-in-Chief of the General Post Office. He has been actively connected with technical education, and during his career in the Post Office has seen enormous strides in the development of the telegraph and telephone services.

C.S.I.—*Hugh Trowbridge Keeling*, Chief Engineer and Secretary to the Chief Commissioner, Delhi.

Imperial Service Order. *David Mitchell Stewart*, Superintending Engineer, General Post Office.

Comparative Tests of Heating by Hot Water and Electricity.—An article in the "Elektrotechnische Zeitschrift" (Jahrgang 35, p. 1089) gives some interesting particulars of tests made at Stockholm by a commission consisting of Mr. Dahlander, the manager of the gas and electricity works, Mr. Decker, the chief engineer of the electricity works, Dr. Ekström, Messrs. Dahlgren and C. A. Rossander, in which a suite of 10 rooms, having a content of 900 c.m. on the first floor of a large building, were fitted with both hot water and electric heating apparatus. The electric heaters had a total loading of 20 kw., and were provided with thermostatically controlled switches (designed by Dr. Ekström) for automatically maintaining the temperature of the rooms at about 18°C. The radiators of the hot-water plant were similarly controlled by thermostats ; the hot-water boiler was heated by means of gas coke. The rooms were heated during six months, one week by hot water and one week by electricity alternately. Two methods of using the electric plant were tried, viz., to switch off the current at the end of office hours and to switch it on at 7 a.m. in time for resumption of work at 9 a.m. and to leave it on throughout the night. The result of the experiments was as follows : With continuous electric heating it was found that 1 hectolitre of coke was equivalent to 198 kw.-hours, the thermal efficiency of the hot-water plant being about 60 per cent. When the current was cut off after office hours, the consumption of electric energy was reduced to 120 kw.-hours. The price of the coke was 1·5 kr. (1 kr.=100 öre=1·12s.) per hectolitre. The cost of electric energy for continuous heating was 0·9 öre, and for intermittent heating 1·5 öre per kilowatt-hour.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Dr. C. C. Garrard concludes his article on "Balance System of Protection" (p. 311).

Prof. Geo. R. Dean deals further with the "Differential Equations of Long-distance Transmission" (p. 318).

We give an abstract of a report on the "Variable Resistance for Motion Offered by the Registering Trains of Electric Supply Meters," by Mr. S. Evershed (p. 303).

Mr. L. Boothman contributes an article on the "Trend in Design of Modern Regulating Rheostats for Electrical Machine Excitation Control" (p. 306).

An abstract of a Paper by Prof. E. W. Marchant on "Methods of Measuring the Strength of Wireless Signals" is concluded (p. 309).

We abstract a Paper on the "Economic Operation of Electric Ovens," by Mr. P. W. Gumaer (p. 320). Our Leading Article discusses this subject (p. 316).

We give an account of the annual general meeting of the Institution of Electrical Engineers (p. 313).

Companies' Meetings and Reports.—Meetings of the Electric Construction Co., United River Plate Telephone Co., Brisbane Electric Tramways Investment Co., Delhi Electric Tramways & Lighting Co. are reported ; and the directors' reports abstracted include those of the Cuban Telephone Co., Kalgoorlie Electric Power & Lighting Corpn., Lancashire Power Construction Co., Reuter's Telegram Co. and Westinghouse Electric & Mfg. Co., Hong Kong Tramway Co. and Shropshire, Worcestershire & Staffordshire Elec. Power Co. (pp. 335-337).

OBITUARY.

Harry Gustav Byng.—We regret to record the death of Second-Lieut. H. G. Byng, third son of the late Gustav Byng (founder and late chairman of the General Electric Co.), who fell fighting for his country in Flanders. Born in 1889, he was educated at Harrow and Faraday House, afterwards going to Harvard University, where he was very popular, both socially and as a good sportsman. He spent some time as a pupil in the works of the General Electric Co. (of America) before returning to a position in the General Electric Co. at Witton. At the outbreak of war he joined the Artists' Rifles and went to France with them at the end of September. He returned home on March 21 on five days' leave, during which time he married Miss Evelyn Curtis, of Boston and Beverley Farms, Mass., U.S.A. Immediately after, he was gazetted Second-Lieut. in the 2nd Border Regiment, and fell gallantly in battle on May 16 near Festubert, in France, whilst leading his platoon. He was a young man of great promise and personal charm, and his death is not only a great loss to his family and friends, but to his battalion, and probably also to the electrical industry of the country.

Mr. G. Horley.—We regret to announce the death on May 25th of Mr. George Horley, resident engineer of the Houndsditch road station of the Westminster Electric Supply Corporation (Ltd.). Mr. Horley was only 43 years of age.

Earl of Jersey.—The death of the seventh Earl of Jersey took place on the 31st ult. The deceased peer, who was a prominent politician, was chairman of the Light Railway Commission for about nine years.

PERSONAL.

The appointment of Admiral Sir Henry Jackson, K.C.V.O., F.R.S., to the First Sea Lordship of the Admiralty will be welcomed by all electrical engineers. His work as Admiral Inspecting Captain of Submarines during the early years, and later as Commander-in-Chief of the Home Fleets, led to his election as a Fellow of the Royal Society in 1901. He is a member of the Institution of Electrical Engineers.

Mr. Marconi arrived in London last Sunday night from America, on his way to Italy, having left by the first boat after the declaration of war. He left London for Italy on Wednesday to take charge of the wireless service there.

We are informed that Mr. Hugh E. Harrison has been appointed representative of the P.N.V.E. attached to H.M.S. Vernon, for special work in connection with the Admiralty. His staff, of course, necessitate considerable increase, but he has moved at 11, Victoria street, S.W. to be centrally situated.

APPOINTMENTS VACANT AND FILLED.

Machine testers, with experience in d.c., a.c. and turbo-generator work, and also men for small a.c. and d.c. motor testing, are wanted in Manchester district. *See advertisement.*

The British Westinghouse Electric & Mfg. Co. advertise for engineering correspondents, with knowledge of commercial electrical and general engineering correspondence.

Junior switchboardmen are required for a large 11,000 volt three-phase [illegible]. *See advertisement.*

Applications are invited for the post of officer-in-charge of the electrocardiograph department of the Middlesex Hospital, London, W. Honorarium, £50 per annum. Applications to the Secretary Superintendent by July 12.

West Hartlepool Corporation invite applications for the position of borough electrical engineer. Commencing salary £400. Applications to the Town Clerk by June 9.

Mr. E. Broad has been promoted to the position of shift engineer at the electricity works of Heston and Isleworth Council in succession to Mr. J. Fletcher, who has taken up an appointment at Worksop as station superintendent.

Mr. J. W. Church, second assistant electrical engineer at Malta Dockyard for the past 3½ years, has been appointed acting first assistant electrical engineer at Dover Dockyard, in succession to Mr. Needham, who has been promoted to first assistant at Bermuda Dockyard.

South Shields Tramways Committee received 39 applications for the position of manager of the municipal tramways and these have been reduced to the following six: Messrs. Percy Priestley (Rawmarsh), John C. Whiteley (Chatham), Chas. O. Silver (Wolverhampton), Charles Burgess (West Hartlepool), F. C. Batey (South Shields), and B. J. C. Bruce (Hull).

Mr. Robt. A. Wetherall, of Stalybridge, has been appointed borough treasurer and manager of the electricity department at Bacup.

Mr. A. Thomson has been appointed charge engineer at Derby electricity works at £130 per annum.

INSTITUTIONS AND SOCIETIES.

Newcastle Section of the Institution of Electrical Engineers.—The annual report of the Comittee of the Newcastle Section was presented at the annual general meeting held on the 17th ultimo. The average attendance at the general meetings during the session has been 43, as compared with 48 in the preceding session. A decrease in membership, mainly in the students' section, and due, probably, to the war, is reported. Nine meetings were held during the session (eight at Newcastle and one at Darlington). The Tees-side branch held eight meetings. The officers and committee for the next session have been elected as follows:—

Chairman: Mr. P. V. Hunter. *Vice-Chairmen:* Messrs. H. W. Clothier and A. H. Marshall. *Past Chairmen:* Messrs. W. C. Mountain, C. Vernier. *Committee:* Messrs. E. Fawssett, G. L. Porter, W. F. T. Pinkney (Power Supply Undertakings), H. S. Ellis, C. Turnbull (Corporations), W. G. Cans, T. Carter, M. G. S. Swallow (Manufacturers), C. S. Vesey Brown, R. W. Gregory, J. R. Beard (Consulting Engineers), G. L. Drury, H. Henderson (Railway Representatives), W. M. Thornton, F. O. Hunt (Scholastic Profession), A. P. Pyne, J. R. M. Elliott, and W. Cross (Shipyards, Post Office and Contractors). *Hon. Treasurer:* Mr. C. Vernier. *Hon. Secretary:* Mr. J. R. Andrews. *Hon. Auditors:* Messrs. H. Hunter and G. Stoney, F.R.S.

Incorporated Municipal Electrical Association.—The official programme of the twentieth annual meeting of the I.M.E.A., which is to be held at the Institution of Electrical Engineers, Victoria Embankment, London, W.C., on Thursday and Friday, June 17 and 18, has just been issued, and confirms the provisional arrangements previously noted in THE ELECTRICIAN. The headquarters of the Council will be at the Hotel Cecil. On the Thursday, at 10 a.m., Messrs. A. S. Edwards, Sunderland, and T. Reiss (Bradford) present a report on [illegible] Five Association, on "The Practical Result of the Point Five Tariff." At 2:30 p.m. a report will be presented by Mr. F. Ayton (Ipswich) on behalf of the Electric Vehicle [illegible] "The Use of Electric Vehicles in Municipal Service," which will be followed at 5 p.m. by a parade and demonstration of electric vehicles on the Embankment. The annual general meeting [illegible] on the Friday, when the usual business will be transacted.

"Tramways and Light Railways Association Journal."—The May [illegible] this journal contains considerable space to the question of road maintenance. A circular letter has been sent round to various tramway managers inviting replies to a series of seven questions dealing with the subject, in order to help the committee in placing the views of the association before the Expert Committee. An abstract of the report relating to road locomotion by the Departmental Committee of 1904 on motor cars is reproduced in the "Journal." A short extract from a speech of the President of the New York Street Railways, on the subject of the paving expenses borne by tramway companies, is also given.

Institute of Radio Engineers.—A Paper read recently by Mr. B Liebowitz on the Pupin theory of asymmetrical rotors in unidirectional fields dealt first with a simple circuit having no resistance and with a periodically varied inductance, showing in a simple manner that an infinite number of harmonics are generated therein. Leading on to the Pupin theory of two circuits, one of which is radiated in the field of the other and upon which a constant voltage is impressed, it was shown that the general theory may be simplified to the extent that it becomes analagous to the first case. The explanation of Pupin's theory to the case including condensers was then taken up and a general application to the theory of the Goldschmidt radio frequency alternator was made.

Royal Society.—The Papers read before the Royal Society yesterday included the following: "On the Shapes of the Equipotential Surfaces in the Air near Long Buildings or Walls and on their Effect on the Measurement of Atmospheric Potential Gradients," by Prof. C. H. Lees, F.R.S.; "The Influence of Gases on the Emission of Electrons and Ions from Hot Metals," by Prof. O. W. Richardson, F.R.S.; and on "The Band Spectrum Associated with Helium," by Prof. J. W. Nicholson.

EDUCATIONAL NOTES.

Imperial College of Science and Technology.—The King has reappointed Sir Donald MacAlister and Mr. Otto Beit members of the governing body of the Imperial College of Science and Technology, and Mr. R. E. Protheroe, M.P., has been appointed in place of Mr. Gerald Balfour, who did not desire to be re-appointed.

Northampton Polytechnic Institute.—A free "Aitchison Memorial Scholarship" of the value of £30, open to all and tenable at this Institute is being offered to students.

The scholarship has for its special object the encouragement of recruits for the optical craft and the subjects of examination include English, mathematics and elementary physics. The conditions of the scholarship have been laid down by a Committee, which includes: Dr. R. Mullineux Walmsley, Prof. S. P. Thompson and Dr. J. W. Ettles (M.D.). Particulars from the hon. secretary and treasurer, Mr. Henry F. Purser, 35, Charles-street, Hatton Garden, London, E.C.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 4th (to-day).

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street, Piccadilly, London, W. Discourse on "Radiations from Exploding Atoms," by Prof. Sir Ernest Rutherford, F.R.S.

SATURDAY, June 5th.

NOTTS AND DERBYSHIRE BRANCH OF THE ASSOCIATION OF MINING ELECTRICAL ENGINEERS.

3:30 p.m. Meeting at University College, Nottingham. Discussion on Paper on "Experiences with Electrical Plant," by Mr. A. Smellie.

THE NATIONAL RELIEF FUND.

(Treasurer, H.R.H. The Prince of Wales.)

This great National Fund, for the relief of those amongst the needier classes who are widowed, orphaned and otherwise affected by the fighting in which our troops and ships are now taking part, urgently seeks contributions however small. These can be sent with the following note, which can be cut out, filled in, put in an envelope and sent *unstamped*, addressed H.R.H. The Prince of Wales, Buckingham Palace, London.

Date.....

I enclose £ [illegible] *d. towards the Prince of Wales*

NATIONAL RELIEF FUND.

Name .....

Address .....

£ .....

THE VARIABLE RESISTANCE TO MOTION OFFERED BY THE REGISTERING TRAINS OF ELECTRIC SUPPLY METERS.*

BY S. EVERSHED.

Introductory.

During the preparation of the amended specification of the Engineering Standards Committee for electric supply meters of the motor type, the panel appointed by the sub-committee on electrical plant accessories to assist the chairman in drafting the clauses had under consideration the difficulties that arise in testing meters for accuracy owing to the variable resistance to motion offered by the registering train. At any considerable load these variations in retarding moment do not appreciably affect the speed of the rotor, but the panel was informed that in many cases the variable resistance of a meter train was sufficient to cause marked changes in speed at loads from one-tenth of full load, downwards; and that, although these variations cancel out in actual service, they make it difficult to obtain trustworthy figures for accuracy at low loads without spending an inordinate amount of time upon the tests. The panel thought it desirable to obtain more precise knowledge of the behaviour of the various kinds of meter train before settling the clauses relating to them, and the British Electrical and Allied Manufacturers' Association was accordingly asked to obtain samples of those in common use, and at the chairman's request the writer undertook an experimental investigation of the causes which lead to a meter train offering a variable resistance to motion and the extent to which the variations affect the speed of the rotor.

General Principles.

A complete meter train comprises a set of registering axles, each carrying some means of indication, and a reducing gear through which the registering axles are driven by the rotor. The register axles are invariably geared to each other in the ratio of 10 to 1, the gear being either continuous, in which case the consumption is indicated as a continuously growing quantity; or discontinuous—each axle coming into gear with the next once in each revolution—in which case the consumption is counted unit by unit and registered as a numeral. Each axle of a continuously geared register indicates by a pointer on a figured dial. This form will be referred to in this report as a *pointer dial* or pointer register. The difficulty of reading a pointer dial is well known to everyone who has to do with meters, and when the register axles are geared together with considerable back-lash, as they should be if the train is to run freely, the pointers sometimes give positively misleading indications. Each axle of a discontinuously geared register carries a disc or cylinder on which the digits from 0 to 9 are marked; these digit wheels (as they may be called) each showing one digit at a time through openings in a dial. This form will be referred to in this report as a *counter train* or counter dial.

Ambiguity of Counter Dials.

During the time a digit wheel in a counter is changing from one digit to the next, and particularly when several wheels are changing from 9 to 0, the reading of the dial becomes ambiguous and remains so until the change has been completed. The time taken to make the change is the same for all the digit wheels and is equal to one-tenth of the time occupied by the driving spindle of the counter in making one revolution. This periodic ambiguity is inherent in all discontinuous gears, and to avoid it a vast amount of ingenuity has been expended on subsidiary devices for compelling a counter to change more or less suddenly from one digit to the next. So far as meter trains are concerned, the only suitable devices of the kind are those in which some of the energy of the rotor is spent in lifting a weight or winding a spring, until, at the completion of a unit, the weight falls, or the spring is released, and drives the units digit wheel forward from one digit to the next practically instantaneously. In this report counters will be distinguished as *jumper counters* or *creep counters*, according to whether they are fitted with a jumper device or not.

Reducing Gear from Rotor to Register.

The reducing gear which transmits motion from the rotor to the register consists of a series of axles so geared to each other as to give the required ratio of reduction. In ordinary practice the registering axles are horizontal, and a worm wheel is introduced. The various axles of a meter train will be referred to so often that it will be well to name them: The axle to which the rotor is directly geared will be called simply "the first axle," and the next in order "the second axle," and so on, the corresponding pointers registering, say, hundreds, tens, units, tenths and hundredths respectively. The tenths and hundredths axles, where they are included in a train (for they are not necessarily present in every meter train), are only used for testing purposes and to confuse the mind of the consumer.

Typical reducing gears from the rotor to the units axle of the register are shown in Figs. 1 and 2. They are both intended for a 1 kw. meter in which the rotor runs at 60 revs. per min. at full load. The same set of wheels is used for both the worm drive and the spur drive, the first and second axles merely changing their places in the series. If the rotor speed at full load is S revs. per min., and the capacity of the meter is W kw., then the rotor will evidently make 60 S/W revolutions per kilowatt hour, and since the tenths axle makes one revolution per unit, the ratio of the reducing gear from the rotor to the tenths axle must be equal to 60 S/W. Hence the

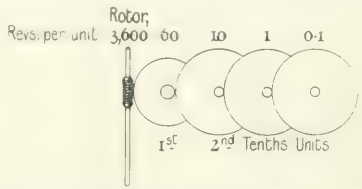


Fig. 1.—Reducing Gear for 1 kw. Meter, speed 60 r.p.m. at Full Load, Worm Drive.

ratio from rotor to units axle will be 600 S/W, and so on. It will be convenient to have these ratios in tabular form.

Table I.—*Reducing Gear Ratios.*

From rotor to hundredths axle			.....	6 S/W to 1
,,	,,	tenths	,, ...	60 S/W ,,
,,	,,	units	,, ...	600 S/W ,,
,,	,,	tens	,, ...	6,000 S/W ,,

To avoid the continual repetition of long words, the moment of frictional resistance of a spindle or wheel will be referred to simply as the friction. It is measured, of course, by the torque required to overcome it. Similarly, the word resistance will be used in the sense moment of resistance of an axle or wheel. Torques will be stated in dyne-centimetres (d.c.), and when, in accordance with common usage, the full load torque of a meter is given in gramme-

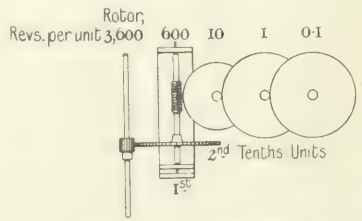


Fig. 2. Reducing Gear for 1 kw. Meter, speed 60 r.p.m. at Full Load, Spur Drive.

centimetres, the gramme will be supposed to have a weight of 1,000 dynes, instead of its legal weight of 981 dynes.

Gear Efficiency.

The efficiency of gearing, which will be frequently referred to in this report, is not the overall efficiency obtained by taking all losses into account, but the differential efficiency—namely,

$$\frac{\text{Increment of resisting moment on driven axle}}{\text{Corresponding increment of torque on driving axle}}$$

In reckoning this efficiency, the only losses taken into account are those caused by the engagement of the gear teeth (tooth losses), and such losses in the bearings as are directly caused by the power which is transmitted. In the case of gearing which, like that in a meter train, runs without lubrication, these losses are simply proportional to the speed, and, since they are also directly proportional to the load, the differential efficiency of the gear is a constant quantity independent both of load and speed.

Preliminary Tests.

In response to the invitation of the British Electrical and Allied Manufacturers' Association, 11 meter makers or their agents sent

* Abstract of a report to the Engineering Standards Committee on electrical plant accessories, published in the "Journal of the Institution of Electrical Engineers."

samples of the meter trains they use. Thirty trains in all were received—namely, 3 pointer, 13 creep counter and 14 jump counter dials.

The greater number of the trains were intended for meters of 1 kw. capacity and under, so that in most cases the reducing gear had a large ratio, and any periodic variation in the resistance of the counters would necessarily be reduced to a very small value as measured on the rotor spindle. As a preliminary, each train was geared to a small hysteresis motor. The motor used for these tests can be driven at any speed up to about 160 revs. per min., and any measured torque can be applied from zero up to about 80 d.c. with a precision of about 0·2 d.c. at all parts of the range. The torque is governed solely by the strength of the rotating field, and is absolutely independent of the speed until the synchronous speed is nearly approached. The rotor, which has a vertical spindle, weighs 6 grammes complete, and the bearing friction is about 0·4 d.c. The moment of inertia of the rotor is almost negligible, and when running on a steady load a very small increase in resistance is sufficient to stop the machine in a few revolutions. This is an important matter in testing the friction of small mechanisms, because a motor which had any considerable inertia would easily overcome temporary increases in resistance, and hence the variation which it is intended to study would pass entirely unnoticed.

To facilitate the tests, the wheel on the first axle of each train was removed and a worm wheel or spur wheel specially prepared for the purpose was fitted in place of it. Corresponding with these two special wheels a worm and a spur pinion were prepared of suitable sizes to fit on the rotor spindle. The use of one worm gear and one spur gear for these tests had the incidental advantage that all the trains were tested under the same conditions as regards efficiency and friction of the gear between rotor and first axle.

The differential efficiency of each of the special gears was calculated from the dimensions, taking the coefficient of friction at 0·20. Each gear was then tested for efficiency by fixing its wheel on a suitable axle, to which measured resistances were applied by weights. The gear being driven by the hysteresis motor, torques were measured for a series of loads, and the differential efficiency worked out from the test figures. The efficiencies were as follows:—

Table II.

Special gears for driving meter trains.	Differential efficiency.	
	Calculated.	Observed.
Worm gear	0·22$_6$	0·21$_8$
Spur gear	0·96$_2$	0·94$_7$

The calculated efficiencies given here only take into account the tooth losses and worm losses. When the wheels are transferred from testing axles, specially constructed to avoid friction, to the first axle of a meter train with comparatively large pivots, the efficiency of the worm gear is not likely to exceed 0·2, and that of the spur gear could hardly exceed 0·9. All these figures for efficiency are absolute, and must be multiplied by 100 to obtain the percentage efficiencies.

The results of the preliminary tests of the meter trains gave an average of 6·1 d.c. as the rotor torque for the pointer dials, 12·3 d.c. for the creep counter dials and 5·5 for the jump counter dial trains. In the case of the creep counters the increase in resistance caused by the periodic engagement of additional digit wheels was easily detected When all five digit wheels were engaged the resistance of the trains rose to a value two or three times as great as the ordinary running value when only one digit wheel is rotating. In the case of the jump counters no trace of any periodic variation in resistance, such as would be caused by the work done in lifting the weight of the jumper device, was detected. The periodic changes in resistance caused by a jump counter in meters of larger capacity are dealt with later on.

The kind of register employed makes but little difference, the average resistance being 5 d.c. or 6 d.c. for all three types. The creep counters alone produced any marked effect on the rotor, and in their case it was not because the resistance of a creep counter necessarily varies so widely, but because all the creep counters were of the Harding type.

Analysis of Pointer Dial Trains.

These being simple trains of spur and worm gearing, there should not be any periodic variations in resistance. In practice, however, such variations do sometimes occur as a result of a gear wheel being slightly out of truth and engaging its teeth too deeply during a part of each revolution. The defects of this kind are not common, and do not the principal cause of change in friction. It is the irregular variations that need to be reckoned with, and these are all the more difficult to deal with because they not only vary widely in magnitude and occur at irregular intervals of time, but their duration is also a matter of extreme uncertainty. They are apt to occur more or less suddenly, and when the friction of a train has undergone this kind of change it may run at the new value for a few minutes or for many hours before a change takes place to a more normal friction.

Table III. shows the estimated resistance such a pointer dial may be expected to have on the rotor of a 1 kw. meter, both for a worm drive and a spur drive. The necessary reducing gears are those shown in Figs. 1 and 2..

Table III.—*Friction of the Different Members of a Pointer Train as reckoned on the Rotor of the Meter*

Part of train.	Axle.	Friction at rotor in d.c.	
		Worm drive.	Spur drive.
Reducing gear	First	5·000	0·294
.. ..	Second	0·980	0·980
.. ..	Third (tenths)		
Register	Units		
..	Tens	0·138	0·138
..	Hundreds		
..	Thousands		
Total friction of train		6·1	1·4

It is at once evident that the difference in the friction of the two drives is due to the great difference in the friction of the first axle, according to whether it is horizontal or vertical. In the latter position the bearing friction can be so enormously reduced that its incidence on the rotor axle is also very largely reduced, notwithstanding the great difference between the ratio of the spur gear and that of the worm gear.

The figures given in Table III. for the total friction afford a good indication of what the friction of a fairly well made and clean pointer train may be expected to be with a worm drive and a spur drive, and in what degree the different parts of the train contribute to the total. As the first two axles account for nearly all the friction, it is clear that Table III. may be taken to apply to any type of train, no matter what the registering devices may be, provided the periodic variations in the resistance of counter registers are not forgotten.

If the total resistance of a train at the rotor axle is multiplied by the first gear and efficiency factors, the total resistance of the train as reckoned at the first axle is arrived at, and a figure is obtained which may be fairly used to compare one train with another, apart from the gear from rotor to first axle. In Table III. the friction of the worm drive being 6·1 d.c. and the gear 60 and efficiency 0·2, the resistance of the first axle would be $6{\cdot}1 \times 60 \times 0{\cdot}2 = 73$ d.c. The corresponding figure for the spur drive, taking an ordinary value for the efficiency of the spur gear, would be $1{\cdot}4 \times 6 \times 0{\cdot}85 = 7{\cdot}2$ d.c. These figures represent good workmanship, cleanliness and absence of accidental defects. It is deduced that the total resistance of train as reckoned on rotor axle is:—

Average for 21 worm-driven trains, $\frac{110}{13{\cdot}2} = 8{\cdot}4$ d.c.

Average for 9 spur-driven trains, $\frac{17{\cdot}5}{7{\cdot}65} = 2{\cdot}3$ d.c.

These values are representative of present practice and will form a good basis on which to calculate the percentage variations in speed caused by irregular changes in friction. Now these irregular variations are no doubt due to more or less accidental circumstances, but the fact remains that the friction of any ordinary train of wheelwork, such as that used in meter trains, is apt to show variations of 10 or 20 per cent. above and below the normal. In the case of meter trains, then, changes of about 15 per cent. either way are to be expected, and although the percentage must vary to some extent with the load transmitted by the gearing, it will be assumed that the variations in friction are simply proportional to the load and that + or − 15 per cent. of the average resistance of the train is an adequate allowance to make for them; a rough estimate at best, but sufficient for the present purpose. For a worm drive, then, the irregular variation in friction will be assumed to be 15 per cent. of 8·4 d.c., or about 1·2 d.c.

Table IV. *Percentage Changes in Speed above and beneath Normal due to variable Friction in the Trains when the Meter is running at one-tenth of Full Load*

Torque of meter at full load.	Percentage speed variation due to variable friction.	
Grm. cm.	Worm drive.	Spur drive.
1	1·2	0·4
2	0·6	0·2
5	0·24	0·08
10	0·12	0·04

either way; and the corresponding figure for the spur drive will be 15 per cent. of 2·3 d.c., or quite roughly 0·4 d.c. either way. The resulting changes in the speed of the rotor will, of course, vary inversely as the driving torque; the percentage speed changes at one-tenth of full load are given in Table IV., for meters from 1 grm. cm. torque at full load, up to 10 grm. cm.—a range which covers ordinary practice.

Speed changes such as these, although small in themselves, may become important when they form an addition to the periodic variations which are characteristic of counter trains.

Analysis of Creep Counter Trains (Harding Counter).

In all the creep counter trains the register was a small Harding counter, the wheels, pinions, and frame all being metal-mould (or die) castings. In the Harding counter the advantage of having all the digit wheels arranged in line on a common axis, is gained at the expense of friction. Not only are the essential moving parts nearly doubled in number, but the axles are long and necessarily of large diameter in order to secure rigidity; they are far too large for their function as pivots. Again, when motion is being transmitted from one digit wheel through a pinion to the next wheel, the same tooth both receives the applied force and hands it on to the next wheel, so that the maximum pressure is exerted on the pinion bearing and the maximum friction is created. There is none of that partial balancing of pressures such as occurs when gear wheels receive and transmit the load at opposite ends of a diameter.

Table V. compares the torque required as measured and as deduced from certain assumption.

Table V.—*Torque required on the first Digit Wheel of a Five-figure Harding Counter when 4 Nines are being changed to Zero, all the Wheels being then in Motion.*

Method.	Resistance, d.c.
Calculated from weights and dimensions of No. 16	503
Measured by weights applied to first digit wheel of No. 16	480
Deduced from rotor torque required to drive complete train; average for Nos. 6, 7 and 16.....	537
Deduced from rotor torque required to drive complete train; average for Nos. 4, 5, 8, 9, 10, 11, 12, 13, 14 and 15.....	585

Torque Required to Set any Number of Nines to Zero, and Decrease of Speed during the Change.

If a five-figure Harding counter requires a torque of 600 d.c. to set four nines to zero it does not follow that it will take 600/4 d.c. to move one digit wheel from 9 to 0. There is a geometrical cumulation of friction as the number of wheels engaged increases. In calculating the percentage speed changes which occur during the change of one or more nines to zero, only the additional resistance of the counter is to be taken into account. A table is given showing the percentage decrease in speed in meters of 1, 2, 5 and 10 grm. cm. torque, and 10, 50 and 100 revs. per min. rotor speed, caused by the charging of nines to zero in a five-figure Harding counter.

Under-registration of a Harding Counter.

It must be remembered that the decrease in speed during the changing of nines to zero only affects one-tenth of the units registered. The other nine-tenths are registered at times when the rotor has only the normal friction of the reducing gear (including the first digit wheel) to overcome, and hence the errors are not as serious as might be thought.

If a meter with a five-figure Harding counter is run until the dial has gone through a complete cycle from 00000 through 99,999 to 00000 again, there will have been 9,000 occasions when one 9 changed to zero, 900 when two nines changed, 90 when three nines changed, and 10 when four nines changed. On each of these occasions the time occupied in making the change was longer than it would have been without the additional resistance; longer than the normal or correct time for registering one dial unit or step. The under-registration depends on what the load happens to be during the nine-changing periods, and it is not affected by the load there may be at other times. Taking an unfavourable case—that of a 1 kw. meter of 1 grm. cm. torque and 10 revs. per min. full-load speed, with a Harding counter which has a maximum resistance of 600 d.c. and has the first digit wheel on the hundredths axle, so that $n = 0{\cdot}01$, the loss during a complete dial cycle [illegible]

At 1·5th full load 3·4 units lost in 1,000 [illegible]
„ 1·10th „ 7·0 „ „ [illegible]
„ 1·20th „ 17·5 „ „ [illegible]

These figures suggest that if the meter were [illegible] about ½ per cent. fast the loss from nine-changing would [illegible] so long as the counter retained its initial friction.

Analysis of Jump Counters.

The jump counter presents a much simpler problem than the creep counter. It is only necessary to measure the maximum moment of the weight or spring which is used to propel the digit wheels, and the periodic speed variations are then merely a matter of arithmetic.

All the jump counters, except one, were of the type in which a weight is lifted and then made to propel the counter during its fall. It was obvious from inspection that there was no material difference in the weight used in the different counters, and a measurement of one of them, taken from a typical jump counter, showed that it had a maximum moment of about 1,000 d.c. This is the moment provided for the purpose of overcoming the additional friction of the counter when all the digit wheels are engaged. To ascertain what the additional friction might be, the total friction and the friction of the first digit wheel were both measured by the falling weight method, and also estimated from the weights of the moving parts and the diameter of the pivots. The counter just referred to was chosen for this comparison, and the measured and estimated amounts were as follows:—

Friction of Four-figure Scallop-wheel Jump Counter.

	Estimated d.c.	Measured d.c.
Total friction with all digit wheels engaged	392	450
Friction of first digit wheel	116	195
Friction to be overcome by jumper weight.....	276	255

From these figures it may be safely assumed that apart from accidental additions to friction this counter requires about 300 d.c. additional driving torque when all the digit wheels are to be set in motion. The torque provided by the jumper weight being about 1,000 d.c. there is evidently an ample margin, especially as the weight falls suddenly and the digit wheels are therefore started by impact.

In nearly all jump counters the work done in lifting the jumper weight is spread over the whole revolution of the axle on which the jump device is fitted, by the use of a counterweight. By this ingenious expedient the maximum torque required to lift the jumper weight is reduced by one-half, and hence the maximum resultant moment to be taken as a basis in calculating the periodic speed variation will be 500 d.c. The extreme variations on either side of the mean are unequal, being 182 d.c. above the mean and 318 d.c. below it.

Tables are given showing the speed changes for jump counters for meters of 1 kw. and 10 kw. capacity, and corresponding figures for a 100 kw. meter. Approximate curves are also given of which Figs. 3 and 4 are examples.

General Conclusions.

The main purpose of this report has been to present the facts, but it will not be out of place to draw one or two broad conclusions from them, and incidentally to make one or two suggestions with reference to meter-testing at low loads.

Pointer Dials.—The only variations to be reckoned with in meters with these dials are the irregular changes which are common to all meter trains, no matter what the registering mechanism may be. These irregular changes are small, but at one-tenth load and with a worm drive they may amount to as much as 1·2 per cent. either way in the case of a meter which has a full-load torque as low as 1 grm. cm., and perhaps as much as 0·4 per cent. with a spur drive. They are quite haphazard in their occurrence and in those instances in which low-load testing is affected by them, nothing but a prolonged run will secure a fair average. In this respect there can be no short cut; time and patience are essential.

Creep Counter Dials.—When a meter has a creep counter dial of the Harding type the fall in speed at times when one or more nines are changing to zero is apt to lead to considerable discrepancies at a low load in the case of all meters which have a torque-speed product of less than 100 grm. cm. revs. per min. The only way to avoid them is to carry out all low-load tests at times when the first digit wheel alone is in motion. This condition is fulfilled so long as the first digit wheel is indicating any digit from 1 to 8.

Although the decrease in speed which results from the increase in resistance during the nine-changing periods may be very large, the resulting under-registration over a long period of time is unlikely to amount to as much as 1 per cent. It might well be allowed for in the initial adjustment of meters.

Jumper Counter Dials.—Provided the jump device is not fitted on an axle nearer to the rotor than the tenths axle in a 1 kw. meter, the units axle in a 10 kw. meter, or the tens axle in a 100 kw. meter, the

periodic changes due to the rising and falling of the jumper weight and counter weight are comparatively small. They would certainly have to be reckoned with in low-load tests on meters which have a torque-speed of less than 50, but in any meter of greater power the periodic changes awould be masked, more or less, by the irregular variations which are inherent in the friction of every kind of train.

Scope for Future Progress.

During the past few years meter trains have been considerably improved, and the directions in which further progress is likely to be made may be briefly referred to.

The pointer dial is still unapproached for simplicity. The one trouble is the difficulty of reading it correctly, especially at times when one or more of the pointers stands between 9 and 0.

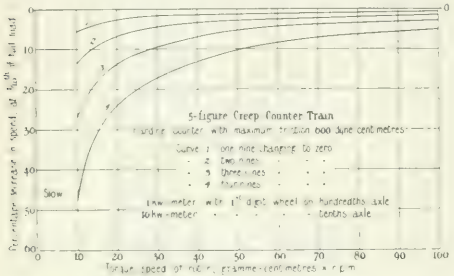


Fig. 3.

Counters were introduced ostensibly to get over this difficulty, but so long as a counter is allowed to creep at the same rate as the creeping consumption of electric energy, the ambiguity is there; and the committee have received abundant evidence that counter dials—creep counters, of course, are misread almost as frequently as pointer dials. But it is easy to convert any type of counter into a jump counter by fitting a suitable jump device. Engine counters—which are nearly always Harding counters—have frequently been so fitted when some special circumstances of use have caused the digits to change too slowly. Yet in applying the Harding counter to electric meters, presumably with the object of obtaining dial readings free from ambiguity, nothing has been done to avoid creeping. The

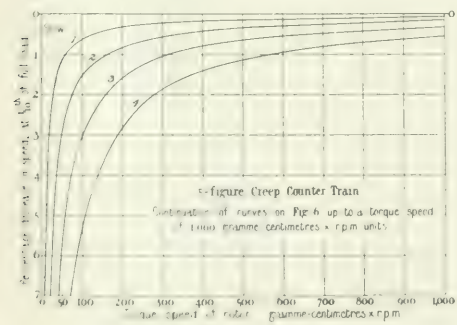


Fig. 4

remedy is so simple that it is difficult to understand how it comes about that the buyer has not long ago insisted on the addition of a jump device.

There is no ground for hoping anywhere between the pointer dial and the jump counter, and there can be little doubt that in one form or another the latter will ultimately take the place of the creep [illegible]. The [illegible] of meter trains is not confined to any one [illegible] on the counter; there are half a dozen [illegible] suggested for the purpose, and the time will surely come when all meter counters, whatever the mechanism may be, will be provided with some simple means for securing instantaneous movement of the digit wheels.

Apart from the universal employment of a jump device, there is still room for improvement in the construction of direct-acting counters.

Some details of counter gears and the jump device are given in an appendix.

THE TREND IN DESIGN OF MODERN REGULATING RHEOSTATS FOR ELECTRICAL MACHINE EXCITATION CONTROL.

BY L. BOOTHMAN.

Summary.—The author refers to the defects which are frequently met with in rheostats, and then describes a special form of rheostat manufactured by the British Westinghouse Co.

Regulating rheostats are at present a necessary evil, and yet it is greatly to be regretted that many rheostats are purchased, or manufactured, for the control of electrical machines on a competitive price basis, with little regard to their design. Apparently this is simply because the cost is so small compared with the machines they regulate that some people think they are hardly worth consideration. Without them, however, the machines are, commercially speaking, practically useless, and in these days, where continuity of service is all important, it seems folly to rely on apparatus of inferior design which reflects adversely on the machine controlled.

A brief survey here follows of practically all rheostat types in use, with especial consideration of the resisters, as these are responsible for nearly all the troubles encountered in most instances.

A common type of rheostat has a mass of leads connecting the resisters to contacts on a faceplate. These connectors are a source

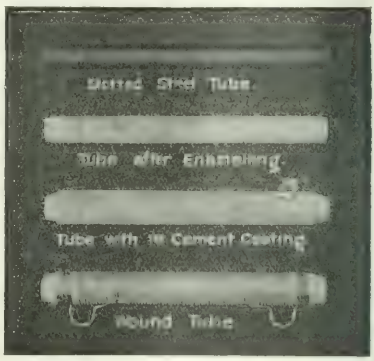


Fig. 1.

of trouble, partly owing to their usually congested state due to many wires being cramped into a small space. Further, it is difficult to see if all the connections, nuts, &c., are secure, and the assembler, who has, therefore, to be relied upon to do this, may easily overlook the effectual locking of a part. This neglect soon develops into a loose connection, and might open-circuit the field. In many cases the connecting wires have an asbestos covering which is fireproof, but has poor insulation properties, especially in moist situations. Sometimes, however, these lead wires are covered with glass insulating beads, giving better insulation but greater congestion.

Resisters are often made of open wire-wound spirals, resulting in a resistance which is cheap and has good heat radiating capacity (assuming that the containing case is well designed), but often gives trouble with its soldered or ineffectually clamped tapping or connecting leads. If a breakage occurs, due to any cause, the then unsupported spiral, falling, short-circuits other coils or earths the circuit to the containing case. Again, this type of self-supporting spiral, unless very liberally spaced, is liable to short-circuit adjacent spirals, due to sagging in centre of coil, caused by its natural expansion on heating. Another disadvantage is that the range of wire sizes that can conveniently be wound, and are self-supporting, is very small. This limits the ohmic values obtainable in a single coil, which militates against obtaining the best grading of the resistance from a regulation point of view, combined with utilising their full heat dissipation capacity for a given temperature rise.

The resistance wire is sometimes wound on asbestos tubes, which are obviously not satisfactory either mechanically or electrically.

The ohmic value limitation previously mentioned holds with these, although in a slightly lesser degree. Sagging, however, is prevented, and they are not so liable to short-circuit other coils in case of wire breakage. Since the resistance cannot be embedded in the asbestos tube, there is a low safe limit to the number of turns of wire per given length of spiral, which if exceeded causes trouble due to expansion, the consequent slackening of wire resulting in many turns short-circuiting each other, especially on small wire sizes. A further type of resistance consists of a porcelain tube, or other shape, with a cement composition coating over the wire. This type practically overcomes all the disadvantages previously outlined; but the porcelain is apt to crack and break under the stress, due to the difference in expansion of metal and porcelain. In rare instances are the terminal leads of sound mechanical connection with the wire.

Rheostats of the flat disc type, with the contacts partly, and the resistance wholly, embedded in enamel or cement composition, are without many of the previous faults. They are relatively low in price, possess fair insulation, occupy little space, and are generally fireproof. However, the range of resistance and capacities obtainable is comparatively small, and grading of the [illegible] requirements that depart from the manufacturer's designed standard cannot be obtained. For the usual rated capacities of this type the temperature rise is also higher than for other types, which, though perhaps not detrimental to the rheostat, is sometimes objectionable for other reasons. If an open circuit occurs on the resistance the whole rheostat has to be replaced.

Having now summarised the advantages and disadvantages of many forms of rheostats in use, a type of construction will be described that eliminates the general faults experienced, and is adaptable for any form of resistance regulation.

In this type of construction, where wire-wound resisters are utilised, the individual units are made as indicated in Fig. 1, which is self-explanatory. The end terminal lugs or connectors consist of triplicate tinned sheet brass stampings, which are so ingeniously bound and clamped to cemented core and wire that it is practically impossible to pull them asunder. The completed winding is then finally covered with a thin binding and protective coating of cement. An identification number for the winding is stamped on the terminal lugs of each unit. The resistance material used has a temperature coefficient almost zero and is non-rusting, even without the additional protective coating. This additional precaution, however, is valuable against corrosive effect of acid or other fumes sometimes encountered, and which would soon corrode through unprotected wire or strip resistance. The partial embedding prevents trouble due to expansion, and allows a large range of wire sizes to be safely utilised. The [illegible] tube core makes breakage unknown. The units are made in seven different sizes, and these, with a single layer of wire, are each made in 36 different ohmic values, so that any resistance grading required can be obtained. The total range is from 0.033 of an ohm to 7,800 ohms in a single unit, and each individual unit must pass successfully a test of 1,000 volts applied between steel tube and wire, and is rejected before completion unless its

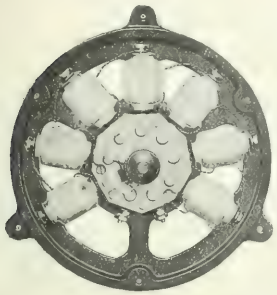


Fig. 2.

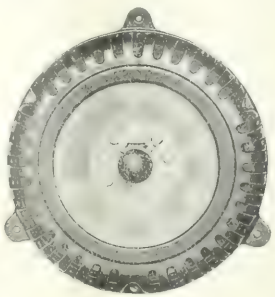


Fig. 3.

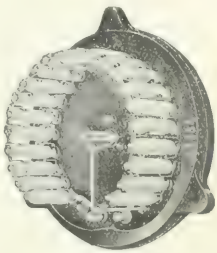


Fig. 4.

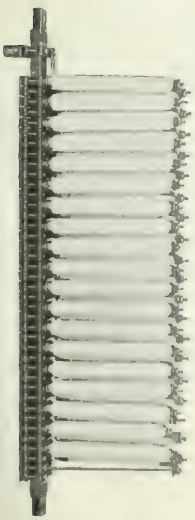


Fig. 5.

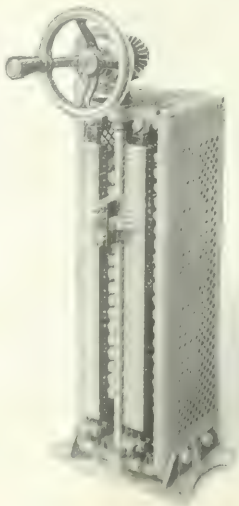


Fig. 6.

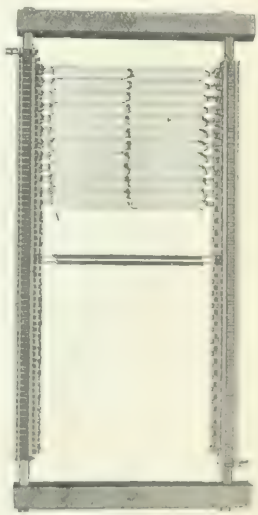


Fig. 7.

ohmic value is within 5 per cent. of its designed standard. The latter feature is a noteworthy instance of the care taken throughout, when it is understood that manufacturers of resistance wires do not guarantee an accuracy of less than 5 per cent. ohmic resistance per given length of wire.

A rheostat utilising the smallest unit, and suitable for small fan and machine regulation, is shown without cover in Fig. 2, the external view as Fig. 3.

Fig. 4 shows the assembled resisters for a larger capacity rheostat, the faceplate being of treated slate insulated by mica from a cast-iron supporting ring. Each resister unit is bolted direct to the contact on faceplate by means of a metal rod (which also serves to carry the current) with locking washers and nuts. Any unit can be inspected in a few moments and effectually locked without having to dissever any portion of the rheostat. The number of steps obtainable in this circular type graduates from 3 to 100 with a further size giving 300 steps.

By fitting a third terminal on the faceplate a potentiometer or differential type of rheostat is obtained. For a reversible potentiometer two rheostats can be used, mechanically coupled together, and

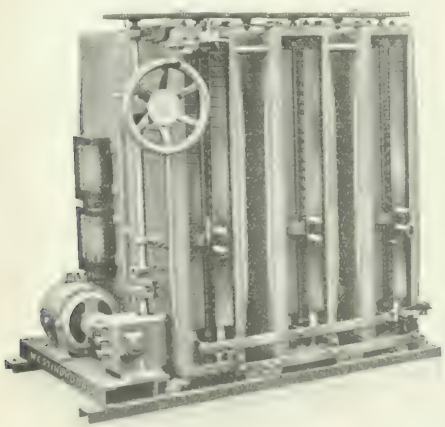


Fig. 9.

the [illegible] connected. Alternatively, it can be obtained by means of a single rheostat having two faceplates, the individual resistance units being mounted on rods directly connected to the contacts on each faceplate, but the contact arms [illegible]

Ordinary reversible potentiometer rheostats usually consist of [illegible]

A rectangular or straight pattern of rheostat, embodying metal and micanite construction throughout, thus being practically unbreakable, is manufactured. They consist of a neat cast-iron framework, on which mica insulated steel bars are bolted. Renewable extruded metal contacts are clamped on these bars (insulation washers and bushes, which are difficult to inspect and often defective, are eschewed). The resistance units, again, are directly bolted to the contacts as shown in Fig. 5. The sliding contact brush is of massive laminated construction, so that even if it only partially covers a contact when in operation no detrimental heating occurs.

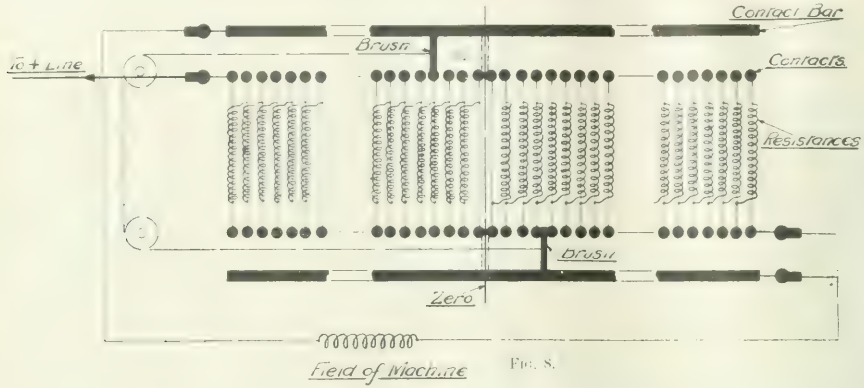


Fig. 8.

The brush pressure is capable of easy adjustment, and alteration of the brush position (*i.e.*, regulation) is obtained by means of a square threaded sleeve on a screwed steel operating spindle. A second guiding spindle is provided which allows ease of operation without interfering with the pressure of brush on the contacts. If the guiding spindle is omitted, as is the case in some rectangular types, the turning movement tends to rock the brush with consequent alteration of brush contact pressure. The external rheostat appearance is clearly illustrated in Fig. 6, which is for a separate mounting type.

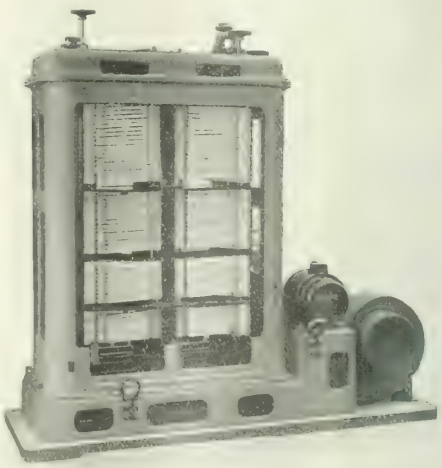


Fig. 10.

For a reversing potentiometer type the arrangement is shown diagrammatically in Fig. 8, while the method of mounting resisters appears in Fig. 7.

For current capacities larger than can conveniently be obtained by the above units, the resisters are of cast grid which are bolted direct on to very massive extended brass contacts clamped on to cross insulated steel bars. Due provision is made for any expansion due to heating in the design of the resister itself, without any neces-

sity for springs or other compensating adjusting devices. The laminated brush pressure is spring controlled and self-aligning, and a notching device is fitted which indicates to the operator when brush is "full on" a contact step. The brushes are made very massive, however, as an additional precaution against overheating, as, of course, very large current capacities are obtainable in this type. An example is illustrated in Fig. 9 which is for a hand and motor operated rheostat having 50 steps, field current of 600 amperes. This consists of three rheostat units mounted and operated together in parallel in order to obtain the capacity with range required, and is a good example of the adaptability of this type of construction.

The number of joints in the path of the current in these rheostats is less than in any other form obtainable—that is to say, there are fewer points of localised heating. The simplicity of this "grid resister direct on contact" method of construction is exemplified by Fig. 10, and should be compared with the usual frames of resistance connected by wires or straps to a faceplate. The illustration shows a partially assembled motor or hand-operated rheostat arranged for forced air draft cooling, the cast resisters being clearly seen. The completed rheostat is shown in Fig. 11. The arrangement is such that immediately the field switch is closed the fan motor is started, and an indicating device is provided which ensures that the fan is in continual operation.

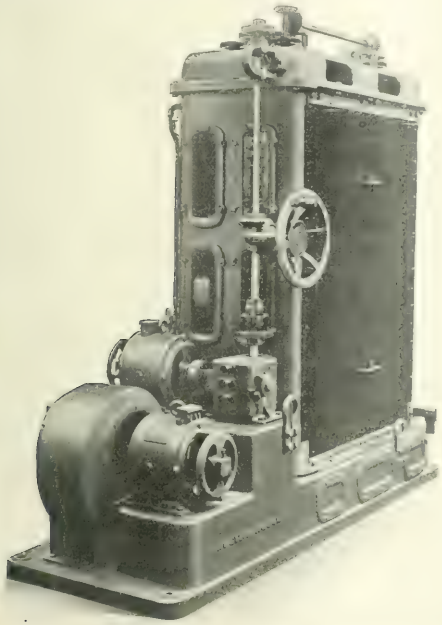


Fig. 11

For the largest machine, where a main field rheostat is required, it becomes somewhat cumbersome and expensive if natural draft cooling is adopted for a normal temperature rise, due to the large quantity of heat to be dissipated. By utilising forced ventilation a smaller, therefore less expensive, rheostat can be used, while the temperature can be kept very low. With turbine-driven generators arrangements can sometimes be made so that air at high velocity can be led from the machine to rheostat, thus avoiding a motor-operated fan specially for the rheostat.

Sufficient has been said to indicate that rheostats can be made comparable to the machines they control as an engineering work, electrically, mechanically and in appearance. It is also significant that several supply authorities have stated their [illegible] type of construction in their specifications.

Other refinements for electrical or mechanical remote control, such as indicators for the number of steps in circuit, or which visibly indicate whether the contact brushes are [illegible] contact, field switch interlocking devices, &c., although interesting, do not come within the scope of this article.

The whole of the apparatus [illegible] the Electric Construction Co., manufacturers, and the writer [illegible] for their permission to publish the information [illegible]

METHODS OF MEASURING THE STRENGTH OF WIRELESS SIGNALS.*

BY J. W. MARCHANT.

(*Concluded from page* 270.)

Before leaving this subject it may be of interest to say something about the developments that have recently been made in the form of the audion of Lee de Forest and the Lieben Reisz relay. These two pieces of apparatus do not differ in any fundamental principle, though they differ in form. In the Lieben Reisz relay the ions, discharged from a cathode of special form, are shot through a grid made of thin aluminium sheet. The bulb of the lamp is made in two parts: the cathode or heated element, which consists of a thin platinum strip coated with oxide of lime, is placed in the lower bulb, and the anode, which in the later form, consists of a spiral of aluminium wire 2 mm. in diameter, is arranged in the upper half of the bulb. The grid is at the junction of the two bulbs. When there is no P.D. between the grid and the heated element, the electrons discharge through the holes of the grid and a current passes between the cathode and the aluminium anode. In the usual arrangement of the valve, a local battery is used to produce the current from the anode to the heated cathode. If a P.D. is applied to the grid, *i.e.*, if the receiving circuit condenser of a wireless receiver is connected between the grid and the heated element, the passage of the electrons through the holes of the grid is affected, and the current in the local circuit is varied. The variation in current produced in this way may be much greater than that in the current between the grid and the heated elements, and thus the bulb may be used as a relay for magnifying currents. In the audion the elements are arranged somewhat differently, and in the later forms a tantalum filament has been used with a grid and plate of nickel, the three elements being only $\frac{1}{16}$ in. apart from each other. This detector is claimed to be quantitative up to the critical point where saturation occurs, and this seems to be borne out by the shape of the curves shown for the Fleming valve with the filament close to the plate, but the quantitative nature of the curves is only approximate, and it seems very unlikely that the detector can be used for really accurate work unless calibration is very frequent, even more frequent than is necessary with a crystal detector. Holweck has recently described a detector with a coated cathode (Wehnelt) in which the distance between the grid and the cathode has been reduced to 0·1mm. A detector of the same type has recently been developed by Majorana using a tantalum filament in a bulb, with a P.D. in the local circuit up to 50 volts. In the later form of the Lieben Reisz relay an atmosphere of mercury vapour is used, and latterly the Cooper-Hewitt Co. have developed a receiver based on the well-known mercury vapour rectifier, which evidently is similar in operation to the Lieben Reisz valve.

Among others which might appear to offer considerable possibilities for accurate work are the magnetic and the electrolytic detectors. We have tried one or two forms of magnetic detector, but though they are very reliable we have not hitherto been able to obtain sufficient sensibility to enable them to be used for measuring weak signals; also it is doubtful whether the detector is really as reliable for accurate measurement as might be expected. If the Marconi form of detector is used, for example, it would seem unlikely that the character of the wire all along the band would be sufficiently uniform, especially at the joint, to make it completely satisfactory for the purpose of accurate investigation. The electrolytic detector is one with which, personally, I have had little experience; from its nature one would not expect it to prove very reliable for accurate measurements. Those who have used these detectors in practice speak highly of them (among the most notable users may be mentioned Col. Ferrié and Fessenden), but there has been very little published in connection with them giving quantitative results.

The number of stations now operating with continuous waves is small, but there is little doubt that the tendency, especially for long-distance and therefore long-wave transmission, is in the direction of using continuous waves, and it may be worth while to say something about the detectors which have been employed to receive them. The best known of these detectors is the heterodyne, originally invented by Fessenden. The principle of the detector is that the received current shall flow round the coil of a special telephone, and shall attract or repel a similar coil attached to the diaphragm of a telephone carrying a current of nearly the same frequency produced locally. The alternation of attraction and repulsion between the two coils will depend upon the difference in frequency between the current in the receiving coil and the note given out by the heterodyne may be controlled by altering the frequency of the current in the local circuit. The heterodyne receiver requires, therefore,

* Paper read before the Wireless Society of London.

to enable it to be used for measurement, a constant local current of high frequency. This current is usually produced by a Poulsen arc. Provided this current is kept constant, both in magnitude and frequency, the strength of signal may be estimated from the sound given out by the receiver. The only method that has hitherto been tried is that in which a non-inductive resistance is shunted across the telephone and the resistance reduced until no sound is audible. This method will be discussed at greater length later, but it is not a very accurate method. When it is used for measuring the strength of signal received from a spark station, where the number of oscillations in a spark train rarely exceeds 40 or 50, it is clear that its operation will be irregular and the receiver nothing like so efficient as it is when working with continuous waves. The wave train on a 3,000 metre wave will last about $\frac{1}{2000}$ of a second, and if the heterodyne is arranged to give a note with a pitch of, say, 500 per second, it is quite likely that the spark signal will be very weak. If it happens that the spark signal when it is first received is 90° out of phase with the local current, it will be in phase with the local current when the spark ceases, and the difference in the attraction between the coils, for maximum repulsion and maximum attraction, which depends on the product of the two currents, will be less than half of what it would be for continuous waves; while if the phase relations are such that the current is 90 deg. out of phase when the middle of the spark is received, the sound in the heterodyne will be even weaker. Some stress has been laid on the operation of this receiver, as the results of experiments have been published in which the efficiencies of arc and spark transmission have been compared by estimating the strength of signal received on the heterodyne. Such comparisons are clearly unfavourable to the spark system, as has been pointed out by Hogan.

A method of receiving continuous waves has recently been described by Goldschmidt and has been given the name of the tonewheel. This receiver is really a mechanical toothed wheel contact maker; the wheel is driven at such a speed that the contact in the oscillating circuit is broken at every half oscillation of the received current, thus

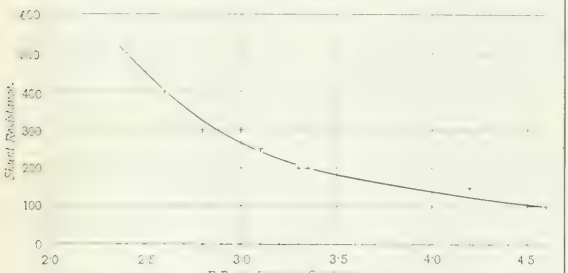


Fig. 5.—Tests of Shunted Telephone Method (Braun) showing Relation between P.D. on Primary Condenser of Test Circuit Buzzer and Resistance shunted to Telephone to Extinguish Sound.

transforming the high frequency alternating current into an interrupted direct current, if the wheel runs synchronously. It is clear that this wheel can only be used on low frequencies (or long wave lengths), since the peripheral speeds necessary to enable it to operate on a 600 metre wave, for example, would be exceedingly high. With a tooth pitch of 0·5 mm. the necessary peripheral speed on a frequency of 100,000 (or 3,000 metre wave) is 50 metres per second, which is, of course, a possible speed. If the contacts on the wheel can be made good, the tonewheel should prove a very useful device for accurate quantitative measurements, but there are many mechanical difficulties involved in its operation, such as the maintenance of a constant speed, which must make it rather a difficult piece of apparatus to manipulate.

It is impossible to deal in detail with all receivers, but the tikker of Poulsen and the new Marconi detector with variable condenser [illegible] should both prove valuable for measurements of continuous waves.

Instruments for Use in Measuring Circuit.—Although it can hardly be regarded as an apparatus for exact measurement, a very interesting form of galvanometer in the shape of a sensitive nerve-muscle combination (frog's leg) has been employed by M. Lebeuve to record [illegible] from the Eiffel Tower. The nerve takes the place of the [illegible] and the signal produces a current [illegible] which causes a deflection of the muscle. So quick-acting a [illegible] that the dots and dashes of the spark from the Eiffel Tower can easily be detected. The experiments of M. Lebeuve are interesting in that they show how sensitive is this combination (the first known method of detecting the presence of an electric current) as a galvanometer.

Many measurements have been made by a shunted telephone. If the telephone is shunted by a non-inductive resistance, and the resistance is varied until no sound is heard in it, some measure is obtained of the strength of the current through this circuit. This method, in effect, amounts to reducing the telephone current to a known value determined by the sensibility of the ear to the sound which the telephone produces. It is not a null method, in that the measurement is made by reducing the sound in the telephone until it is inaudible. It is clear from the modus operandi that a great deal depends on the "personal equation" of the operator. Austin has introduced a term which he calls the audibility factor. It is defined by the ratio $\frac{R+S}{S}$, where R is the equivalent resistance of the telephones and S the resistance that is shunted across it. The loudness of a signal determined in this way is found by him to be proportional to the galvanometer deflection with a crystal detector, *i.e.*, to the square of the oscillating current. A number of tests have also been made by Braun which have been plotted as a curve (*see* Fig. 5). It will be noticed that the points on this curve are fairly regular, and that the method appears to hold out, under favourable conditions, some hope of accuracy. Other experiments have been made by Klages and

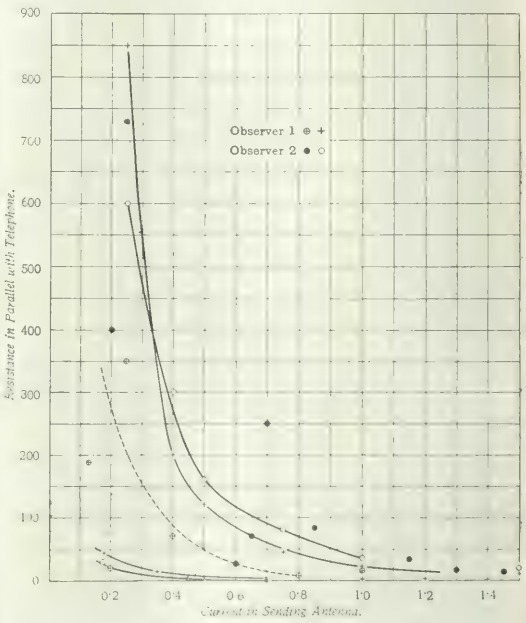


Fig. 6.—Tests of Shunted Telephone Method (Klages and Demmler) with Galena Detector.

Demmler with two different observers, the results of which have been plotted in Fig. 6, and which are very far from lying on any regular curve. These two observers have come to the conclusion that for quantitative work the method is useless. This conclusion is borne out by experiments I have made on this method of test. I have found it almost impossible to measure signal strength with any approach to accuracy, partly on account of the varying sensibility of the ear and partly because of the effect of small inequalities in the calibrating current on the audibility or non-audibility of the sound in the telephone. Where no other method is possible the shunted telephone must be used, and it gives a rough idea of signal strength, but it seems to me of very little value for accurate quantitative work.

Before leaving the subject of measurement by shunted telephone it may be of interest to refer to a novel form of telephone which has recently received some attention, *i.e.*, the condenser or static telephone. The fact that a condenser carrying an alternating current gave out considerable sound was first noticed, I believe, in connection with Duddell's experiment with the musical arc. Ort and Riegen have made a number of experiments with a condenser of about 0·05 mfd. capacity constructed with paper dielectric interleaved with

tinfoil sheets. Holes were cut through the centre and at the edges of the condenser to find out whether it vibrates as a whole or only at the edges. Indiarubber was then substituted for paper and aluminium plates 0·001 mm. thick for tinfoil to make the moving parts as light as possible. An E.M.F. of 240 volts was used between the plates of the condenser to increase the sensitiveness of it, the object being the same as that effected by using a permanent magnet to increase the sensitiveness of a polarised relay. This arrangement when tested with a microphone gave considerable sensibilty, but was not so good as an ordinary telephone.

Before leaving the subject of telephone measurements there is one further point to be considered in the arrangement of the receiving circuit, namely, the use of a block condenser shunted on the telephone. This condenser has been constantly used, but in our tests, though we used it at first, it was finally discarded. The best result with a block condenser is obtained when the telephone and condenser are in tune for the musical note of the spark. Where this note is a pure one the condenser is advantageous, but where the note is a low-pitched sound, such as is heard from Paris, the harmonics of the sound are relatively important, and several maxima may be found for different values of the condenser capacity corresponding to these harmonics. For quantitative work where signals of different notes have to be compared, for example, the signal from a buzzer with the signal from a station, I believe the unshunted telephone is best.

For accurate measurement of current there is no doubt that some form of galvanometer is the most suitable. In our early experiments we employed an ordinary Broca galvanometer with a sensibility of about 400 mm. per micro-ampere and a period of about nine seconds. This galvanometer was quite satisfactory when conditions were good, and when a long signal was emitted, but when atmospherics were bad and when the signal or dash lasted for only a second or so the galvanometer was not of much value. As first adjusted it was very suitable for measuring the five single dashes that were sent out by Norddeich, as the dots produced a cumulative deflection, the needle swinging back and reaching zero just as the second series of dots came through. Some satisfactory measurements were made in this way. As no information could be obtained as to the strength of the Norddeich sending antenna current, however, the measurements were abandoned.

A very sensitive galvanometer has recently been constructed by M. Abraham, of Paris, in which he has been able to obtain a sensibility of 240 mm. per micro-ampere with a period of less than one-tenth of a second. In this instrument a very powerful field of 20,000 gauss is employed and exceedingly fine wire in the moving coil. This galvanometer was used in connection with the measurements between Paris and Washington, to find the velocity of propagation of the signals across the Atlantic. It is remarakble for the clearness of the definition of the spot of light reflected from the mirror used to record the motion of the coil. It was found possible to measure the time interval between two successive signals to within $\frac{1}{10000}$th of a second.

The galvanometer with which I have had most experience is the Einthoven thread galvanometer, but as this work has recently been published I need not say very much about it here. With a high magnification it is possible to get a sensitiveness of 400 mm. per microampere, with a period of about $\frac{1}{20}$th of a second. The period of the thread can only be estimated, as the motion of it is very nearly critically damped at this sensitiveness. The image of the fibre at this magnification is about 2 mm. wide. The edge of the image is not always quite sharp, but it is possible to read it, as a rule, to about $\frac{1}{4}$ mm. under favourable condition. With a smaller magnification and a sensitiveness of about 40 mm. per microampere, it is possible to measure one-tenth of a millimetre on a record, and for much of our work the latter arrangement has been preferred on account of the greater ease of adjustment. The difficulty in using this instrument is its rapid variation in sensitiveness, and this must be watched by having an arrangement for easily testing it. The advantage of a photographic record such as is obtained with the Einthoven is sufficiently obvious, and this galvanometer fitted with a recording device is certainly one of the most effective for measuring the strength of wireless signals.

Measurement of Decrement.—The measurement of the decrement of a wave train is a measurement of such importance that it would be undesirable to conclude a lecture on the measurement of signal strength without referring to it. The decrement measured in a secondary circuit is really the sum of three decrements: (1) The decrement of the wave train emitted by the transmitting aerial; (2) the decrement of the receiving aerial; and (3) the decrement of the secondary circuit of the receiving system. In order, therefore, to obtain a measurement of any one of these [illegible] two decrements should remain constant. The decrement is nearly always measured by the Bjerknes or half-deflection method. This method may be very readily used where a photograph [illegible] as the strength of the oscillating current can be measured (1) when the secondary circuit is in tune, (2) when the secondary circuit is a known amount out of tune. The decrement can then be estimated from the well-known formula.

In conclusion, may I express the hope that a number of members of this society will take up the subject of the accurate measurement of wireless signals, and attempt to undertake tests, as I am sure that measurements of this kind, in combination with meterological observations, will do more than anything else to increase our knowledge of the conditions which affect the transmission of wireless messages.

BALANCE SYSTEMS OF PROTECTION.*

BY C. C. GARRARD.

(*Concluded from p.* 238.)

Summary.—The author deals in some detail with the Merz-Price systems of protecting cables, generators and transformers, and concludes with a discussion of the use of split conductors so as to avoid the employment of pilot wires.

Balance Protection of Branch Feeders.—The application of the Merz-Price system to branch feeders, or tees, which has found most favour is the voltage balance system, and is illustrated in Fig. 10. It will be seen that under normal conditions the sum of the voltages induced in the secondaries of the three current transformers is zero. A fault, or earth, anywhere in

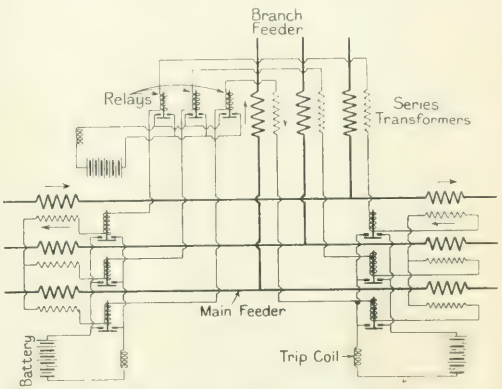


Fig. 10.—Merz-Price Voltage Balance Protection for Branch Feeder.

the main cable or branch upsets the balance and the whole of the switches are tripped. It is very necessary that the current transformers should have straight line secondary voltage characteristics at all loads, as it is only by this means that the voltages induced will be proportional to the primary currents and tripping on overloads prevented. This is the more necessary where more than one tapping is taken off. In fact, it is improbable that the system can be used at all if more than three branch feeders are employed. The use of the balanced voltage system for tees is, however, to be preferred to the current, or magnetic, balance, in that it can also be used for feeders and mains generally, and thus one universal scheme is available for all cable protection.

Alternating-current Tripping with Balance Protection.—In the foregoing remarks, when the fault current in the pilot was not used directly to operate the tripping coils, an auxiliary source of continuous current was used for this purpose. Many engineers who have had considerable experience with the Merz-Price system recommend the continuous-current trip. An alternating-current trip can, however, be arranged as in Fig. 11. It will be seen that the relays in operating close the circuit of the current transformers through the trip coils. Unless the feeders are long it is necessary artificially to increase

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the resistance of the pilot wires in order that the current transformers may, when a fault occurs, induce sufficient voltage to operate the trip coil. In the case of a fault fed from both ends the current transformers help each other to send current through the pilot, and this latter, if too short, acts as a short circuit and prevents sufficient voltage being induced to work the trip coil. Hence the need of the artificial resistance.

Determination of the Tripping Current with Merz-Price Protection.—The Merz-Price system, being a somewhat complicated one, the calibration of the apparatus involved is by no means a simple process. This is especially the case with the balanced voltage svetem. The use of relays simplifies matters considerably, as these have small impedance, and it is not necessary to allow for the varying impedance of the trip coils. Under any circumstances, however, the calibration is affected by the length of the pilot wires, impedance of the current transformers, &c., and it is a matter for an expert to predetermine the tripping currents and to lay out the scheme to give satisfactory results. The number of methods of application of the Merz-Price scheme is very large, but it is a very sound principle to choose the simplest possible and one that is capable of extension with the growth of the plant. In any case the system, owing to its inherent complexity, is only justified for large and important undertakings.

Effect of Capacity-Currents in the Merz-Price System.—The capacity current of the pilot cable is of importance with the balanced voltage system. In order to limit the effect to a minimum it is necessary to keep the maximum voltage which can be induced in the pilot cable, under short-circuit conditions, as low as possible. Having determined what this is, the capacity current of the pilot must be calculated in order to see that there is no danger of it being large enough to trip the switches. Faye-Hansen and Harlow (*loc. cit.*) recommend a factor of safety of 4 in this connection as being desirable.

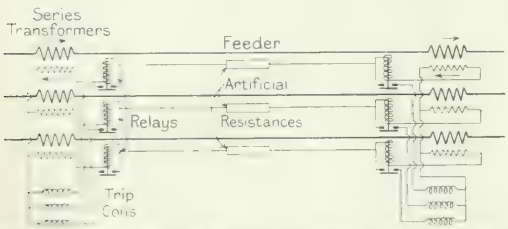


Fig. 11.—Balanced Voltage Protection with Alternating-Current Tripping.

Break in the Pilot Wire with Merz-Price Protection.—If a break occur in the pilot wire circuit on the balanced voltage system (such as is used generally for feeders) there is nothing to show that this has occurred, and when a fault comes on the protective gear will be inoperative. Frequent inspection and testing of the pilot circuit is, therefore, necessary. With the balanced current system such a break immediately results (if the current flowing is large enough) in the section switches operating.

Balanced Current Protection for Feeders.—In the Paper before referred to Faye-Hansen and Harlow describe a scheme whereby the balanced current system is applied to the protection of cables, and for which they claim the following special advantages: (1) No relays, (2) no auxiliary source of tripping current, (3) accurate balancing of the transformers not necessary.

The arrangement is shown, as for a single phase, in Fig. 12. The principle is that of the balanced current system whereby equipotential points (under healthy conditions) are obtained at each station by means of tappings from the transformer secondaries and additional resistances. The resistance shown is approximately equal to the resistance of one of the pilot wires. Under normal conditions the middle point of the secondary is at the same potential as the end of the resistance, therefore, no current will flow through the trip coil. A fault upsets this balance and the trip coil is excited. Applying this method to a three-phase circuit the connections become somewhat complicated, and the number of pieces of apparatus to be balanced relatively large. Faye-Hansen and Harlow have made a detailed comparison between their system and the balanced voltage system with continuous-current and alternating-current trips respectively (Figs. 1 and 11). The balanced voltage system with continuous-current trip yields, on the whole, the best results, and has the lowest voltage in the pilot wire, &c. It has the disadvantage of requiring a source of continuous current for tripping. Balanced voltage with alternating-current tripping (Fig. 11) comes next and yields comparable results. Of course, the capacity of the current transformers has to be larger than with continuous-current tripping. The Faye-Hansen and Harlow method requires still larger current transformers, but not such large ones as to

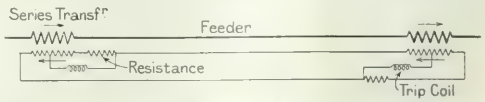


Fig. 12.—Faye-Hansen and Harlow's Modified Current Balance Protection for Feeders.

render their use prohibitive. The values for the secondary output in volt-amperes when tripping occurs being for the three systems about 7 watts, 54 watts and 190 watts respectively. The results as regards the value of fault current required for tripping with the Faye-Hansen and Harlow method are not very different from the balanced voltage system, and the advantage is present that only two pilot wires are used for a three-phase system as against three for the balanced voltage method. As regards the practical operation of this modification of the balanced current protection of feeders, results are not known to the present author. It would appear, however, that the system should be useful in gassy mines owing to the elimination of the relay with the sparking at its contacts.

THE SPLIT CONDUCTOR SYSTEM OF PROTECTION.

In considering the Merz-Price system of protection it was seen that its advantages were bound up in the use of one or more pilot wires. Attempts have been made to secure the benefits of a balance system of protection without the expense of the pilot, and the split conductor system is one of the more



Fig. 12.—Three-core Split Conductor Cable (6,000 volts).



Fig. 13.—Three-core Split Conductor Cable (20,000 volts).

successful efforts in this direction. To carry out the system each phase conductor is divided into two halves. For an overhead line each half may be mounted on separate insulators in which case the system really becomes a case of duplicate feeder protection. For high voltages the two halves may be relatively lightly insulated from each other and the pair heavily insulated from earth (compare British Patents No. 4,004/1911, 26,857/1911). When cables are used they are constructed as in Figs. 12 and 13. The connections are shown in Fig. 11. With everything in order it is obvious that the current in each half of the conductor is approximately equal and the currents in the split conductor current transformer balance each other out and no current is induced in the relay winding. A fault, how-

ever, will either only affect (in the first instant) one-half of the conductor or cause the currents in the two halves to become unequal. This causes the core of the current transformer to become magnetised and to induce a current in the relay winding, thus tripping the circuit breaker.

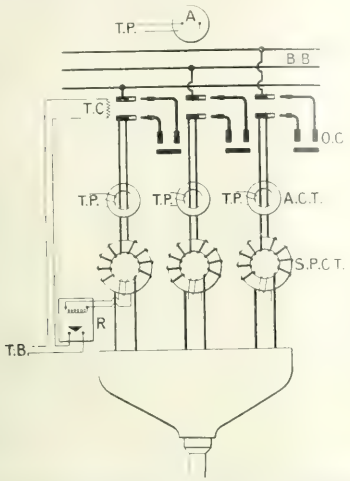


Fig. 14.—Connections of Cable protected on the Split Conductor System.

A.=Ammeter. A.C.T.=Ammeter Transformers. B.B.='Bus Bars. OC.=Oilswitch Contacts. R.=Relay. S.P.C.T.=Split Conductor Protector Transformers. T.B.=To Battery. T.C.=Trip Coil. T.P.=To Ammeter Plug.

An oil switch constructed for use on the split conductor system is shown in Fig. 15. It will be noticed that the split is carried right through the switch, the plug contacts being of the concentric form. The reason for carrying the split right through the switch will be clear from the following paragraph.

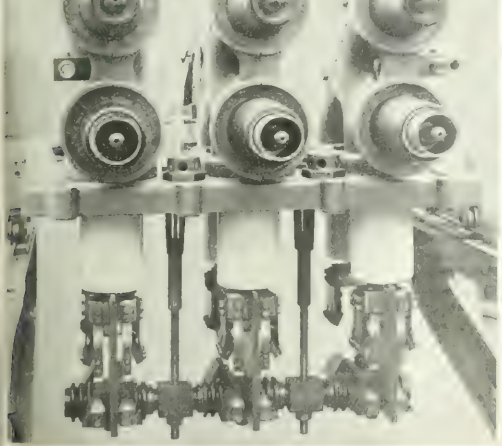


Fig. 15.—Oil Switch by Messrs. A. Reyrolle & Co., Ltd., with Split Conductor System of Protection.

(Compare with "Electrical Engineering," Oct. 22, 1914, p. 561, Vol. X.)

In Fig. 16 one phase of a line is shown having [illegible] the right-hand end. It will be seen that the current [illegible] winding of the right-hand transformer has reversed so that its core will become magnetised and the right-hand switch will trip. The currents in neither of the windings of the left-hand transformer will have reversed, and if the split had not been taken right through the right-hand switch, will continue to flow through both halves of the conductor in parellel into the fault. It may well be that, due to the impedance of the right-hand transformer, the difference in currents between the two halves will be sufficient to cause the left-hand switch to operate also. It is obvious, however, that greater sensitiveness is attained if the split be carried right through the switch. If this be done, then, after the right-hand breaker has operated the whole of the leakage current flows through one winding only of the left-hand transformer and maximum sensitiveness is attained. This method of splitting the switch is to be preferred to the alternative one of having large current transformers of considerable impedance. This is more especially the case the longer the feeders are.

In actual practice on a number of feeders it has been found possible to get such a good balance, even with large overloads, between the currents in the split conductors, that it has been possible to set the relays with such sensitiveness that ordinary (not split) switches have been used and this without prohibitively large current transformers. It is found, however, that



Fig. 16.—Diagram illustrating Split Conductor system of Protection with Split carried right through the Oil Switches.

better results are obtained by using the split switch, and this is now to be considered the standard method.

The split conductor system can hardly be termed a simple, straightforward one. For example, the determination of the tripping currents of the apparatus necessitates a certain amount of calculation based upon the electrical constants of the circuits and the apparatus used. It can scarcely be recommended, except for those installations where highly trained engineers are available for operating it.

THE ANNUAL MEETING OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The annual meeting of the Institution of Electrical Engineers was held on Thursday, May 27th, under the presidency of Sir John Snell. There was a slightly larger attendance compared with last year, the Council being present in full force, but the attendance of ordinary members could only be described as very moderate. An abstract of the annual report of the Council appeared on p. 272 of our last issue.

The President opened the proceedings by announcing the result of the ballot for vacancies on the Council. These resulted in the election of the following ordinary members of Council: W. A. Chamen, H. Dickinson, Prof. T. Mather, F.R.S., H. F. Proctor and G. S. Ram, so that the new Council is constituted as follows:

President.
C. P. Sparks.
Vice-Presidents.

J. S. Highfield.	Dr. A. Russell.
R. T. Smith.	C. H. Wordingham.

Hon. Treasurer.
R. Hammond.
Ordinary Members of Council.
Members.

W. A. Chamen.	Prof. B. Hopkinson, F.R.S.	H. F. Proctor.
R. A. Chattock.	Prof. T. Mather, F.R.S.	G. S. Ram.
J. Christie.	G. W. Partridge.	R. J. Wallis-Jones.
H. Dickinson.	W. H. Patchell.	W. B. Woodhouse.
	Junior Member.	
F. E. Berry.	Major E. O. Henrici, R.E.	A. W. Martin.
	Associates.	
E. Russell Clarke.	J. Hunter Gray.	A. M. Ogilvie.

The PRESIDENT referred to the lack of interest shown by the general body of members in the election of the Council, as only 551 ballot papers had been returned out of a total of 4,000 that had been sent out. He said that the ordinary members outside the Council had power to make nominations, and he hoped in future these powers would be used to a greater extent. The attendance at London meetings, considering the conditions under which the country was placed at the present time, could be regarded as satisfactory and the excellent series of Papers presented was also well up to the average. Reference was made to the death of three past Presidents of the Institution who had passed away during the year—namely, Prof. W. Grylls Adams, F.R.S., Mr. R. K. Gray and Sir Joseph Wilson Swan, F.R.S.—and also to the seven members who had given their lives for their country on active service. In referring to the work of the sectional committees the President mentioned that these should be a great help in the organisation of the Institution, and should stimulate the reading of Papers dealing with the branches of electrical engineering which they represented. The work which the Institution had undertaken in connection with national services was referred to, the President stating that he thought the total of 928 members who were engaged on naval and military services was a very fair percentage of the total membership (7,000) of the Institution, when it was taken into consideration that a very great percentage of their members were engaged in the equally important duty of helping to provide for munitions of war. He was also glad to announce that an Engineers' Volunteer Corps was in the process of being formed, and that they had appointed as commandant a well-known member in Lieut.-Col. Clay. In connection with the committee that was appointed by the Council to keep in touch with the B.E.A.M.A. in regard to the question of securing for British manufacturers the trade hitherto done by Germany and Austria-Hungary, he wished to emphasise that the conclusion that had been reached by that committee was reached with the full concurrence of the manufacturers' representatives. The Council had often been criticised over their action with regard to industrial matters and, therefore, he wished to bring this point to the notice of members. With regard to the work of the committee appointed to consider the question of the periods of repayment for municipal loans, action had been taken, in conjunction with the Institutions of Mechanical and Civil Engineers, in approaching the proper authorities with regard to the regulation during the war of all municipal loans. A strong appeal for subscriptions to the Benevolent Fund was made, and the President stated that the present state of the Fund was totally inadequate in view of the claims liable to be made upon the Committee of Management. At the present time two cases were before them with which they were unable to deal in a satisfactory manner, and at the end of the present war it was to be anticipated that certain of the 928 members who were on active service would never return. This would probably mean further claims upon the Benevolent Fund of the Institution, and, therefore, he ventured to make a further appeal for contributions even of quite small amounts from members of the Institution. He then formally proposed the adoption of the report, the motion being seconded by Mr. Robert Hammond.

Mr. L. B. ATKINSON said that he would like to congratulate the Institution upon its activities with regard to national service. He asked whether it was possible for a full list of the names of the members of the many committees appointed by the Institution to be published at certain intervals. He thought that the general body of members were completely in the dark as to the names of the members of these committees. With regard to the President's remarks upon members outside the Council proposing further names for election to the Council, his opinion was that the general feeling amongst the members was that the Council proposed certain representative names and that any further nominations were in the nature of a criticism of the Council. He, therefore, thought that the President had done well to make those remarks. With regard to the Benevolent Fund, the matter had not come before the general attention of the members to a sufficient extent. Although the present time was not opportune for a very great appeal to members, he thought that later on greater pressure might be applied and further publicity given to the fund.

Prof. J. T. MORRIS asked for information with regard to the decrease in membership. There were reductions in each class with the exception of the Graduates' class, and although enlistment might account for the decrease in the number of students, he would like information as to the reasons for the reductions in the number of members and associate members.

Mr. S. EVERSHED said that with regard to Mr. Atkinson's remarks it was a very difficult matter for the Council to choose the names for election. He thought that the Council might ask old members of the Council for suggestions. Those who had served on the Council knew the requirements necessary for a member to become a successful and useful member of the Council, and he thought that this might remedy the difficulty of discovering suitable names for nomination.

Mr. J. F. SHIPLEY inquired as to the reason why the Scottish Students' Section had not held any meetings during the past session.

Mr. W. M. MORDEY stated that the contributions to the Benevolent Fund worked out at less than 6d. per member. He thought that there [illegible] a small subscription from a large number of members with a view to producing a steady income. An average of half a crown all [illegible] in a healthy position.

Mr. [illegible] suggested that the Benevolent Fund accounts [illegible] in a different form, so as to give members a [illegible] Fund. He thought that an appeal [illegible] maximum amount.

Mr. [illegible] on the question of the Benevolent Fund. A [illegible] committee might be formed to write personal letters and make personal appeals for subscriptions, and this should result in obtaining a greater number of what Mr. Mordey had called the gold contributions. Also large firms might be approached through their heads for practical support. He asked if the Council could not see their way to do something with regard to the subscriptions of those members serving with the forces. The majority of clubs and institutions throughout the country had remitted the subscriptions of those members serving with the forces, and he would like to know if something could not be done in that direction.

Mr. A. HOME-MORTON made the suggestion that a small amount should be added to the subscription of every member and paid automatically into the Benevolent Fund.

The PRESIDENT, in replying to the questions asked, said that he welcomed the suggestions that had been made, and would state that all these suggestions would be duly considered by the Council. With regard to the publishing of a list of names of members of the various committees, he, personally, welcomed the suggestion, but could not make any definite announcement without consulting the Council on the question. He agreed with Mr. Evershed's remarks with regard to the nomination of names for the Council. The question of the decrease of members could be satisfactorily explained. The examinations were one reason for this, and the war had also affected them to a certain extent. Consideration would be given to the question of remitting the subscriptions of members on active service, but he thought, personally, that it was too big a matter if the funds of the Institution were to be kept in a healthy state. The Scottish Students' Section had been too weak for any meetings to be held. Most of the suggestions put forward regarding the Benevolent Fund had been considered by the Committee of Management, but nevertheless he welcomed the suggestions that had been made.

Mr. ROBERT HAMMOND, in presenting the accounts, said that they did not call for any detailed explanation. He viewed without concern the decrease in membership, and he gave reasons why this had been expected. He moved the adoption of the accounts.

Mr. J. S. HIGHFIELD seconded the motion.

Mr. W. B. ESSON said that the balance-sheet was slightly inaccurate with regard to the method of stating the depreciation for the building. The cost was put down, less reserve for depreciation, being sinking fund premiums paid. This item should be the surrender value of the policy. With regard to the trust funds, as these were in the general balance-sheet, was not the Institution responsible for the funds being maintained at their original value ?

Mr. HAMMOND, in reply, said that the trust funds were once put separately from the general accounts, but it had been found more convenient to put them as part of the general balance-sheet. Now that the matter had been brought up, he would consult their honorary solicitors as to whether this implied that the Institution was actually responsible for holding the sums at their original value. With regard to the depreciation of the building, he thought Mr. Esson was right.

Mr. ATKINSON also made a few remarks with regard to the accounts.

The motion that the accounts be adopted was then put and carried unanimously.

Formal votes of thanks to the honorary secretaries of the local institutions, to local honorary secretaries abroad, to the honorary treasurer, to the honorary auditors and the honorary solicitors were then put and carried. The honorary auditors were then re-elected for the forthcoming year, and the meeting concluded.

WIRELESS TELEPHONY.*

BY H. J. ROUND.

Meissner, in 1913, suggested the use of the Lieben tube for the production of continuous oscillations by allowing the two transformers to react upon one another, and by inserting in the circuits condensers to give them a definite natural period; and he succeeded in producing 8 watts of high-frequency alternating current by this means.† The tubes, apparently, only lasted about 10 minutes at this power, owing to the disintegration of the filament. This reaction method has an exact analogy in the singing microphone telephone. As is well known, any telephone receiver when held opposite its own microphone (providing the line is short in length) will give a musical note, because the microphone is a magnifier. A Brown relay, if connected back on itself, will also sing violently.

The writer has so developed these two properties of the valve during the last 18 months as to make a fairly practical telephone system. The reaction valve is used for producing the transmitting oscillations; and, the energy employed being small, the magnifying valve is used for magnifying the received result up to a practical loudness. It was very soon found out that the ordinary magnifying valve was, in practice, quite useless for the production of oscillations, owing to the filament disintegrating, and the present oscillating valve has, at the most, a magnification of 3, but it will easily give current up to 1 ampere in the aerial without serious filament wear.

The first distance tests were carried out in Italy by the writer between two Italian cruisers in the presence of the Duke of Abruzzi and Mr. Marconi. It was at once found that unbelievably small aerial currents, such as 0·2 ampere, were sufficient to enable speech

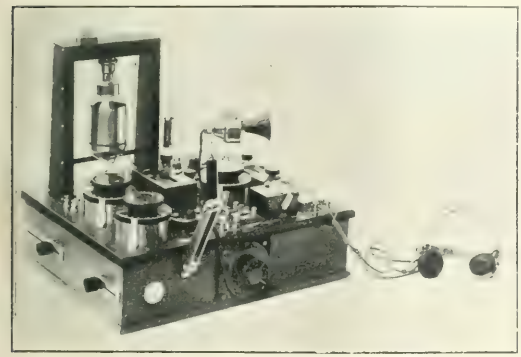
* Extract from an article in the "Year Book of Wireless Telegraphy."

† See THE ELECTRICIAN, Vol. LXXIII., p. 702, July 31, 1914.

to be transmitted 70 km., this high efficiency being due to the absolutely silent and constant character of the oscillations produced and to the consequent ability to magnify at the receiving end.

The question of magnification at the receiving end is one well worth a little consideration. The extraordinary sensitiveness for weak signals of the "heterodyne" indicated to the writer that the crystal detector is approximately obeying the law indicated by its direct-current characteristic, and that, owing to the bend in the curve, rectifying efficiency falls off rapidly with increased applied signal voltage. Consequently, a crystal detector is more efficient for weak signals from a spark station than equally powered signals from an arc station, because, particularly with short waves, the maximum voltage of the sparks is much higher than the maximum voltage of the continuous wave. This at once reduced the efficiency of continuous wave telephony, as the "heterodyne" cannot possibly be used. But by the now simple process of magnifying the received oscillations before they reach the rectifier, this lack of efficiency is partly overcome. Of course, this magnification would also further improve spark telephony, but no spark telephony yet produced is sufficiently free from horrid noises to allow of any magnification.

In addition to this, a great improvement is obtained by utilising a principle due to Mr. C. S. Franklin. The circuit with the magnified energy in it is allowed to react back on the receiving aerial, so that the whole system has an effective damping only slightly greater than zero. The result is an additional magnification, and the total result is that speech or spark signals, quite inaudible with a crystal receiver, are received strongly and with great selectivity, due to the extremely low effective damping of the receiving system. A development of the sets used in Italy is shown in the illustration.



MARCONI WIRELESS TELEPHONE APPARATUS.

The set delivers 0·6 ampere to the aerial, the microphone usually being inserted in series with this aerial. The sets are guaranteed for 50 km. between ships at sea. The set can be further extended to give 1 ampere in the aerial with an estimated range at sea between moderate sized ship aerials of 100 miles; 500 volts and 15 milliamperes are required to produce 0·6 ampere in an average aerial. The writer had already obtained 3 amperes in an aerial by this method (the voltage required is 2,000 and the milliamperes 100), and, as this voltage is rather excessive, an attempt is being made to reduce it and use more current; but heavier current tubes usually result in greater filament wear. No microphone troubles have yet appeared, as, owing to the magnifying power of these tubes, it is not at all necessary to place the microphones in the aerial.

Incidentally, these combined transmitter and receiver sets are useful for telegraphy, as the receiver is a "self heterodyne" by slightly altering the adjustment. The telegraphic range is twice the telephone range. A good many faults can still be found with this telephone. The tuning of both transmitter and receiver is a little too fine. Also the tuning conditions may be [illegible]. These faults will shortly be remedied.

Electric Incubator. According to the [illegible] experiments have been carried out with an electric [illegible] at the North of Scotland College of Agriculture. [illegible] proved very satisfactory, 65 chickens being reared [illegible]. With electricity at 1d. per unit, the cost per [illegible] was found to be 3s. 5d.

IONOMAGNETIC ROTATIONS.*

BY A. RIGHI.

The author lays stress on the enormous influence which the modern discoveries, and especially that of electrons, have had on the fundamental conceptions of science. These have led the author to the discovery of what he calls magnetic rays. He finds that a body turning lightly on an axis and placed inside a gas suitably diluted and ionised (for instance, by means of sparks) will commence to rotate around its axis as soon as a magnetic field is created in the direction of the axis. This phenomena the author has called ionomagnetic rotation, and is explained as follows: It is known that the path of an electrically charged particle (ion or electron) changes when a magnetic field commences to act, and when this field is uniform, the path becomes a helix with its axis parallel to the field. The sense in which this curve is followed is identical with the sense of the current flowing in the coil producing the field, when there are negative ions or electrons; the sense is the opposite when there are positive ions. So when there exists a magnetic field the ions and the electrons will follow helical arcs instead of straight paths.

Based on this fact it has been possible to demonstrate by certain calculations, and also simply by geometrical considerations, that the shocks produced on the surface of a movable body by the ions of the same sign, for instance, the positive ones, under the action of the magnetic field, will be directed all in the same sense and all around the body, thus producing the rotation of the latter. This will occur in the same sense as the current producing the field in the case of positive ions, and in the contrary sense in the case of negative ions. As the couple changes sign with change in sign of the electric particles, the ionomagnetic rotations will be generally produced by the difference of two couples of contrary signs.

The author is making apparatus for showing the phenomena here described. In one type of apparatus the movable body is electrified and works as an electrode when a current passes through the gas.

This current ionises the gas, so that it is not necessary to use other ionising means. The principal characteristic of the new experiments is that the body being electrically charged, movement is due almost solely to the shocks of particles of a sign contrary to that of its charge, so that quicker motion is produced.

A last class of experiments described and executed by the author differs from the preceeding experiments because the electrodes from which the current enters into the gas are fixed, and a body free to rotate around an axis parallel to the field is placed between the former, which, ordinarily, have the form of coaxial cylinders. In these new experiments it is to be remarked that the couples due to the shocks of the particles of both signs add together, instead of producing a differential effect, as in the former ones.

At the beginning of these researches the author was for long in doubt whether the rotations observed could be explained by the actions of the ordinary electromagnetic forces. Having finally succeeded in eliminating this doubt he has been naturally led to an opposite conclusion—*i.e.*, to suppose that the well-known forces which provoke the movement of a conductor through which an electric current is passing, when other currents or a magnetic field are acting, are the result of the shocks of the electrons which, according to modern theories, move in the interior of the conductor and constitute the current. With a view to explaining this new idea the author has made a particular experiment in which a closed box turns in the annular space limited by the two electrodes. The movement is produced by the shocks of the electrons of the gas contained in the box against the walls of the same as soon as a magnetic field parallel to the axis of rotation is set up. In this case it is possible to pass from the ionomagnetic rotation to the ordinary case of common electromagnetic rotation, substituting in the box containing the gas a metallic conductor for the ions contained in the gas the electrons contained in the metal, and, finally, for the walls of the box the surface of the metal which does not leave any passage to the electrons, as the former does not permit the exit of the ions.

In this way it is possible to demonstrate [illegible] the theory of the [illegible] conductors carrying electric currents. [illegible] theory leads to an expression of the forces as a function of field intensity and of current, exactly as perfectly equivalent to the well known [illegible] expression.

The new theory covers a gap which existed till now in the electronic theory of metals. It is known that by this theory many phenomena are satisfactorily explained, as for instance, the proportionality between electric and heat conductivity, the E.M.F.s of contact, the thermoelectric phenomena and also the phenomena (like those of Hall, galvanomagnetic, &c.) in which there exists the action of a magnetic field. The forces on conductors carrying electric currents were till now unexplained by the electronic theory.

* Abstract of a Paper in the "Atti. Accad. El Italiana."

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In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY NOON, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Advertisements of all kinds of which no proofs are required before first insertion can be accepted up to FIRST POST THURSDAY MORNING.

OPERATION OF ELECTRIC OVENS.

The introduction of electrical methods into industrial work at once gives a means of obtaining an exactness not previously available in inquiring how power is being used or wasted in the component operations. For example, little was known of the various losses occurring in the driving of factories, in rolling mills and in winding in mines before the use of electrical methods; but since electric driving has been introduced our knowledge in this direction has increased enormously, and we now know very exactly what power is required and where waste occurs. The latest example of this development is electric cooking. In the electric oven we are able to regulate the temperature more easily than by any other means of heating, and we are able to measure with more exactness the energy that is used. Consequently, our knowledge of the conditions under which the best results are obtained can be gained very much more easily under these new conditions than by the use of gas or coal.

The most recent contribution in this direction is that by Mr. P. W. GUMAER in a Paper read before the American Institute of Electrical Engineers. From the abstract which appears elsewhere our readers will see that Mr. GUMAER's investigations are concerned purely with electric ovens. He rightly draws attention to the distinction between electric energy used in the pre-heating of an oven and the power required for maintaining any given temperature. As to which is the more important must depend upon the operation to be carried out. If this requires only a short time, then the energy used in pre-heating is the chief part of the cost. On the other hand, if the temperature is to be maintained for a long period the energy required in pre-heating may be relatively unimportant.

Mr. GUMAER carried out a lengthy investigation to determine the best temperature at which meat should be cooked, and he arrived at the result that there is a certain comparatively low temperature which is the most economical. When we come to other articles of food the conditions are very different, and the temperature may have to be much higher in order to avoid desiccation. In the case of meat

it is only necessary to have the initial temperature somewhat high in order to ensure coagulation at the outer surface, and thus to retain the juices of the meat. In order to avoid bringing the oven up to this initial high temperature, Mr. Gumaer adopted an unusual method—namely, a preliminary searing of the meat in a metal dish on a hot-plate, after which it was placed in the oven at the ordinary cooking temperature. The author carried out experiments in this special way, and also in the more ordinary way by using a high initial temperature in the oven, and he shows that the latter is much the more expensive. We think, however, that he adopted a much higher temperature than is usual, or desirable—namely, about 480°F.—for his initial temperature. This is very high and would lead to unnecessary waste of electrical energy. Also it does not seem to us that the method of preliminary searing is really as effective as the more ordinary method, for his figures given for loss by shrinkage are considerably higher than those obtainable with an oven properly used.

Undoubtedly the more information of an exact nature we can have on these subjects the better, but in applying the results so obtained it may be necessary to differentiate between household cooking and what may be called "factory cooking." In the latter the exactness of the temperature may make all the difference between good and bad results, or economical running, on a large scale. In the average household, however, we cannot expect anything like such exactness. The average cook, or even householder, will not carry out special searing operations for meat because this would make the process more complicated, and would add to the work entailed. We may rest assured that the cook will not depart from present methods more than she can help, and, therefore, in investigating such matters it should be borne in mind that refinements must not be carried too far.

REVIEWS.

Copies of the undermentioned works can be had from The Electrician Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Automatic Telephony. By A. B. Smith and W. L. Campbell. (London: Hill Publishing Co.) Pp. xv + 407. 12 × 8½ ins.

Probably no two more capable men could be found to deal with this subject than the authors. Mr. Arthur Bessey Smith was formerly Professor of Telephone Engineering, Purdue University, and is now one of the Automatic Electric Co.'s engineers, whilst Mr. Wilson Lee Campbell has read several Papers on automatic telephony before the American Institute of Electrical Engineers, and is factory manager for the same company. They are co-workers with Mr. Almon B. Strowger Keith, who has done more than any other man to advance the art of automatic telephony as commercially used.

The book consists of about 400 pages, with [illegible] diagrams and curves. It is written in a [illegible] and is very free from "Americanese." Naturally, [illegible] prominence is given to the system developed by [illegible] Electric Co., Chicago, commonly known as [illegible]. That system is in commercial use to a very much greater extent than any other. Other systems are [illegible], and it is to be noted that the Western Electric Co.'s system [illegible], the setting-up lever-calling device only, on the instrument, whereas the dial form is used in this country; and the Siemens' instrument is shown using an earth connection [illegible] used here on what is known as a loop or [illegible] system. The diagrams of the Automatic Electric Co.'s system are reduced to too small a scale, and are painfully difficult to read. Those for auxiliary circuits are much clearer, and in better form.

The book is divided into sixteen chapters, Nos. I., XV., and XVI., on trunking, traffic and development respectively, being, perhaps, the most instructive and informative. Chapters II., III., IV., IX., XII. and XIV. deal with the A.E. Co.'s system. Six chapters deal with the systems of the American Automatic Telephone Co., Siemens & Halske, Lorimer, Copenhagen, Clement Automanual and Western Electric Co. Chapter XIII. deals with "Cutovers and Interconnections on Manual and Automatic Offices," and describes mainly the A.E. Co.'s practice. The subject matter will be briefly considered under the different sub-divisions mentioned above. First, there is trunking. All automatic systems are built up in comparatively small units, usually 100 lines (W.E. Co.'s system, 200); multiples of these form a 1,000-line group, and multiples of these again a 10,000-line group, and similarly for 100,000. These groups are connected together by trunks or junctions which are usually multipled at the outgoing end, and terminate on switches at the other. To prevent all switches having first access to the first line of a group, "slipping of the banks" is resorted to, so that each switch will find a different line on the first terminal of a level. Should it be necessary to increase the number of lines to a group, certain lines may be individual and others multipled or common.

The use of line switches of the Keith plunger type, the rotary individual and the rotary call-finder type are described and the advantages of each are set out. The use of primary and secondary line switches is described.

The "exchange" is held to mean the whole multi-office system in an area, and each installation is an "office." The term "exchange" is used more loosely in this country. Coming to traffic, this is defined as the volume of calls, and its measure is the individual call considered in connection with its duration. The busy hour is reckoned to average one-eighth of the total business day. In the States it is found that 8 per cent. trunking is sufficient for a 1,000-line installation and 10 per cent. for larger installations having primary line switches only. Large installations with secondary line switches have 10 per cent. of connectors, the line switches being divided into two groups with seven or eight trunks to each. There are provided 100 first selectors for each 2,000 lines. In very large installations 15 connector banks are provided.

The efficiency of trunk groups of different sizes is then considered. A large group carries more calls per trunk than a small one. The curves show that the carrying capacity of a manual trunk is 19·2 connections, whereas an automatic trunk will carry 33. It is shown that groups of from 30 to 40 trunks worked automatically will carry nearly double the number of calls worked manually. The occupied time in the manual is taken at 120, whereas the automatic is taken at 83 seconds. Reasons are given for the difference.

Various methods are described for equalising the loads of the various sections, and it is recommended that the lines be arranged according to trades and residence or business. In considering development studies, different examples of lay-out are given, and it is argued that the automatic system may be sub-divided economically, so as to reduce the average length of the subscribers' lines.

In describing the Automatic Electric Co.'s system, as already [illegible] the [illegible] is fully illustrated by good diagrams. The auxiliary services, are, however, well described, and [illegible] are [illegible] Descriptions are all confined to the loop, or so-called two-wire system. The various mechanical and electro-mechanical parts are first described; then it is shown how the different service conditions are met. The [illegible] are worked [illegible] to a great extent, but automatic calling over large areas like Columbus, Ohio, are described, where the inter-town lines are called by dial.

The chapter on power plant includes particulars of solenoid ringing interrupter, fuses, calling device speed indicator, engineer's and other desks, dead numbers and levels, and reverting calls on party lines.

In regard to traffic distribution systems, the traffic from each

unit is distributed among all the operators, but it is stated that no installation has been long enough in use to prove its efficiency. It is, however, expected to increase the busy hour working from two-thirds to five-sixths of an hour, an increase of efficiency of 66·6 per cent. in the busy hour, requiring 38 per cent. fewer operators. Circuits are shown of the A.E.Co.'s and Siemens & Halske's application of this to order wire working.

The descriptions of other automatic systems and semi-automatic systems are given in considerable detail, but as already mentioned, several features do not agree with the installations equipped or being equipped in this country. Can it be that "the state of the art" is more advanced here than in the United States?

One might take exception to the numerous references to the American I.E.E. "Journal" and to manufacturers' descriptive matter, the latter, at any rate, not being readily obtainable here. It can, however, be readily understood that the authors must have had difficulty in discriminating between what was suitable and unsuitable for inclusion.

There is a great mass of information in the book which the space available for a review does not permit of being touched on, much that will interest both the engineer and the student.

W. AITKEN.

The Year Book of Wireless Telegraphy and Telephony. Pp. lxvi. + 800. (London: The Wireless Press.) 3s. 6d. net.

In the present instance this year book has been extended to a somewhat larger number of pages than the volume of last year, but, owing to a change in the paper, the thickness is somewhat less, which is no doubt an advantage. The volume includes a mass of information of great utility, including the usual calendars, data of weights and measures, monetary, thermometric, barometric and other similar tables.

The more technical reader will find pleasure in the list of formulæ and equations and in the technical articles, of which there are quite a number. Among the latter is reproduced the address of Dr. J. A. Fleming to the Wireless Society of London on "The Function of the Earth in Radiotelegraphy." Mr. H. J. Round contributes an article on "Wireless Telephony," which is of more than usual interest, as it gives some account of investigations carried out by the Marconi Company. For this reason we reproduce part of this contribution in another column. Other articles are: "International Radiotelegraphy Research during 1914," by Dr. W. H. Eccles; "Wireless and War at Sea," by Mr. A. Hurd; "Influence of Wireless Telegraphy on Modern Strategy," by Col. F. N. Maude; "Some Applications of Radiotelegraphy," by Mr. A. H. Morse; "Applications of Wireless Telegraphy to Meteorology," by Mr. R. J. K. Lempfert; and "Wireless Telegraphy in Survey," by Mr. A. R. Hinks. The volume includes, as usual, biographical notes, a long list of wireless patent applications for 1914, and a great deal of other information. It is well illustrated, and should prove valuable to all those interested in radiotelegraphy.

THE DIFFERENTIAL EQUATIONS OF LONG-DISTANCE TRANSMISSION.*

BY GEO. R. DEAN.

[illegible]

IV.—THE CALCULATION OF LINE LOSSES.

1. *The Loss in the Dielectric.* Denoting this by P_c, we have

$$P_c = \int^{l} SV^2 dx.$$

where V is the effective value of the voltage at distance x from one end of the line.

$$V_1^2 = A_1^2 \cosh^2 kx \cos^2 kx + A_2^2 \sinh^2 kx \sin^2 kx + B_1^2 \sinh^2 kx \cos^2 kx + B_2^2 \cosh^2 kx \sin^2 kx - 2(A_1A_2 + B_1B_2) \sinh kx \cosh kx \sin kx \cos kx + 2A_1B_1 \sinh kx \cosh kx \cos^2 kx - 2A_1B_2 \cosh^2 kx \sin kx \cos kx + 2A_2B_1 \sinh^2 kx \cos kx \sin kx - 2A_2B_2 \sinh kx \cosh kx \sin^2 kx.$$

* See THE ELECTRICIAN, Vol. LXXIV., p. 355.

The expression for V_2^2 is found by substituting A_2 for A_1, $-A_1$ for A_2, B_2 for B_1, and $-B_1$ for B_2.

Using the identities $2\cosh^2 hx = (\cosh 2hx + 1)$,
$2\cos^2 kx = (1 + \cos 2kx)$,
$2\sinh^2 kx = (\cosh 2kx - 1)$,
$2\sin^2 kx = (1 - \cos 2kx)$,

we find

$$V_1^2 - V_2^2 = \tfrac{1}{2}(A_1^2 + A_2^2 + B_1^2 + B_2^2)\cosh 2kx + \tfrac{1}{2}(A_1^2 + A_2^2 + B_1^2 + B_2^2)\cos 2kx - (A_1B_1 + A_2B_2)\sinh 2kx - (A_2B_1 - A_1B_2)\sin 2kx.$$

$$\int^{l} SV^2 dx = \frac{S}{k}\Big[(A_1^2 + A_2^2 + B_1^2 + B_2^2)\frac{\sinh 2kl}{k} - (A_1^2 + A_2^2 + B_1^2 + B_2^2)\frac{\sin 2kl}{k} - 2(A_1B_1 + A_2B_2)\frac{\cosh 2kl}{k} + 2(A_1B_2 - A_2B_1)\frac{\cos 2kl}{k} - 2\Big(\frac{A_1B_1 + A_2B_2}{k} + \frac{A_1B_2 + A_2B_1}{k}\Big)\Big].$$

2. *The Loss in the Conductors.*—Denoting this by P_R, we have

$$P_R = \int^{l} RI^2 dx.$$

where I denotes the effective current at distance x from end. To obtain the expression for I^2 substitute C's for A's and D's for B's in the formula for V^2. Then

$$I^2 = \tfrac{1}{2}(C_1^2 + C_2^2 + D_1^2 + D_2^2)\cosh 2kx + \tfrac{1}{2}(C_1^2 + C_2^2 - D_1^2 - D_2^2)\cos 2kx + (C_1D_1 + C_2D_2)\sinh 2kx - (C_2D_1 - C_1D_2)\sin 2kx.$$

From formulæ (58), (59), (60), (61) we see that

$$C_1^2 + C_2^2 = \frac{Y}{Z}(B_1^2 + B_2^2).$$

$$D_1^2 + D_2^2 = \frac{Y}{Z}(A_1^2 + A_2^2).$$

$$C_1D_1 + C_2D_2 = \frac{Y}{Z}(A_1B_1 + A_2B_2).$$

$$C_2D_2 - C_1D_2 = \frac{Y}{Z}(A_1B_2 - A_2B_1).$$

We therefore have

$$\int^{l} RI^2 dx = \frac{RY}{4Z}\Big[(A_1^2 + B_1^2 + A_2^2 + B_2^2)\frac{\sinh 2kl}{k} - (A_1^2 + A_2^2 - B_1^2 - B_2^2)\frac{\sin 2kl}{k} - 2(A_1B_1 + A_2B_2)\frac{\cos 2kl}{k} + 2(A_2B_1 - A_1B_2)\frac{\cos 2kl}{k} - 2\Big(\frac{A_1B_1 + A_2B_2}{k} + \frac{A_2B_1 - A_1B_2}{k}\Big)\Big].$$

If we write $S = \frac{RY}{Z}$ $2Y\cos\tfrac{1}{2}(\delta + \gamma)\cos\tfrac{1}{2}(\delta - \gamma)$,

and $S = \frac{RY}{Z}$ $2Y\sin\tfrac{1}{2}(\delta + \gamma)\sin\tfrac{1}{2}(\delta - \gamma)$,

we get for the total line loss

$$P_c + P_R = \tfrac{1}{2}\sqrt{\frac{Y}{Z}}\Big[\cos\tfrac{1}{2}(\delta - \gamma)\{(A_1^2 + A_2^2 + B_1^2 + B_2^2)\sinh 2kl + 2(A_1B_1 + A_2B_2)(\cosh 2kl - 1)\} + \sin\tfrac{1}{2}(\delta + \gamma)\{(A_1^2 + A_2^2 - B_1^2 - B_2^2)\sin 2kl + 2(A_2B_1 - A_1B_2)(1 - \cos 2kl)\}\Big].$$

3. *Special Form of Formula for Line Loss when Voltage, Current and Power Factor at Receiver are given.*—If the voltage

at receiver is $E_0 + jO$, and the current $I_0 \cos\theta - j \sin\theta$), we have

$$A_1 = E_0, \; A_2 = 0, \; C_1 = I_0 \cos\theta, \; C_2 = -I_0 \sin\theta$$

$$B_1 = I_0 \sqrt{\frac{Z}{Y}} \cos(\theta - \xi - \delta), \qquad B_2 = I_0 \sqrt{\frac{Z}{Y}} \sin(\theta - \xi - \delta),$$

$$D_1 = -\sqrt{\frac{Y}{Z}} E_0 \cos(\xi - \delta), \qquad D_2 = \sqrt{\frac{Y}{Z}} E_0 \sin(\xi - \delta),$$

$$A_1^2 - A_2^2 - B_1^2 - B_2^2 = E_0^2 - \frac{Z}{Y} I_0^2,$$

$$A_1 B_1 - A_2 B_2 = E_0 I_0 \sqrt{\frac{Y}{Z}} \cos(\theta - \xi - \delta).$$

$$A_1^2 + A_2^2 - B_1^2 - B_2^2 = E_0^2 - \frac{Z}{Y} I_0^2,$$

$$A_2 B_1 - A_1 B_2 = -E_0 I_0 \sqrt{\frac{Y}{Z}} \sin(\theta - \xi - \delta).$$

Total line loss is

$$\tfrac{1}{2}\sqrt{\frac{Y}{Z}}\Big[\cos\tfrac{1}{2}(\delta - \gamma)\Big\{(E_0^2 - \frac{Z}{Y} I^2)\sinh 2hl + 2E_0 I_0 \sqrt{\frac{Z}{Y}} \cos(\theta - \xi - \delta)(\cosh 2hl - 1)\Big\} - \sin\tfrac{1}{2}(\delta - \gamma)\Big\{(E_0^2 - \frac{Z}{Y} I_0^2)\sin 2kl + 2E_0 I_0 \sqrt{\frac{Z}{Y}} \sin(\theta - \xi - \delta)(1 - \cos 2kl)\Big\}\Big].$$

The separate line losses are easily found in the formulæ above.

V.—Line of Finite Length Short-circuited at Receiver End.

1. In order to save the reader the trouble of referring to previous Papers, we write down the general formulæ for the components of current and voltage at any point of the line.

Writing Q_1 for $\cosh hx \cos kx$, Q_2 for $\sinh hx \sin kx$,
Q_3 for $\sinh hx \cos kx$, Q_4 for $\cosh hx \sin kx$,

we have

$$V_1 = A_1Q_1 - A_2Q_2 + B_1Q_3 - B_2Q_4, \quad . \quad . \quad . \quad . \quad (54)$$

$$V_2 = A_2Q_1 + A_1Q_2 + B_2Q_3 + B_1Q_4, \quad . \quad . \quad . \quad . \quad (55)$$

$$I_1 = C_1Q_1 - C_2Q_2 + D_1Q_3 - D_2Q_4, \quad . \quad . \quad . \quad . \quad (56)$$

$$I_2 = C_2Q_1 + C_1Q_2 + D_2Q_3 + D_1Q_4, \quad . \quad . \quad . \quad . \quad (57)$$

$$C_1 = \sqrt{\frac{Y}{Z}}\{B_1 \cos(\xi - \delta) - B_2 \sin(\xi - \delta)\}, \quad . \quad (58)$$

$$C_2 = \sqrt{\frac{Y}{Z}}\{B_1 \sin(\xi - \delta) + B_1 \cos(\xi - \delta)\}, \quad . \quad (59)$$

$$D_1 = \sqrt{\frac{Y}{Z}}\{A_1 \cos(\xi - \delta) - A_2 \sin(\xi - \delta)\} \quad . \quad . \quad (60)$$

$$D_2 = \sqrt{\frac{Y}{Z}}\{A_1 \sin(\xi - \delta) + A_1 \cos(\xi - \delta)\} \quad . \quad . \quad (61)$$

2. When the line is short-circuited at the receiver end, and the components of the voltage at the generator terminals are E_1 and 0, we have, taking origin at receiver,

$$V_1 = 0, \; V_2 = 0, \text{ when } x = 0.$$

Substituting in the general formulæ, we find

$$A_1 = 0, \text{ and } A_2 = 0.$$

Then

$$V_1 = B_1Q_3 - B_2Q_4, \; V_2 = B_2Q_3 + B_1Q_4, \quad . \quad . \quad (61), \; (62)$$

We have also

$$V_1 = E_1, \; V_2 = 0, \text{ when } x = l$$

Then (61) and (62) give

$$B_1 \sinh hl \cos kl - B_2 \cosh hl \sin kl = E_1, \quad . \quad . \quad (63)$$

$$B_2 \sinh hl \cos kl + B_1 \cosh hl \sin kl = 0, \quad . \quad . \quad (64)$$

Solving for B_1 and B_2, and noting that

$$\sinh^2 hl \cos^2 kl + \cosh^2 hl \sin^2 kl = \tfrac{1}{2}(\cosh 2hl - \cos 2kl)$$

we find

$$B_1 = \frac{2E_1 \sinh hl \cos kl}{\cosh 2hl - \cos 2kl} \quad . \quad . \quad . \quad (65)$$

$$B_2 = -\frac{2E_1 \cosh hl \sin kl}{\cosh 2hl - \cos 2kl} \quad . \quad . \quad . \quad (66)$$

Squaring and adding (65) and (66),

$$B_1^2 + B_2^2 = \frac{2E_1^2}{\cosh 2hl - \cos 2kl} \quad . \quad . \quad (67)$$

Squaring and adding (61) and (62),

$$V_1^2 + V_2^2 = (B_1^2 + B_2^2)(Q_3^2 + Q_4^2)$$

$$\frac{2E_1^2}{\cosh 2hl - \cos 2kl} \cdot \tfrac{1}{2}(\cosh 2hx - \cos 2kx.$$

Therefore,

$$V_x = E_1 \sqrt{\frac{\cosh 2hx - \cos 2kx}{\cosh 2hl - \cos 2kl}} \quad . \quad . \quad . \quad . \quad . \quad (68)$$

Since $A_1 = 0$ and $A_2 = 0$, we see from (60) and (61) that $D_1 = 0$, $D_2 = 0$. The formulæ (56) and (57) become

$$I_1 = C_1Q_1 - C_2Q_2, \; I_2 = C_2Q_1 + C_1Q_2 \quad . \quad . \quad . \quad . \quad (69)$$

Squaring and adding

$$I_1^2 + I_2^2 = (C_1^2 + C_2^2)(Q_1^2 + Q_2^2).$$

Now $C_1^2 + C_2^2 = \frac{Y}{Z}(B_1^2 + B_2^2) = \frac{Y}{Z} \cdot \frac{2E_1^2}{\cosh 2hl - \cos 2kl}$ . . . (70)

and $Q_1^2 + Q_2^2 = \frac{1}{2}(\cosh 2hl + \cos 2kl)$.

Hence $I_1 = E_1 \sqrt{\frac{Y}{Z}} \sqrt{\frac{\cosh 2hl + \cos 2kl}{\cosh 2hl - \cos 2kl}}$ . . . (71)

$$I_2 = E_1 \sqrt{\frac{Y}{Z}} \sqrt{\frac{\cosh 2hl - \cos 2kl}{\cosh 2hl + \cos 2kl}} \quad . \quad . \quad . \quad (72)$$

3. Power losses: The loss in the dielectric is $\int_0^l SV_x^2 dx$, and the loss in conductors is $\int_0^l RI_x^2 dx$.

$$\int_0^l SV_x^2 dx = \frac{SE_1^2}{2(\cosh 2hl - \cos 2kl)}\left\{\frac{\sinh 2hl}{h} - \frac{\sin 2kl}{k}\right\} \quad . \quad (73)$$

$$\int_0^l RI_x^2 dx = \frac{RYE_1^2}{2Z(\cosh 2hl - \cos 2kl)}\left\{\frac{\sinh 2hl}{h} + \frac{\sin 2kl}{k}\right\} \quad . \quad (74)$$

Numerical Illustration.

4. Taking $l = 300$ miles, $R = 0{\cdot}30$ ohm, $L = 0{\cdot}00196$ henry, $C = 0{\cdot}0153 \times 10^{-6}$ farad, $S = 0$, $p = 377$, we find

$\delta = 67° 53'$, $\gamma = 90°$, $\xi = 78° 56' 30''$, $Z = 0{\cdot}795$, $Y = 5{\cdot}77 \times 10^{-6}$,
$\xi - \delta = 11° 3' 30''$, $ZY = 4{\cdot}58 \times 10^{-6}$, $\sqrt{ZY} = 2{\cdot}14 \times 10^{-3}$,

$$\sqrt{\frac{Z}{Y}} = 371{\cdot}5, \quad \sqrt{\frac{Y}{Z}} = 2{\cdot}693 \times 10^{-3},$$

$h = 0{\cdot}000412$, $k = 0{\cdot}002100$,
$hl = 0{\cdot}1236$, $kl = 0{\cdot}630 = 36° 6'$,
$2hl = 0{\cdot}2472$, $2kl = 72° 12'$,
$\sin(\xi - \delta) = 0{\cdot}19181$, $\cos(\xi - \delta) = 0{\cdot}98143$,
$\sinh hl = 0{\cdot}1239$, $\cosh hl = 1{\cdot}0077$, $\cosh 2hl = 1{\cdot}0307$, $\sinh 2hl = \sin kl = 0{\cdot}5892$, $\cos kl = 0{\cdot}8080$, $\cos 2kl = 0{\cdot}3057$, $\cos 2kl = \cosh 2hl + \cos 2kl = 1{\cdot}3364$, $\cosh 2hl - \cos 2kl = 0{\cdot}7250$,
$Q_1 = 0{\cdot}8142$, $Q_2 = 0{\cdot}0730$, $Q_3 = 0{\cdot}1000$, $Q_4 = 0{\cdot}5935$.

Taking $E_1 = 100{,}000$, we find by (65), (66), (58), (59)

$B_1 = 27{,}510$, $B_2 = 164{,}000$, $C_1 = 24{\cdot}3$, $C_2 = 450{\cdot}0$

$I_{01} = 24{\cdot}3$, $I_{02} = 450{\cdot}0$, $I_0 = \frac{24{\cdot}3}{0{\cdot}05393} = \mathbf{451{\cdot}0}$ amperes

$\tan\varphi_i = -\frac{450{\cdot}0}{24{\cdot}3} = -18{\cdot}50$, $\varphi_i = -86° 53' 30''$, $\cos\varphi_i = 0{\cdot}05393$,

$I_{1'} = (-24{\cdot}3 \times 0{\cdot}8142) - (450{\cdot}0 \times 0{\cdot}0730) = -52{\cdot}6$
$I_{2'} = (450 \times 0{\cdot}8142) - (24{\cdot}3)(0{\cdot}073) = 365{\cdot}2$;
$I = \mathbf{368{\cdot}0}$ amperes

$\tan\varphi_r = \frac{365{\cdot}2}{52{\cdot}6} = 6{\cdot}950$, $\varphi_r = 81° 49'$, $\cos\varphi_r = 0{\cdot}14231$.

Otherwise,

$$I = E_1 \sqrt{\frac{Y}{Z}} \sqrt{\frac{\cosh 2hl - \cos 2kl}{\cosh 2hl + \cos 2kl}} = 367{\cdot}0 \text{ amperes}$$

$V_{1'} = (27{,}510)(0{\cdot}1) - (164{,}000)(0{\cdot}5935) = 2{,}751{\cdot}0 - 97{,}300 = -94{,}549{\cdot}0$

$V_{2'} = (164{,}000)(0{\cdot}1) + (27{,}510)(0{\cdot}5935) = 16{,}400 + 16{,}400 = 32{,}8000$

$$\tan \varphi_{cd} = -\frac{32,800}{94,549} \quad 0{\cdot}3470,\ \varphi_{cd} = -20^\circ 18',\ \cos \varphi_{cd} = 0{\cdot}9378$$

$$V_c = \frac{94,549}{93,780} \times 100,000. \quad \text{Ought to be } 100,000.$$

$$\text{Power input} = 100,000 \times 368{\cdot}0 \times \cos 61^\circ 31'$$
$$= 17,200,000 \text{ watts.}$$

Since S=0, the power input is also $\int_0^l RI^2 dx$. Therefore

$$\text{Power input} = \frac{0{\cdot}30 \times 5{\cdot}77 \times 10^{-6} \times (10)^{10}}{2} \left\{ 0{\cdot}2197 + 0{\cdot}95213 \right.$$
$$\left. \times 0{\cdot}795 + 0{\cdot}7250 + 0{\cdot}000412 + 0{\cdot}0021 \right\}$$
$$= 15,000{\cdot}0 \times 1,059{\cdot}5 = 15,930,000.$$

(To be concluded.)

ECONOMIC OPERATION OF ELECTRIC OVENS.*

BY P. W. GUMAER.

Summary.—The energy losses in an electric oven may be divided into radiation and convection loss, preheating loss and the loss due to opening the oven door. Each of these losses was determined. The results of the experiments performed indicate that for each article of food there is a particular time and temperature for which the cooking can be satisfactorily performed with a minimum amount of energy.

Apparatus Used.

In order to determine the losses of energy in electric cooking and the best methods of preparing various articles of food in electric ovens, tests were made on three commercial ovens and an experimental oven. Each commercial oven was selected as representing a general type of electric oven in use for domestic cooking. Oven No. 1 is a large range suitable for a good size family. The inside dimensions of the oven are 12 in. by 12 in. by 18 in. Two heating units are used, one in the top and one in the bottom of the oven. Each unit consists of two heating coils controlled from a snap switch on the front of the oven so as to consume 220, 440 or 880 watts. From one to two inches of mineral wool is used as heat insulation. The outside surface of the oven is blued steel with nickeled legs and trimmings. The oven door is 12 in. by 18 in. and 1·5 in. thick. It fits tightly and clamps firmly in place when shut. Three heating units are also placed on top of the stove for the cooking which is not done in the oven. Fig. 1 is a cross-section of the oven through the centre showing the position of the heating coils and the thermo-couple used to measure the temperature.

Oven No. 2 is a small well-insulated oven suitable for a small or medium size family. The inside dimensions of the oven are 9·5 in. by 9·5 in. deep and 12 in. high. The inside finish is seamless drawn aluminium and the outside is blued steel with nickeled trimmings. For heat insulation 2½ in. of mineral wool is used. An open coil heating element is placed in the bottom of the oven. The heating element consumes 500 watts when connected to a 110 volt circuit. The heat cannot be turned partly off, as there is only one heating element. There is no heating unit in the top of the oven. Underneath the oven is an automatic temperature control which may be set at various values by means of a dial. The dial is graduated in arbitrary numbers from one to eleven. When the handle of the dial is set at a given number a thermostat will open the circuit of the heating element as soon as the inside of the oven has reached a certain temperature. As the oven cools the thermostat must be reset by hand by pushing the handle of the dial. Fig. 2 is a cross-section of the oven through the centre showing the position of the heating coil and the thermo-couples.

Oven No. 3 is one of the well-known makes of fireless cookers with a heating element placed underneath the inner lining. The inside dimensions are 10·5 in. deep and 12·5 in. diameter. The inside lining is seamless drawn aluminium and the outside finish is varnished oak. The sides and bottom are insulated with powdered kieselguhr, while the cover is insulated with granulated cork. Fig. 4 is a cross-section of the oven showing the position of the thermo-couple and heating coil. The oven uses 500 watts at 110 volts. There is no method of turning the oven partly off.

Oven No. 4 was constructed by the author so as to obtain data on the characteristics of an especially well insulated oven. The inside dimensions were the same as oven No. 2. A 220-, 440-, 880-watt heating unit was placed in the bottom of the oven and a 440-watt heating unit was placed in the top as shown in Fig. 5. Sheet iron was used for the inside lining of the oven. A 4 in. layer of a commercial brand of diatomincus insulating brick was used for insulation. Later 4 in. of corkboard was added as shown in the drawing. This was put on with cement, and no outside covering was used except on the front and the door which were covered with wood.

The temperature of the ovens was measured by means of copper-constantan thermo-couples. An indicating galvanometer and a recording galvanometer were used to determine the E.M.F. of the thermo-couples. The recording galvanometer traced a curve by intermittent contact on a circular smoked chart. Two thermo-couples were used in series so that a larger deflection was obtained, and as the hot junctions were in different parts of the oven the temperature recorded was a mean of the two values. In oven No. 1 an extra thermo-couple was inserted for measuring the internal temperature of food. The wires entered the oven through two glass bushings and were left bare except for a 3 in. glass tube at the end, which was inserted in the food.

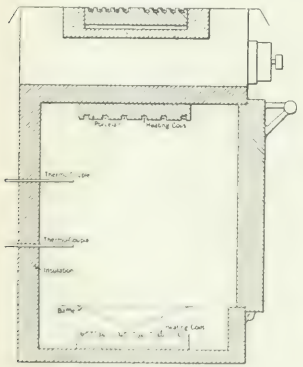


Fig. 1.—Cross-section of Oven No. 1.

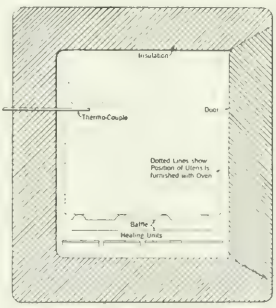


Fig. 2.—Cross-section of Oven No. 2.

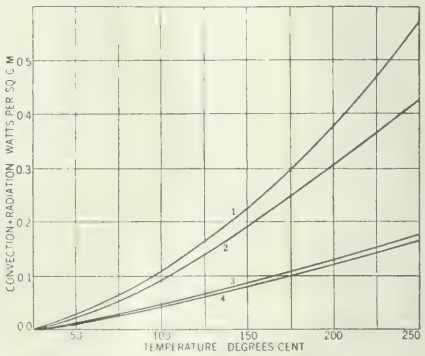


Fig. 3.—Total Losses from Heated Surfaces in Air. Convection Loss is for Vertical Surfaces.
1. Black body. 2. Oxidised copper. 3. Pure silver 4. Convection only.

Losses of Energy in Electric Ovens.

Convection and Radiation.—The radiation and convection losses from horizontal and vertical plane surfaces have been determined by Langmuir* for various materials. Fig. 3 shows the convection and radiation losses for vertical plane surfaces for temperatures up to 250 deg., the highest used in cooking.

As shown by the curves, the radiation loss from a black body constitutes a large part of the total loss, while the radiation from a polished silver surface forms but a small part of the total loss. For all other surfaces the radiation loss lies between that of a silver surface and a black surface, the convection being the same for all surfaces. There are two ways in which the heat loss of an electric

* Abstract of a Paper read before the American Institute of Electrical Engineers.

* "Trans." of Am. Electro Chem. Soc., Vol. XXII., p. 299 (1913).

oven may be reduced. Consider an oven of [illegible] dimensions built on the plan of an ordinary gas oven, with [illegible] outside surface and no heat insulation. The temperature of the outside surface will be within a few degrees of the temperature of the oven. A large amount of energy will be required to maintain a cooking temperature inside the oven. Suppose that enough heat insulation were introduced to reduce the outside temperature from 200° C. to 110°C.; the watts lost per square centimetre of outside surface would be reduced from 0·37 to 0·12 as shown by the curves of Fig. 3. Stated in another way, the energy required to maintain the inside temperature of the oven at its former value would be reduced from 1,000 watts to 325 watts for the same outside surface. For the same inside dimensions, however, the area of the outside will be larger because of the added insulation, and hence the energy will be slightly greater than the above value. Another method of reducing the heat losses would be to silver-plate the outside of the oven. The heat loss would

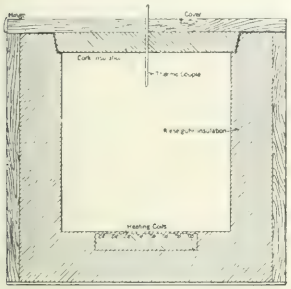


Fig. 4.—Cross-section of Oven No. 3.

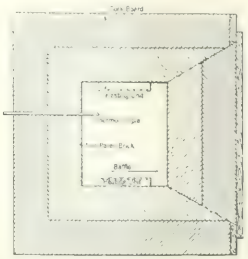


Fig. 5.—Cross-section of Oven No. 4.

then be decreased from 0·37 watt per square centimetre to 0·13, or the energy required to maintain the same inside temperature would be reduced from 1,000 watts to 350 watts. By a combination of the two methods the input of the oven for the required internal temperature would be reduced from 1,000 watts to 165 watts. To silver-plate the outside surface of an electric oven would be too expensive to be practical, but there are cheaper surfaces which radiate a small amount of energy compared to the ordinary black oven. A white enamelled surface, for instance, would be much more efficient than the black surface.

The heat losses from an electric oven can be easily determined by measuring the energy input and the temperature after the equilibrium conditions are established. The heat losses for the ovens tested were obtained in the following manner: A thermo-couple inside the oven was connected to a recording galvanometer. A given amount of energy was turned on so that the temperature of the oven increased, until finally the heat lost equalled the energy measured by the watt meter. The tests were continued until the oven temperature had remained constant for at least two hours. Fig. 6 shows the results.

Preheating.—The amount of energy required to preheat an oven to the desired temperature depends on the insulation of the oven, its size and the thermal capacity of the inside, and the size of the heating coils. Fig. 7 shows the results of tests. It will be noticed that although oven No. 4 was better insulated than oven No. 2 it required more energy for the preheating. This was probably due to the greater heat capacity of the inside lining and the insulation. The effect of too small a heating coil is shown for the curve for oven No. 3. For high temperatures, the energy required for preheating this oven is altogether too large for the size of the oven. The time required for the oven to reach a baking temperature of 200° C. was 2·5 hours. In order that the electric energy for preheating shall be as small as possible, the inner parts of the oven should have small heat capacity as is practical, and the heating coils should be large enough to heat the oven to the desired temperature in a fairly short time. If the time required for the oven to reach the desired cooking temperature is excessive not only is there a waste [illegible] operation but a larger amount of the energy is lost into the room by radiation and convection during the preheating.

Heat Loss when the Oven Door is Opened.—[illegible] hours lost each time the door of oven No. 1 is opened for 15 seconds and the fall in temperature of the oven when [illegible] different oven temperatures.

Experiments in Roasting Beef.

The experiments of Grindly and Sprague [illegible] that beef can be satisfactorily roasted at an oven temperature any where between 100°C. and 200°C. A beef roast prepared at any temperature within this interval was found to be well browned and attractive looking. No difference was discernible in the tenderness of duplicate roasts cooked at the extremes of temperature.

Twenty-two roasts, consisting of the third and fourth standing rib cuts, were obtained by the author from the local market. The meat was freed from bone and tightly rolled and secured with wooden skewers. Samples were roasted at 100°C., 120°C., 140°C., 160°C. and 180°C. The time required for the cooking and the amount of energy used at each oven temperature was measured. From these values the most economical temperature for roasting a rolled roast was determined. In order to get uniform results in the

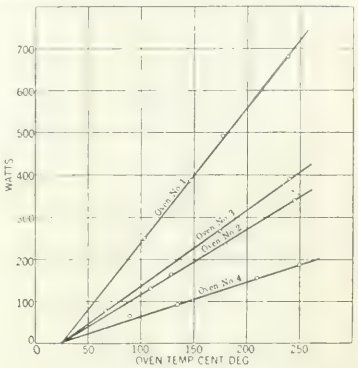


Fig. 6.—Energy Required to Maintain Ovens at Constant Temperature.

degree of cooking the meat, it was necessary to decide on a rather exact method of determining when the meat was sufficiently cooked. Grindly and Sprague* found that if the inner temperature of a roast is between 55°C. and 65°C. the meat will be rare (*i.e.*, underdone), if it is between 65°C. and 70°C. it will be medium rare, and if between 70°C. and 80°C. it will be well done. In order to secure as much uniformity as possible in the results, a definite temperature rather than a range of temperatures was taken as the indication of when

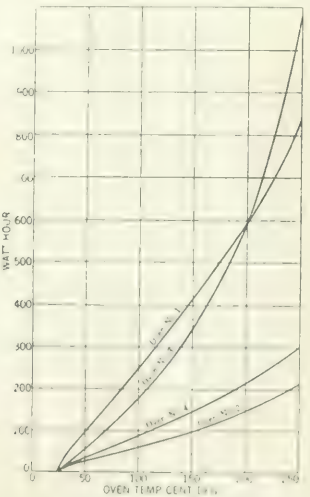


Fig. 7.—Energy Required to Preheat Ovens.

the roast was sufficiently cooked. 55° C. was used for rare, 65° C. for medium rare and 75°C. for well done.

A copper constantan thermo couple was used to measure the temperature inside the roast. The thermo couple was connected to the recording galvanometer which gave a continuous record of the

* Univ. of Ill. "Bull.," Vol. II., p. 290.

temperature inside the roast. The authorities on meat cooking recommend that a roast be cooked for the first 10 or 15 minutes at an oven temperature of 250°C. so as to sear the outside of the meat. The theory is that the coagulation of the outer surfaces of the meat will act as a seal to keep in the meat juices and volatile flavours. A consideration of the heating curves of the electric ovens, discussed in the first part of the Paper, shows that to heat an oven up to 250°C. and to keep it there for 15 minutes will increase the cost of the electricity for roasting the meat about 50 per cent. In order to reduce this extra cost of energy, another method was tried which proved very successful. Instead of searing the meat in the oven at a

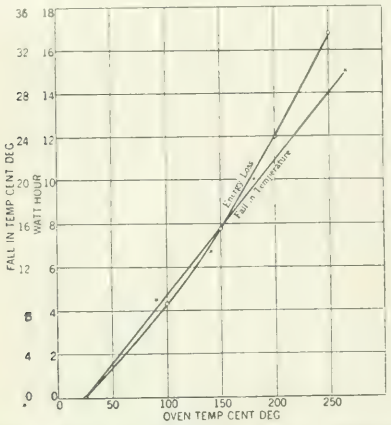


FIG. 8.—EFFECT OF OPENING DOOR OF OVEN No. 1 FOR 15 SECONDS UPON ENERGY LOST AND FALL IN TEMPERATURE OF THE OVEN.

high temperature it was seared on the top of the stove or rather by placing the meat in an aluminium dish over an 880-watt heating coil. The current was turned on for three minutes to get the dish quite hot. The meat was then placed in the hot dish and seared for 10 minutes, being turned frequently so as to sear all sides. After searing, an incision was made in the roast with a sharp narrow bladed knife, and the thermo-couple was inserted as near as possible in the centre of the large muscle of the roast. The roast was then placed in the oven at the desired temperature.

Fig. 9 shows the average time of cooking plotted against oven temperature. The weight of joint was in the neighbourhood of 4 lb., and the average loss of weight varied from 20½ per cent. up to 31 per cent., increasing with the temperature.

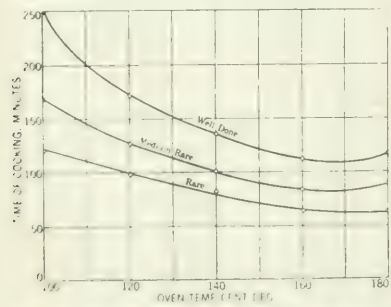


FIG. 9.—EFFECT OF OVEN TEMPERATURE ON TIME OF COOKING OF BEEF ROASTS.

The other important factor which determines the best roasting temperature is the cost of the electricity used. In the tests described, for rare roasts 100 deg. is the most economical temperature in each case. For the medium rare 100 deg. is the most economical, except for oven No. 1, for which 120 deg. to 140 deg. is the best. For the well done roasts there is a slight difference in the cost of cooking the roast at the various oven temperatures. For all ovens and the most economical temperature for the well done roasts has been 120°C. and 140°C. When preheating is included the difference between the cost of preparing a roast at 100 deg. and 180 deg. is greater. For ovens No. 1 and 2, 120 deg. is the most economical temperature for well done roasts. While the cost of electricity at 2·5d. per kilowatt-hour for oven No. 1 the difference between the cost of roasting meat at 100 deg. and 180 deg. is 1d. for rare and 1·25d. for medium rare, and for well done the difference between 120 deg. and 180 deg. is 1·25d. The saving in the month's bill would probably amount to about 2s., depending, of course, on the number of roasts prepared.

An experiment was tried by searing the roasts in the manner recommended by the cookery books. The oven was heated to 250 deg., the roast was placed therein, and full current was turned on until the temperature had returned to the desired value. The current was then turned off and the oven allowed to cool down to 100 deg. where it was kept constant during the remainder of the experiment. The energy required to prepare the roasts by both methods is given in the following table :—

Watt-hours Used in Preparing Roasts by the two Methods of Searing.

Searing on top coil.	Remainder of test in oven at 100 deg.	Total	Total when seared in oven.	Difference.
Rare..... 190	790	880	1,950	1,070
Well done..... 190	1,325	1,515	2,580	1,065

The saving in energy in favour of searing on top of the stove is surprisingly great, making a difference of 2·5d. (at 2·5d. per kilowatt-hour) in the cost of preparing the roast.

BAKING EXPERIMENTS.

Several curves are given showing the loss of weight and time required for cooking biscuits and other articles of food at various temperatures. In the case of biscuits, the percentage loss of weight begins to increase very rapidly as the temperature decreases below 200 deg. This increase in the loss of weight for the biscuits at the low temperature indicated that the samples dried out to a greater extent due to the increased time of baking. The range of temperature, therefore, for baking biscuits prepared according to the recipe adopted is from 200°C. to 240°C.

In the case of bread experiments the most satisfactory results were obtained above 180 deg. At the lower temperature the crust was hard and thick, due to excessive evaporation of moisture.

Consideration of the results as a whole emphasise the importance of the preheating characteristics in designing an efficient electric oven. For the kind of baking which requires a high temperature for a short time the preheating loss is considerably greater than the radiation and convection loss. Unless some method can be found for decreasing the energy used in heating the oven up from room temperature, it will not be practical to increase greatly the heat insulation of the ovens used for domestic baking. This does not apply, however, to ovens which are used for long intervals at the same temperature.

CONCLUSIONS.

With reference to the use of a thermometer for the standardisation of oven temperatures Miss M. B. Van Arsdale, assistant professor of household arts at Columbia University, says :—

"Regarding the inexperienced housewife, it can truly be said that with an accurate thermometer her results would undoubtedly be more uniformly good—and we believe that the recipe books of the future should not read merely 'bake until done in a moderate oven' or 'according to judgment,' but will also state how long and at what temperature, so that in the hands of even the inexperienced these recipes will yield not occasionally good but uniformly good results without the discouragement of many failures, the sacrifice of much time and the waste of much good material. Thus the scientific treatment of the subject added to our traditional knowledge should tend to evolve an even higher type of cookery than we have had in the past."

With the advent of electric ovens a revolution in the methods of cooking has become possible. Automatic electric ovens will probably be developed in which the temperature will be accurately controlled and the necessity of constant vigilance will be removed. Some kinds of food will even be prepared in advance, placed in the oven, and without any further attention on the part of the housewife the current will automatically be turned on at a predetermined time. The temperature of the oven will increase to the desired value and there remain constant until the food is properly cooked.

Electric cooking may be classified according to the temperature to be used in the oven. The baking of bread, cake and pastry requires a high oven temperature from 170°C. to 240°C. In the average family where the oven is used intermittently a large part of the electricity used in this class of baking will go to heat up the oven from

room temperature to the required baking temperature. In other words, the preheating loss will be large compared with the radiation and convection loss. The preparation of vegetables, cereals, and meats, except for searing, broiling and frying, requires a temperature of heat, 80°C. to 120°C., applied for several hours. In this class of cooking the preheating loss is small in proportion to the radiation and convection loss. The increased popularity of the fireless cooker indicates that people are learning that food can be cooked at temperatures lower than the boiling point of water. The particular temperature of 100°C. has long been the one used for cooking cereals, vegetables and meats, because it is the easiest temperature to maintain at a constant value and not necessarily because it gives the best possible results. The fact that several hours are required for the cooking of [illegible] does not require the attention of the housewife. Aside from the question of the quality of the food and the saving in electricity, four hours would probably be the best time to cook the food. The housewife could put in the food for the midday meal immediately after breakfast while the oven was still hot. When it is taken out she could put in the evening meal, so that the oven would be used continuously. The preheating loss would thus be reduced to a minimum. During the latter part of the afternoon the housewife need not be tied to her kitchen, as all that would be necessary at this time would be to dish up the food and serve it. Electric light and power companies should be interested in perfecting this method of cooking and in bringing it to the attention of their customers. A combination of the electric oven and the popular fireless cooker would be a very desirable load for the central station, as it would be used early in the [illegible] and would not interfere with the peak load even in the winter, as sufficient heat can be stored in a well insulated oven to keep the food hot enough to serve for an hour or more after the current is turned off.

CORRESPONDENCE.

PURE ELECTRON DISCHARGE

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The article on the above subject by Dr. Irving Langmuir is most interesting, but I should like to point out that the fact that a very high temperature and perfect freedom from gases inside the tube or in the wire to obtain a pure electron discharge has been known for a long time previous to the above article (*see* Prof. J. J. Thomson, "Conduction of Electricity through Gases," 1906, pp. 192 and 193).

Also that a double layer of electricity at the surface of the wire would produce enormous changes in the amount of negative electricity coming from the wire, and to increase the voltage from 4·6 to 5·6 volts under these circumstances might increase the current more than 150,000 times (*see* p. 202).

Sir J. J. Thomson is interesting in many other particulars. For instance, he points out that the introduction of hydrogen gas might considerably increase the negative leak.

With regard to the positive discharge from hot wires it appears that this discharge is due to gases, particularly oxygen. If all traces of these gases could be removed, perhaps by treating the filament and glass surface with hydrogen, the disintegration of the wire due to the positive discharge could be stopped.

This fact appears to have a very practical bearing on the manufacture of tungsten filament lamps working at high efficiency, because in this case we could have a considerable increase in the temperature of the wire without disintegration.—I am, &c.,

London, May 26. S. G. BROWN.

SYSTEMS OF WIRING

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest your account of the Commercial and Industrial section of your issue of May 28th, and wish to take exception to a few of your remarks in the comparison of wiring methods used in England and the United States.

Several years ago I had an inspection of the Edison Service Corporation supplying electric power to most of Chicago and the surrounding suburbs, and as I am also interested in and worked with the electrical methods here in Montreal I found had a good opportunity for comparisons, if we take the City of Chicago and its suburbs and the City of London and its suburbs as examples, and I regret to say that by far the majority of cases of wiring here would fail to pass "inspection."

The knob and tube work, of which you speak so disparagingly, is allowed in the outlying or thinly-populated districts, but the rules imposed upon such wiring make it perfectly safe. In no case in this or any other type of wiring is either wire allowed to touch wood or pass through the wall or ceiling without being protected by being enclosed in circular loom. This circular or flexible loom is impervious to fire and water, being made of a mica compound, and is one of the best insulations obtainable. Here in England both wires may be brought *together* through the ceiling without any further insulation whatever, and using an inferior insulated wire to what is required in the States. Here wire is run through conduit without any bushes at the end to prevent the insulation from being damaged, with the attendant possibility of a short. Here, also, the wires are run out of the conduit on to a wooden block in the wall to be brought to the switch, both wires lying side by side on the wood against a possibly damp wall. This would never be tolerated in the States. Here there seems to be no inspection to see whether the fixtures are properly installed, while in the States the house is left disconnected until all the work is properly finished, the joints of which are inspected to see that they have been soldered and well taped. In London we are allowed to use a flex that has about one-third the insulation required by the City of Chicago.

The above applies mostly to residence wiring, and in the realm of factory and office lighting I find the conditions very similar, the chief difference here lying, however, in the switches, panel boards, &c., which one must see and use to appreciate.

As to whether the concentric system of wiring will find favour across the sea will depend upon whether it is proved to be a safe system, for the fact that by far the majority of houses are of wood construction makes the fire risk more dangerous than in a brick or stone residence.

I hope I have cleared up a misunderstanding you seemed to have obtained from the comments you have read in the American electrical magazines.—I am, &c.,

Sanderstead, June 1. O. E. GRIGSBY, M.Sc.

[We shall be glad to know if other correspondents support the views expressed by Mr. Grigsby.—ED. *E.*]

THE GYROSCOPIC COMPASS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read Mr. Longland's letter of May 28th and note the statement that I am in error with regard to the Sea-Star compass.

Mr. Longland's letter has five paragraphs: the first is reasonable; the second and third are misleading; the fourth is a mere confusion of words; and the fifth is nonsense.

The second and third paragraphs endeavour to describe the construction of the Sea-Star compass. Paragraph 3 [illegible] a gyroscope having three degrees of freedom. This leads the reader to suppose that, in principle, the Sea-Star is a gyroscope having three degrees of freedom. That it has not three degrees of freedom the reader is left to infer from paragraph three, though if he has been clever enough to infer this important fact, paragraph five will lead him astray again.

As a matter of fact the simple arrangement with which I have specially dealt in my Paper—a gyro wheel symmetrically mounted so that its axle hinders across between the prongs of a fork whose shaft is held in a vertical socket on which it can turn freely—might be used as a Sea-Star compass. External contacts would have to be provided in each bearing of the gyro axle. Some ingenuity would be required in the construction of such contacts, but they would have to possess the property of closing an electrical circuit across the plunger on the vertical bearing irrespective of the pressure which the vertical bearing might exert. Inequality of pressure would be set up by any torque tending to force the gyro axle out of the horizontal. In the mechanical arrangement thus

closed would be the so-called "meridian motor" geared so as to turn the vertical shaft of the fork.

Paragraph four is the important one, purporting to prove that the Sea-Star compass has no latitude error. To my mind it proves nothing, but from it I am led to infer that the writer of the letter has not yet realised the nature of latitude error in any form of gyro-compass. In this paragraph the word "meridian" is used 13 times; once correctly and 12 times incorrectly! It is only in the last four lines of the praragraph that the reader is able to discover why the word meridian is thus used at all. These four lines read: "It is only at the meridian where there is a balance of the turning influences, so that, once the axle is in this position there it remains with its ends moving in curves, symmetrical about the meridian." This is altogether wrong—except at the equator. It is obviously wrong to anyone who understands the nature of latitude error in the ordinary forms of gyro-compass.

The last paragraph of the letter is nonsense. It states that "the Sea-Star is free to turn about . . . the horizontal axis perpendicular to the axis of the wheels axle." Yet paragraphs two and three have carefully explained the mechanism by which any tendency to move about the axis just named causes the "meridian motor" to prevent such movement—indirectly but none the less effectually. Could there ever be a better example of nonsense than to say a thing is free to move but is always prevented from doing so? If it were not nonsense, but really true, to say there is freedom about this axis I would simply remark that the Sea-Star would then be a gyroscope having three degrees of freedom; for in addition to having the freedom just claimed it could spin upon its axle, and could turn about the vertical diametral axis (the meridian motor need have no friction). But a gyro-compass having three degrees of freedom is, as everybody knows, impracticable.

Reviewing then the whole letter the essential point lies in the last four lines of paragraph four. If instead of the bare statement the writer of the letter had endeavoured to give proof of such a striking proposition as these four lines contain I think he would never have written his letter but would have abandoned the wreck of the Sea-Star to which he now so fondly clings.

The axle of the Sea-Star would probably, as the letter states, swing continually from left to right. This swing might be made small. The meridian motor would maintain the axle horizontal. Is it not obvious that the gyroscope would set itself so that, on the average, the direction of the axle would be that of the axis of the resultant of all the torques acting on the gyroscope? The torque due to the meridian motor is first to left and then to right, an alternating torque whose average value is nil. Of the two torques everybody knows that when the gyro axle is horizontal the axis of the resultant torque is in the meridian at the equator, points east of the meridian in northern latitudes and west of the meridian in southern latitudes.—I am, &c.,

London, May 31. F. M. DENTON.

THE RANGE OF WIRELESS SIGNALS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an article on "Dust" in "Knowledge" of April, 1915, the following figures are given for the dust particles per cubic centimetre in air over oceans:—

Atlantic Ocean	2,000
Pacific Ocean	600
Indian Ocean	200 to 500.

It occurred to me that this difference may be connected with the extraordinary wireless ranges reported over the Pacific and Indian Oceans as compared with the Atlantic.

In the same article 150,000 is given as the number in town air, and for Ben Nevis Summit 14,000 in the afternoon to 100 in the early morning. If the latter figure is general for the upper air the difference between night and day ranges may be in part due to the same dust effect.—I am, &c.,

London, May 29th. HENRY M. SAYLE.

[We presume that Mr. Sayle has in mind dust particles which are charged and which would then be counted as heavy ions. These, we think, have already been considered in regard to wave propagation.—ED. *E.*]

MEASUREMENT OF THE LOGARITHMIC DECREMENT OF CONDENSERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have not until now had an opportunity of seeing THE ELECTRICIAN for 1915, and on inspection of it my attention was drawn to an article by Mr. August Hund in your issue of January 8th, pp. 458-461.

The author says, p. 460: "For this reason the author has developed the thermo-cross bridge method, &c. . . ."

I must state that the thermo-cross bridge as described in the article and shown in Fig. 4 bears a closer resemblance than might be reasonably expected to a scheme of my own, described in the "Physikalische Zeitschrift," Vol. XII., pp. 1224-1226 (1911), and shown there in Fig. 2. The only difference I can see consists in the use of block condensers in all the arms of the bridge, which "limit the thermo-electric current to the bridge." But I do not see why this last is necessary.—I am, &c.,

L. ISAKOW,
Inspector of the C.C. for W. and M.

Chambre Centrale des Poids et Mesures,
Petrograd, May 2.

ELECTRICAL SUPPLIES TO BELGIUM.

In our last issue we made brief reference to a lecture which was given on Thursday last at the Cannon-street Hotel, London, under the auspices of the London Chamber of Commerce and the Belgian Committee for Trade with the Allies. It is to be regretted that the meeting was but poorly attended, owing doubtless to the fact that the electrical organisations of this country had not been approached in the matter, and that timely notice was not given to the trade press. We understand, however, that it is proposed to hold a further meeting, and that steps will be taken to ensure a representative attendance. The lecture was delivered in French by Mr. R. Steylaers, and at intervals an English interpretation was given by Mr. G. Barwick.

Mr. A. H. LAWRENCE, vice-president of the British Chamber of Commerce in Belgium, occupied the chair, and said that, his own home being in Belgium, he could assure his countrymen on this side that the trade was theirs if only they would make some little effort, and perhaps some sacrifice, which would be well repaid. He was authorised, on behalf of the London Chamber of Commerce, to say that they, through their electrical section, would be pleased to give every assistance.

Following is an abstracted report of the English interpretation of Mr. Steylaers' lecture:—

He (Mr. Steylaers) was approached by the Belgian Committee to develop, through the medium of a meeting such as this, a definite and positive policy that could be operated immediately Belgium and Northern France are free. He considered that an open discussion was preferable for the mutual exchange of ideas to an individual exposition, hence the calling together of the manufacturers of British electrical supplies and Belgian buyers, to study the most appropriate means of realising the desired object. He regretted that, at the recent exhibition along the lines of the Leipzig Fair, recently held at Islington for toys and cheap ware, space could not be allocated for the exhibiting of the productions of British manufacturers who will take part in the rebuilding of Belgium, and whilst appreciating the spirit that promoted the exhibition, suggested that Belgians would have been interested in seeing those products which will enter into the industrial rebuilding of their country. The British manufacturer could not successfully continue his efforts to the British Empire alone; if he is to beat German competition he must find a world market. The production of cheap articles necessitated an enormous demand, which could not be responded to by the British Empire alone. There was a scheme under consideration to organise an exhibition of the products in which those present were interested, and steps were being taken by various committees to obtain a venue for this purpose. When these arrangements are completed an announcement would be made in due course.

The principal phase is the industrial rebuilding of Belgium, embracing the industry of electrical engineering and the manufacture of electrical supplies, and the selling of these products to Belgian buyers at the termination of the war. He considered it a duty to assist in the re-organisation and establishment of the new economical conditions, as a compensation for the sacrifices of the Allied armies. Belgian machine tools in all factories were being transferred to Germany; raw material had been appropriated; the enemy had stolen and was utilising commercial secrets, and was disclosing in interested quarters the names of Belgian customers, for prior to the war German manufacturers were beginning to fear the effects of Belgian commercial development. The greater part of Belgian electrical supplies were, either directly or indirectly, controlled by German manufacturers. In Belgium there was first the Belgian Union Co. (Ltd.), in reality a branch of the Allgemeine Elektricitäts Gesellschaft, the renowned A.E.G., Chaussée de Charleroi, in Brussels; similar to the Parisian concern, the Société Française d'Electricité (A.E.G.) rue d'Amsterdam in Paris. As a matter of fact these companies were Belgian and French in name only. The Belgian company's capital

was 1,000,000 frs. and the French company's 2,000,000 frs. The object of the company (expressed in the articles of [illegible]) was "for the exploitation of workshops for the construction of electrical supplies generally, and particularly the productions of the Allegemeine Elektricitäts-Gesellschaft, Berlin," capital 70,000,000 frs. There were in Belgium and France also the Siemens-Schuckert Co. and the Siemens & Halske Co. The articles of association of these companies stated that their object was "the sale in Belgium and France of the productions of the two German companies Siemens & Halske and Siemens & Schuckertwerke A.-G., mit Beschränkter Haftung." Further, the French Siemens company acquired a large financial interest in the French "Cie. d'Electricité de Creil (Ltd.)," capital 3,800,000 frs., with head offices in Paris. This company was the former French concern Dayde & Pille, Paris. Other apparently French electrical concerns which were actually branches controlled by the German Siemens company were :—

1. La Société Industrielle d'Energie Electrique, Paris. (Directorate included MM. Cahen, Petri and Simler).

2. La Société d'Electricité de Varsovie. (MM. Salomon and Cahen).

3. La Société Continentale de Traction et d'Eclairage. (MM. Cahen, Petri and Rosenbaum).

4. La Société des Applications de l'Electricité à la Traction. (MM. Von Chauvin and Von Siemens Natalis.)

All these four concerns had been seized by the French Government since the outbreak of war. Their aggregate capital was 32,000,000 frs. in shares and 10,000,000 frs. in debentures.

In Belgium there was also the Electric Motor Co. Lahmeyer (recently acquired by the A.E.G.). Against these great German corporations (partly financed, he regretted, by French and Belgian capital) there existed the following Belgian concerns : Ateliers de Constructions de Charleroi, the Pieper Co. (Liége), and the Ateliers du Cables de Seneffe. In France there were the Electricité & Electromecanique Co., and the British trade was represented by the Westinghouse Co., the British Thomson-Houston Co., and the Tudor Accumulator Co., and just prior to the war the General Electric Co. for supplies. For these concerns, however, the competitive fight was unequal against the financially strong German trusts. The German concerns had received very large contracts from the French and Belgian Governments, including electrical works and supplies at such important places as Bizerta, Paris, Antwerp, Zeebrugge, &c., which work had placed the German military authorities in possession of most valuable information concerning the fortifications of these great centres.

Backed by the financial support of a number of manufacturers of German electrical supplies on a co-operative basis, these German concerns acquired a unique standing in the Belgian market, securing a substantial portion of Belgian trade. Catalogues of an expensive and elaborate nature were freely distributed. Belgian wholesale houses were unable to compete successfully with the German wholesaler. These Belgian concerns endeavoured to sell outside the Trust, but the high individual selling cost and the question of individual credit mitigated against them to such an extent that their success was limited. Immediately before the war the A.E.G. began the last phase of their carefully and skilfully prepared scheme ; they approached the consumer direct, thereby eliminating the intermediaries' profit. On the retailer resenting what he considered a violation of his rights, the A.E.G. condescended to withdraw their quotation in favour of a Belgian concern, on the mutual understanding that, in the event of the particular concern securing the business, the order for the material necessary for the execution of the installation must be placed with the A.E.G. It was safe to assume that 95 per cent. of the electrical supplies business was dominated and controlled by German manufacturers, who secured the contracts both of the public services and private businesses. How could Belgian workshops (however soundly operated) profitably meet this competition ? The position was identical in the telephone and electric lamps branches. In Belgium the Telephone Co. La Société de Téléphonie Privée had to recently contend with aggressive competition from the Berliner Company L'Otomat, who skilfully and persistently invaded the public services, banks and Government offices. Paris also had to contend with this competition, where the German company competed against the French company under a French name, flooding the market with German raw material and telephone apparatus, employing German labour and gaining entry into the administrations of the French Government, the military circle of the Avenue de l'Opera in Paris, the town councils of the 9th and 10th arrondissement in Paris, the town councils of Clichy, Dunkirk and Mauberge ; they even obtained the concession for the telephone installation of the International Exhibition in Lyons.

Appealing to his own countrymen, Mr. Steylaers asked whether they were prepared to continue to be dominated by the German manufacturers, and suggested that the spirit animating all Belgians was the desire to recover their economical independence in the same way as they would reconquer their territorial independence. The problem presented many difficulties. It necessitated the co-operation of all the interests engaged —the co-operation of the British manufacturers, the co-operation of the Belgian consumers. In a legitimate manner it was possible to commence where the German manufacturer left off, to [illegible] the causes of his success and development, to extract the best from his operations, and apply them to the scheme of re-construction. But he must be kept out. The policy of cut prices established by the German producer might, from the point of view of the [illegible] superficially appear to enhance the difficulty of [illegible] new market, but closer investigation would satisfy him that by a system of specialisation it was not only possible to produce the goods in which the German specialised, but to produce them at a [illegible] opportune moment for the British manufacturer to take advantage of the forced residence in this country of Belgian [illegible] co-operate with them as to potential requirements, and to carefully analyse the question of price and productive cost, and by this process to arrive at such an understanding as would establish a sound and satisfactory foundation.

Mr. Steylaers proceeded to review the German methods of securing business, the question of credit as operated by the German houses, and German methods of selling and publicity. On the latter point he said the German manufacturer is not a successful pioneer, but is essentially a copyist. If he desires to exploit a new market he instructs his most progressive salesman to go to this market, and procure samples of the goods commanding the best sale, with prices and discounts allowed by the manufacturer. He then analyses the proposition to the minutest detail, eliminates any feature that he considers superfluous and bases his productive costs on an enormous output. A few weeks later the salesman is back again, offering a copy of the article in question, at lower prices and on better credit terms, so that he is able to secure large orders and contracts immediately. There was in addition (he said) an indirect system far more insidious—a system of commercial espionage, and proceeded to describe the well-known and subtle device of the German trader whereby a clerk subsidised by a German manufacturer enters a British or Belgian office or factory, under the pretence of learning the language, at a very low salary, and despatches to his employers the names of potential customers, keeping him furnished with data and information that could be used to advantage. Such devices and both direct and indirect trade with Germany could only be met and defeated by aggressive policy, and he called for the abolition of German companies trading under Belgian names. The object of the Belgian electricians should be to induce the British manufacturer to produce such goods as would meet their actual requirements, habits and working methods. His opinion was, however, that his countrymen would have to fight hard to become masters in their own house. The proposal was, therefore, that an organisation be created to act as a connecting link with the manufacturer and the purchaser, and that financial measures be adopted for the constitution of a corporation to act as a clearing house to transmit orders to the Allies, the development of Belgian national industries taking place during the interim. This organisation would appeal to the wholesale trade and replace the German organisation operating before the war. His suggestion was the creation of a corporation under the name of "The Union of Belgian Electricians" (U.B.E.), deposing the other Union, which was Belgian in name only. The initial capital should be 1,000,000 frs. Such a corporation, well patronised, solidly backed and scientifically organised in regard to its selling policy, would obtain better credit terms from the manufacturers than those extended to any individual outside its scope. As to credit, the corporation, being on the spot, would have a better knowledge of the financial status of each customer, and would of necessity be more conversant with the prevailing conditions. All specialities handled by the corporation would be sold under the manufacturers' name and trade marks, and every effort made to place the business with those manufacturers interested in the corporation, thus creating a goodwill for such manufacturers' goods.

Was this proposal worthy of consideration by the British manufacturer ? The time for talking was passed. The opportunity must be accepted now, otherwise Belgium will be reluctantly compelled to reopen relations, because of its urgency, with the nation which had prostituted all that she holds most dear. Belgian electrical experts now in this country waiting for their country to be free might be here a few weeks, maybe a few months. This period should be utilised by these gentlemen and the British manufacturers for an interchange of ideas, because the moment the invaded territories were free the refugee population in this country and France would rush back to their homes, and themselves commence to rebuild their country out of the ashes.

BOOKS RECEIVED.

[Copies of the undermentioned works [illegible] to The Electrician Office post free on receipt of the publishers' prices. Any of these books can be obtained through us at the prices quoted plus 4½ per cent. for delivery in this country. Add 10 per cent. for abroad or for foreign postage.]

"Single-phase Electric Railways." By Edwin Austin. (London : Constable & Co.) Pp. xiv.+303. 21s. net.

"Electric Railway Handbook." By Albert S. Richey, assisted by W. C. Greenough. (London : Hill Publishing Co.) Pp. xi.+332. 17s. net.

"Transactions" of the North-east Coast Institution of Engineers and Shipbuilders. Edited by E. W. Fraser Smith. (Newcastle-on-Tyne : The Institution.) Vol. XXXI., Part I. Pp. 38.

"Journal" of the Franklin Institute. (Philadelphia : Franklin Institute of the State of Pennsylvania.) Vol. CLXXIX., No. 5. Pp. 103–150.

"Standards for Gas Service." (Washington : Government Printing Office.) No. 32. Pp. 197.

"A Comparison of Static Radiometers and Radiometer Measurements on the Static by W. Coblentz." (Washington : Government Printing Office.) No. 244. Pp. 43. 15 cents.

"Technologic Papers. Physical and Electrical Testing Laboratory." (Washington : Government Printing Office.) No. 53. Pp. 35. 10 cents.

"Journal" of the Western Society of Engineers. (Chicago : Western Society of Engineers.) Vol. XX., No. 3. Pp. 92. 50 cents.

"Engineering" Directory (No. 60, April, 1915). (London : "Engineering," Limited.)

LEGAL INTELLIGENCE.

Merchandise Marks Act Prosecution.

At the Mansion House London Police Court on Thursday last the British Thomson-Houston Co. were summoned for unlawfully applying and selling an electrophone to which a false trade description had been applied in contravention of the Merchandise Marks Act, 1887. Mr. J. Hunter Gray appeared for the company, and pleaded guilty.

Mr. BODKIN (who prosecuted) said the proceedings were at the instance of a Mr. Hummer, the owner of certain patents and registered designs in connection with electrophones. In 1912 and 1913 Mr. Hummer was connected with a London company for representing the Stolz Electrophone Co. (of Chicago), and being connected with that company and the owner of patents, an arrangement was come to between that company and the British Thomson-Houston Co. to manufacture electrophones according to a description in a patent of which Mr. Hummer was the owner. After a deal of correspondence an order was placed with the British Thomson-Houston Co. to manufacture a large number of electrophones for the London Stolz Co., the former company taking a collateral guarantee for payment. Four thousand electrophones were to be manufactured. A sample instrument was submitted for the approval of the patentee, and according to that model the order was to be executed. For turning out the instruments a large quantity of special tools had to be made by defendants. From the correspondence it appeared that the goods were not to be made at the company's works at Rugby, but in Berlin.

Mr. GRAY: I object to this. The company never had works at Berlin.

Mr. BODKIN: I am only speaking from my instructions, and was referring to a letter, when

Mr. GRAY said "That is wrong. We have no Berlin factory."

Mr. BODKIN said that in the correspondence a question was raised as to how those goods manufactured, as it was understood, in Berlin, ought to be marked in order to comply with the Merchandise Marks Act, for there would be a breach of that statute if they were marked "Made in London," when, in fact, they were manufactured abroad. In order to conform to the law the words "Made in Germany" were stamped upon the completed articles supplied by defendant company. Those instruments embodied certain designs as well as patents, and it was necessary, to preserve the rights of the owner of the designs, to stamp the articles with a registered number. With regard to the 4,000 order, he said the Stolz London Co. went into liquidation, and the guarantee for the payment to the defendant company for the instruments by Mr. Holt became worthless. The result was that defendants having manufactured a good number of those electrophones, stamped "Made in Germany," they had them on their hands unpaid for. The reason payment was not made, which Mr. Hummer gave, was that the articles (between 150 and 200) of the first consignment sent were not in accordance with the Merchandise Marks Act as regarded the mark applied to them. Mr. Bodkin produced an electrophone in court, and on the top of the transmitter he pointed, out there was a sort of metal loop, adapted to hook on to the coat of a person using the instrument. This was screwed to the back of the instrument to prevent any meddling and putting the instrument out of gear. It was contended on the part of the prosecution that, as that metal hook covered up the words "Made in Germany," that the article was not marked in accordance with the Act. That covering up of the words mentioned was the reason for the refusal to pay for the goods manufactured in that way. On the back of the instrument there was a line which read, "Reg. design No. ——," but the instrument could not be possibly defined, because the registered number had been deliberately defaced, while on those goods supplied by defendants on which the words "Made in Germany" were concealed, the registered number was plainly visible. The Stolz London Co. having gone into liquidation, and the order for the manufacture of those instruments having come to an end, Mr. Hummer eventually discovered that defendants were selling electrophones, and in order to ascertain what sort of instrument it was that they were selling, Mr. Peters, clerk in the office of the solicitors prosecuting, purchased one. On the front the name of Stolz was omitted, on the back a metal hook covered up the words "Made in Germany," and the number had been defaced. Upon examination, Mr. Hummer found that the instrument was exactly similar to his own patent, and accordingly the present proceedings were brought. In November last defendant company sent out a circular headed "The British Thomson-Houston Electrophone," and represented to the public that they had produced a reliable instrument with all the latest improvements. It did not convey, said Mr. Bodkin, that those goods were the subject of another person's patent. It was suggested that the company, in order not to suffer a bad debt, had adapted that registered design and patent as their own, and had advertised the sale of the instrument as if they were the owners. On the part of the instrument purchased appeared the description British Thomson-Houston Co. as the manufacturers.

Evidence in support of the statements was given by Mr. J. C. Hummer, and the further hearing was adjourned.

Dundee Tramway Arbitration.

The Board of Trade arbitration, Mr. W. A. Casson, C.B., currently conducted at the Caledonian Station Hotel, Dundee, on the question of the amount to be paid by the Dundee Corporation to the Dundee Tramways Company, Limited, in respect of the purchase by the Corporation of the undertaking of the latter company, was resumed on Tuesday last. The Corporation require to be a capital expenditure of £399 to bring it up to a proper state. The whin and granite setts would require to be taken up and re-laid, and the rails placed on a new level on one route, and on the other a portion of new rails would have to be put in and the setts re-laid.

In cross-examination by Mr. T. B. MORISON, K.C. (for the company), Witness said he was not brought up as an engineer, and he had no engineering qualifications. He began tramway work 21 years ago. In Leeds construction cost between £5,000 and £6,000 per mile of single track. He had renewed every portion of the rails in 13 years and some portions twice. If the average cost in Leeds was £6,000 per mile, he would be surprised that the average cost in Dundee was £2,000 more. He estimated the life of the granite setts on the first portion of the line at a little more than half their original life; on the second portion the setts were practically as good as when put in. He did not agree that 10 per cent. was a fair estimate of depreciation. His valuations were made on the basis that the line was in an exceptionally bad condition. He would be astonished if Dundee Corporation did not have to renew the rails in three years. He did not think there would be much difference in the cost of constructing a tramway between 1914 and 1905. His estimate of a fair price to pay for the two portions of the tramway, including £640, which was the agreed price for the overhead equipment, was £5,281. 18s. 4d. That did not include Craigie-avenue.

Mr. PETER FISHER, tramways manager, Dundee, said that in regard to the life of rails, six years ago Blackburn made inquiries on the point. He was furnished with the tabulated result of the experience of the different tramway managers, and in no case was there a longer life than 20 years. In the light of six years' more experience, most of the managers had lessened the period, and only in one case had it been increased—by two years. 20 years would be a very generous allowance for the life of the rails on the section in dispute. There was no doubt that the condition of the rails was due to the high speed of the cars. His valuation of the first portion was £2,246. 0s. 2d., of the second portion £2,843. 14s., the electrical equipment (agreed on) £640, and the making up of Craigie-avenue (accepting the City Engineer's valuation) £1,407. 14s. 7d.—a total valuation of £7,127. 8s. 9d.

In cross-examination he said the cost of constructing about the same length of double line on the Downfield route was £9,044, but that line was exceptionally well laid.

Mr. W. H. BLYTH MARTIN, town clerk of Dundee, said he had gone into the question of a fair sum to be attributed to the cost of obtaining Parliamentary powers for the mile of tramway in dispute and he considered the figure of Mr. Balfour (over £3,400) altogether excessive. His estimate of the amount that might be allocated to the cost of promoting the order for the mile in question was £350.

The city engineer (Mr. Jas. Thomson), the cleansing superintendent (Mr. J. Duncan) and others gave evidence that the line in question was in poor condition.

After hearing counsel the Arbitrator announced that on the disputed question of interest he should not allow it on the price he was to put on the subjects from August, 1914. He might decide that it should be paid from the date of the award until the date of payment. The parties then agreed that the company would waive any claim for interest, and the Corporation any claim to call upon the company to account for earnings since August, 1914. The award will be issued in due course.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstracts from the specifications recently published have been specially compiled by Messrs. MARKS & CLERK, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

Wherever the subscription date is given it is the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

application, 20,274 14.)

control electrical contacts.

7,298 BENJAMIN. Electric lamp sockets. (11.4.13.)

11,116 TORCHIO. Electrical reactance coils.

and bottom headers, blocks adjacent to each of said headers, having inward extension first-named blocks, and bolts extending through said headers, blocks and spacing blocks.

11,399 CROMPTON & CO. & PENSARENE. Dynamo-electric machines.

A self-regulating direct-current dynamo, in which the brushes are placed at an angle between 60 deg. and 70 deg. from the neutral position with reference to the

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AN INDUSTRIAL HEATING ASSOCIATION.

In our issue of April 30 we described an instructive installation in which electric motors were introduced as the result of a gas engine breakdown, the factory involved being one engaged upon war material of an important nature. The employment of electric motors for driving the works evidently brought more nearly home to the management the fact that the same electric service which furnished light and power to the factory could also be utilised in displacing a number of gas-heated appliances which formed an essential portion of the factory equipment. After a number of experiments, the economy, efficiency and expediency of electric heating were established, and the machinery is now in process of conversion from gas to electrically-heated dies.

Quite apart from the greater economy and cleanliness of the electrical method, the management were abundantly persuaded of its commercial value on hygienic grounds. An extended experience of gas-heated appliances had kept them constantly anxious regarding the health of the employés, whose business it was to work directly over the fumes emitted by the open gas burners, which had of necessity to be used. The foremen were always in doubt as to what number of girls would turn up to work in the morning, a state of things which is not surprising having regard to the depressing influence and general debilitating effect of gas fumes in a workshop.

In commenting editorially upon the wide field of development which is awaiting the electrical industry in this respect, we suggested that electrical manufacturers should take up the matter upon progressive lines and proceed with the conversion of the innumerable pieces of industrial apparatus in which gas is now employed for heating purposes and with which electrical energy can be entrusted. By comparison with the work which British electric heating engineers have accomplished the achievements of the American electrical men in this field have "nothing to write home about," yet it is significant that they already realise the importance of taking immediate steps to "get together" on the industrial heating proposition. We read with interest of the birth of a new Association, the Industrial Electric Heating Association, and we note that our contemporaries on the other side of the water have heralded this event as one of prime importance to the future of the electric heating business. It appears that in the city of Toledo, in which the present moving spirits in the Association reside, a number of industrial heating installations have been put down. The aims of the organisation are summed up in the following remarks, which are taken from its constitution: "Recognising the opening of a new and heretofore undeveloped field in the electrical industry, the importance of which, and the possibilities for the development of which, are so great and the present knowledge so small, it seems imperative that an organisation should be perfected to study and gather together all the available information on this great subject for the benefit of its members and of the industry at large and for the exchange of ideas and data."

We think this progressive attitude of American electrical men towards the problems of industrial electric heating should give the cue to those electrical manufacturers in this country who have specialised in electric heating and cooking appliances, but have not yet turned their attention to the many applications for electric heating in the industrial field. There is probably no need to form an independent association, because the time is hardly ripe for that, but it is not too soon for the subject to be studied by electric heating engineers, and for data and information to be exchanged and collected. A committee, or a sub-committee, of the B.E.A.M.A. would answer the purpose in the initial stages until such time as the movement became sufficiently strong to admit of the formation of an independent organisation. In any case, the method adopted is of no particular importance; what we would like to see is an organised effort made to remove gas from an industrial sphere in which its employment is both uneconomical and deleterious to the health of factory workers.

F

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

[illegible] May 25, 1915, to May 29, 1915.

In view of the increased interest which is being taken in the subject of the importation and the exportation of Electrical Manufactures, from the Board of Trade returns, we reproduce our weekly lists. [illegible] to Articles of Exports.

IMPORTS.

[illegible]

elec. lamps, £477; lamp parts, £11; telephone materials, £2,695; unenumerated, £2,502. [illegible] lamps, £808—17 pkgs.; lamp parts, £135; elec. machinery, £99. *Sweden:* Lamp parts, £390; telephone material, £212—15 pkgs. *France:* Elec. lamps, £340; elec. machinery £149; lamp parts, £330; unenumerated, £29—4 pkgs. *Italy:* Elec. wire, 32 pkgs. *Spain:* Telephone materials, £26; wire and cable, £194; unenumerated, £1,803.

[illegible]

MANCHESTER.—*U.S.A.:* Elec. fans, 10 pkgs.; unenumerated, 48 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Elec. machinery, £315; unenumerated, £246. *Melbourne:* Elec. machinery, £609; wire and cable, £450; unenumerated, £633. *Sydney:* Wire and cable, £2,853; unenumerated, £612. *Wellington:* Wire and cable, £1,208; unenumerated, £939. *Adelaide:* Machinery, £264; unenumerated, £96. *Brisbane:* Unenumerated, £285. *Fremantle:* Unenumerated, £69. *Dunedin:* Elec. machinery, £135; unenumerated, £344. *Christchurch:* Elec. machinery, £163; unenumerated, £24. *Hobart:* Wire and cable, £100; unenumerated, £27. *Lyttelton:* Elec. machinery, £147; unenumerated, £309. *Nelson:* Telegraph material, £600. *Perth:* Wire and cable, £101; unenumerated, £136.

AFRICA.—*Durban:* Wire and cable, £426; unenumerated, £293. *Port Elizabeth:* Wire and cable, £128; unenumerated, £182. *Cape Town:* Unenumerated, £59. *East London:* Elec. machinery, £30. *Delagoa Bay:* Wire and cable, £31. *Port Said:* Wire and cable, [illegible]

SPAIN.—*Cartagena:* Unenumerated, £39. *Huelvas:* Unenumerated, £25. *Savanilla:* Unenumerated, £154.

CHINA.—*Hongkong:* Unenumerated, £14. *Shanghai:* Wire and cable, £194; unenumerated, £129. *Tientsin:* Unenumerated, £58.

INDIA, CEYLON AND INDO-CHINA.—*Bombay:* Elec. machinery, £135; wire and cable, £310; unenumerated, £526. *Calcutta:* Wire and cable, £245; unenumerated, £592. *Colombo:* Unenumerated, £110. *Madras:* Elec. machinery, £293; wire and cable, £529; unenumerated, £233. *Karachi:* Unenumerated, £17. *Singapore:* Elec. machinery, £210; unenumerated, £109. *Bankok:* Unenumerated, £29. *Port Swettenham:* Elec. machinery, £99. *Penang:* Elec. machinery, £122; unenumerated, £62.

CANADA.—*Montreal:* Unenumerated, £22. *Toronto:* Unenumerated, £43.

FRANCE.—*Dieppe:* Machinery, £228; unenumerated, £70. *Boulogne:* Unenumerated, £90. *Paris:* Elec. machinery, £761; unenumerated, £302. *Havre:* Wire and cable, £267. *Nantes:* Elec. machinery, £150. *Treport:* Unenumerated, £11.

[illegible]

Elec. motor, £109.

WEST INDIES.—*Trinidad:* Elec. machinery, £17.

HOLLAND.—*Amsterdam:* Wire and cable, £167.

DENMARK.—*Copenhagen:* Unenumerated, £89.

U.S.A.—*New York:* Unenumerated, £316.

JAPAN.—*Kobe:* Unenumerated, £12. *Yokohama:* Unenumerated, £196.

SWEDEN.—*Stockholm:* Unenumerated, £57.

[illegible]

FOREIGN GOODS (duty paid and free).

Sydney: Unenumerated, £300. *Dieppe:* Unenumerated, £30. *Yokohama:* Unenumerated, telegraph material, £70. *Karachi:* Unenumerated, £30. *Kobe:* Unenumerated, £47. *New York:* Unenumerated, £100. *Rouen:* Unenumerated, £106 *Shanghai:* Unenumerated, £30.

NOTE.—The large number of items in these official returns under the [illegible] unenumerated relate to what is described as electrical goods and electrical materials.

BUSINESS NOTICES.

Messrs. Adcock Bros. have acquired the Longton business of Messrs. Newton Bros., electrical engineers, of Derby, and they have also purchased the business of the Baywood Accumulator Co. The new telephone number is 179 Longton.

Increase of Prices.—Messrs. A. P. Lundberg & Sons, electrical [illegible] manufacturers, of 177-189, Liverpool-road, London, N., [illegible] that in consequence of further increases in the cost of labour and material, on all orders received on and after May 24 the net amount [illegible] accepted will be subject to an increase of 15 per cent. until further notice, instead of 5 per cent. as hitherto.

On account of the increase in the price of indian dyes Messrs. Siemens Bros. Dynamo Works (1914), Ltd., have found it necessary to advance the price of bamboo shades [illegible] to 20 per cent.

The [illegible] are so well known to the trade as they were exceptionally well, do not "flake" under the heating effect of the lamp, and are not affected by atmospheric conditions. The price of Siemens' [illegible] 20 per cent.

[illegible] Messrs. Siemens Bros. Dynamo Works (1914), Ltd., have decided to advance the list price of lighting [illegible] 12½ per cent. as from the 1st inst.

Plant for Sale. The Austin Motor Co. (1904) (Ltd.), Northfield, [illegible] electrical plant, including [illegible] engine and 50 k.w. dynamo, 20 h.p. motors, 5 h.p. motor-driven electroplating set, motor-generator battery charging set, &c.

Patent Development.—The proprietor of patent No. 15,951 of 1913 for "Improvements in safety devices for electric conductors," desires to make arrangements for exploiting same in this country. Particulars from Messrs. Hood Bros., Ltd., patent agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

Application for Restoration of Patent.—Augustus Chas. Hyde and the Vactite Wire Co. (Ltd.) have applied for the restoration of the patent (No. 17,817/07, and dated Aug. 6, 1907) granted to Augustus Chas. Hyde for "Improvements in [illegible] electrical conducting joints in metallic filament incandescent lamps." Notices of opposition on Patents form 16 to the Patent Office, Southampton-buildings, London, W.C., by July 27.

BANKRUPTCY.

A supplemental dividend of 7½d. is payable at 12, Duke-street, Bradford, to creditors of Cecil Wray, mechanical and electrical engineer, formerly trading at 24, Simes-street, Bradford.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barnsley.—The Corporation have decided to apply for sanction to a loan of £21,850 for extensions of the electricity undertaking.

Burton-on-Trent.—The Electric Supply Committee are extending the supply mains to Messrs. Ind, Coope & Co.'s bottling stores.

Derby.—The Corporation have been authorised to borrow £25,090 for extensions of the electric supply undertaking.

On Wednesday the Corporation adopted a recommendation of the Electric Lighting Committee to increase the present charges for electricity by 10 per cent. on account of the increased cost of coal, &c., and to avoid a loss on the working of the undertaking. The additional revenue will not wholly cover the higher expenditure.

Edinburgh. Last week the Council were recommended by the Electric Lighting Committee to accept the tender of the Stirling Boiler Co. for water-tube boilers for the new Portobello power station at £32,286. Though the Convener of the Committee (Mr. Stevenson) explained that if Government work intervened, the Council's offer would have to stand aside, it was decided to ask the Committee to take back the recommendation.

Gloucester.—Last week the Electricity and Light Railways Committee reported that the Gloucester Railway Carriage & Wagon Co., who took a supply of electricity for certain purposes, had applied for a supply to a new wing of their works.

The extension was directly connected with work in hand and anticipated for munitions of war, but it was expected that the supply would afterwards be required for plant regularly used. The cost of laying the necessary mains, &c., was estimated at £1,500, which was much in excess of the amount authorised to be borrowed for mains. As the matter was urgent, for the company want to have power by August or September next, the Town Clerk had written to the L.G. Board explaining the facts, and had received a telegram stating that the Board agreed to the main being laid. It was resolved to refer the matter to a sub-committee, with power to authorise the Sealing of a contract and to make other necessary arrangements.

Hornsey.—The L.G. Board have intimated that they will raise no objection to the Council proceeding with certain portions of the proposed expenditure out of loans already taken up for the electricity sub-station at Fortis Green, the laying of cables and ducts and the provision of plant and on mains, meter and house services, the taking up of further loans to be duly sanctioned and the necessary adjustments to be made when all the conditions have been acted on. £1,338 will be a debit for further expenditure on mains and house services.

Hounslow. The Heston and Isleworth electric supply undertaking are laying a new feeder to the Sutton-road.

Southampton.—In reply to the Council's application for sanction to borrow £8,400 and £6,000 respectively for [illegible] the L.G. Board has intimated that they are prepared to sanction the loans, subject to the usual conditions as to repayment, &c.

West Bromwich. The L.G. Board have sanctioned the borrowing of £3,300 for mains and £3,000 for new boiler, pipe-work, feed pumps, transformer, switchgear, transformer and cable connections.

Application is to be made to the Board for leave to put up another cyclone main in order to give a larger supply of current to Messrs. J. Brockhouse & Co.

GENERAL.

Aberdeen.—At the meeting of the [illegible] last week it was reported that the number of units [illegible] month showed an increase of 40,000 over the corresponding month of 1914.

The city electrical engineer (Mr. J. Alex. Ball) [illegible] to the annual conference in London of the Incorporated Municipal Electrical Association.

Of the employés of military age in the electricity supply department 31 men (or 51 per cent. of the total) have joined the colours. Two others were rejected on medical grounds.

Ballater.—At a recent meeting of the County Council [illegible] to Darroch's Electricity Supply Co. [illegible] a supply of electricity to premises in Ballater.

Bath.—At the meeting of the Corporation on Tuesday the electric lighting committee's recommendation to carry out certain repair work to the Diesel engine at an estimated cost of £150 was adopted.

Buxton.—The Council have recently revised and increased their charges for electric current for lighting and power.

Cahirciveen (co. Kerry).—It has been decided to form a local company to establish electricity supply works, and at a recent public meeting Messrs. T. B. Morley, M. J. Healy, T. C. Fitzgerald, P. J. Reardon and J. Brennan were appointed to be local directors of the new company.

Ely.—The Board of Trade have refused the application of the Ely Gas & Electricity Co. for a provisional electric lighting order for the district.

Glasgow.—As from 1st inst., Mr. James Fleming, treasurer to the gas and the electricity departments of the Corporation, is retiring, and the Corporation have agreed that in future the finances of the two departments concerned shall be handed over to the control of the respective managers, Mr. W. W. Lackie, chief engineer and manager of the electricity department, and Mr. Alexr. Wilson, engineer and manager of the gas department. This rearrangement will put the electricity and gas departments of the Corporation on the same self-contained footing as the Glasgow tramways department is.

Great Yarmouth.—At the recent meeting of the Council it was announced that a rebate of £330 had been made off the public lighting account.

It was reported that an arrangement had been entered into provisionally by the chairmen of the Electricity and General Purposes Committees by which the Council were to pay 60 per cent. of the usual charges in order to cover capital charges. Whether or not they used any light, they were to pay 60 per cent., and this caused some discussion. A motion to refer the matter back was agreed to.

Haslingden.—The Electricity Committee will employ female assistants for clerical work in the electricity offices on account of enlistments.

Hawarden.—[illegible] Company [illegible] held at Queen's Ferry [illegible] the application of the District Council for sanction to a loan for electricity supply works.

Mr. H. Goodman Roberts, clerk to the District Council, said that his Council had applied to the L.G. Board for sanction to borrow money for the electric lighting of the districts of Hawarden and West Saltney. In 1912 a local Act was obtained to supply electricity for the Hawarden district, but it was decided that the lighting should be by the rural district authorities. West Saltney Parish Council pressed Hawarden District Council to go on with the scheme, and the latter Council had included a portion of Hawarden parish (Shotton Ward) in their order. The clerk to Hawarden Parish Council had written to say his Council did not wish the [illegible] to be supplied with [illegible] The proposed lighting area included the whole of the parish of West Saltney, which was in the compulsory area. When the plans were deposited in October and November 1913 [illegible] from the parish Hawarden [illegible] Hawarden representatives [illegible] opposed by Mr. J. W. Squire, representing [illegible] the ratepayers of Hawarden [illegible] Queen's Ferry [illegible] area, and several had taken gas for their houses and shops. The contract [illegible] Mr. J. W. Squire supplied [illegible] The District Council had accepted the tender of Sandycroft (Ltd.) for the whole scheme, at £5,740, and had placed the order on condition that the L.G. Board would grant the loan. At present there was no public [illegible] Queen's Ferry, Penyffordd or Saltney [illegible] Saltney [illegible] the Council [illegible] the Council [illegible] the Council [illegible] the Council [illegible] which was [illegible] price of gas was 3s. 11d. For power, heating and cooking, the price would be 2d. to 1½d. per unit.

After hearing evidence in favour of the scheme, Mr. T. H. Haswell, clerk to Hawarden Parish Council, objected to Shotton being included in the scheme. Mr. T. Pennington, secretary to Connah's Quay Gas Co., also opposed.

Increase of Electricity Supply Charges.—The Associated Municipal Electrical Engineers' Executive Committee has issued a circular letter to the town clerks and the managers of electricity undertakings of local authorities affiliated. In this letter the hon. secretary (Mr. E. Calvert, of Finchley), writes as follows:—

I am instructed to inform you that the Association have carefully considered the present increased cost of producing electricity owing to the abnormally high price of coal, the allowances to men serving with the King's Forces and for other reasons attributable to the European conflict, and to advise that the Association is of opinion that, wherever possible, the selling price should not be increased, but where an increase of price is imperative such increase should be at the rate of 10 per cent.

London Electricity Supply.—At the recent conference between representatives of the London County Council and of the Metropolitan Borough Councils, a resolution was passed urging the London County Council not to promote any Bill without first consulting those authorities owning undertakings, and also private companies.

A second resolution was passed, with which the London County Council agreed, that a committee should be formed composed of representatives of each section, to confer with the County Council on the matter.

Salford.—On Wednesday the Council were recommended by the Electricity Committee to sanction an increase in the charges for electric current for lighting and power, by 7½ per cent. as from July 1 next. Consumers with special agreement, such as the tramways department, will not be affected. The recommendation was adopted without discussion.

Stoke-on-Trent.—At the meeting of the Corporation last week it was resolved that no member of the Council be competent to sit on a committee under which a relative is employed.

A discussion also took place on the reading of electricity meters, and the chairman of the Electricity Committee (Ald. H. Leese) stated that mistakes had been made in the reading of the meters of three large firms to the total amount of about £1,000. The meters, which were of a complicated type, had been read by five different readers before the mistakes were found out and rectified, and the firms concerned had agreed to pay the differences in their accounts. There would be no loss to the ratepayers except a certain amount of interest on the money outstanding, but a firm which owed over £600 due to the incorrect reading would not pay its final instalment until March 1, 1918.

Tunbridge Wells.—The Board of Trade have granted the application of the Corporation for [illegible] extension provisional order [illegible] supply [illegible] to the urban district of Southborough and parts of the parishes of Bidborough, [illegible] Tonbridge.

Walthamstow.—As from the June quarter the prices of electric current for private and public lighting and for power and heating will be increased by 15 per cent.

The electrical engineer (Mr. G. R. Spurr) is to negotiate with consumers who have period contracts, with a view to their paying the increased price without prejudice to the terms of the contract.

Wharfedale (Yorks).—A recent conference of representatives of local authorities in the Wharfedale district was held to consider the question recently introduced by Guiseley Council of a combination of townships for the supply of electricity in the area.

Representatives were present from Rawdon, Yeadon, Guiseley, Burley and Otley Urban District Councils and Wharfedale Rural District Council. Dr. R. Muschamp, of Guiseley, who presided, moved a resolution that, in the opinion of the conference, the generation of electricity [illegible] the several local authorities concerned would be advantageous to the communities concerned. This was seconded and passed. A committee, consisting of one representative from each authority, was formed for obtaining detailed information as to the cost of purchasing energy in bulk from every available company or Corporation in the locality; also as to the best means and the expense of obtaining a pro-[illegible]

Ystradgynlais (Glam.).—The Council's application for a provisional [illegible] the war was over, but it was explained that the board would not allow [illegible]

LIGHTING, POWER & HEATING NOTES.

Bolton. Owing to the increased cost of generation, due to the price of fuel, the charge for current for lighting has been raised from 3 d. to 3½d. per unit, and the charge for power will also be increased by about 10 per cent.

Bournemouth.—The Bournemouth, Poole & District Electricity Supply Co. is in the fortunate position of being able to make a reduction of ½d. per unit in the charge for electric current for private lighting.

Electricity in Mining. The Ulleco Mining Co., of Whitehaven, have decided upon an electrification scheme for their No. 7 pit.

The plant will consist of a 200 kw. combined engine and generator and a 50 kw. stand-by unit. Current will be supplied from the plant to an endless rope haulage gear and compressors in the No. 7 pit and also to underground haulage gears and pumps and the workshops at Nos. 1 and 2 pits of the company. The work, which is now in hand, is being carried out to the specification and under the direction of Messrs. W. C. & K. A. Mountain, consulting engineers.

Nuneaton.—The electrical engineer (Mr. S. C. Gibson) has been authorised to purchase suitable apparatus in connection with a scheme for the supply of electric cooking appliances.

York. At last week's meeting of the Corporation Education Committee, Councillor Hargrave, in submitting the report of the Sites Sub-committee, said that careful consideration had been given to the suggestion that electrical appliances should be installed for the teaching of domestic subjects at the Knavesmire Council school instead of gas. Various figures and opinions were weighed by the sub-committee, which decided not to adopt electrical appliances at present.

Ald. MEYER said there had been great development in the use of electricity in working class houses. He thought it was rather a retrograde step to equip a school of that kind with gas only. There was no doubt the time was coming when the working class would demand the supply of electricity. He moved that the matter be referred back to enable the members to inspect the working class houses of the Corporation which were supplied with electricity.

The amendment was rejected by 7 votes to 6.

TRACTION NOTES.

Glasgow. Last week the Corporation approved the Tramway Committee's recommendation to reduce the amount to be set aside for depreciation for the next year.

The CONVENER (Mr. Kirkland) said that owing to the abnormal conditions at present it was estimated that they would have a deficiency for the year of £31,000. The Committee took up the question of depreciation and came to the conclusion that they could with perfect safety recommend that on various items the allowances be reduced. The amount of depreciation per mile of permanent way was formerly £500. In the year to May, 1914, it was £440, and now they recommended that the amount should be £350. Outside the city there was less tear and wear on the lines, and consequently less depreciation and the Committee were of opinion that in making the reduction they were still setting aside a sufficient sum. On the electrical equipment there was to be a reduction from 4·3 per cent. to 2·9 per cent., and there were also some other slight reductions. The result was that there would be a saving of something like £40,000, which after meeting the estimated deficit would bring out a surplus of £10,000.

Mr KYLE moved an amendment that the depreciation be the same as that for the year ended May 31, 1914. He said it was quite clear that the department was going to have a deficit if they struck the balance on the lines that had been adopted for several years past. The cause of that was mismanagement, which existed in the Council as a whole thinking that there could be no end to the profits of the tramways department and persistently milking it. He objected on principle to the present depreciation proposals, because if the Council adopted them they would simply be bringing in a false balance-sheet and "cooking" the books.

Further amendments to remit back the minutes to the Tramways Sub-committee on Finance for further consideration and to vary the proposed rate of depreciation were rejected and ultimately the original minutes were adopted.

L.C.C. Tramways. Recently a deputation from Fernhead [illegible] (London) Borough Council was informed by the County Council that, [illegible] ready to extend the electrification of the tramway [illegible] Park road, the Treasury would not grant [illegible]. The Borough Council have sent a letter of protest to the Treasury urging that the money be granted.

[illegible] the London County Council case be found to be over, as the [illegible] have returned to work and the service is gradually improving. It is stated that about 3,000 men of military age have not been permitted to resume work, but special circumstances which have prevented men of military age from enlisting are being considered.

Metropolitan Railway.—A new double track line between Finchley-road (London) and Wembley Park has recently been completed and opened for traffic. Automatic signalling has been installed throughout the new section.

Southampton.—In view of the successful operation of the electric van which was put into service recently, the Electricity Committee have decided to exercise an option on an additional chassis.

At the outbreak of war the Government commandeered the 500 kw. rotary converter on order from the British Thomson-Houston Co., but as the tramcar service has since been increased the tramcars are now supplied with current from the 1,000 kw. sets (the smaller sets being used for lighting, and it has been decided to order a 750 kw. set for tramway supply at £1,909. The L.G. Board have been asked to sanction the borrowing of this sum.

Women Tramcar Conductors.—At the last meeting of Newcastle-on-Tyne Tramways Committee it was announced that 4[illegible] women conductors had been trained, and 24 were now in full charge of cars on the Osborne-road route, and the rest were in training on the Jesmond route.

It was reported that the employment of women had been an unqualified success and had surprised all anticipations. Applications are being invited for further women conductors. The Committee decided to abolish ½d. workmen's fares, the minimum in future to be 1d.

At Salford 15 women conductors started work on Monday on two routes.

Women conductors are also to be employed on the less frequented routes of Coventry municipal tramways, and on the Blackpool, Greenock and Preston tramways.

Glasgow Corporation tramways department now employs 250 women conductors, and it is intended to increase the number to 500. Over 1,400 applications for employment have been received.

York.—The contractors for the construction of the Hull-road tramway (Messrs. Pearce & Co.) hope to commence the work at an early date. The Haxby-road extension will also be constructed as soon as possible.

EMPIRE NOTES.

Canada.—The report of the telephone department of the Province of Alberta states that the growth of the rural line system is satisfactory as over 9,000 farmers are connected.

The total capital expenditure is about $8,500,000 and the revenue for 1914 was $991,616. The Government owns and operates 165 exchanges, with 27,514 subscribers' stations—18,192 exchange telephones and 9,322 rural telephones. Continuous service is given at 37 exchanges. On the long-distance lines there are 16,112 miles of wire, and on the rural lines 27,722 miles of wire. 550 towns, villages and communities are served by the system. During the year the long-distance system was linked up with the Saskatchewan Government system, and an interchange system inaugurated, covering the territory from Edmonton to Saskatoon, and Calgary to Regina. The inter provincial service now extends to 22 points in Saskatchewan and 35 points in British Columbia.

Newfoundland.—A new company has been formed at St. John's with a capital of $21,000,000 to establish at Bay of Islands a lumber industry, and industries for the manufacture of ammonium phosphate ammonia, cement and wood pulp.

The proposed expenditure includes construction of dams, power houses, water wheels, electrical equipment, &c., $6,440,300; coke and gas works, $799,000; calcium carbide works, $462,800; saw mills, $211,800; sulphite pulp mills, electrolytic bleaching plants, &c., $1,568,000; machine shops, iron and brass foundries, &c., $161,400; construction of docks and retaining walls, $270,600; installation of coal and material handling equipment, $692,000; railway works and equipment, $453,000; phosphoric acid plant, $900,000; and ammonia plant, $450,000.

South Africa.—According to the "South African Mining Journal" a good business is being done in the Transvaal in electric motors though prices have gone up from 20 to 25 per cent.

Before the war a Dutch electric lamp came into this market at a cutting price, and the Americans quickly brought down their lamps to the same price. These countries have had the run of the market, although the British standard lamps have pretty well held their own, and might have done better but for the pressure on British factories to supply munitions and lamps for home consumption. There is quite a shortage in lamp-holders (ceiling roses), also all electrical goods are rather scarce.

FOREIGN NOTES.

Algeria.—A report on the trade of Al[illegible] to 1913 [illegible] that imports of electrical machinery were valu[illegible] 3,457,000 fr. (against 1,531,000 fr. in 1912) and of other machin[illegible] 33,254,000 fr. (against 12,230,000 fr.) and parts (electrical and other) 7,510,000 fr. (7,725,000 fr.); electric and other meters 1,526,000 fr. (1,674,000 fr.)

The value of the trade between Algeria and [illegible] and Austro-Hungarian Empires amounted to £1,279,160, including exports to Germany £546,640, and imports from Germany £298,900, the balance being almost equally divided between imports from and exports to Austria-Hungary. Local traders state that they would prefer to buy British goods although higher in price, but unless British exporters carry out customer's requests neither the entente cordiale nor the war, nor any other influence will sell British goods. Correspondence must be in French, and invoices must be in French and fully detailed. Catalogues in English go straight to the wastepaper basket. Catalogues in French which serve for Algeria will, of course, also serve for France and other French Colonies. Prices must include customs duty, and must be in francs, while weights and measures must be metric. German packing is exemplary, especially in the case of electric lamp shades and similar fragile objects. An importer says he has found from 30 to 40 per cent. of breakages in consignments from Gt. Britain while similar goods from Germany have only 1 or 2 per cent. of breakages. The Germans have excellent arrangements for pushing their goods, especially by sending out keen travellers. Although more machinery is imported from the United Kingdom than from Germany, engines, printing and paper trades' and agricultural machinery, various machines for mills and factories, sewing machines, typewriters, calculating machines, &c., are received from Germany, and there is also a fair sale for German electrical machinery.

Argentina. By decree of the National Government, [illegible] in the new Port of Buenos Aires construction contract providing for the erection of an electric power house for $30,700 and corresponding machinery ($153,240) by the contractors, Messrs. C. H. Walker & Co. has been annulled.

A decree dated April 7 authorises Dr. M. Bonet, concessionaire of a telephone service in the National Territories of Neuquen and Rio Negro under a decree of March 4, 1912, to extend the system by a line connecting Roca and Choele-Choel, installing a central exchange at the latter point, with connections to the island of the same name and to adjacent colonies.

Colombia.—Imports of electrical goods to Colombia in 1912 were valued at $175,639 (compared with $100,090 in 1911), including $22,889 ($10,307) from the United Kingdom, $110,522 ($50,398) from the U.S.A., $29,720 ($29,818) from Germany and $1,795 ($3,739) from France.

A consular report from Antioquia states that a contract for a new telephone service for the town has been placed in the United States. The town is lighted electrically by a native company.

The construction of an important ropeway from Manizales to Mariquita has been undertaken by the Dorada Railway (Ropeway Extension), Ltd., which is practically subsidiary to the railway company. The contract for the construction was given to a British firm, and the work is expected to be completed by the end of this year. The length of the line will be 73·35 km. (about 45½ miles). There will be from six to eight motor stations on the line and these will receive power from a generating station near the junction of the Sucio and Guali Rivers. The present station is designed for 1,200 H.P., but provision is being made for an increase of 800 H.P. The object of the ropeway is to act as a feeder to the railway.

The same British company has contracted for the supply of plans for the improvement of the port of Cartagena. Estimates are to be prepared for the provision of luminous or bell-buoys for the port and channel; for electric power for lighting purposes and for working the cranes on the wharf; and for a service of signals and telephones.

Cuba. Permission has been granted to the following persons to instal electric power and lighting plant in Cuba: Señor W. S. Cifuentes (at San José de los Ramos), Señor [illegible] (at Nueva Gerona), Señor Rodriguez (at Florida) and Señor [illegible] y Hno. (at Florida).

Hydro-Electric Works in Sweden.—In an article in the year book of the Swedish Chamber of Commerce, compiled from Mr. W. Borgquist's Paper on "The Utilisation of Water Power in Sweden," and Mr. Mauritz Serrander's pamphlet on "Water Power Elections in Sweden during 1914," it is stated that the [illegible] power used in Sweden is obtained from waterfalls.

Water power in 1912 was estimated at 60 [illegible] total effective power, but as water power is used, [illegible] a longer period than steam power the actual estimate may be put at 80 per cent. It is only during the last 10 or 15 years that water power has been brought into use, and electro-chemical and electro-thermo industries are practically dependent upon water power. Among the [illegible] power stations are the South Swedish Water Power Co. (27,000 H.P.), Hensjo Water Power Co. (10,280 H.P.), Ytterselet Water Power Co. (16,250 H.P.), Trollhättan Water Power Works (State owned) 80,000 H.P.), Gullspang Munkfors Water Power [illegible] Gullmedahytte Co. (6,750 H.P.), Virsbo-Ramnäs Water Power Co. (3,045 H.P.), Untra Water Power Works (under construction) [illegible] Stockholm) (42,000 H.P.), Alfkarleby Water Power [illegible] under construction) (45,000 H.P.), Horndals Ironworks Co. (8,000 H.P.), West Dal River Water Power Co. (19,200 H.P.), Graningeverkens Co. (9,150 H.P.), Klabböle (4,525 H.P.), Finnforsen (9,400 H.P.), Sikfors (5,000 H.P.), Porjus Water Power Works (State owned) (50,000 H.P.). Amongst the largest water power plants erected exclusively for industrial use are the following: Uddeholms Co. (Vermland Province) (35,000 H.P.), Stora Kopparbergs Bergslags Co. (Dalecarlia River) (50,000 H.P.), Stockholms Superfosfat Co. (Ljungan River, and at Mansbo) (30,000 H.P.), Alby Waterfalls Co. (Ringdalsforsen River, and at Alby) (15,000 H.P.). At the end of 1912 waterfalls were harnessed to the extent of 700,000 H.P., which increased by the end of 1914 to 760,000 H.P. When the large plant at Porjus (Lapland) and Alfkarleby (north of Stockholm) have been completed the total will reach about 900,000 H.P. The water power obtainable in Sweden is estimated at 6,000,000 H.P. About 2,500,000 H.P. can be obtained from falls in Northern Sweden, which is, however, sparsely populated. Mr. Borgquist points out that, owing to the rapid improvements in steam turbines and oil motors, erections of water-power plant are being retarded. On Oct. 17, 1914, the first turbine was started at the Porjus station, and on Nov. 5 the first electric locomotive ran through the Lapland fields. On Nov. 7, a fully loaded iron ore train was driven by electricity with power from the Porjus station. The Alfkarleby works are rapidly approaching completion, about 850 men being employed. As regards Trollhättan, on the Göta River, the Swedish Riksdag decided last year that additional plant should be installed for utilising 30,000 H.P. to 40,000 H.P. The two previous installations utilise 80,000 H.P. A table is reprinted from a Paper read before the Canadian Society of Civil Engineers, by Mr. A. Surveyer, showing the extent to which the world's water power is being utilised. It is stated that the figures for Sweden are not up to date. The figures are: Germany, 445,000 H.P. developed (31·2 per cent. of the available power); Switzerland, 380,000 H.P. (25 per cent.); Sweden, 760,000 H.P. (12·6 per cent.); Norway, 920,000 H.P. (12·3 per cent.); France, 650,000 H.P. (11·1 per cent.); Italy, 565,000 H.P. (10·2 per cent.); Great Britain, 80,000 H.P. (8·3 per cent.); Austria-Hungary, 515,000 H.P. (8 per cent.); Spain, 300,000 H.P. (6 per cent.); total, 4,615,000 H.P. (11·4 per cent.). According to Mr. Surveyer, the percentage of utilised water power in the United States is 7·49, and in Canada 8·2; but the details of conditions in Canada were based on 1911 statistics. The large development at Cedars raised the figures for Quebec to over 500,000 developed horse-power.

Italy.—The following are abstracts from consular reports for 1913:

Mr. Consul J. H. Towsey in his report on the Milan district quotes an article from "Industria Tessile e Tintoria," on the Italian silk industry, in which the author says the looms in 1912 were 18,600. Of these, 14,100 were power looms, and the remainder hand, the total production being valued at 135,145,800 lire. The utilisation of water power, which was made possible by the use of electrical transmission, has but little minimised the state of inferiority of the industry through the lack of coal in Italy. The cost of a kilowatt per year is 340 lire whether supplied by one of the electrical companies in the north of Italy, or produced in Italy by the manufacturer by the use of a steam engine driven by German coal whereas the cost per kilowatt-year produced in Switzerland or Germany by generating plant driven by a steam engine driven with German coal is 270 lire. Assuming an average yearly consumption per loom of 0·25 kw., the cost of loom would be under present conditions in Italy 85 lire and in Switzerland or Germany 67·5 lire. Hence it appears that the only advantage to be gained by the Italian manufacturer who uses hydro-electric power is that of sparing himself the investment of capital required to lay down a steam engine and generating plant. It appears that manufacturers in Northern Switzerland and Germany have a lighter expense in energy of 17 lire 50c. per loom per annum, compared with that of Italian manufacturers. The Consul at Milan also quotes the following particulars from "L'Elettricita" on imports and exports during 1913: Italy bought 2,000 met. tons of electrical machinery, weighing more than a ton, against 2,900 tons in 1912; Germany sent 700 tons less, while the United Kingdom and Switzerland were stationary, whereas Austria-Hungary and other countries sent together about 200 tons less. 1,500 tons of light machinery were imported against 1,800 tons in 1912; Germany sent 200 tons less, whilst other countries maintained their position. 1,300 tons of transformers were imported (decrease of 200 tons); German supplies decreased 400 tons, which Austria-Hungary and other countries gained, while Switzerland's position was unchanged. Italian production of electrical machinery was estimated at 10,000 tons, and there was an increased exportation of 1,000 tons to Argentina and France. Of subsidiary apparatus in 1913 there was an importation of 1,221 tons (against 1,154 in 1912), nearly all from Germany. Electric lamps (except arc lamps, the imports of which diminish steadily) seemed to have reached a fixed level. Italy bought 9,671,300 in 1912, whereof 5,832,700 were from Germany and 2,511,000 from Austria-Hungary. Raw copper wire exceeding [illegible] in. diameter imported was [illegible] 900 tons, against 1,000 tons in 1912. Besides 200 tons of [illegible] plant [illegible] in the previous years, France and Germany being equal suppliers. 500 tons of [illegible] lating wire and cord were imported against 320, three-fifths all from Germany. Only 800 tons of [illegible] were imported against 1,000; Germany, though the largest supplier, lost ground. Exports of wire and cable made in Italy amounted to 904 tons, against 1,156, the United Kingdom, Argentina, Belgium, France and Brazil being Italy's best [illegible] 1,300 tons of [illegible] were imported against 500 tons, carbons for lamps and similar articles, 1,000 tons (against 1,100).

A report from Venice says that there is an opportunity for an extension of British exports of electric light fittings, &c., to that district.

MISCELLANEOUS NOTES.

British Industries Fair.—[illegible] early next year.

City of London Year Book.—We have received from Messrs. W. H. & L. [illegible] 1915 edition of "The City of London Year Book and Civic Directory" which [illegible] information touching the busy life of our great commercial capital which is given in this admirable work of reference is of the fullest and [illegible] and Livery of each Guild, but of the whole of the Livery voters of the City of London, are included. An interesting feature consists of biographical sketches (with portraits) of the Lord Mayor and the Sheriffs. Particulars of City schools, churches, institutions, &c., also appear. The price of the "Year Book," which is the most comprehensive and useful guide to the manifold activities of the City, is only 5s.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence [illegible] 22 and 23 of articles which inquirers desire to purchase. Communications to the Director, 73, Basinghall-street, London, E.C.

Inquest.—[illegible] and a jury held an inquiry into the death of John Stirling, coal-cutting machineman, who was fatally injured in No. 3 Broomrigg Pit, Dennyloanhead, belonging to the Bankrock Coal Co., on April 19th.

Mr. D. Todd, certificated colliery manager, and Wm. McCallum, chief electrical engineer to the Bankrock Coal Co., were warned that, in view of possible future proceedings, they need not answer questions which might appear to prejudice them.

Sheriff Moffat, in addressing the jury at the close of the inquiry, said it was quite apparent from the medical evidence that all the appearances were consistent with death resulting from electric shock, and there was quite clear evidence that at the time of the accident deceased was grasping a highly-charged electric coal-cutting machine which was in a defective condition. The chief electrician (McCallum) who was a most reliable witness, said the machine was defective owing to the non-use of a bolt, which caused the connection of the cable not to be tight. This in turn brought about the leakage of electricity into the frame of the machine and naturally was the cause of death. The fact that the coal-cutter [illegible] body of the machine. Then it was quite apparent it was not Mr. McCallum's [illegible] or less in the light of an adviser to the company. It was unfortunate that McCann, who was the electrical engineer at the pit, had been absent from the inquiry. It was most awkward that the principal person who had the supervision of the machine had not the opportunity to give evidence.

The jury returned a verdict that the accident occurred through the faulty condition of the machine caused by want of proper insulation, adding a rider to the effect that there seemed to have been some negligence but they did not feel called upon to lay the blame on any particular person.

Ironmongery and Allied Trades Exhibition.—This exhibition, which is being held at the City Exhibition Hall, Deansgate, Manchester, was opened yesterday, Thursday. There is a good display of electric cooking and heating apparatus, fittings, &c., and the exhibition will remain open until Saturday, June 12th.

Municipal Telephony.—At the recent meeting of the Hull Finance Committee, the chairman, Mr. [illegible] borrowed from the Bank of England £100,000 [illegible] purchase of the National Company's telephone plant from the Post Office. They had now repaid that sum, and had paid the whole of the cost of telephone purchase, without incurring any expense in commission.

Presentation.—The staff and workmen of South Shields Corporation tramways department recently presented Mr. W. T. Robson, the general manager (who has secured a similar appointment at Southampton), with a handsome wardrobe constructed of part of the timber of "H.M.S. Royal Albert," which was broken up at Woolwich 25 years ago, and a framed photograph of the employees.

Prohibition of Exports.—The list of goods the export of which from the United Kingdom to all destinations is prohibited has been extended, and among the articles added are tungsten filaments for electric lamps, oxides and salts of tungsten and nickel, hydrochloric acid and wulfenite.

Will.—The personal estate of Dr. Sidney Rawson, D.Sc., F.I.C., F.C.S., principal of Battersea Polytechnic, for some time lecturer in chemistry at University College, Liverpool, and chairman of the council of the Association of Technical Institutions, has been declared £4,237 gross.

TENDERS INVITED.

Motor Generator.

Tenders are invited for the supply and delivery in MELBOURNE of one 1,000-kw. direct-current Generator with Field Regulator and accessories, one Liquid Starter with accessories, together with one spare set of Carbon Brushes and one spare Field Coil for generator. Tender form, with specification, &c., from the agents for Melbourne City Council (Messrs. McIlwraith, [illegible] E.C. Tenders to the Chairman of the Electric Supply Committee, [illegible] Melbourne, by 10 a.m. Aug. 11. *See advertisement.*

Galvanised Iron Wire.

The Director [illegible] to the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department, [illegible] Commonwealth Offices, 72, Victoria Street, London, S.W. *See advertisement.*

Electrical and General Stores.

The Corporation [illegible] require tender by 10 a.m. June 7 for one year's supply of Electrical Stores, Asbestos and Packing, India-rubber, Iron and Steel Castings, Oils, &c. Specifications from the Superintendent of Stores, 16, Robert-[illegible]

[illegible] Council [illegible] and Metal Dealers' Committee require tenders by 11 a.m. June 14 for the supply of [illegible] and Fittings, Lead, Lead Pipe, &c. Forms of tender from the Clerk of the Committee, 9, Carlton-gardens, Pall Mall, London, S.W.

Turbo-Alternators and Condensing Plant.

EDINBURGH Corporation [illegible] tenders for the supply and erection of two 5,000 kw. Turbo-Alternators and Condensing Plant at their new electricity supply station at Portobello. Specification, &c., from the engineer, Mr. F. A. Newington, Dewar-place, Edinburgh. Specifications, &c., can be seen at, but not obtained from, the offices of the consulting engineer, Sir Alex. Kennedy (Messrs. Kennedy & Donkin), 17, Victoria-street, London, S.W. Tenders to the town clerk, Sir Thomas Hunter, W.S., by 10 a.m. Monday, June 21.

The NEW SOUTH WALES GOVERNMENT RAILWAYS AND TRAMWAYS DEPARTMENT [illegible] tenders by noon July 21 for supply and erection of a 250 kw. Direct coupled Turbo generator. Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

SYDNEY (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

Wiring, Fittings and Lamps.

The Pembroke [illegible] Co. (Ltd.), PENBRYN-CHEER, Glam. require tenders by June 8 for three, six or 12 months' supply of Electrical Fittings. Forms of tender from the Secretary.

ECCLES Corporation require tenders by 10 a.m. June 9 for the Electric Lighting of Anson-street Council School, Winton. Specification, &c., from the Town Clerk.

KILMARNOCK Corporation [illegible] tenders for about 100 Half-watt 1,000 c.p. Lamps and Lanterns. Tenders to Burgh Electrical Engineer by June 14.

WEST HAM Education [illegible] tenders for the Electric Lighting of Kings Road Special School. Specification, &c., from Mr. Wm. Jacques, 2, Fen-court, Fenchurch-street, E.C.

Switchboard.

REDDITCH Urban District Council invites tenders for a High-tension Three-phase Switchboard. Specifications from the consulting engineers (Messrs. Handcock & Dykes), 11, Victoria-street, Westminster, S.W. Tenders by June 14.

Foundations for Cooling Towers.

MANCHESTER Electricity Committee want tenders by 10 a.m. June 9 for Foundations for additional [illegible] street generating station. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Machinery Oils.

DUBLIN Corporation require tenders by June 10 [illegible] supply of Machinery Oils to [illegible] tender from the Town Clerk.

Armature Winding Machines.

The VICTORIAN RAILWAY COMMISSIONERS, Spencer-street, Melbourne, require tenders by 11 a.m. July 14 for supply of two Armature Winding Machines and [illegible] and Wattmeters. Specifications, &c., from [illegible]

Telegraph and Telephone Instruments and Material, &c.

The Deputy Postmaster-General, Sydney (N.S.W.), will receive tenders until 2:30 p.m. June 16 for the supply of 400 pony pattern Morse Sounders to the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specification, &c., from the Deputy Postmaster-General.

The Deputy Postmaster-General, Perth (W.A.) will receive tenders until 3 p.m. July 7 for 31,000 Porcelain (or Stoneware) Insulators (schedule 432 W.A.) for the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department. Sample may be seen at the offices of the High Commissioner for the Commonwealth, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Hobart, Tasmania, will receive tenders until June 21 for supply of 8 miles Paper-insulated Lead-covered Cable (schedule T175), 500 Glass Cells, 1,000 Zincs and 1,000 Porous Pots and 3 cwt. Sal Ammoniac (schedule T176), Telephone Instruments and parts (schedule T177), 27,000 Porcelain Insulators (schedule T180), Iron, Steel, Copper and Bronze Wire, Copper Tapes, Binders and Sleeves (schedule T181), 25 miles Insulated Copper Wire (schedule T182) and 50,000 Paper Jointing Sleeves, Soldering Solution, Insulated Staples and Linesmen's Equipment (schedule T184), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from Deputy Postmaster-General, Hobart.

The Deputy Postmaster-General, Adelaide, will receive tenders until 2 p.m. June 30 for 120 miles of outside Distributing Wire and 123 miles of Insulated Copper Wire (schedule 380), and until 2 p.m. July 7 for 27,000 Jointing Sleeves and 55,000 Copper Binders (schedule 381), for the AUSTRALIAN COMMONWEALTH [illegible] Deputy Postmaster-General.

Maximum Demand Indicators.

SYDNEY (N.S.W.) Council [illegible] June 19 for the supply of Maximum Demand Indicators. Specification from the City Electrical Engineer. (The Council have decided to grant 10 per cent. preference on British goods and 5 per cent. preference on those of the allied countries during the period of the war.)

Commutator-Grinding Lathe, Motor Generator, Motors, Cables, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. June 30 for 13 in. Centre Lathe for turning or grinding commutators (contract 28,737), and 9 kw. Motor Generator and Accessories (contract 28,760); also for Four Electric Motors, varying from 7 H.P. to 1 H.P. (Contract 28,771). Particulars from the Commissioners' Offices, Spencer-street, Melbourne.

LAUNCESTON (Tasmania) Council want tenders by 4 p.m., July 26, for converter, switchgear, underground feeder cable, &c. Specifications, &c., from the City Electrical Engineer.

Fire Alarms.

RANGOON Burmah Mercantile [illegible] for the installation of a system of Fire Alarms [illegible] Rangoon. Specification, &c., from Messrs. [illegible] & Co., 67, Cornhill, London, E.C.

Submarine Cable.

The SPANISH POST AND TELEGRAPH DEPARTMENT [illegible] tenders to June 22 for the [illegible] Cadiz to Lanzarote and for the [illegible] The "Madrid Gazette" of April 23, containing the conditions of tender, &c., can be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

MANCHESTER.—The Corporation have accepted the tender of the British Westinghouse Co. for the supply of three 1,200 k.v.a. static transformers.

LEYTON.—The Urban Council has entered into contracts with the Electrical Apparatus Co., the British Thomson-Houston Co. and the Reason Manufacturing Co. for the supply of ordinary meters, and with the British Insulated and Helsby Cables for the supply of slot [illegible]

SALFORD.—The Electricity Committee has accepted the following tenders:—

British Westinghouse Co., h.t. cubicle and control panel, £371; Heenan & Froud, wet air filter, £327; Ferranti Ltd., transformer, £160.

GRANGETOWN.—The contract for the erection of the overhead equipment and feeder system for the trolley omnibus scheme of the Grangetown, North Ormesby & South Bank Rail-less Traction Co. (about 5 miles) has been secured by Clough, Smith & Co., of London.

BOURTON-ON-THE-WATER.—The Parish Council have accepted the tender of the local Electric Light & Power Co. for the public lighting at £47 per annum.

BRIDLINGTON. The Electricity Committee have placed an order for the erection and equipment of a refuse destructor with the New Destructor Co., at £6,332.

GLASGOW.—The Tramways Committee have placed an order with the British Westinghouse Co. for the supply of two 500 kw. rotary converters.

The Corporation have also placed a contract with the British Thomson-Houston Co. (Ltd.) for a supply of their direct-current house service meters for the ensuing 12 months.

KINGSTON-ON-THAMES.—The tender of the Anglo-American Oil Co. has been accepted by the Corporation for the supply of 1,400 tons of fuel oil for the Diesel engines at £3. 5s. per ton, delivered at Purfleet.

DOVER. The Corporation recently placed an order with Edison Accumulators (Ltd.) for the supply of six electric vehicles, at £6,760. The General Vehicle Co.'s tender (at £5,850) was informal, and Wolseley Motors (Ltd.) tendered at £6,490.

Meter Contracts.—The following additional contracts for the annual supply of meters have been made:—

[illegible]

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government departments:—

[illegible] Western Electric Co., cable, £11,100; Automatic Telephones (Ltd.), dials £57. 10s., springs, [illegible]

[illegible]

£11. 5s., heat coils £93. 10s. 10d., cord, £10. 13s. 4d., carpenters £10. 8s. 4d.; Colton, Palmer & Preston, opal caps, £2. 8s. 1d.

[illegible]

Hellesen's cells £203. 2s. 6d., cable £38. 10s.; J. R. W. Gardam, Wheatstone receivers, £138; H. T. Wright, rheostat, £25. 12s. 6d.

Department of Home Affairs, Melbourne.—Julius Colvin & Co., electric lighting of drill hall, Haberfield, £59.

Public Works Dept., N.S.W.—J. E. Toole & Co., electric cranes for Newcastle Dockyard, £5,878.

Public Works Dept., Victoria.—A. E. Machin & Co., switchboard motor-generator set, &c., £262. 5s. 4d.

Victorian Railways Dept.—Callender's Cable & Construction Co., cable (at rates); S. R. O. Allen, sulp. of copper, £26. 10s. per ton; Edmiston & O'Neill, parts for conversion of electric freight lift at Flinder's-street into a passenger lift £233; H. V. Duncan & Co., primary cells (at rates).

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Barnes. The accounts of the electricity department for the past year show that the gross capital expenditure is £83,664 and the outstanding capital is £53,872.

Revenue was £15,899, and working and general expenses were £8,014, leaving gross profit £7,885. Interest required £2,037 and instalments of loans £4,083, the net profit being £1,765 (against £3,214 in previous year). Works costs were 0·85d. (against 0·76d.), total working costs 1·29d. (1·18d.), and capital charges were 1·04d. (0·95d.) Units sold were 1,405,141 (increase 2,921)=12·50 (13·60) units per (equivalent) 30 watt lamp installed. The average price obtained was 2·42d. (2·46d.) The reduction in net profit is attributed to the effects of the war. Six of the staff out of 27 have joined H.M. Forces.

Birmingham. The accounts of the electric supply and tramways departments were adopted by the City Council on Tuesday.

The capital expenditure on the electric supply department to March 31 last amounted to £2,238,640 (an increase of £82,433 during the past year).

£13,251 has been spent for the foundations at Nechells, the buildings at Summer-lane generating station, and the sub-stations at Greet and Harborne. An expenditure of £28,283 has been incurred in respect of turbines and generators, boilers, cooling towers, switchgear &c., at Summer-lane station (£15,258); converting machinery and switchgear at sub-stations (£8,703); high-tension switchgear, &c. (£4,322). Mains and services cost £38,094, low-tension mains and services £26,243, e.h.t. mains £8,120, and traction mains £3,731. Sales of current produced £379,625, compared with £346,561 in previous year. The output for lighting and power, exclusive of tramways, was 18·1 per cent. higher than in the previous year. The increase in the output for tramway supply is 0·6 per cent. Gross profit was £192,376. 13s. 4d., and after meeting interest and sinking fund, there remains a balance of £60,385. 6s. 4d. £25,000 has been placed to renewals and special expenditure account, leaving a surplus of £35,385. 6s. 4d., which it is proposed to devote to relief of borough rate, nearly £10,250 in excess of the amount contributed last year. Units sold were 82,909,182 (73,767,178).

The accounts of the tramways department show gross capital expenditure £2,472,938 (increase £138,501). Traffic revenue was £640,091 (against £628,016 in previous year), equal to 10·793d. (10·563d.) per car mile; total revenue was £647,014 (£635,471), working expenses were £473,879 (£445,507), gross profit was £173,135 (£189,964); average working expenses per car-mile were 7·991d. (7·494d.), car-miles run were 14,232,902 (14,268,244), and passengers carried 149,443,199 (146,930,986). Units used per car-mile were 1·7 (1·7).

The year's capital expenditure (£138,591) was chiefly in connection with the construction of tramways from Hall Green and Warwick-road, and it also included £40,752 on account of purchase of 75 new tramcars. When the war broke out the receipts were showing increases of upwards of £1,200 per week, and at the beginning of August there was an accumulated increase of over £20,000. The effect of the war has been not only to cut off increases, but almost to diminish the £20,000 by upwards of £8,000. It is believed the loss of traffic due to the war has been between £10,000 and £30,000. On the expenditure side the items are abnormally high in consequence of increased cost of labour and materials. Rates and taxes also are higher by £8,796, and allowances to employés serving with H.M. Forces amount to £17,000. In connection with the omnibus services, the balance of £4,549 carried to profit and loss account is sufficient to write off the cost of the omnibuses on the basis of a five-years' life, to pay interest and sinking fund on the remainder of the capital and leave a balance of £1,000.

The Tramways Committee have had under consideration the financial position of the tramways undertaking owing to circumstances connected with the war. They feel they have no alternative but to increase the existing tramway fares. No fare will be increased more than ½d., and the average distance for each fare is as follows: 1 mile 1,200 yds., 1d.; [illegible] 2½d.; 4 miles 650 yds., 2½d. [illegible] Council to adopt the revised schedule, and the Finance Committee considered the increases fully justified.

Blackburn. The [illegible] department for the [illegible] ended March 31 [illegible] £236,258. The amount repaid to Public Works Loan Commissioners is £99,918, and £98,089 has been placed to sinking fund.

Revenue was £68,303 (compared with £71,339 in previous year), and working expenses were £46,929 (£47,170), leaving gross profit £21,374 (£24,169). Interest and income tax required £4,639 (£4,982), and repayment of loans and sinking fund £15,450 (£15,176), and the net profit £1,572 (£4,011) is being carried to permanent way renewals fund. Total revenue per car-mile was 13·81d. (14·08d.), and average working expenses, including power, were 9·48d. (9·32d.). Average fare charged per mile was 0·76d. Passengers carried were 12,223,569 (compared with 12,731,532). car-miles run 1,121,769 (1,149,462), and units used 1,739,274 (=1·54 per car-mile, against 1·64). In the report of the general manager (Mr. J. H. Cowell) it is stated that the receipts from carriage of parcels were £2,312 (increase £1). 76 employés are serving with H.M. Forces, and £602 has been granted to their dependents.

Dundee.—The total revenue of the electricity department during the past year was £65,529, compared with £58,790 in 1913-14.

The expenditure was £38,617 and £26,912 was carried to net revenue account. After paying interest, &c., £2,835 has been carried to current year's account. The estimates for the current year show a revenue of £76,184; the expenditure includes £30,860 for the generation of energy, £4,680 for distribution, and after meeting other outlays, there is an estimated balance of £29 to meet contingencies.

Hull. The accounts of the electricity department for the year ended March 31 show total capital expenditure £530,863 (increase £17,486), of which £45,301 has been redeemed.

Revenue was £81,691, working expenses (including £269 for police, protection of works, and £1,109 proportions of salaries and wages of mobilised employés) were £44,726, leaving gross profit £36,965. After providing for interest, loan instalments and income tax, the net profit, £2,374, has been carried to reserve. Works costs were 0·66d. per unit (against 0·77d. in previous year), total working costs 0·81d. (0·92d.), and total costs, including interest and sinking fund, 1·42d. (1·51d.). Units generated were 17,729,060 (16,963,469) and sold 12,969,776 (12,208,731). Total maximum supply demanded was 6,700 kw. (7,180 kw.)

The deputy city electrical engineer (Mr. J. F. Magoris) states that 32 per cent. of the staff and employés of the department have joined H.M. Forces, and he calls attention to the fact that the allowances of £1,109 and £269 have been made before arriving at the gross profit. The works costs were more than 14 per cent. and the total working costs nearly 12 per cent. below those of the previous year.

Manchester. The total capital expenditure of the tramways department at March 31 was £2,215,000 (increase £85,105) and the total amount of sinking fund is £548,499.

Revenue was £901,876, working expenses were £572,442, and war service allowances, &c., amounted to £31,764, leaving gross profit £297,670. After providing for capital charges, income tax, rents, reserve and contributions for street improvements, &c., the contribution to rates was £100,000 (=1·253d. per car-mile, compared with 1·271d. in previous year). Total revenue per car mile was 11·3d. (against 11·41d.), working expenses, including power, were 7·172d. (7·216d.), and units used were 29,922,197, or 1·562 (1·543) per car-mile. Passengers carried were 202,768,420 (against 205,608,741) and car-miles run 19,155,051 (19,463,646). Included in the receipts are £787, balance of motor omnibus account, and £3,639 (3,642) balance of parcels account. The traffic revenue on the 'buses was £6,193 and the working expenses were £4,935 (=7·367d. per 'bus-mile, including petrol 1·77d.), and £471 was allowed for depreciation.

The Tramways Committee's report states that the length of (equivalent) single track open (including lines over which the Corporation has running powers) is 195 miles. Total revenue fell £23,434, due to the war, the reduction caused by the war being calculated at nearly £50,000, and after providing for the war service allowances the amount which could be placed to reserve, renewals and depreciation was only £48,584 (against £97,219 in previous year). The price paid to the electricity department for current was 1·023d. (against 1·026d.) per unit. There are 552 covered and 81 uncovered cars in stock. Parcels carried were 1,236,500 (1,303,353).

Stafford.—The accounts of the electric lighting department for the year ended March 31 show total capital expenditure £35,335, of which £16,799 is outstanding.

Revenue was £7,194 and working and general expenses, including depreciation £1,000) were £4,662, leaving gross profit £2,532. Instalment of loans required £1,501, interest £658 and income tax £146, leaving net profit £343. Total revenue was equal to 1·689d. per unit sold, and working and general expenses were 0·860d. Total maximum demand was 600 kw. (compared with 530 kw. in previous year). Units generated were 1,287,074 (against 1,036,135) and sold 1,021,633 (788,516).

COMPANIES' MEETINGS AND REPORTS.

Electric Construction Co. (Ltd.)

The 22nd annual general meeting was held on Thursday last week, Mr. PHILIP E. BEACHCROFT presiding.

The SECRETARY (Mr. David Willock) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: The forecast I made last year has been justified and that we are able to submit results to-day with which I am sure you are satisfied. Our gross profit amounted to £71,998. 15s. 11d., an increase of 4·2 per cent. Ever since 1911 we have recorded substantial improvements year by year, and in five years we have increased our gross profit by more than 50 per cent., and, given ordinarily good times, we do not think we have reached our maximum. Since the outbreak of war we have suffered from a scarcity of labour, no less than 30 per cent. of our workmen having joined the forces. Great delay has occurred also in obtaining delivery of certain classes of raw material, while the demand for prompt delivery of our products has been insistent. Prices of raw materials (almost exclusively manufactured articles) have risen steadily since war was declared, while as we had a considerable amount of orders booked on the old basis we were unable to obtain the benefit of higher prices for our own products until the financial year was well advanced. It must not be assumed that the receipt of Government or war orders necessarily means larger profits; this is not so in our case. I desire to express the appreciation of the directors for the admirable manner in which the orders we have received have been executed. The work has been carried out uncomplainingly by all, from the managing director downwards. Towards the end of the financial year we, in conjunction with other engineering establishments in Wolverhampton, granted an increase in wages of 3s. per week to skilled men and a correspondingly lower increase to unskilled, and a war bonus has been granted to members of the staff whose wages are less than 55s. per week. Turning again to profit and loss on the debit side interest stands at the same rate as last year. General charges have increased practically by the amount of increased rates and taxes and the contribution of £262. 10s. to the Prince of Wales' National Relief Fund. The increase in these charges has been counteracted by lower cost of maintenance of plant and buildings. Total expenditure shows no increase, and the whole improvement of £3,000 in gross profit is available for distribution. The net profits for the past five years have been £15,000, £20,300, £27,500, £32,400 and £35,500 respectively. These show that the increase in standing charges on the bigger volume of business has been inappreciable. The net profit for the year is £35,567. 4s. 7d., which, with £7,153. 7s. 3d. brought forward, makes £42,720. 11s. 10d. From this has to be deducted the interim preference dividend, leaving £40,523. 5s. 10d. available for distribution. We recommend a preference dividend at the rate of 7 per cent. for six months, an ordinary dividend of 6 per cent., the transfer to general reserve of £17,402. 12s., leaving £7,471. 7s. 10d. to be carried forward. In normal times we should have been justified in recommending a larger dividend, but we consider that, having regard to all the uncertainties produced by the war, we should be consulting your best interests by paying the same rate of dividend as last year.

The only further item calling for comment is "shares in other companies." This asset is almost entirely represented by our holding in the Electrical Power Storage Co. (Ltd.), and is now written down to what is considered the realisable value. An extraordinary general meeting of that company is to be held on June 3 to consider the question of amalgamation with Pritchetts & Gold (Ltd.). If the provisional scheme of amalgamation is approved the manufacturing operations of the Electrical Power Storage Co. will be transferred to Dagenham and the economics effected thereby will enable a good dividend to be earned upon the reduced value of the shares. I would again direct your attention to the strong financial position we enjoy. Our entire liabilities, apart from debenture stock, are only £22,232, whereas our realisable assets amount to £173,964, and we have, in addition, £17,983 in cash. After providing for depreciation, the debenture interest last year was covered six times over and the preference dividend almost nine times.

The Chairman referred with regret to the death of Mr. William Bulloch in February last, and said the directors had elected Mr. David Willock, who had been in the company's service 18 years, 14 years as secretary, to fill the vacancy on the board. It afforded the directors great satisfaction to thus reward his able, loyal and indefatigable services. Mr. William M. Furniss, who has been with the company 11 years, [illegible] manager at Wolverhampton. With regard to the future, all the indications at present pointed to a busy and [illegible]

The report and accounts were unanimously adopted.

United River Plate Telephone Co. (Ltd.)

The 29th ordinary general meeting was held on Thursday last week, Mr. GEORGE FRANKLIN, Litt.D., J.P., presiding.

The SECRETARY (Mr. A. H. Dawborn) having read the notice convening the meeting and the auditors' certificate,

The CHAIRMAN, after referring in feeling terms to the death of Mr. David Smith, managing director and secretary of the company, said: The report indicates that, notwithstanding the general conditions in Argentina, as affected by the world's war, the company has been able not merely to hold its own, but, whether looked at from the point of view of gross earnings or net profits, our position is practically substantially maintained with that of the previous year. The gross earnings for the year were £630,651, compared with £611,657 in 1913, an increase of £18,994, equal to 3·1 per cent. Maintenance and other expenses of management in Argentina and London, including debenture interest, came to £468,846, against £447,604, increase £21,242, equal 4·8 per cent. The final result is that we have £161,805, compared with £164,052, a decrease of £2,247. Included in the expenses are all provisions, especially that for the maintenance and renewal of plant, this item absorbing £129,803, an increase of £23,965 over the previous year. Income tax is increased by £4,521, and £8,100 more is required for ordinary dividend. Capital expenditure has absorbed £186,065, of which £70,206 is for underground plant, and compares with £364,304. On real estate we have spent this year £46,605, compared with £24,671. This has been due to our continuing of substituting underground for overhead plant and the purchase and ownership of the land and buildings upon which our exchanges are erected. Reserve for the renewal of plant is £512,535, and this, with the reserve fund—which amounts to £316,138 after to-day's appropriation—the board consider adequate for any possible wastage likely to accrue from the capital expenditure in Argentina, now amounting to £2,390,828. We know that the stronger the company is in its reserves the better able you are to meet all possibilities. The reduction in capital expenditure is due to our feeling that it is necessary to limit capital expenditure to the smallest possible amount. Securities at cost or under stand at £131,671. These are high-class securities, and if realised the difference between the prices which might be obtained to-day for them and the value at which they stand in the company's books is amply provided for. Stock of materials, £165,474, shows a reduction of £37,689, a satisfactory feature, because a large stock of materials on the other side is liable to depreciate. It is proposed to pay a final dividend of 5 per cent., making 8 per cent. for the year, tax free. We are transferring £20,000 to reserve, compared with £30,000 last year, £2,000 to staff provident fund, and we carry forward £6,562.

The growth of the company's business shows, for the first time, I think, in the history of the company, no increase during the year, which indicates the gravity of the crisis through which Argentina has passed. This position has enabled us to postpone with greater ease the erection of new buildings and the provision of exchanges. The stagnation is, I am convinced, only temporary and due to abnormal causes. During the past few months the Municipality of Buenos Aires has granted to the company a new concession on satisfactory terms, allowing us to extend our underground system and to put down subways and other works in that city. This concession was originally granted in 1905, but had expired. We have also been granted concessions by the Municipalities of San Isidro, Lomas, Vicente Lopez and Castelli to lay subways and open exchanges. With respect to our trunk line system giving connection to the Federal Capital, this remains as at the beginning of last year, but we have extended our trunk lines, and are joining up to Villa Maria, a distance of 88½ miles. We have now, as I reported last year, in Cordoba an excellent automatic system of exchange established, and in January of this year there was put into service a 5,000-line automatic installation in the City of Rosario. Both are working satisfactorily. We have also installed small magneto switchboards in various provincial towns, while extensions at Avenida, Libertad, Palermo and Belgrano have been completed and brought into service.

I would take this opportunity of recognising the valuable work done for the company by our local Advisory Committee and the staff both in the Argentine and in London. The board feel, in common with the shareholders, under great obligation to Dr. Drago and the members of the Committee, who, with the general manager (Mr. Parker) and the engineer-in-chief (Mr. Roberts), have been unremitting in their attention to the special difficulties of the company at this time and to the care of its interests always, whilst in London I must not forget the work done by our secretary, Mr. Dawborn and such of the staff as have remained to us after the calls for military service.

Several shareholders joined in condolences with the family of the late secretary and testified their appreciation of his services to the company. The report and accounts were then adopted.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO (LTD.) Mr. H. B. Beeton, who presided at the meeting last week, said that the profit of the Brisbane Tramways Co. for 1914 was £[illegible], against £124,308 in 1913. [illegible] the available balance of £[illegible] a dividend of 10,000 had been carried to renewals fund and £144,000 had been paid in dividends, leaving £2,882 to be carried forward. After adding to the above fund they had accepted on their behalf the amount brought forward, and after deducting London and Brisbane charges the net balance was £144,063. Debenture and interest absorbed £[illegible], interim ordinary amounting to £32,808 had been paid on the preference and ordinary [illegible], and after adding

ward £3,069. 12s. 11d. Capital expenditure of £103,751 had been incurred for the Brisbane Tramways Co. in constructing extensions, purchase of equipment and plant, building of new car sheds and the acquisition of a new power-house site. The most important event had been the High Court's decision in the tramways case, which, as anticipated, annulled the award of the Commonwealth Conciliation and Arbitration Court.

CUBAN TELEPHONE CO. [illegible] cellaneous sources in 1914 was over $1,200,000, and after deducting costs of operation, taxes and general expenses, and providing depreciation reserves, the net balance was over $559,000. After paying year's interest on its bonded and unfunded indebtedness, the net surplus was $244,000. The company paid two quarterly dividends on preferred stock and one quarterly dividend on common stock. Nearly $700,000 of the accumulated net cash surplus has been used for carrying on construction work.

DELHI ELECTRIC TRAMWAYS & LIGHTING CO. LTD. [illegible] (Mr. A. W. Tait) stated at the recent meeting that the net revenue for 1914 was £8,163, compared with £6,252 in 1913, but both branches of their undertaking had been affected by the war. The gross revenue of the tramways had increased by 10 per cent. and that of the electric supply department by 19 per cent. The unsuitable type of tramcar was responsible for heavy annual maintenance charges and abnormal current consumption. The present single motor equipments were not only unsuitable but unsatisfactory, and therefore the maintenance charges were extraordinarily heavy, but considerable economies could be effected by new equipment. They should be able also to place upon the system cars more suited to the climate and particular local conditions, which would probably increase the receipts per car mile. The passengers carried were 5,465,450, against 4,811,106, an increase of about 13 per cent.; the car-miles run were 434,094, against 397,969. The peculiar feature was that over 57 per cent. of the passengers only travelled ½ mile or under, and first-class traffic remained very small. The receipts per car-mile were 5·4d., against 5·2d., and the total available population was carried 23½ times during the year, against 20⅞ times in 1913. The figures showed that the problem of running tramways profitably in the East was not the same as that in the West. During the year they had some difficulty with the staff, and in the month of May they had a serious strike, in which they lost nearly half of their drivers, which was largely due to the dismissal of certain suspected men by the traffic superintendent. Apart from that question, the daily absences among their traffic staff varied from 10 to 30 per cent. With regard to the electricity undertaking, the new Sulzer engine had given every satisfaction since its installation in June last. The other plant had been kept in good repair and the Carels engine had been working at a uniform medium load. In order to cope with peak loads, and to supply further stand-by in case of breakdown of either of the oil engines or of the steam plant, satisfactory arrangements had been made whereby their station was to be linked up with the Government station. The orders had been placed for the plant, and it was expected to be shipped in a month or six weeks' time. They were also laying further feeder cables in certain parts of the city where the existing feeders were already overloaded. The existing battery would [illegible] units generated showed an increase of 26 per cent., and the average cost [illegible] sidering that they had mixed oil and steam units, and on the latter they suffered from uneconomical fuel consumption. There was some small reduction in the price of coal fuel during the year, but liquid fuel, which was obtained under contract, was at the same price as the previous year. 931,219 units were sold for lighting and power, an increase of 26 per cent., and the units used by the tramway system were 572,393, an increase of 16 per cent. During the first six months of the year they connected 193 new consumers, but during the second six months they only connected 138. [illegible] considerable influence in the reduction of generation costs, had been quite satisfactory, the units sold for power being 367,381, an increase of [illegible] small profit of £43, was practically closed down. The policy of the com-[illegible]

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The [illegible] carried forward.

LANCASHIRE POWER CONSTRUCTION CO. (LTD.)—The report for the [illegible] and plant, and has brought into account the balance of profit due thereon [illegible] pressure interest (£1,500) and allocating £10,000 to reserve fund, a dividend of [illegible]

paid, £3,421. 13s. 7d. having been carried forward. 32,157,185 units were generated, against 28,191,442 in 1913 and 23,110,807 in 1912. The maximum load was 10,210 kw., against 9,720 kw. and 6,730 kw. in 1913 and 1912 respectively. The horse-power connected being 27,018, 23,900 and 16,400 respectively. The revenue account of the Construction Company shows total receipts for the year ended March 31 of £19,333. 16s. 10d. and after deducting the expenditure (£17,110. 4s. 8d.) the available balance was £2,223. 12s. 2d., which it is proposed to carry to reserve.

REUTER'S TELEGRAM CO. (LTD.)—The directors' report for 1914 states that the net profit, after payment [illegible] and deducting rebate on unexpired subscriptions to news services, amounted to £14,849, including £8,913 brought forward. The great falling-off in revenue is largely due to the disturbing influence of the war. The severe restrictions imposed by the military authorities upon news from the seats of war and the total prohibition of the company's code for private telegrams have greatly diminished the revenue from those sources. Steps have been taken to counteract the diminution of gross receipts by a considerable reduction of working expenses during the present year. In consequence of the uncertain position created by the war, the directors have decided to make no distribution of profit, but to transfer £10,000 to reserve account and to carry forward the balance (£4,849. 1s. 9d.). It has been decided to write off the whole of the goodwill account hitherto valued at £65,000. The sum of £10,000 has been written off investments and £5,000 off freeholds. The directors have decided not to fill the post of managing director, lately rendered vacant by the death of Baron de Reuter, and have appointed Mr. Walter F. Bradshaw, who has been secretary for 25 years, to be manager and secretary. On the invitation of the directors Mr. Gerald W. Williams joined the board in February last.

WESTINGHOUSE ELECTRIC & MFG. CO.—The gross earnings for the year to March 31 were $33,671,485, against $43,733,646 in 1914, and net manufacturing profit was $2,562,411, against $4,717,222, the total income being $3,720,938, against $5,764,814. The amount available for dividends, &c., is $2,009,744, decrease $3,755,070, and net surplus $7,473,411, against $7,659,130. The decrease in gross receipts is due to unfavourable business conditions and to the strike, which closed the main plant east of Pittsburgh in June and July.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

W. C. CARTER & MOORE (LTD.) (140,456).—Reg. May 25, capital £100 in £1 shares, to carry on the business of consulting, marine, mechanical and electrical engineers, manufacturers of and dealers in all kinds of machinery and plant, general traders and merchants, &c. Private company. First directors are W. C. Carter (chairman) and W. H. Moore (both permanent, subject to holding five shares each). Secretary: H. [illegible] W.C.

HALLIWELL & CO. (LTD.) (140,421).—Reg. May 21, capital £2,000 in £1 shares, to carry on the business of electricians, mechanical engineers and manufacturers, generators, and suppliers of electricity, &c. Private company. H. Halliwell is permanent governing director. Reg. office: 43, [illegible]

HIGHFIELD SYND. (LTD.) (140,408).—Reg. May 20, capital £5,000 in 4,875 cumulative preference shares of £1 each and 5,000 deferred ordinary shares of 6d. each, to adopt agreement with F. W. Highfield, to develop and turn to account patents referred to therein, to carry on the business of precipitating or condensing dust, metallic or other particles, fume vapours and volatilisation products, electric and general smelting and refining, &c. Private company. First directors are F. H. Haviland and F. W. Highfield.

HOLME ELECTRIC CO. (LTD.) (140,393).—Reg. May 19, capital £1,000 in £1 shares, to [illegible] Holme and elsewhere in the West Riding of Yorkshire, the [illegible] electric light company. No share shall be allotted or [illegible] not either a ratepayer of the Urban District of Holme or resident within or owner of property within the district. First directors are C. Tinker, H. Howard, C. Boardsell, Harry Hatfield and R. Calvert. Reg. office: Council Offices, Holme, near Huddersfield.

HUMFREY, STARK & CO. (LTD.) (140,323.)—Reg. May 13, capital £5,000 in £1 shares, [illegible] A [illegible] £1,200 B preference and [illegible] ordinary. To take over the [illegible] several businesses, hardware dealers, hydraulic [illegible] engineers, &c., carried on at [illegible] Bank, as H. Humfrey & Co., [illegible] company. H. Humfrey and J. J. Stark are permanent joint managing directors. Reg. office, 12, High-street, Abingdon, Berks.

MICO (LTD.) (140,410).—Reg. May 22, capital £400 in £1 shares, to [illegible] to become [illegible] dealers in accumulators, lamps, batteries, [illegible] and electrical appliances, &c. Private company. Mrs. W. H. Haycock permanent managing director.

POULSEN WIRELESS TELEGRAPH CO. (LTD.) (140,494).—Reg. May 28, capital £450,000 in £1 shares, to carry on the business of electricians, generators, suppliers and distributors of electric and electrical energy for telegraphic, telephonic, lighting, heating and other purposes; telegraphists, telephonists, proprietors and managers of telegraph and telephone works, lines, systems, &c., and to adopt an agreement with the British & Overseas Engineering Synd. (Ltd.) First directors are Sir Leigh Hoskyns, Bt., A. Davidson, S. F. St. J. Steadman, L. S. Robertson, V. Gandil and C. Hage. So long as C. Hage or his personal representative and the company called Det Kontinentale Syndikat for Poulsen Radio-Telegrafi Aktieselskab and their original nominees or their personal representatives respectively hold at least 100,000 shares, the said C. Hage and the said company shall be entitled to two nominees on the board, and so long as they hold less than 100,000 but not less than 50,000 shares, one nominee. Reg. office: 4, Suffolk-street, Pall Mall East, S.W.

SEMPLE & CO. (LTD.) (9,402).—Reg. in Edinburgh on May 28, capital £1,000 in £1 shares, to acquire the business of electrical and mechanical engineers carried on by Semple & Co. of Glasgow. Private company. First directors are R. Semple and J. H. Ballantyne. Reg. office: 170, Hope-street, Glasgow.

STATUTORY RETURNS.

ELECTRIC ZINC CO. (LTD.)—According to return to Dec. 31, 1914, capital is £2,000,000 in £1 shares (400,000 preference and 1,600,000 ordinary). Seven shares taken up. Nothing called up. Mortgages and charges nil.

HARROW ELECTRIC LIGHT & POWER CO. (LTD.)—Capital in return to March 11 is £50,000 in 6,667 ordinary and 3,333 preference shares of £5 each. All shares taken up. £50,000 paid. Mortgages and charges, £26,325.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—In return to April 9 capital is £150,000 in 20,000 ordinary and 10,000 preference shares of £5 each. All shares taken up. £150,000 paid. Mortgages and charges, £92,355. (Originally registered in 1897 as the Southern Electric Light & Power Co., Ltd.), renamed in 1900.)

MELTON MOWBRAY ELECTRIC LIGHT CO. (LTD.)—Capital at March 19 was £25,000 in £5 shares. 4,000 shares taken up. £20,000 paid. Mortgages and charges, £19,500. Reg. office: 35, Regent-street, Melton Mowbray.

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—Capital at March 19 was £300,000 in £10 shares. All shares taken up and £297,500 paid, leaving £2,500 in arrears. Mortgages and charges, £320,780.

WYCOMBE BOROUGH ELECTRIC LIGHT & POWER CO. (LTD.)—Capital in return to March 24 is £50,000 in £5 shares. 8,000 shares taken up. £40,000 paid. Mortgages and charges: £40,000.

MORTGAGES AND CHARGES.

BRITISH BATTERY CO. (LTD.)—Debenture dated May 17, 1915, to secure £700 charged on company's undertaking and property, present and future. Holders: A. H. Rose and T. A. Rose.

COAST DEVELOPMENT CORPN. (LTD.)—Second mortgage dated May 3, 1915, to secure £3,000, charged on the electric lighting station at Walton-on-the-Naze, and goodwill of business carried on there. Holders: Sir Thomas S. Cave, K.C.B., and others.

CRYSELCO (LTD.)—Trust deed dated May 20, 1915, to secure £10,000 debenture stock, charged on Kempston Iron Works, Kempston, and company's undertaking and property, present and future. Trustees: H. S. Deacon and A. Baker.

A memorandum of satisfaction in full on May 19, 1915, of trust deed dated May 6, 1910, securing £7,500 first and £7,500 second debenture stock, has been filed.

MIDGET LAMP CO. (LTD.)—Particulars of £400 second and £1,000 third debentures, created April 8, 1915, have been filed, amount of present issue being £400 and £500 respectively. Charged on [illegible] undertaking and property, present and future. [illegible]

RAWLINGS BROS. (LTD.)—Issue on May 20, 1915, of £500 debentures, part of a series of which particulars have already been filed.

STELLA CONDUIT CO. (LTD.)—Mortgage on land and premises at Bilston, Staffs, dated April 19, 1915, to secure all moneys due to Lloyds Bank, not exceeding £2,100.

CITY NOTES.

MEMORANDA (June 3).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 66¼. Console Pay Day July 1. Stocks and Shares Pay Days June 10 and 24. Pay Days June 11 and 25. Price of Silver, 24d.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—The directors have declared a dividend of 1½ per cent. for the quarter on the cumulative participating preference shares.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—Mr. G. Stanley White of Messrs. George White & Co., Bristol, has been appointed a director in the place of the late Mr. Hugh G. Doggett. Mr. Samuel White relinquishes the position of managing director owing to ill-health, but remains on the board. Mr. W. G. Verdon Smith has been appointed managing director.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—A quarterly dividend of 1¾ per cent. has been declared on the common stock for the quarter ended June 30.

CIA DE ELECTRICIDAD DE LA PROVINCIA DE BUENOS AYRES.—The company announced that although the conditions in the Argentine have improved, the directors do not feel justified in paying a dividend to the [illegible]

COMPANIES STRUCK OFF THE REGISTER. The following were struck off the Register of Joint Stock Companies on May 25:—

Alkaline Accumulators Paul Gouin, Anglo-Brazilian Power & Shipping Corpn., Beam Co. (British Electrical & Mechanical Co.), Blast Furnace Power Synd., County Electric Traction Co., Electric Batteries & Carbons, Leeds Electric Co., Southwold Electricity Works, Witney Electric Supply Co.

CORNWALL ELECTRIC POWER CO.—During the week this company invited applications for an issue of £60,000 5 per cent. debenture stock at 95 per cent. The proceeds of the issue, after payment of outstanding accounts for plant, &c., will provide about £21,000 for future extensions, which will shortly be necessary to meet the growing demand for power.

HONG KONG TRAMWAY CO. (LTD.)—The accounts for 1914 show, after providing for debenture interest and setting aside £6,530 for depreciation of track, &c., a net profit (including £7,480 brought forward) of £17,022. The directors recommend a dividend of 10 per cent., the appropriation of £2,000 in writing down cost of tramway undertaking, leaving £6,897 to be carried forward.

IMPERIAL TRAMWAYS CO. (LTD.)—Mr. J. H. Howell, J.P., has been appointed a director in the place of Mr. H. G. Doggett.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE ELECTRIC POWER CO.—The directors' report for the past year states that the net revenue amounted to £25,366. After deducting expenses (including £250 written off cost of electric lighting orders) and adding amount brought forward, a sum of £14,399 remains. The directors propose to add £4,500 to reserve, to pay a dividend at the rate of 3 per cent. per annum and to carry forward £899.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—The directors are offering to the holders of their shares and debenture stock a further £25,000 4½ per cent. first mortgage debenture stock at £95 per cent. and the remaining 25,000 6 per cent. cumulative second preference shares of £1 each at par. The additional capital is required to meet the continuous increase in the company's business.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, June 2. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Last Dividend	NAME.	Price, Wed. June 2.	Net Yield per £100	Dividend Due.
	Electricity Supply.		£ s. d.	
[illegible]	[illegible]	[illegible]	7 3 6	Mar, Sept
[illegible]	[illegible]	[illegible]	4 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	12 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	5 19 1	Mar, Sept
4	Central Elec. Supp. G. Deb. St	90½	[illegible]	[illegible]
4	Charing Cross West End & City Debs.	[illegible]	[illegible]	Jan, July
5 2/3	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	10	[illegible]	[illegible] Aug
[illegible]	[illegible]	12½	4 4 0	Mar, July
5%	Do. 5% Deb. St.	[illegible]	[illegible]	Jun, Dec
[illegible]	County of London Ord.	[illegible]	[illegible]	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	My, Nov
[illegible]	Edmundson's Elec. Supp. 4½% Debs.	[illegible]	5 12 6	[illegible]
[illegible]	Kensington and Knightsbridge Ord.	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Do. 4% Mort. Debs.	[illegible]	4 11 11	Jan, July
[illegible]	Metropolitan E. Supp. Ord.	[illegible]	[illegible]	[illegible]
[illegible]	Do. 1st Mort. Deb.	[illegible]	4 15 3	Jan, July
[illegible]	Newcastle & Dist. E. L. 6% 2nd Dbs.	[illegible]	[illegible]	[illegible]
[illegible]	Newcastle-on-Tyne E.S.S.% 2d Mt. Db. St.	[illegible]	[illegible]	[illegible]
[illegible]	North Metropolitan E. P. Supp. 6% Pref.	[illegible]	[illegible]	Apl, Oct
5%	South London E.S. 1st Mort. Debs.	[illegible]	[illegible]	Jan, July
[illegible]	Urban Elec. Supp. 4½% Db. St.	[illegible]	5 10 7	Apl, Oct
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Electric Railways & Tramways.			
[illegible]	[illegible]	[illegible]	[illegible]	Apl, Oct
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	Central London Guar. Assented Ord.	7½	[illegible]	[illegible]
[illegible]	Do. do. Assented Def. Ord.	[illegible]	[illegible]	[illegible]
[illegible]	City & S. London Deb.	[illegible]	4 15 3	May, Nov
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	5 17 11	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
[illegible]	Ry. Con. Ord.	[illegible]	4 6 [illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	Convertible Pref.	[illegible]	4 14 [illegible]	[illegible] Aug
[illegible]	[illegible]	82½	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	NAME.	Price, Wed., June 2.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*	£ s. d.		
St.	4%	Metropolitan Dist. Ry. Ord.	16½	.. .. ..	Feb, Aug
St.	4%	Do. 4% Deb.	92	4 7 0	May, Nov
St.	4%	Do. 4% Deb.	73½	6 2 6	Feb, Aug
St.	4%	Do. 4% Deb.	12½	4 12 6	Jan, July
St.	4%	Do. 4% Deb.	[illegible]	4 10 6	Jan, July
St.	4%	Do. 4% Deb.	[illegible]	4 11 10	Jan, July
St.	4%	Do. 4% Deb.	[illegible]	5 [illegible]	Mar, Sept
10	..	Do. [illegible] Shares	[illegible]	.. ..	..
10	..	Do. [illegible]	1[illegible]	.. ..	..
St.	6%	Do. [illegible]	112½	5 6 [illegible]	Mar, Sept
..	6%	Do. [illegible]	[illegible]	[illegible]	Mar, Sept
..	4½	Do. [illegible]	103½	4 5 10	Jan, July
5	..	Yorkshire [illegible]	[illegible]	.. ..	March
		Electric Manufacturing, &c.			
1	1/9	Babcock & Wilcox Ord.	2[illegible]	[illegible] 17 3	Apl, Oct
1	1/9	Brit. Aluminium Ord.	[illegible]	4 11 [illegible]	Mar
100	5%	Do. Prior Lien Debs.	93	[illegible]	Jan, July.
1	[illegible]	[illegible]	[illegible]	[illegible] 3 10	Jan, July
1	1/-	Brit. Insulated & Helsby Ord.	111	[illegible] 13 4	Aug, Feb
5	3%	Do. [illegible] Pref.	[illegible]	4 11 [illegible]	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	1[illegible]	5 12 11	Mar, Sep
2	7½	Brit. Westinghouse Pref.	1[illegible]	[illegible] 0	Apl, Oct
100	6%	Do. [illegible] Pref.	100[illegible]	[illegible] 19 8	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
5	15/0	Callender's Cable,&c.,Co.Ord.xd & bonus	12[illegible]	6 4 4	Jan, July
5	2/6	Do. 5% Pref.	[illegible]	4 17 7	Feb, Aug
1	15%	Casmer Kellner Ord.	3[illegible]	4 13 2	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	[illegible]	[illegible] 12 0	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	[illegible]	.. ..	Feb, Aug
1	6%	Elec. Construction Ord.	[illegible]	[illegible] 12 0	May
1	[illegible]	Do. [illegible] Pref.	[illegible]	[illegible] 6 7 5	June, July
St.	4%	Do. 4% Debs.	6[illegible]	[illegible] 13 1	Jan, July
10	6/0	General Electric 6% Pref.	1[illegible]	[illegible] 19 3	Jan, Dec
5	20%	W. T. Henley's Teleph. Wks. Co. Ord.	1[illegible]	[illegible] [illegible]	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	[illegible]	4 10 [illegible]	..
St.	4½%	Do. 4½% Db.	96	4 13 [illegible]	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	[illegible]	[illegible] 11 1	Feb, Aug
10	5%	Do. Pref.	[illegible]	[illegible] 16 9	Apl, Oct
100	4%	Do. 4% Debs.	9[illegible]	4 7 [illegible]	Apl, Oct
12	36/0	Telegh. Con. & Main. Co.	3[illegible]	[illegible] 16 2	Mar, July
100	4%	Do. 4½% Debs.	9[illegible]	4 4 3	Jan, July
1	7½	Vickers Ord.	[illegible]	[illegible] 3 1	May, Aug
1	6d.	Do. 8% Pref.	1[illegible]	4 14 1	May, Aug
St.	4%	Do. 1st Debs.	93	4 [illegible] 0	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	104½	4 6 1	Jun, Dec
		Telegraphs.			
10	5	Anglo-American Tel. 5% Def. Ord.	9[illegible]	5 5 3	Jan, July
St.	3%	Anglo-American 6% Pref. Ord.	10[illegible]	5 13 4	Fb,My,Aug,N
St.	33/0	Do. Def. Ord.	2[illegible]	6 14 8	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	7[illegible]	5 2 7	Jan,Apl,Jly,O
10	5%	Cuba Submarine Ord.	[illegible]	[illegible] 13 6	Mar, Nov.
10	10/0	Do. 10% Pref.	1[illegible]	6 9 0	..
5	5/0	Direct Spanish 10% Pref.	[illegible]	6 13 4	..
10	4%	Direct United States	[illegible]	5 18 6	Ja.Ap,Jly,O
St.	65/0	Eastern Tel. Co. Ord.	1[illegible]	5 6 5	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	7[illegible]	4 12 5	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	9[illegible]	4 4 11	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	9[illegible]	4 5 11	Feb, Aug
10	..	Do. Ord.	12[illegible]	5 8 3	Ja, Ap, Jly, O
10	..	Gt. Northern Tel. Co. with Coup. 7	[illegible]	[illegible] 19 6	Ja. My. Jly
25	15	Indo-European xd and bonus	5[illegible]	[illegible] 0 4	Mar., Nov
1	2	Marconi's Wireless Tel. Co.	1[illegible]	11 12 6	April
1	1/4	Do. 7% Pref.	1[illegible]	[illegible] 5 4	July
10	..	West India & Panama Ord.	1[illegible]	[illegible] 0 0	May, Nov
12	6%	Do. 1st Pref.	[illegible]	[illegible] 7 3 4	May, Nov
10	4%	Western Union Co.	13[illegible]	[illegible] 5 2 9	Mr, Jly, O. Dec
St.	4%	Do. 4% Deb. St.	8[illegible]	4 9 8	Jun, Dec
		Telephones.			
..	£2	American Telephn. & Telgh. $100 Cap	124½	6 8 9	Ja.Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	7[illegible]	6 6 2	Jan. Jly
1	7½	Mexican Telephone Ord.	[illegible]	[illegible] 12 5	Nov.
..	4½	New York Telephone 4½% Bds.	[illegible]	4 15 11	May, Nov
1	10%	Oriental Telephone Ord.	2[illegible]	4 15 6	Apl, Oct
St.	4%	Do. Db. St.	[illegible]	4 12 [illegible]	Jan, Oct
St.	4½%	Telephn. Co. of Egypt Db. St.	[illegible]	5 2 3	Jan, July
..	..	United River Plate Ord.	[illegible]	[illegible] 12 0	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4[illegible]	[illegible] 3 3	Jan, July
St.	4%	Do. [illegible]	[illegible]	4 15 3	Jan, July
		Financial and Investment.			
1[illegible]	[illegible]	Cl[illegible] & Tr[illegible]	1[illegible]	5 10 4	Sp.Dc.Mr.Jn
1[illegible]	[illegible]	Do. 6% Pf.	11[illegible]	5 5 6	Sp.Dc.Mr.Jn
1[illegible]	[illegible]	Mackay Companies' Common	[illegible]	6 5 0	Ja. Apl. Jly. O
..	4%	Do. Pref.	[illegible]	[illegible] 14 3	Ja.Ap[illegible].O
100	6%	Submarine Cable Trust Certs.	12[illegible]	4 15 [illegible]	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	[illegible]	5 14 11	Jun, Dec
St.	4½%	Do. [illegible]	[illegible]	[illegible] 5 3	Jan, July
St.	4%	Do. 4% Debs.	[illegible]	4 15 5	Jan, July
..	..	Do. [illegible]	[illegible]	[illegible] 6 3 11	Jan, July
[illegible]	[illegible]	Do. 5½% 2nd Pref.	[illegible]	[illegible] 7 9 2	Jan, July
1[illegible]	3½	Brazilian Traction Ord.	[illegible]	[illegible] 12 0	Fb,My,Aug,N
1[illegible]	3½	[illegible]	[illegible]	[illegible] 6 1 [illegible]	Ja.Apr,Jly,O
..	..	Brisbane Trams Ord.	[illegible]	[illegible] May	..
..	2/6	Do. 5% Cum. Pref.	[illegible]	[illegible] 5 0 6	May, Nov
St.	4½	British Columbia 4½% Con. Debs.	[illegible]	[illegible] 5 [illegible] 11	..
..	..	Calcutta Elec. Trams. Ord.	[illegible]	[illegible] 7 1 6	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	88½	[illegible] 5 13 3	Feb, Aug
..	..	Madras Elec. Trams 6% Cum. Pref.	[illegible]	[illegible] 6 9 0	..
1[illegible]	..	Manaos Trams 5% Debs.	[illegible]	[illegible] 7 4 11	Jan, July
..	..	Mexico Trams Common St.	[illegible]	30	Fb.M,Aug,N,
..	..	[illegible]	[illegible]	[illegible] [illegible] 15 [illegible]	Mar, Sep
St.	4½	Montreal Street Ry. 4½% Debs. (1922)	100[illegible]	[illegible] 4 4	Feb, Aug
100	5%	Port [illegible] Bds.	[illegible]	[illegible] [illegible] 0	Jun, Dec
1[illegible]	[illegible]	Tr[illegible]	95[illegible]	4 14 3	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
2[illegible]	..	A[illegible]	[illegible]	[illegible] 5 13 [illegible]	Mar, Sept
..	..	[illegible]	[illegible]	[illegible] 4 18 [illegible]	Jun, Dec
..	..	[illegible]	1[illegible]	[illegible] [illegible] 13 [illegible]	..
..	..	[illegible]	[illegible]	[illegible] [illegible] 11 [illegible]	Apl, Oct
..	..	[illegible]	[illegible]	[illegible] [illegible] 11 [illegible]	..
..	..	[illegible]	92	7 12 2	Ja.Apl,Jly,O
..	..	[illegible]	102[illegible]	4 17 7	June, Dec
5[illegible]	..	[illegible]	[illegible]	4 19 0	Apl, Oct
..	..	[illegible]	[illegible]	[illegible] [illegible] 3	Jan, July
..	..	[illegible]	[illegible]	[illegible] [illegible] 11	Ja.Apl,Jly,O
5[illegible]	[illegible]	[illegible]	[illegible]	[illegible] [illegible] 3	Jan, July
5[illegible]	[illegible]	[illegible]	[illegible]	[illegible] [illegible] 3	Mar, Nov
..	..	Victoria Falls & Transvaal P. Co., 6% Pf.	[illegible]	[illegible] [illegible] 6	Jan, July
..	..	[illegible]	[illegible]	[illegible] [illegible] 3	Jan, July

† Ex [illegible] dend for interest

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date June 1, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	13½d.	Antimony	£115 0 0
Solid Drawn Copper Tubes	13½d.	English Lead	£22 0 0
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	14d.	**Old Metals:**	per ton.
Brass Wire	13½d.	Clean Scrap Copper	£73 0 0
Copper Wire	12½d.	Brazlery Copper Scrap	£68 0 0
Rolled Brass	13d.	Clean Scrap Brass	£54 10 0
Brass Sheets	13½d.	Old Lead	£19 10 0
	per ton.	Old Zinc	£50 0 0
Copper Sheets	£100 0 0	Hollow Pewter	£123 0 0
Spelter	£[illegible] 0 0	Black Pewter	£85 0 0
		Gun Metal	£63 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date June 1, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£66 0 0	Old Lead	£19 0 0
Clean Mixed Brass	£55 0 0	Tea Lead	£17 10 0
Clean Copper	£72 0 0	Old Zinc	£64 0 0
Brazlery Copper	£[illegible]	Hollow Pewter	£120 0 0
Clean Copper Wire	£[illegible]	Snaped Black Pewter	£85 0 0
Gun Metal	£64		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75. Commercial Tinman's Solder, £95: Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	No. of weeks.	Aggregats. Amount	Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	.. ..	[illegible]	[illegible]	..	..	..
Anglo-Argentine	May 27	53,580	+ 1,977	21	1,082,097	− 100,175
Ashton-under-Lyne	.. ..	[illegible]	[illegible] 237	9	4,389	− 135
Ayr Corporation	.. ..	322	13	2	655	− 67
Bath Elec Trams. Ltd	.. ..	..	..	..	..	..
Birkenhead Corporation	.. ..	1,527	[illegible] 304	9	11,423	+ 196
†**Birmingham Corporation**	.. ..	13,769	[illegible] 251	8	99,951	+ 411
Blackburn Corporation	.. ..	2,037	[illegible] 242	9	11,819	− 368
Bolton Corporation	.. ..	2,635	[illegible] 137	9	22,168	− 3,172
†**Bournemouth Corporation**	.. ..	2,619	[illegible] 233	8	17,532	+ 997
Bradford Corporation	.. ..	[illegible]	[illegible] 2,719	9	57,113	+ 2,023
Brighton Corporation	.. ..	1,291	[illegible] 201	9[illegible]	8,862	− 490
†**Bristol Trams & Carriage**	.. ..	13,767	+ 5,397	21	190,392	+ 21,378
Burmah E. Trams & Ltg	.. ..	R4,060	− R379	21	..	− R41,291
Burnley Corporation	.. ..	1,957	[illegible] 486	9	14,516	− 899
Burton Corporation	.. ..	315	[illegible] 17	9	2,442	− 178
Bury Corporation	.. ..	1,664	[illegible] 345	9[illegible]	11,974	− 365
Calcutta Tramways Co.	.. ..	R62,425	− R367	21	R1,391,483	− R83,358
Camborne-Redruth	.. ..	197	[illegible] 38	21	2,715	− 105
Cardiff Corporation	.. ..	2,707	[illegible] 78	7	19,374	− 2,276
Central London Railway	.. ..	..	..	..	..	..
Cork Electric Trams Co.	.. ..	618	[illegible] 113	21	9,854	− 196
Corn Corporation	.. ..	1,683	[illegible] 142	7	13,130	− 434
*†**Derby Corporation**	.. ..	1,327	[illegible] 338	8[illegible]	8,968	+ 49
Dover Corporation	.. ..	360	[illegible] 135	8	2,513	+ 472
Dublin & Lucan Railway	.. ..	[illegible]	[illegible] 104	21	2,864	+ 146
Dublin United	.. ..	[illegible]	[illegible] 1,821	21	123,869	+ 7,355
Dundee Corporation	.. ..	1,358	[illegible] 82	9	2,021	− 63
East Ham Council	.. ..	1,410	[illegible] 433	8	11,257	+ 2,459
Erith Urban Council	.. ..	..	..	..	..	..
Exeter Corporation	.. ..	[illegible]	[illegible] 147	3	3,108	− 69
Glasgow Corporation	.. ..	22,8[illegible]	[illegible] 873	52	1,064,738	− 6,646
Glossop Trams	.. ..	[illegible]	[illegible] 42	22	2,537	− 155
Gloucester Corpn.	.. ..	455	[illegible] 146	8	2,654	− 27
†**Halifax Corporation**	.. ..	3,439	[illegible] 381	49	18,731	− 767
Hastings Elec. Trams Co.	.. ..	1,315	[illegible] 314	21	16,982	393
Hong Kong	.. ..	..	..	..	..	..
Huddersfield Corp	.. ..	[illegible]	[illegible] 1,722	9	23,365	+ 3,229
Hull Corporation	.. ..	[illegible]	[illegible] 345	8	25,026	− 1,125
Ilford District Council	.. ..	[illegible]	[illegible] 341	8	5,512	+ 1,308
Ilkeston Corporation	.. ..	[illegible]	[illegible] 42	8	1,018	− 40
Ipswich Corporation	.. ..	[illegible]	[illegible] 245	8	21,022	+ 121
Isle of Thanet Co.	.. ..	[illegible]	[illegible] 3	34	10,759	− 2,713
Kilmarnock Corporation	.. ..	159	[illegible] 7	2	329	− 82
Lancashire Trams Co.	.. ..	2,093	[illegible] 182	21	37,910	− 1,947
Lancashire United	.. ..	2,102	[illegible] 533	21	33,660	− 66
Leeds Corporation	.. ..	11,651	3,523	9	76,160	+ 4,557
Leicester Corporation	.. ..	3,878	[illegible] 936	22	62,309	+ 1,214
Leith Corporation	.. ..	[illegible]	[illegible] 89	2	1,535	+ 46
Lincoln Corporation	.. ..	153	[illegible] 24	9	1,208	39
Liverpool Corporation	.. ..	..	..	..	..	..
Liverpool Overhead Rly.	.. ..	..	..	..	..	..
Llandudno&ColwynBayR	.. ..	[illegible] 341	+ 234	25	6,533	+ 1,232
London County Council	.. ..	..	..	..	..	..
London Elec. Ry. Co.	.. ..	..	..	..	..	..
London United	.. ..	..	..	..	..	..
Lowestoft Corporation	.. ..	..	..	..	..	..
Maidstone Corporation	.. ..	..	..	..	..	..
Manchester Corporation	.. ..	21,1[illegible]	[illegible] 3,641	8	152,383	+ 374
Mersey Railway	.. ..	..	..	..	..	..
Nelson Corporation	.. ..	[illegible] 281	[illegible] 11	8	1,674	− 258
Newcastle-on-Tyne Corpn	.. ..	6,531	+ 1,397	8[illegible]	51,824	+ 6,939
Newport (Mon.) Corpn.	.. ..	[illegible]	+ 10	8	[illegible]	− 355
Northampton Corporation	.. ..	1,074	+ [illegible]	8**	6,264	+ 1,312
Oldham Corporation	.. ..	2,712	+ 428	10	21,995	− 665
Perth (N.B.) Corporation	.. ..	..	..	..	..	..
Perth (W.A.) Elec. Trams	.. ..	..	..	..	..	..
Portsmouth Corporation	.. ..	2,474	+ 109	8	18,542	..
Preston Corporation	.. ..	1,216	+ [illegible] 44	8**	7,683	− 193
Rotherham Corporation	.. ..	[illegible] 1,453	[illegible]	8	8,818	+ 1,031
Salford Corporation	.. ..	6,306	+ [illegible] 1,13[illegible]	9[illegible]	45,703	+ 827
Shanghai	.. ..	..	..	..	..	..
†**Sheffield Corporation**	.. ..	9,678	+ 1,816	9	83,493	+ 5,991
Singapore Trams	.. ..	..	..	..	..	..
Southampton Corpn.	.. ..	1,830	+ [illegible] 8	8	11,[illegible]	+ 690
Southend Corporation	.. ..	[illegible] 1,134	[illegible]	8	[illegible]	− 886
St'lyb'dge, Hyde, &c., Jt. B.	.. ..	1,236	+ [illegible] 15	8	7,124	+ 130
Sunderland Corporation	.. ..	1,678	+ [illegible] 3	9	12,437	+ 94
Sunderland District	.. ..	[illegible]	[illegible] 18	30	16,394	− 876
Swindon Corporation	.. ..	[illegible]	[illegible] 8	8	1,564	+ 154
Tynemouth Corporation	.. ..	[illegible]	[illegible] 3	9	10,559	+ 99
Wallasey Corporation	.. ..	1,668	+ [illegible] 411	8[illegible]	10,582	+ 400
Walsall Corporation	.. ..	1,028	+ [illegible] 11	22	[illegible]	+ 1,337
Warrington Corporation	.. ..	[illegible] 492	[illegible] 3	8	3,596	..
West Ham Corporation	.. ..	[illegible]	[illegible] 3	8	25,357	+ 2,021
Wolverhampton Corpn.	.. ..	1,580	+ 564	8	8,968	+ 321
Yorkshire W.R. Trams	.. 30	2,372	+ 885	22	33,581	+ 2,044

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses &c. ‡ Minus 2 days. ‖ Minus 3 days ⇓ Plus 3 days ¶ Plus 2 days. ** Compared with one week more last year.

THE ELECTRICIAN:

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NOTES.

Heating of Cables.

The generation of heat in electrical machinery is one of those accompaniments of electrical working that is altogether undesired. We need scarcely remark that the inefficiency of electrical plant is chiefly due to this cause. At the same time, having established the fact that heating is inevitable, there is no objection to increasing this heat loss indefinitely, provided always there is a corresponding gain, and assuming, of course, that other electrical conditions can be maintained. For example, there would be no objection to running a motor red hot, provided the insulation would stand such a temperature; and the degree to which such heating can be taken profitably must depend upon what is to be gained in other directions. Since electrical insulation, unfortunately, will not, as a rule, admit of high temperatures, the only thing to be done is to remove the heat generated with sufficient rapidity to maintain a reasonable temperature. At the moment, in electrical generators, this is being done most effectively by means of spray air-filters. Obviously, the greater the amount of heat that can be removed in a given time by such means the smaller can be the generator for a given output. This procedure is limited, however, by temperature limits on the one hand, and by the criterion that where special cooling arrangements are used the cost must not be more than the gain [illegible] reduction in size of the generator.

So far artificial cooling has been restricted to generators, motors and transformers and similar plant; but in a Paper which we give elsewhere by Mr. L. E. Imlay, an account is given of the application of water cooling to electric cables. The idea strikes one as novel, but perfectly feasible. It is well known that the temperature rise of buried cables depends upon the character of the surrounding soil and upon the time of year. In hot weather it is quite possible that the temperature rise of feeders may become dangerously high. Moreover, for this very reason, the soil is slowly dried, it becomes a better thermal insulator, and so the conditions are aggravated still further. On the other hand, if the soil is moistened the heat is more easily carried away and the cable cools. This is what has been done in the Paper to which we have referred. Water is supplied when necessary through porous tiles so as to make the soil in the neighbourhood of the ducts moist. In fact, when overheating is expected, a man is sent round with a resistance thermometer to explore the temperature of the ducts. If he finds the danger point is being reached, he simply turns the water on and thus the temperature is controlled. It is stated that since this method has been adopted no breakdowns of insulation have occurred due to high temperatures. The method certainly seems to be worthy of careful study.

Magnetic Induction.

There has been much discussion at times as to the correct statement of the law of electromagnetic induction, the seat of the E.M.F. and similar problems, and many experiments have been devised in order to catch Nature on the hop, as it were, and to arrive at some more definite conclusion as to what takes place. Dr. Carl Hering is a keen deviser of experiments of this kind, but it is generally found that Nature is not to be caught napping. The latest attempt, as described elsewhere, is by Mr. A. Blondel. Assuming a constant flux through a number of convolutions, then the E.M.F. should vary according to the rate of variation of the number of convolutions, if such variation can be brought about. Mr. Blondel attempted to create this variation by unwinding a coil placed in the field of an electromagnet so that the flux passed down the axis of the coil. It was found that if any E.M.F. was observed it was due to the way in which the end connection was made, and the conclusion is reached that there can only be an induced E.M.F. in a circuit with a constant electromagnetic field if the deformation of the circuit causes the lines of force to be cut by a moving portion of this circuit. This result is probably what

most physicists would have stated to be their conviction beforehand, but it is just as well to have had the point experimentally verified, so that future definitions may be more exact.

Establishment Charges.

If there is one item more than another which the directors of a manufacturing company like to see at a low figure in their accounts it is that under the heading of "rent, rates and taxes." These form a part of the establishment charges, and have to be met before any profit can be obtained. The item always seems to be such an unproductive one—at least, the rates and taxes part of it. Probably this is not realised by the average local authority, and the result is that rates and taxes are raised from time to time, the idea being that this is a very useful means of obtaining as much revenue as may be desired. The inevitable effect, however, is to cause the manufacturer to keep away from large towns. This is more particularly the case in London, unless a site can by chance be found in that favoured spot called West Ham, which by some accident is beyond the bounds of the London County Council. Thus, accommodation must be sought at some considerable distance, sufficiently far away, in fact, to be sure that the London boundary will not one day be increased to include the selected spot. The latest example of this tendency to migrate is that of the Electrical Power Storage Co., who are amalgamating with Messrs. Pritchetts & Gold, and who are moving their works down to Dagenham Dock. This step will no doubt give relief in the item of rates and taxes, and will give other advantages in addition. It is obvious that if this process continues there will be comparatively few works left in the London area, and it would be well for the local authorities concerned (chiefly the L.C.C.) to realise the desirability of not altogether killing the goose that lays the golden eggs.

Royal Engineers (T.F.).—The following appointments and changes have been made:—

Durham (Fortress) Engineers: J. Aitken (late Qmr. and hon. lieut. Tyne Electrical Engineers) to be second lieutenant.

Tyne Electrical Engineers: Lieut. G. L. L. Russell to be temporary captain. Second-lieutenants D. A. Williamson, R. L. Wood and W. Hall to be temporary lieutenants.

Devon (Fortress) Engineers, No. 5 Electric Lights Company: H. L. Hodgson to be second lieutenant.

Birthday Honours.—To the list set out in our last issue the following should be added:—

K.C.M.G.—*William Peterson*, LL.D., C.M.G., Principal and Vice-Chancellor of the McGill University, Montreal.

K.C.I.E.—*William Maxwell*, C.I.E., M.V.O., I.C.S., Director-General of Indian Posts and Telegraphs.

New Knight.—*Robert Richard Gales*, A.M.Inst.C.E., F.C.H., Indian Public Works Dept., engineer-in-chief, Hardinge Bridge, Sara, Bengal.

Imperial Service Order.—*Charles Edward James Twisaday*.

Mr. Twisaday has been for 46 years connected with the Indo-European Telegraph Dept., India Office. He was appointed to the London office of the Department in 1869, and accompanied the late Col. Bateman Champain, Director-in-Chief, to Constantinople in 1880. In 1885 he went to the Persian Gulf with the third Persian Gulf Cable Expedition, and afterwards to India. He was transferred to the India Office in 1889, and retired from the service in May, 1915.

Richard Joshua Keys, Indian Telegraph Dept., Deputy Superintendent, Simla.

"Faraday House Journal."—The summer number of this journal has come to hand, and in it we note a further list of over 50 names of Faradians who are serving in the Allied Forces. We also learn with regret that three Faradians have lost their lives on active service in France. These are Major H. H. Stanley March (4th London Field Co., 2nd London Divisional Engineers), who was wounded by a shell whilst superintending a working party under fire, and died in hospital at Béthune the next day; Private H. A. Godby (1st Batt. H.A.C.), who was wounded when returning from the trenches, and died at Bailleul five days later; and Second-Lieut. E. H. Orton, who was killed in action near Armentières. The technical contributions to the "Journal" consist of a short article by Mr. Joseph Goodman on "A Note on the Third Harmonic in Transformers," and one by Dr. Alexander Russell on "Interpolation." Biographical sketches are given of Mr. T. P. E. Butt, the well-known South African consulting engineer; Mr. L. H. Combe, chief and consulting engineer to the Colombo Electric Tramways & Lighting Co.; and Mr. H. W. Swann, resident engineer and [illegible] Barnet undertaking of the North Metropolitan Company.

Coal Supplies.—The report of the Departmental Committee appointed to inquire into the conditions prevailing in the coal-mining industry due to the war was issued as a White Paper on Tuesday. The report deals with the causes of the decrease in output, which has amounted to 13½ per cent., the recruiting of miners, the suspension of the Eight Hours Act, and other questions, and recommends several proposals for remedying present conditions, the basis of all of which is harmonious co-operation between employers and employes.

A deputation of representatives from the gas and electricity supply undertakings (as the result of the recent conference at the Institution of Electrical Engineers) met about 100 members of the House of Commons on Wednesday last. The meeting was adjourned until Tuesday next.

The Heraeus Electric Vacuum Meter.—This instrument, which is described in the "Zeitschrift für Elektrochemie," Bd. 20, p. 539, permits the measurement of gas-pressures down to 10^{-5} mm. of mercury, and is based on the following principles:

If a thermo-element arranged in a vacuum is provided with a constant supply of heat, the heating of the hot junctions is greater the less energy is withdrawn from the element by conduction in the gas, *i.e.*, the better the vacuum. In the Heracus instrument 20 thermo-elements, consisting of narrow bands of two nickel alloys (E.M.F. = 0·06 mv. per degree) coupled up in series, are cemented between two square glass plates, which are 12 mm. thick and have each a central transverse hole 50 mm. diameter, thus forming a cylindrical chamber along a diameter of which are arranged the junctions to be heated. Ten of the elements enter this chamber from each side, so that the hot junctions lie in two rows in juxtaposition. The ends of the chamber are closed by thin glass plates, and communication between the chamber and the space, the vacuum in which is to be measured, is made through a glass tube mounted in a radial hole. The constant supply of heat is afforded by means of a 10 c.p. 10 volt incandescent lamp arranged with the filament opposite one end of the cylindrical chamber. A heavy nickelled metal casing is provided around the glass cell, which ensures a constant temperature for the cold junctions of the thermo-elements. The E.M.F. developed is measured by a voltmeter of the d'Arsonval type having a range of 18 mv., each division being equivalent to 10^{-4} volts. By means of a switch, this instrument can be used for controlling the constancy of the current in the lamp used for supplying heat.

Illumination for Steam Shovels.—The "Mining and Engineering World" gives particulars of the methods adopted by an American mining company in order to obtain adequate illumination for operating their steam shovels at night. Acetylene, which was first tried for the work, proved too troublesome, costly and somewhat dangerous, and was consequently discarded in favour of electricity. The general illumination of the bank is furnished by a battery of powerful searchlights situated on the opposite side of the canyon from which the shovels dig. About 20 incandescent lights are also placed on each side of the shovel to provide local illumination, but to supply these with current proved to be difficult, as the shovels are continually on the move. A method of mounting a reel on each shovel with a flexible cable, which was unwound on to the ground as the shovel proceeded was tried for several years. The cable was tapped on to a power circuit, carried by poles. This method proved to be unsatisfactory owing to the continual damaging of the cables, due to the movement of stones during blasting, &c. The problem was eventually solved by mounting a 1 kw. turbo-generator, driven direct from the steam shovel boiler, on to the frame of the shovel.

Electrically-Operated Suction Dredger.—An interesting type of suction dredger is described in a recent issue of "Engi-

neering News." The dredger is used on the construction of a cut on the Cuyahoga River, Cleveland, U.S.A., and is operated entirely by electricity which is conveyed to the boat by cable from the bank, where a transmission line runs parallel to the cut. All machinery is driven by three-phase 60-cycle 2,200-volt motors, the variable-speed motors being of slip-ring type, equipped with 14-point reversing controllers. The main dredging pump has 16 in. suction and discharge openings and is direct-connected by means of a flexible insulating coupling to a 300 H.P. motor mounted on the same bedplate. The pump is designed to deliver 225 cubic yds. of solid material per hour through 1,000 ft. of discharge pipe to 12 ft. above water, when running at 345 revs. per min. Owing to the great variation in the length of the discharge pipe required at various times, the motor was provided with controlling apparatus for running continuously with 25 per cent. speed reduction. To sluice material into the cut ahead of the dredge, a 2 in. hydraulic giant is mounted on the bow of the dredge. Water for this giant is provided by a 6 in. three-stage Worthington turbine pump, delivering 1,300 gallons per minute at a head of 360 ft., direct-connected to a 200 H.P. motor operating at 1,140 revs. per min. The cutter drive and suction pipe are mounted on a structural steel ladder suspended at the bow of the dredger on steel trunnions. The cutter is driven through reduction gearing by a 75 H.P. motor running normally at 575 revs. per min. but able to operate continuously at half speed.

Portland Cement Works in Queensland.—Owing to the shortage of German and Belgian supplies, a good deal of attention is being given to the manufacture of Portland cement in the Colonies and other places abroad, where limestone, shale or clay and coal can be obtained of suitable quality, and in sufficient quantities to make the manufacture likely to be successful and remunerative. The Queensland Cement & Lime Co. has now arranged to establish a works at Darra, near Brisbane. The plant is designed to produce about 40,000 tons of cement per annum. The complete contract for the supply and erection of the plant, which will be entirely of British manufacture, has been placed with Messrs. Noyes Bros. (Sydney). Grinding mills of the combination ball and tube mill type and a kiln 140 ft. long and 8 ft. diameter will be erected, and these together with all the subsidiary plant will be electrically driven, direct-coupled wherever possible. The motors are for three-phase, 50 cycles, 440 volts, and will be supplied with power from generating plant in the works, which will be direct-coupled to vertical high-speed engines. The general layout of the plant has been made with the expectation that the works will soon be duplicated and even further increased.

British Wire Manufacturers and Germany's European Trade.—A correspondent writes :—

As a result of the almost entire stoppage of German trade with the chief European markets interested in the wire drawing industry, particularly in the copper section, British manufacturers are constantly receiving inquiries from buyers abroad who hitherto have dealt entirely with German firms. This encouraging feature in the expansion of the overseas trade has stimulated many large manufacturing firms in this country into organising still more comprehensively and efficiently the departments associated with this section, and many others will doubtless institute similar extensions immediately the heavy pressure at present prevailing in the copper and bronze wire-drawing works is relieved by more normal working conditions. Unfortunately, at the present time it is impossible to obtain anything like full benefit from this fresh source of trade, as a result of the heavy Admiralty and War Office requirements and British wire manufacturers and the difficulties presented by the skilled labour problem. For the past decade or so Germany has supplied the bulk of the European trade in copper goods, very largely as a result of more favourable geographical considerations, which have given the Germans an enormous advantage in carriage and freight rates ; but also, it must be confessed, as a result of the sustained enterprise and efficient organisation employed in the development of the overseas trade.

That every possible effort to regain this trade will be made by Germany after the conclusion of the war there can be no doubt, but their ability to succeed in this direction must depend very largely upon the hold which British and other manufacturers have in the meantime acquired upon these strongholds of German trade. In 1912 Germany exported copper goods to European countries to the value of £1,708,750, the greater part of which was copper for electrical purposes. The exports from the United Kingdom to the same countries for the year 1913 were £261,300, which shows an enormous disparity in Germany's favour. It must also be borne in mind that in 1912 Germany exported nuts and bolts and copper goods to the value of £317,800, all of which trade has been entirely suspended. Particularly in regard to this last item, every effort should be made to retain permanent hold upon the greater portion of the home demands.

Electric Iron-Ore Smelting in Norway.—According to a recent article in "Engineering" the adoption of electric furnaces in Sweden for the reduction of iron ore is apparently spreading, and the results obtained are encouraging, and likely to lead to further developments in this direction. In Norway matters have not progressed quite so smoothly, owing to the different conditions prevailing in the two countries. In Sweden charcoal is used as the means of reduction, but in Norway charcoal becomes too expensive, and unless coke can be used the process cannot be worked with advantage, in spite of Norway's wealth of water-power. The first attempt with coke at the Hardanger works proved so little encouraging that the whole works eventually stopped, although the ores used were rich in iron. At Tinfos, however, the very opposite experience has been encountered. A regular and remunerative manufacture of electric iron has now been going on for some time, and the production for the present year is estimated at 10,000 tons of electric pig. This satisfactory result is all the more noteworthy inasmuch as the ores used are rather poor so far as their percentage of iron goes, but otherwise what may be called good ore, averaging about 4 per cent. of magnetic iron ore. The four electric furnaces used at Tinfos have been worked regularly since the beginning of the present year, one being always kept in reserve. Each furnace produces about 9 tons per day, or 27 tons for the three, making some 10,000 tons per annum. The percentage of pig-iron from the ore varies from 44 to 47 per cent. according to the quality of the ore. The power in the furnace may be as much as 1,200 kw. to 1,400 kw.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Prof. J. A. Fleming contributes an article "On the Causes of Ionisation of the Atmosphere" (p. 348).

Dr. C. C. Garrard commences an article on "Apparatus for Protecting Electrical Machinery Against Abnormal Electrical Conditions" (p. 350).

Prof. Geo. R. Dean concludes an article on the "Differential Equations of Long-distance Transmission" (p. 358).

We reproduce a Paper on the "Effect of Moisture in the Earth on the Temperature of Underground Cables," by Mr. L. E. Imlay (p. 343).

An abstract of a Paper on the "Laws of Induction," by Mr. A. Blondel is given (p. 344).

We give a report of the annual general meeting of the Association of Consulting Engineers (p. 354).

A Paper on "An Electromagnetic Vacuum Balance," by Dr. J. S. Anderson, is abstracted (p. 359).

We publish a description of the pumping equipment at the Gladstone Dock, Liverpool (p. 347).

An account of an investigation by Mr. W. P. Kennedy on the operating cost of Electric Vehicles is given (p. 346).

Companies' Meetings and Reports. Meetings of the Electrical Power Storage Co., Reuter's Telegram Co. and Shropshire, Worcestershire & Staffordshire Electric Power Co. are reported ; and the reports of the directors of the New General Traction Co. and United Electric Tramways of Montevideo are abstracted (pp. 370-371).

OBITUARY.

JOHN CHAPMAN.—We learn with regret of the death from wounds caused by a sniper's bullet of Capt. John Chapman, Leith Lovecster-Lane Regiment, I.F.A. Capt. Chapman served his pupilage with the Brush Electrical Engineering Co., afterwards serving in the works electrician's department, and latterly being attached to the company's London office. He was a young man of attractive personality and of great promise in his profession, and his death at the early age of 26 years will be regretted by all who knew him. The gallant officer at the outbreak of war held the rank of lieutenant, but was shortly afterwards promoted captain, and left with the regiment for the front some time ago.

R. S. TRESILIAN.—We regret to record the death of Mr. Robert S. Tresilian, secretary of the Dublin United Tramways Co. The deceased had been with the company over 40 years.

PERSONAL.

Sir W. Maxwell, K.C.I.E., Director-General of Indian Government Posts and Telegraphs, has been granted a year's combined leave, and Mr. C. H. Harrison will act as Director-General.

Mr. Percy Taylor, assistant electrical engineer at Darwen, who enlisted in the Mechanical Transport Service a few weeks ago, has been appointed mechanical staff sergeant.

Mr. R. W. Klitz, chief assistant electrical engineer at Wimbledon, has applied for leave of absence to enable him to join the army.

Mr. Trevor Duesbury, borough electrical engineer of Sutton Coldfield, has joined the Army.

Mr. R. N. Mayne, engineer and manager of the Redditch Council electricity works, has received a commission as second lieutenant. The Electric Supply Committee have passed a resolution expressing appreciation of Mr. Mayne's patriotism, but stating that it was vital to the general interests of the town in its relation to the manufacture of war munitions that Mr. Mayne should remain at Redditch, so as to ensure a regular supply of electric current for power, and appealing to him to reconsider his decision.

We learn with pleasure that Lieut. E. G. Boissier, Royal Naval Volunteer Reserve (Howe Batt. R. N. Division), who at one time held the position of mains superintendent in the Derby Corporation electricity department, afterwards going to Messrs. Aiton & Co., Derby, as works manager, has been awarded the Distinguished Service Order.

By a petition to the Circuit Court of Hudson County, New Jersey (U.S.A.), Mr. Gilbert Rowe (formerly Rosenbusch), of Queen Anne's Chambers, Westminster, has changed his name in order that he may dissociate himself from everything German. Mr. Rowe is an American citizen, born in the United States, and is well known as an expert in all classes of lift work.

APPOINTMENTS VACANT AND FILLED.

A demonstrator is required in the physics department of the Birmingham Municipal Technical School. Commencing salary £125. Applications to the secretary, Mr. Geo. Mellor, Suffolk-street, Birmingham, by June 30. *See an advertisement.*

An assistant manager is required by the Chatham & District Light Railways Co. Commencing salary £200 per annum. Applications to the Secretary, 83, Cannon-street, London, E.C. *See advertisement.*

Junior switchboardmen are required for a large 11,000 volt three-phase power station. *See advertisement.*

An assistant is wanted in the testing department of a cable works in the Manchester district. *See advertisement.*

A resident assistant engineer, ineligible for Army service, and with experience in electric lighting and telephone work, is wanted for Bethnal Green Military Hospital, Cambridge Heath, London, N.E. Wages 32s. 6d. per week, with board, &c. Applications to the Chief Engineer.

Applications are invited for the post of officer-in-charge of the electrocardiograph department of the Middlesex Hospital, London, W. Honorarium, £50 per annum. Applications to the Secretary Superintendent by July 12.

South Shields Corporation have appointed Mr. J. C. Whiteley, assistant tramways manager of the Chatham & District Light Railways Co., to the position of manager of the municipal tramways at £300 per annum.

INSTITUTIONS AND SOCIETIES.

Development Committee of the I.M.E.A. The fifth meeting of the committee was held on April 15, when a report was received from the Publicity Sub-committee on the work done with regard to a preparatory scheme for the production of printed matter on a co-operative basis. The chairman reported that Mr. Dunlop, on behalf of the B.E.A.M.A., had very kindly offered the use of offices and clerical assistance in connection with the routine work of purchase and distribution of such printed matter, at least during the early stages of the [illegible] The meeting expressed their appreciation [illegible] Mr. Cousins, of the General [illegible] sub-committee in place of [illegible] A report was also [illegible] Sub-committee, and one by [illegible] Committee outlining a [illegible] matter [illegible] which the [illegible] The committee recommended the inclusion of Mr. Shaw (Worcester) and Mr. Wilmshurst (Derby) as members of this sub-committee. Also, that from time to time members of manufacturing firms should be co-opted for advice and assistance in regard to specific objects which might be considered helpful to the work of the Development Committee. In general discussion arising out of the work of the committee, the point was made that although depletion of staffs arising out of the war, and restrictions placed on borrowing money must in the nature of things considerably hamper development work, yet there remained with most undertakings a large amount of new business to be obtained with very little expenditure, and, therefore, there still existed room for selective canvassing and publicity work which might be directed to helping manufacturers and traders under the present difficult conditions, if electricity supply were put forward, more particularly in regard to power, on the strength of its real time and labour-saving advantages and not merely as an improvement on existing conditions. The secretary reported the correspondence he had had with Mr. Wakeman, Society for Electrical Development, New York, and the committee instructed him to thank Mr. Wakeman for material sent and offers of assistance and co-operation, which the committee appreciated very much, and hoped that under more favourable conditions in the near future further development in this direction might become possible.

EDUCATIONAL NOTE.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses, giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

ARRANGEMENTS FOR THE WEEK.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Thursday, June 17th.

10 a.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C. Report on "The Practical Result of the Point Five Tariff," by Messrs. H. S. Blackman and T. Roles.

2 p.m. Report on the "Use of Electric Vehicles in Municipal Service," by Mr. F. Ayton.

5 p.m. Parade and demonstration of electric vehicles on the Victoria Embankment.

Friday, June 18th.

10 a.m. Annual general meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C.

FRIDAY, June 11th (to-day).

PHYSICAL SOCIETY.

8 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington, London, S.W. Agenda: Papers on "The Coefficient of Expansion of Sodium," by Messrs. E. A. Griffiths and E. Griffiths; "Notes on the Calculation of Thin Objectives," by Mr. T. Smith; "On Tracing Rays through an Optical System," by Mr. T. Smith; and "The Accuracy of the Lens and Drop Method of Measuring Refractive Index," by Mr. H. Redmayne Nettleton.

THE NATIONAL RELIEF FUND.

(Treasurer, H.R.H. The Prince of Wales.)

This great National Fund, for the relief of those amongst the needier classes who are widowed, orphaned and otherwise affected by the fighting in which our troops and ships are now taking part, urgently seeks contributions however small. These can be sent with the following note, which can be cut out, filled in, put in an envelope and sent *unstamped*, addressed H.R.H. The Prince of Wales, Buckingham Palace, London.

Date .....

I enclose £ ..... *on behalf of the Prince of Wales' National Relief Fund.*

Name .....

Address .....

EFFECT OF MOISTURE IN THE EARTH ON TEMPERATURE OF UNDERGROUND CABLES.*

BY L. E. IMLAY.

Summary.—The author describes a method of [illegible] the temperature of underground cables, and gives results showing the distribution of heat in the earth around cables. The effect of introducing moisture in the earth is to reduce the cable temperatures, and practical methods of supplying this moisture are described.

It is not practicable to measure directly the temperature of the insulation of a cable at the surface of the conductor, without resorting to apparatus that is not suitable for [illegible] cable system. For practical purposes, however, the temperature of the conductor can be obtained by exploring with a resistance thermometer the temperature of a duct adjacent to the cable that is the source of the heat. As we are principally interested in maximum temperatures, a cable should be selected for this purpose that is most unfavourably situated for radiation of heat. This cable can usually

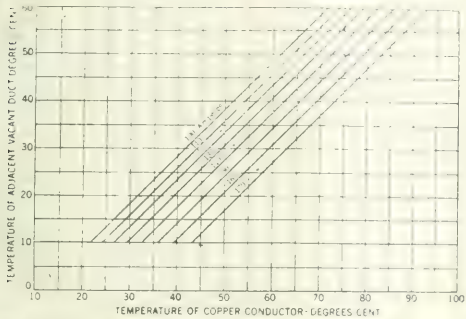


FIG. 1.—3 0 THREE-CONDUCTOR, 11,000-VOLT PAPER AND LEAD CABLE.

be selected by inspection. If the cables are situated as in Fig. 4 and temperatures are taken in duct marked T, the temperature of the insulation at the surface of the conductor is taken from a curve that applies to that particular cable. Fig. 1 is such a curve for a 3/0, three-conductor 11,000-volt cable. For example, if a 3/0 three-conductor 11,000-volt cable is carrying 170 amperes and the temperature of the adjacent duct T is 39°C., the temperature of the insulation at the surface of the conductor is 72°C. These curves are deduced from a formula given by Messrs. Atkinson and Fisher.† The maximum safe limiting temperature of paper insulation at the surface of the conductor in a cable, as stated in the Standardisation Rules of the A.I.E.E., is 85°C., less a number of degrees equal to the kilovolts at which the cable is operated. In the case of a three-

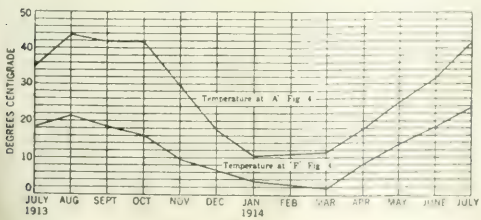


FIG. 2.

conductor 11,000-volt cable, the limiting temperature of the insulation at the conductor is, therefore, 74°C., and in the case of a 2,000-volt cable the limiting temperature is 83°C.

It was decided to adopt 66°C. as the maximum temperature for continuous operation of 11,000-volt paper insulated cables, and 75°C. as the maximum temperature for continuous operation of 2,200-volt paper insulated cables. This is 8°C. [illegible] the safe limiting temperature specified in the Standardisation Rules, which are based on the heating load with peak of one [illegible].

To get some idea of the seasonal variations in temperature of the earth, readings were taken each month in the year at a point about 3 ft. below the surface of the earth. This point was chosen near a section of conduit where over-heating of cables had occurred, but at such distance that it was practically unaffected by heat from the conduit. In Fig. 2 the lower curve shows the seasonal variation in the temperature of the earth. The upper curve shows the temperature variation 3 ft. below the surface of the earth, above a conduit containing cables. Fig. 3 shows the distance to which the earth surrounding a conduit is affected by heat from cables. The measurements were taken at different seasons of the year under approximately identical load conditions. The results indicate that parallel conduits must be at least 30 ft. apart in order that the heat from one of them shall not appreciably affect the other.

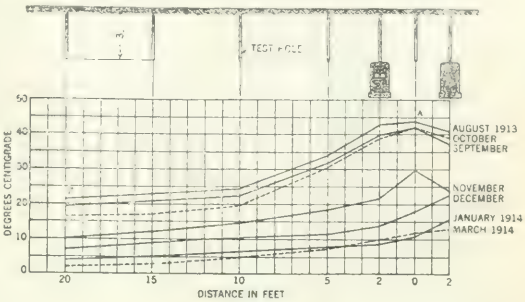


FIG. 3.

An effective remedy for hot spots in cables is to unearth the conduit and expose it to the air. In uncovering a conduit directly after a cable breakdown, it was found that the adjacent earth was very hot and so dry that it would crumble to powder. This condition suggested digging a ditch a few inches deep in the ground just over and along the length of the conduit and directing a stream of water through it, as irrigation for crops is carried on in the Western States. This remedy immediately lowered the temperature of the cables several degrees. Where conduit was under roadways and paved streets the open ditch method was not available, and at these points water was discharged into a vacant duct by means of a garden hose. This was found to be even more effective than the open ditch method. In some cases, however, where multiple duct was used the water

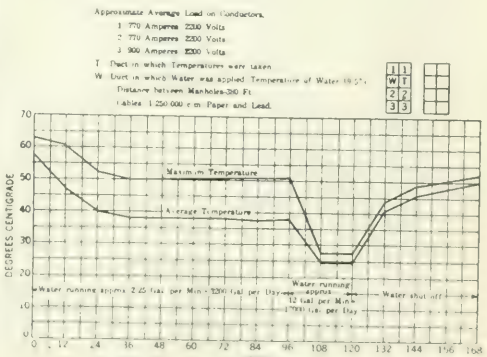


FIG. 4.

would not flow from one manhole to another, being lost on the way. Fig. 4 shows the effect on the temperature of cables of water discharged in a vacant duct. Two and a quarter gallons per minute reduced the temperature 13°C., and held it about constant. When the amount of water was increased to 12 gallons per minute, the temperature was reduced 17°C. further and then became constant. The remainder of the curve shows the gradual rise in temperature after the water was shut off.

Plans were worked out to bring the temperature points the way to a permanent installation to control the temperature of cables in conduit. The method finally adopted is shown in Figs. 5 and 6. Porous drain tiles 4 in. in diameter were made in sewer pipe moulds. These were laid in a trench in the earth above the conduit, as shown

* Paper read before the American Institute of Electrical Engineers, and abbreviated.

† Trans. A.I.E.E., Vol. XXXII., p. 325.

in cross-section in Fig. 5. The joints were cemented to prevent leakage except through the pores of the tiles. This tile serves a purpose exactly opposite to that for which drain tile is generally used—that is, water is supplied through it to the surrounding earth instead of being conducted away. The first experiment indicated that it might be difficult to get tile porous enough to exude a sufficient amount of water effectively to moisten the earth. This test was made with tile lying on the ground exposed to the air. After some

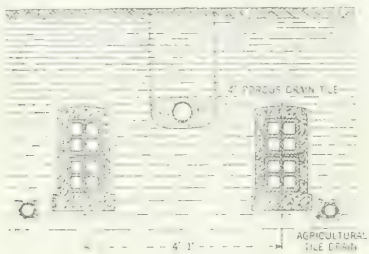


FIG. 5.

experimenting it was found that the amount of water that would pass through the pores of the tile could be greatly increased by a covering of earth. Clean sand around the tile was more effective in producing the desired result than any other material tried.

In Fig. 7, curve A shows the distribution of heat in the earth at right angles to a line of conduit containing 2,200-volt cables before

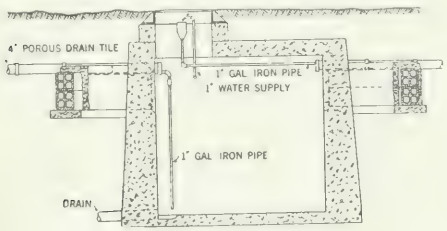


FIG. 6.

water was applied by the drain tile method. Curve B shows the temperature after three gallons of water per minute had been applied about 36 hours.

It has been maintained by some that cables will run cooler in conduit surrounded by earth than in conduit surrounded by air. In Fig. 8 the upper curve shows temperatures obtained in duct indicated by letter T before any effort was made to reduce the normal

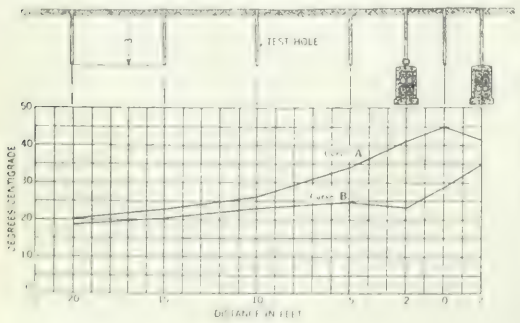


FIG. 7.

temperature. The middle curve shows temperatures obtained in the same duct after the top of the conduit had been unearthed. In this case the sides of the conduit were still covered with earth. The temperature of the air at the time of the test was about 16° C. The lower curve shows temperatures that were obtained after the duct had been laid, the earth replaced, and three gallons of water per minute supplied continuously for moistening the earth. The current on the cables was practically constant throughout the interval covered by these tests.

In practice the work of looking after the temperature of the cables is as follows: When the season of the year arrives when overheating may be expected, a man is sent around with a resistance thermometer to explore the temperature of the ducts. If he finds the danger point is being reached or even approximated, water is turned

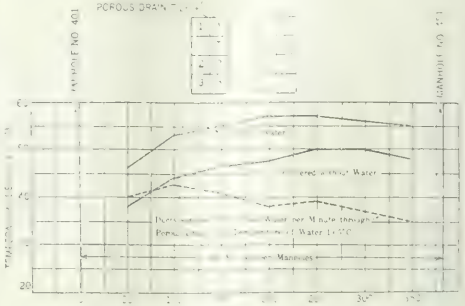


FIG. 8.

into the porous drain tile. The following day the temperature is again taken to see whether the desired reduction has been obtained. In this way one or two men with portable resistance thermometers attached to long leads can keep track of and control the temperature of cables in a large system. Since this plan was adopted no breakdowns in insulation of cables have occurred due to high temperatures. The plans for installing the porous drain tile for cooling have been adopted as a standard, and whenever new conduits are laid in which high temperatures may be expected the conduit will be provided with this means of cooling.

THE LAWS OF INDUCTION.*

BY A. BLONDEL.

Considerable discussion has arisen at different times as to the most general method of stating the laws of induction. The question is whether it should be considered that an E.M.F. is produced by any variation in the magnetic flux which is included within the circuit of a conductor, or whether it is produced by the act of the conductor in brushing through a portion of this flux. Many physicists think that the former is the more general mode of statement, and that it implicitly includes the latter. Helmholtz and Lord Kelvin have given a demonstration in the case where the induction gives rise to a current, but the more general case ought to include the problem of dealing with an induced E.M.F. in an open-circuited secondary.

The author has made use of a new experimental arrangement; this makes it possible to vary the total magnetic flux passing through a coil, and this is done by continuously varying the number of turns on the coil by a method which allows it to be unwound as desired. If Φ is the flux contained by a circular turn, and N is the number of similar turns through which this same flux passes, then the total flux passing through the coil will be $N\Phi$. If we admit with Mascart and many other writers that the E.M.F. is produced by the variation of the flux, then this E.M.F. may be algebraically expressed as follows—viz.,

$$e = \frac{d(N\Phi)}{dt} = \Phi \frac{dN}{dt},$$

supposing that the magnetic field remains constant, while the number of turns through which this flux passes is varied. This E.M.F. ought to be measured easily, if it is actually produced. For the purposes of experiment the author has arranged for the construction of a large special electromagnet, as shown in the diagram. It may be said to be U shaped, but its poles are so arranged as to face one another, terminating in two plates, 240 mm. in diameter and 260 mm. apart. If the electromagnet is excited, there is a practically uniform magnetic field between these plates of 800 gauss; in this field there is placed a wooden drum of 200 mm. diameter, and on this drum is wound in regular layers a conductor in the form of a

* Abstract of a communication to the Academie des Sciences.

soft copper wire having a total cross-section of about 0·5 sq. mm., covered with two layers of cotton. The copper wire is sufficiently strong and sufficiently flexible to be able to be wound and unwound at high speed on the drum, which is mounted on an axis and which turns very freely on its bearings. A second drum, similar to the first, and driven through a pulley by means of an electric motor, is arranged near the first on an axis parallel to that of the first.

The coil is wound in the first instance on the main drum, and the free end of the wire is connected to the secondary drum, which is then rotated briskly so as to attain quickly a constant speed of rotation, the electric motor being shunt wound, and having, of course, a considerable inertia. In this way a speed of unwinding amounting to 400 turns a minute can be reached; this is something between 6 and 10 turns a second. Two little copper rings are mounted, one on the axis of each drum; these are connected to the free ends of the winding of the conductor, such connections being made by soldered joints. Two copper brushes press on these rings, and the author has satisfied himself that no parasitic E.M.F. can arise in the circuit during the period of rotation. The two rubbing surfaces are made of copper, well smoothed, and all kinds of P.D. at the contact is eliminated. The pressure is sufficient to assure continuity of contact, as may be shown by the oscillograph. At first it was feared that layers of air or of copper oxide might prevent the passage of current under the very low E.M.F.s which it was intended to use, and in order to meet this possible objection the surfaces and brushes were made of silver; but this caused excessive friction, with consequent wear. However, experience has shown that silver is unnecessary, and that copper that has been sufficiently treated by friction serves

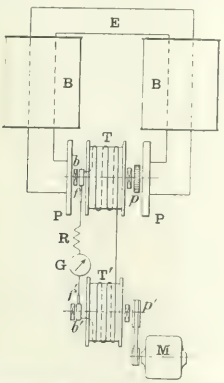


Diagram showing the Experimental Apparatus.

E = Electromagnet. P = Pedal Pivots. T, T' = Rotating Drums. b, b' = Slip Rings. f, f' = Brushes. p, p' = Pu...

the purpose just as well. The circuit is completed by a resistance of 10,000 ohms, which renders the variation of the contact resistance negligible, and there is also a d'Arsonval galvanometer. The sensitiveness of the galvanometer was such that a deviation from 24 mm. to 1 metre corresponded to 0·005 volt. The period of oscillation is of the order of a second. This, therefore, describes the nature of the apparatus, and, with the wire wound in the first instance on the drum T, the five following characteristic experiments were carried out :—

Experiment 1.—The fixed extremity of the coil on drum T is connected to the axis of rotation, as shown in the figure. Drum T' is then rotated as quickly as possible till a speed of [illegible] per min. is reached, which is maintained for about a minute; the galvanometer showed a deflection of 70 mm. The corresponding E.M.F., reduced to a speed of 10 revs. per second, is then 0·022 volt. During the process of unwinding the E.M.F. appears to decrease slightly; this is due, as will be seen later on, to a reduction of the diameter of the turns as one passes from layer to layer.

Experiment 2.—The fixed extremity of the coil (with relation to the drum) is connected to a ring of the same [illegible] as the drum; a brush connects this ring to the galvanometer. [illegible] from the preceding experiment in that the diameter of the rubbing part, on which the brush presses, is equal to the [illegible] and not simply to that of the axis, which is negligible. [illegible] shows, then, that the induced E.M.F. during the [illegible] is zero. This may arise from the fact that during [illegible] between the brush, pressing on the ring, and the [illegible] of the ring to the coil includes two different paths, which partly neutralise one another. In order to avoid this objection the following experiment was made :—

Experiment 3.—The internal extremity of the coil rubs on the periphery of a copper disc of the same diameter, fixed in space. On the unwinding drum a rubbing contact is fixed, to which the extremity of the coil is connected. This rubbing contact of brush projects beyond the drum and rubs on the edge of a circular massive copper disc parallel to the vertical face of the drum, and pierced at its centre by a hole through which the axis of rotation passes without touching. To the edge of the hole in the disc is fixed the extremity of the wire connecting to the galvanometer. This, again, gives no E.M.F. The result is the same if, in place of a disc, one employs a ring of the same external diameter as the drum, connecting the wire from the galvanometer to any point on this ring, while the brush fixed on the drum rubs on the periphery of the ring. The employment of the ring in the second experiment is equivalent to the employment of the disc in the third, although in the first case the ring rotates. It is, therefore, possible to conclude that the induced E.M.F. in the first experiment was not due to the progressive diminution of the flux included in the circuit, but rather to the brushing of the flux by the radial part of the wire on the coil. In order to prove this the following experiment was made :—

Experiment 4.—The extremity of the coil is fixed to the periphery of a disc which turns along with it. The disc of the preceding experiment is mounted on the axis of the drum and the extremity of the coil is soldered directly to the periphery of this disc, while the brush connected to the galvanometer rubs on the centre of the disc. The galvanometer shows an E.M.F. precisely equal to that of the preceding experiment. One has still the same E.M.F. if the disc only is turned while the drum remains fixed, the contact being made with the extremity of the coil by a brush pressing on the periphery. The E.M.F. obtained in Experiment 1 is therefore due to the cutting or brushing of the flux.

The Barlow disc gives us a method of obtaining a measurement of the magnetic field and to demonstrate its almost complete uniformity in the part in which the disc is placed. The rubbing brush, which makes contact with the disc, is moved along a radial arm, which is fixed, and this allows us to place it at variable, but known, distances from the axis of rotation. If a curve is traced showing the E.M.F. expressed as a function of this radial distance, this curve is found to be practically a parabola—that is to say, the flux brushed in unit of time increases in proportion to the surface of the circle described by a point of contact of the disc; but it is not necessary that this condition should be complied with. In the experiments 1 and 4 the E.M.F. was integrated from a point very near the centre to a point placed at a distance of 10 cm. from the centre. [illegible]

In other preceding experiments another less cumbrous apparatus has been used, consisting of a framework for a bobbin of smaller diameter, say 8 cm., turning round a cylindrical piece of iron, which forms a portion of an electromagnet. The flux traversing the bobbin was almost exactly the same as above, but the coil had a much larger number of layers, and the diameters of the turns varied by about 30 per cent. between the beginning and end of the unwinding. In this way one got a large E.M.F., decreasing steadily from beginning to end. This E.M.F. was due to the flux which was cut in a radial sense at the moment when the wire passes from one layer in unwinding to the next. It has only a negligible value when one uses a large drum which carries only a few layers.

These experiments prove in the first place that there can only be an induced E.M.F. in a circuit with a constant magnetic field if the deformation of the circuit causes the lines of force to be cut by a moving portion of this circuit. This is not the case when the wire carrying the current is displaced tangentially to its trajectory. In the second place it is not equivalent that the line of closure of a circuit should be displaced in a massive conductor between moving contacts or that the massive conductor should be itself displaced. Many enunciations of the law of induction which can be found in well-known treatises ought, therefore, to be considered to be too general in their terms and therefore inexact, as, for instance, the following: "When for any cause whatever the number of magnetic lines of induction which cross a wire placed in a magnetic field undergoes any change, an induced current is caused to flow in the wire, or an E.M.F. is generated in a closed circuit when the number of magnetic lines which cross the latter is changed. In order to render this last statement exact it is necessary to add the following restriction, viz. : "And when the variation is produced, either by the cutting of the lines of force by the conductor or by a variation of the inductive field itself." A variation of the inductive field does not arise in the case of the armature of a dynamo with a commutator turning between fixed magnets excited by continuous current. The induction of an E.M.F. can, therefore, only be at re-

buted to the cutting of the lines of force, even if this should not seem to be the case, as when the armature has its wires buried in holes in the core. On the other hand, it does not appear to be logical to introduce into the law of induction a reservation excluding the case where the induced circuit contains movable contacts. For even in this case E.M.F.s are produced every time that a part of the circuit cuts through a fixed magnetic flux. The first conclusion shows that in unipolar machines with sliding contacts the production of the E.M.F. cannot be attributed, as was formerly thought to be the case, to an increase of the flux included by a tangential trajectory.

THE OPERATING COST OF COMMERCIAL ELECTRIC VEHICLES.

BY WILLIAM P. KENNEDY.

An investigation has recently been undertaken by the "Electrical World" to obtain reliable data based on users' records of the operating cost of commercial electrical vehicles, the results of which were published in the issue of our contemporary for May 22. A selection was made of 150 of the most representative installations, the collective value of whose equipment aggregated over £2,000,000. They include 3,990 machines of all sizes ranging from 700 lb. to 5 ton haulage capacity. In order to keep the data as compatible as possible all unessential variations are eliminated. For instance, the investment of each machine is taken at its market value instead of the price actually paid for it. Also, all items relating to tyres and batteries are put down at their market value rather than at any lower price which might hold in the case of firms buying in quantities. The cost of electrical energy for battery charging was taken at the uniform rates of 2d. per unit, and the operators' wages at 8s., 10s. and 12s. per day for small, medium, and heavy machines respectively, only one operator being charged in each case. Hence the figures given represent such figures as an ordinary user could obtain in the United States, and firms who possess large fleets and who operate these at their maximum efficiency would obtain figures of from 5 to 15 per cent. less than those given.

To obtain the necessary data two schedules were sent out. One of these was to obtain the daily operating cost of a machine of each size with or without the driver. The annual operating expenses, which were asked for on the second form, covered all charges which could be made against the equipment upon an annual basis under five subdivisions of fixed charges, maintenance, garaging, operation and administration. The fixed charges include interest and depreciation at the generally accepted rates. Interest is shown at 3 per cent. on the original investment, this being intended as an equivalent of 6 per cent. on the average investment spread over the life of the equipment. Under fixed charges are included insurance and licences in order that maintenance (or the upkeep of the equipment in working condition) and garaging may be separated, as maintenance and garaging are often separately contracted for outside of the organisation of the owner. Under insurance there has been made in most cases a limited charge of £20 per car for liability, and 1 per cent. of its value for insurance against loss by fire.

A Table is given for the annual and daily operating cost of over 150 fleets of electrics. From this we reproduce herewith the figures for a few of the larger fleets.

The whole results may be briefly summarised in the following. Electric vehicles are now being operated for the following daily cost, with a possible reduction of from 5 per cent. to 10 per cent. in large installations or in service where only a limited amount of the machine's daily normal working capacity can be taken advantage of:

Haulage weight, lb.	Cost per day to operate.	Haulage weight, lb.	Cost per day to operate.
700	23·8s.	4,000	37·2
1,000	28·42s.	7,000	43·1
2,000	31·5s.	10,000	49·0

In the table below are shown the costs of operating the regular standard sizes in which electric vehicles are made, in so far as mechanical and motor equipments are concerned. Each size may be modified or augmented by change in the battery and the tyre equipment.

The following lessons are drawn from the investigation. An interesting fact demonstrated by the successful conduct of the research and the determination of the operating cost is that it is possible to procure authenticated records of cost, a project which was previously very much in doubt, and which many had pronounced hopeless. This fact indicates the possibility of doing a number of other things for the promotion of electric-vehicle use now also regarded as not feasible. Another interesting fact demonstrated by the compilation is the substantial value of the investments represented in each installation. The readiness of many conservative organisations to invest in this type of equipment is the greatest proof that could be produced of the possibility of exploiting electric vehicles to a very much greater degree than has been accomplished in the past. Nearly all communications received from owners contained gratifying expressions of satisfaction with their machines and with the service rendered. Only one discontinuance of them was recorded, the case being that of a horse-vehicle contractor, who found them "most unsatisfactory." In one other case, where the machines were in operation during only a portion of the year, yet carried all annual charges against the service rendered in that period, the owner considered them too expensive, although he was satisfied with their performance in all other respects.

DATA ON OPERATING COSTS OF ELECTRIC VEHICLES. — OPERATING COST PER DAY IN SHILLINGS.

Name.	Business.	Investment in equipment.	Annual operating expense.	Number of machines.	Capacity in tons. ⅓	½	¾	1	1½	2	3	3½	5
Adams' Express Co., New York.	Express.....	£30,250	£23,282·0	52	...	27·2	...	33·3	...	...	...	...	...
Adams' Express Co., Philadelphia	Express.....	116,880	79,399·0	146	...	...	31·8	33·0	33·9	40·2	...	...	...
Anheuser-Busch Co., St. Louis	Brewers	41,382	31,745·0	50	...	...	...		33·6	...	...	43·2	49·0
Carson, Pirie, Scott & Co., Chicago.	Dept. store	29,701	21,389·0	46	...	...	27·8	32·9	38·4	...	43·3	48·0	...
Commonwealth Edison Co., Chicago	Energy supply	85,853	62,295·6	120	23·7	26·4	29·3	29·3	38·4	37·1	...	43·1	48·9
Peter Doelger Brewing Co., New York	Brewers	45,003	39,190·2	54	...	...	...		...	...	...	...	49·0
Gimbel Bros., New York	Dept. store	43,861	34,445·2	83	...	25·6	...	31·2	33·8	...	...	44·2	...
R. H. Macy & Co., New York	Dept. store	222,32	15,800·4	35	...	...	...	31·0	...	37·2	...	...	...
Piercy Contracting Co., New York	Transportation	18,570	15,790·8	39	24·6	26·4	...	31·1	31·2	33·5	...	...	48·9
Philadelphia Elec. Co., Philadelphia.	Energy supply	23,455·8	19,724·2	41	30·4	31·8	...	40·1	...	23·6	43·2	...	49·5
[illegible]	Brewers	28,710	2,239·2	34	...	...	...	31·3	...	37·2	40·6	43·2	49·0
[illegible]	Energy supply	23,582·4	19,851·6	46	23·7	26·4	...	31·2	33·6	37·1	...	43·2	48·9
[illegible]	Brewers	21,849·4	10,924·4	25	...	...	...	31·3	...	37·2	...	43·3	49·0
[illegible]	Energy supply	18,303·6	12·003	27	21·4	24·9	...	28·0	...	33·5	...	37·6	41·6
Ward Baking Co., Brooklyn, N.Y.	Bakers	62,598·4	53,935·2	145	...	23·2	...	29·5	...	...	...	...	...
Ward Baking Co., Brooklyn, N.Y.	Bakers	63,372·4	54,888·2	155	...	23·4	25·1	...	...	...	...	...	...
	Transportation	98,198	73,294·6	132	...	25·9	...	31·2	...	37·3	40·2	42·8	...

It is very evident that the general employment of some method of uniform accounting is desirable from the point of view of all interested in promoting electric vehicles—the user, the manufacturer and the central station. The value of uniform records to the owner is evident from the fact that unless he is aware of his operating cost, including latent charges as well as active charges, he may not secure from his customer or the beneficiary of his transportation service a sufficient amount to cover his expenses, including depreciation and interest. Another advantageous feature of uniform accounting would be the possibility of comparison between owners of equipment, and the beneficial interchange of information that would result would produce a tendency to lower the cost of operation to its practicable minimum. The manufacturer would obtain the endorsement of electric vehicles by the present owners for use in convincing prospective users, and could secure diverse cost information, duly authenticated, which would be serviceable in advertising and other sales campaign activity to a greater degree than is true of any other material now available. The central-station organisations would also be assured of concrete and specific argument for their solicitors, and would gain information of material aid in the several plans now under active consideration for possible extensive exploitation to secure the much desired "off-peak" period load of the electric vehicle.

It must devolve principally upon manufacturers to persuade users of their product to adopt some scheme of uniform accounting. It has been found from the examination of extracts from users' books that there is necessarily great diversity in the methods of detail cost-keeping employed in various lines of business, since the specific information derived must serve many minor purposes.

THE PUMPING STATION AT THE GLADSTONE DOCK, LIVERPOOL.

It will be remembered that in July, 1913, His Majesty the King took advantage of one of his industrial visits to Lancashire to open the new Gladstone Dock, Liverpool. At that time, the pumping machinery was not installed, but has subsequently been completed and is in successful service, and, by the courtesy of Mr. Thomas M. Newell, the chief engineer of the Mersey Docks and Harbour Board, the installation is illustrated by means of two photographs.

The Gladstone Dock has a length of 1,050 ft., a width at entrance of 120 ft., whilst the entrance sill is laid 15 ft. below L.w.o.s.t. The entrance of the dock is closed by a sliding caisson, which maintains the water in the dock or excludes it therefrom, according to the nature of the duties of the dock for the time being. In order that the dock may be rapidly cleared of water when required for use as a graving dock, exceptionally powerful pumps are required.

This installation is of more than ordinary interest by reason of the fact that the pumps are driven by internal combustion engines, and this takes rank as the most powerful pumping plant driven by Diesel engines. There are five units, each composed of a 54 in. Worthington centrifugal pump direct-connected to a 1,000 B.H.P. Carels Diesel engine. The duty required of the pumps is to empty the dock of its whole contents—amounting to about 44 million gallons, say, 200,000 tons of water to an 18 ft. tide—in 2½ hours. Each pump is provided with 54 in. discharge branches with two suction branches, each 40 in. diameter. The mean capacity of each pump is not less than 58,000 gallons per minute, and the pumps are designed to work against a maximum static head of 48 ft. when running at a speed of 180 revs. per min. Two of the engines and pumps are also designed so that they are able to pump under exceptional circumstances against a maximum head of 61 ft. when required for drainage purposes. Two others are arranged so that if necessary they can pump water from the entrance channel into the dock when used as a wet dock, and so provide against any shortage of water in the dock through leakage or otherwise. The engines are of the vertical [illegible] cylinder Diesel type, built at the works of Messrs. Carels [illegible] Ghent, to the order of the Worthington Pump Co. [illegible] engine is capable of developing its normal output of 1,000 B.H.P. and an overload of 10 per cent. for two hours when running at 180 revs. per min. Each of the cylinders has a diameter of 510 mm., the stroke of the pistons being 660 mm., and when the engines are developing 1,000 B.H.P. at 180 revs. per min. the mean effective pressure is 6·75 atmospheres.

These engines mark a distinct departure in Diesel engine design, inasmuch as they are fitted with marine type crossheads, very similar in design to those so well known to the steam engineer, instead of the usual "trunk" type piston. These crossheads run in efficiently water-cooled guides, which thus take the thrust that formerly came on the side of the engine cylinders. This allows much greater clearance to be given to the pistons, and, further, eliminates risk of seizure.

Two fuel-pumps are employed, each pump having two plungers, one for each cylinder. Distributors are not used, fuel being delivered direct to each fuel-valve. Both pumps are uniformly controlled by the governor, which is placed between the two middle cylinders. This governor is of the Hartung type, and is driven from the vertical shaft in the usual manner. The scavenge pump delivers air at about 5 lb. per square inch pressure to the scavenge valves, four of which are situated in each cylinder cover. These valves are driven in an ingenious manner, two valves being operated from one lever.

The high-pressure air pumps are of the quadruplex water-cooled type, delivering air for fuel-injection and starting purposes. This air is first delivered to the injection vessel, one of which is supplied with each engine. The overflow from this injection vessel is sufficient to keep fully charged two steel vessels used for starting purposes, the average pressure of these receivers being about 65 atmospheres. These air-vessels are inter-connected with each other and with an auxiliary motor-driven compressor. This compressor is capable of charging any of the starting air-vessels up to 600 lb. per square inch in four hours. It will thus be seen that the contingency of any engine not being able to start through loss of air has been amply provided against, as each engine will have the other engine's supply of air to draw upon, in addition to the auxiliary compressor, in the extremely unlikely event of the entire supply failing. Owing to the water-level being considerably above the engine-room level, the air vessels are supported in a special cradle, and do not touch the side or bottom of the pit in which they stand. This arrangement also allows them to be readily withdrawn for periodical painting.

Noise in the engine room, which might be occasioned by the inrush of suction air, has been provided for by the use of suction-air silencers.

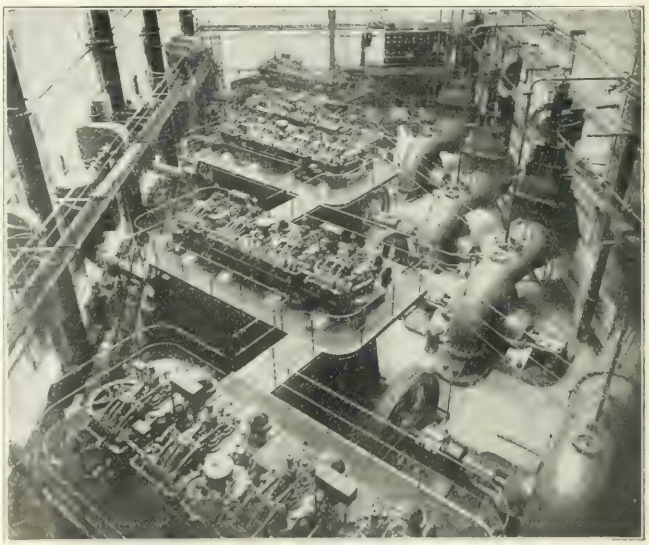


FIG. 1.—VIEW OF THE PUMP ROOM.

These have been arranged on the engine-room wall, and the whole of the air supply to each scavenge pump passes through these silencers before going to the engine. In order that the scavenge air shall not be supplied to the cylinders at too high a pressure, blow-off valves are arranged in the scavenge-pipe collector; these valves opening at 8 lb. per square inch.

The exhaust leaves the engines through ports in the side of the

cylinders and is then taken through water-cooled down-take pipes to a collector-pipe situated below the engine-room floor. From the collector-pipe the exhaust is taken up the engine-room wall to the silencers, which are situated 50 ft. above, *i.e.*, on the ground level, and from there to an outlet well above the roof of the building. It will thus be seen that the exhaust-pipe line is a very long one, and special precautions have, therefore, been taken adequately to provide for expansion and contraction.

Under each engine cylinder is a ring for collecting the cylinder lubricating oil and to prevent it mixing with the oil in the crank-pit. The oil from the collecting ring is taken away to a separate pump, and in this manner the oil consumption can be economically adjusted. A speed-varying gear is fitted to each of the engines, in order that the speed may be regulated between 180 and 198 revs. per min., this variation being necessary to deal with the varying heads the pumps have to operate against. Ample provision has been made in the cylinder jackets and covers for cleaning.

For placing the cranks in starting position a small hand-barring machine is employed. This machine, being chain-driven, is a distinct improvement upon the older types of level-barring gear. The piston-cooling pumps are of the "plunger-displacement" type and driven direct from the engine crosshead, the water being forced through the centre of the gudgeon pin up the piston-rod. These pumps have been found to give excellent results in practice.

Three Worthington motor-driven cooling-water pumps have been supplied, two of which are capable of dealing with all cooling water required for the jackets, pistons, exhaust pipes, crosshead guides, &c., the remaining set acting as a stand-by. The whole of the cooling water from the engines runs into a sump situated in one corner of the engine room, from which the pumps force it to the top of the cooling tower. The water, after gravitating through the cooling tower, flows through the cylinder jackets under a practically constant head. This method of cooling has been found by the makers to be most satisfactory. The cooling tower, supplied by the Midland Engineering Co., of Smethwick, Birmingham, is of the "natural draught" type, and is 60 ft. high, having a base 36 ft. by 20 ft.

The oil fuel is stored in two separate tanks of 25,000 gallons capacity each, situated outside the engine house.

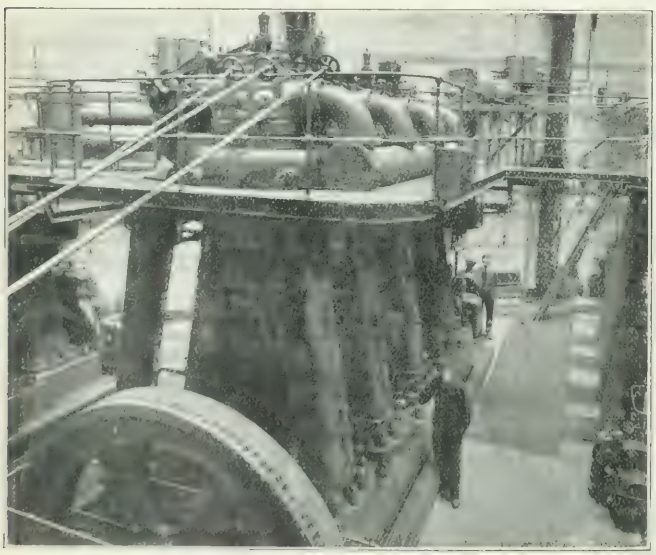


Fig. 2.—One of the Diesel Pumping Engines.

Two intermediate fuel tanks, each of 500 gallons capacity, are situated in the engine room, and the oil from the main fuel storage [illegible] by gravity. These two tanks are surrounded by a [illegible] to the valves, &c., of the tank can be obtained.

Each pump [illegible] is constructed in halves, the discharge [illegible] from the upper part of the casing. The impellers [illegible] carried on [illegible] steel shaft. The pump [illegible] are of the enclosed type, and are entirely separated from the [illegible] bearings, so that not only is correct [illegible] but the entrance of any foreign material from the stuffing box to the bearing is entirely prevented. On the discharge side of each pump is provided a 54 in. sluice valve operated by a hydraulic cylinder, working at a pressure of 800 lb. per square inch, the water under this pressure being taken from the Mersey Dock Board's hydraulic supply station near by. In order to ensure the starting of the pumps under any conditions of suction lift, priming air pumps have been provided of the duplex single-acting Edwards type. These pumps are driven by electric motors of such capacity as to evacuate the main pumps quickly when required. The control of the priming and hydraulic valves is so arranged that the attendant on the engine platform can at will manipulate either of these systems, and will be able to start any unit without leaving the engine platform.

The whole of the auxiliary plant is electrically driven by motors supplied with current from 440-volt direct-current local supply, all the auxiliary pumps being arranged in the south-east corner of the engine room, underneath the switchboard platform.

The engine house is equipped with a 15-ton overhead travelling electric crane, which was used for erecting the pumping machinery, and the engine house is ventilated by six electrically-driven Davidson "Sirocco" fans drawing air from above the quay level, and discharging it near the floor level.

ON THE CAUSES OF IONISATION OF THE ATMOSPHERE.

BY J. A. FLEMING, M.A., D.SC., F.R.S.

Summary.—In connection with the propagation of electric waves, the Author considers the production of a permanently ionised layer in the earth's atmosphere by light-propelled ions from the sun.

Correspondents of THE ELECTRICIAN continue to discuss in its columns the question of the ionisation of the atmosphere in reference to radiotelegraphy. Some of them express doubt or disbelief in the existence of this ionisation, or at any rate call for proof of it. In two recent lectures on photoelectric phenomena at the Royal Institution the writer laid some stress on the probable share taken in this ionisation production by light-propelled ions reaching our atmosphere from the sun. As no reference to these lectures has so far appeared in THE ELECTRICIAN, the writer ventures to reproduce here some of the facts and arguments put forward in the second of the above lectures as a contribution to this discussion.

One of the questions concerned is that of the gaseous composition of the upper layers of the terrestrial atmosphere and of the action of ultra-violet light upon it. The chemical constitution of our atmosphere was the subject of a Royal Institution discourse by Sir James Dewar as far back as 1902,* and mentioned in a Presidential Address† by him to the British Association in the same year.

He showed that broadly speaking the atmosphere could be divided into two regions, a lower in which winds and convection keep the atmospheric constituents mixed up, so that the percentage composition remains fairly constant, and a higher region in which the gases sort themselves out in order of density so that the upper levels must consist of hydrogen and helium with the possible presence of some of the rarer gases.

The mathematical consideration of the problem on the lines taken by Heinrich, Ferrel and the author‡ shows that on certain assumptions as to the temperature gradient, the oxygen and

* "Problems of the Atmosphere." See "Proc." Roy. Inst., vol. XVII., p. 223, Friday Evening Discourse, April 11, 1902.

† B.A. "Report, Belfast, 1902."

‡ See J. A. Fleming "On Atmospheric Refraction and its Bearing on the Transmission of Electromagnetic Waves Round the Earth's Surface." "Proc." Phys. Soc. (London), vol. XXVI., p. 318, 1914.

nitrogen, which are the prevailing constituents at lower levels, die away at and above a height of 100 [illegible] miles) and that at higher levels the atmospheric constituents are chiefly hydrogen and helium. According to Wegener there is also some unknown gas of very small density which, at great heights, is more important than hydrogen and [illegible] spectrum at very high levels.

Turning then to the possibility of atmospheric ionisation by ultra-violet light, we have the well-ascertained fact that air and doubtless also hydrogen and helium are incapable of true gaseous ionisation by wave-lengths much larger than 1,300 to 1,500 Angström units (A.U.). The law connecting ionising potential (V_0) in volts with maximum ionising wave-length (λ_0) in A.U. has been established in a number of cases to be

$$V_0\lambda_0 = 12{,}000 \text{ (nearly)}.$$

Hence, since the ionising potential of oxygen is nearly equal to 9 volts, if the above law is applicable to the gaseous atom we must have $\lambda_0 = 1{,}350$ A.U. nearly for oxygen.

In accordance with this deduction, experiment shows that the true light ionisation of pure dry air, which produces positive and negative ions in equal number, cannot be effected except by extremely short wave-lengths lying in the Schumann and Lyman regions of the ultra-violet spectrum. Both Huggins and Cornu pointed out that the photographic spectrum of celestial bodies as taken at the earth's surface is terminated pretty sharply at or near the wave-length 2,950 A.U. Since quartz is not transparent to wave-lengths of less than about 1,850 A.U., and since this quartz-light will not ionise air, the proof is tolerably complete that no true ultra-violet light ionisation of air can take place at low levels in our atmosphere. If there is any such ionisation as proved by the electric conductivity then it can only be due to photo-electric action on dust, ice particles, or to radioactive matter in the sea or soil or some indirect photo-electric process which yields negative ions.

On the other hand solar light, owing to the high temperature of the photosphere, probably does contain rays of short wave-length lying within the Schumann (2,000 A.U. to 1,000 A.U.), and Lyman (1,000 A.U. to less) regions. Hence, even although the ionising potential of oxygen, nitrogen, hydrogen and helium is 9 volts and upwards, a true ultra-violet light ionisation may take place in the levels of the atmosphere lying perhaps above 10 km. or 20 km. height.

This, however, does not explain the possibility of a permanently ionised layer. It would merely account for a diurnal layer ionised by day or in the side of the atmosphere facing the sun and disappearing by night. To account for the permanently ionised layer, which it has become the custom, though as the writer thinks somewhat unappropriately, to call the Heaviside layer, it is essential to show cause for the production of ions of one sign only at some high level in the atmosphere. Good reasons have been given for supposing that the photosphere of the sun principally consists of carbon, probably condensed into flakes of soot or granules, and that the temperature at any rate of its outer portions is about 6,000°C. to 7,000°C. In other words, the chief light and heat-giving portion of the sun is a gigantic carbon filament of very high temperature. Now we know that such incandescent carbon not only [illegible] other wave radiation but emits positive and negative electrons, chiefly the latter.

In the Royal Institution lecture the writer demonstrated this thermionic emission by the following experiment: An incandescent electric lamp with a carbon filament had a metal cylinder sealed within the bulb surrounding the filament. This cylinder was connected to a platinum wire [illegible] the bulb. The cylinder was connected to a gold leaf electroscope and a charge of electricity positive or negative given to it. Under these conditions when the filament was not incandescent the electroscope held its charge perfectly whether + or −. If the charge was −, then when the current was switched into the carbon filament rendering the latter incandescent, the electroscope was discharged slowly, thus showing the emission of some positive ions. If, however, the charge of the cylinder was +, then on switching on the current [illegible] instantly collapsed, thus proving the copious emission of negative ions from the incandescent filament. There seems good reason for adopting the view of Arrhenius that the same thermionic emission is taking place in the solar photosphere. If so, these electrons, chiefly negative, would in passing outwards through the reversing layer and chromosphere take up and condense round themselves chemical atoms, thus forming negative ions of various sizes. These ions would then be propelled by light pressure outwards. The probability of this process taking place as above suggested was endorsed by Sir James Dewar in the Royal Institution Discourse above mentioned.

It is a comparatively easy matter to calculate the velocity, and time of passage from the sun to the earth, of such ions of various sizes under the action of solar light pressure. We start with the known facts that the Maxwell light pressure in dynes per square centimetre is numerically equal to the light energy in ergs per centimetre cube, and that the best value of the solar constant is 2·1 gram calories per square centimetre per minute, or $1{\cdot}47\times10^6$ ergs are imparted per second to a perfectly black surface by normally incident bright sunshine corrected for atmospheric absorption. Hence it follows that the light energy per cubic centimetre is 49×10^{-6} ergs, and the light pressure nearly 5×10^{-6} dynes per square centimetre at the earth's surface. Light intensity at the sun's surface is, however, 46,000 times greater than at the earth's surface, and hence the light pressure at the sun is 2·3 dynes per square centimetre. These figures show that 1 cubic mile of sunlight at the earth's surface contains light energy equal to 14,710 ft.-lb., and the light pressure is 2·8 lb. per square mile. At the sun's surface the light pressure is 58 tons per square mile and the light energy per cubic mile is 302,300 ft.-tons, or energy enough to throw 20 of H.M.S. "Queen Elizabeth's" 15 in. shells over the top of Mont Blanc. Supposing then we consider a small sphere of unit density placed near the sun's surface; let its diameter be d cm. Let P be the light pressure per square centimetre, and let g be the acceleration of gravity at the sun's surface. This last is 27 times greater than gravity at the earth's surface or is 27×981cm. per second per second. Accordingly the weight or gravitation pull on the particle is $g\frac{\tau}{6}d^3$ and the light-pressure push is $\frac{\tau}{4}d^2$P. Hence the two just balance when $d = 1{\cdot}5\frac{\mathrm{P}}{g}$, or when $d = 0{\cdot}000013$cm. or 13,000 A.U. Schwarzschild claims to have shown that when the circumference of the particle is equal to the wave-length of the light the light-pressure is a maximum, but this has been disputed.

We can, however, calculate easily from the above data the time required for particles of less than the limiting diameter (13,000 A.U.) to come from the sun to the earth, starting from rest. Let a be the distance from the sun's centre at which the particle starts, and let x be any other distance. Let v be the velocity of the particle at x and μ/a and μ/x the potential energies at a and at x. Hence we have the energy equation

$$\frac{v^2}{2} - \frac{\mu}{a} = -\frac{\mu}{x},$$

or

$$v = \left(\frac{2\mu}{a} - \frac{2\mu}{x}\right)^{\frac{1}{2}},$$

or

$$dt = \frac{dx}{\left(\frac{2\mu}{a} - \frac{2\mu}{x}\right)^{\frac{1}{2}}},$$

$$dt = \left(\frac{a}{2\mu}\right)^{\frac{1}{2}}\left(\frac{2x}{2\sqrt{x^2 - ax}} - \frac{a}{2\sqrt{x^2 - ax}}\right)dx.$$

Integrating this last expression between the limits $x=a$ and $x=x$, we have

$$t = \left(\frac{a}{2\mu}\right)^{\frac{1}{2}}\left\{\sqrt{x^2 - ax} - \frac{a}{2}\log\left(x + \sqrt{x^2 - ax}\right) + \frac{a}{2}\log\frac{a}{2}\right\}.$$

If, however, x=93,000,000 miles is the radius of the earth's orbit and if a = 433,000 miles = radius of sun, then a/x is 1·215

or a small fraction, and we can write the expression for the time of transit

$$t = \sqrt{\frac{a}{2q}}\, x - \log \frac{4x}{a}.$$

Now it is easy to show that

$$\frac{2q}{a} \cdot \frac{3Pa}{d} = 2qx.$$

Hence

$$t = \frac{1}{\sqrt{\frac{3Pa}{d} - 2qa}}\, x - \frac{a}{2} \log \frac{4x}{a}.$$

But the last term in the bracket is small compared with x, and hence if we put in the values $a = 7 \times 10^{10}$ cm., $x = 15 \times 10^{12}$ cm., and the value $q = 27 \times 981$, P = 2·3 dynes/sq. cm., we have for the time of transit from the sun to the earth of a particle of diameter d the expression,

$$t = \frac{15 \cdot 10^{12}}{\sqrt{\frac{49 \cdot 10^{10}}{d} - 37 \cdot 10^{11}}} \text{ seconds.}$$

from which also the final velocity can be obtained.

Suppose we apply this formula to calculate the time of transit of spherical ions of unit density of three diameters, viz., 1,600, 5,000 and 10,000 A.U. respectively, we find the times to be 25 hours 17 minutes, 55 hours 33 minutes, and 112 hours 17 minutes.

Again, suppose the ions not to start from rest but to be ejected from the sun with a velocity, say, of 200 km. per second, and then to be propelled by light pressure. Taking the above three sizes we find the velocity of arrival at the earth's surface and kinetic energy to be 1,900 km. per second, 1,000 km. per second and 550 km. per second respectively, and the energies 38, 325 and 780 ergs per particle. If, however, we consider, not single ions, but 1 kg. of this solar dust of the above diameters, and calculate the energy brought by it into the earth's atmosphere, we obtain the following remarkable figures. Taking the dust particles to be of diameters 1,600, 5,000 and 10,000 A.U., the energy per kilogram brought with it is 187×10^{17} ergs $= 700{,}000$ H.P.-hours for the smallest size; 50×10^{17} ergs $= 180{,}000$ H.P.-hours for the middle size; and 15×10^{17} ergs $= 55{,}000$ H.P.-hours for the coarsest dust.

Hence, as much of this finest solar dust as one could carry in one's pocket brings into the earth's atmosphere, in virtue of the enormous velocity acquired under light pressure, energy sufficient to run one of our largest battle cruisers at full speed for 24 hours. The energy must be in some way utilised. It is not unreasonable to consider that it would in part expend itself in ionising the upper atmosphere. In any case it is itself electrified and brings into the atmosphere ions chiefly negative. These in virtue of their small size and in consequence of the negative electric charge of the earth would sink very slowly and would be a possible cause of a permanent negatively ionised layer in the highest levels of the atmosphere. As Arrhenius has shown in his book, "Worlds in the Making," such a theory can be applied with promise to explain the phenomena of Aurora, and magnetic storms and their interconnection with sunspots. Arrhenius has collected a number of instances which show that there is a delay of about 45 hours in the passage of a sunspot across a central solar meridian and the occurrence of a terrestrial magnetic disturbance. This interval is of the same order as that of the time of transit of light propelled ions having a diameter about equal to the wave-

If this projection of ions takes place chiefly from sun spot regions and in a direction normal to the sun's surface, then since the earth travels about 16 million miles per day in its orbit it considerably in front of the earth in order that they may hit it after their two-day journey from the sun. Even then it is

atmosphere. We have in these light-propelled ions coming from the sun a very likely source of that permanent ionisation which is required to account for some of the phenomena of long-distance wireless telegraphy. Hence the suggestions made by the writer in the above-mentioned lecture were to the following effect. There is probably at high levels in the atmosphere a permanent ionisation of negative sign created by the arrival in it of light-propelled ions from the sun. Again, within, and perhaps below, this level there is an ionisation by day produced by solar ultra-violet light of wave-length not greater than about 1,500 to 1,800 A.U. This last ionisation will be annulled or greatly reduced at night. Lastly any ionisation at lower levels must be photo-electric or perhaps radioactive in origin and cannot be due to true light ionisation on gaseous atoms.

Nevertheless we have in these three sources of ionisation possible causes for the production of an upper permanently negative ionised layer in the atmosphere and a diurnal or temporary light-produced ionisation which more or less vanishes at night. These are just the conditions required to make some theory of ionic refraction, such as that proposed by Dr. Eccles, valid. It provides a layer of increased wave velocity and variable thickness which is able to produce an inverted mirage effect on radiotelegraphic rays sent upwards and bend them down again earthwards at various ranges from the transmitter.

According to the most recent mathematical investigations, by Prof. A. E. H. Love, who has confirmed results obtained by Prof. H. M. Macdonald, the full discussion of the problem of diffraction of long electric waves round a sphere seems to indicate that with waves 20,000 ft. in wave-length diffraction alone will account for the daytime propagation of radiotelegraphic waves over such distances as 3,000 miles. Whether this be so or not, it is perfectly certain that some additional agency is at work in the night time. The onus rests on those who reject the theories built on atmospheric ionisation to substitute for them some other valid explanation of the irregularities and generally greater range of night time signalling. The writer, however, ventures to think that the possible ionisation by solar light-propelled dust has not hitherto been sufficiently considered.

It is perfectly obvious that for knowledge of the physical state of the atmosphere above a height of, say, 20 miles, we shall have to rely on indirect evidence and deductions from observed facts. It is possible that by using directive antennæ to project electric rays upwards at various angles and discovering where they chiefly come to earth again we may be able to employ radiotelegraphy as an atmosphere-exploring agency, just as we can employ a searchlight to discover reflecting objects or clouds in the lower levels of the atmosphere. This and all other such-like work is, however, in abeyance during the terrible struggle now existing between all European nations in arms.

APPARATUS FOR PROTECTING ELECTRICAL MACHINERY AGAINST ABNORMAL ELECTRICAL CONDITIONS.*

BY [illegible] GARRARD.

Summary.—The author deals first with the conditions which give rise to abnormal electrical conditions of a transient type, such as those due to [illegible] arcs and [illegible]. Methods of suppressing arcs to earth are [illegible]. The author [illegible] on to pressure rises between the turns of electrical [illegible] due to causes external to the [illegible] such as [illegible] protective devices are described, [illegible] Marchant and other condensers, Giles' valve and the more ordinary lightning arresters. In conclusion the [illegible]

The present article does not deal with abnormal conditions due to overloads and the dangerous conditions of the current flowing, but essentially with transient phenomena, such as surges, pressure rises, lightning strokes, &c., generally of very short duration and [illegible] not directly connected to

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or caused by the current flowing, and which manifest themselves by the breakdown of the insulation or the burning out of windings. Such abnormal conditions may be caused by conditions internal to the system or external to the system, the latter being lightning or other forms of atmospheric electricity.

ABNORMAL ELECTRICAL CONDITIONS DUE TO INTERNAL CAUSES.

Generally speaking, an abnormal electrical condition is only of consequence when it takes the form of a dangerous rise of pressure, and the causes internal to a system which may result in such rises are—

1. Resonance.
2. Switching.
3. Arcs and sparks.

(Compare W. Duddell, "Journal" I.E.E., Vol. LII., 1913, p. 1.)

1. Pressure Rises due to Resonance.—Any electric circuit containing self-induction and capacity has a natural frequency of oscillation of its own, and oscillations may (if the apparent resistance of the circuit be not too high) be set up in it if the periodicity of the supply voltage, or any harmonic contained in the same, agrees with this natural frequency.

Resonance with the fundamental frequency of the supply is practically unknown, and we need only concern ourselves with harmonics. Even with the harmonics, however, under normal

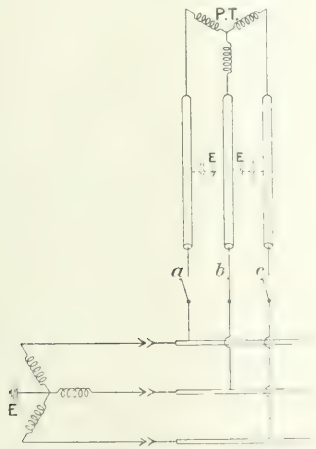


Fig. 1.—Diagram illustrating Resonance of the Fundamental Frequency with a Potential Transformer.

conditions of loaded cables and transmission lines, and with modern alternators, resonance phenomena are very rare, and, if a few precautionary rules are observed, can be entirely guarded against. Among these rules may be mentioned the following :—

1. Never run alternators up or down in speed when excited and connected to cables on open circuit. If this be done there is danger of passing through a possible resonance of an upper harmonic.

2. Avoid as far as possible switching off at the generating station a cable connected at its far end to a running motor or rotary. These latter run, after the cable is switched off, for a short time, as generators, and as they slow up there is danger of resonance even of the fundamental.

3. Avoid arrangements whereby the self-induction of transformers may get connected in series with the capacities of the feeders.

As an example of 3, the following case, which [illegible] extremely interesting (see Fig. 1) :—

A three-phase potential transformer P.T. was connected to the high-tension bus-bars by [illegible] with having a capacity of about [illegible] links *a*, *b* and *c* were provided at the 'bus-bar end, and if one of these only were closed (as at *b*) resonance at the fundamental frequency occurred, causing a pressure rise of more than 100 per cent. This was due to the following : The neutral point of the generator was earthed, so that with *b* closed there was a complete circuit via earth through the self-induction formed by two legs of the potential transformer and the capacity of the cable, and as it happened there were just of the proper values to cause the resonance. It will be observed that if the links *a*, *b* and *c* had been connected together in the form of a three-pole switch this dangerous condition of affairs could not have happened.

2. Pressure Rises due to Switching.—Two cases may be considered : Firstly, the sudden breaking of an inductive load ; and, secondly, the sudden switching on of a condenser as when an unloaded cable is switched on to a generator.

Breaking an Inductive Circuit.—If a circuit containing a large amount of self-induction be suddenly broken, considerable rises of potential can occur. The most common case is the breaking of a field circuit of a generator or motor. If an air-break switch be used the arc formed on breaking, acting as a gradually increasing resistance introduced into the circuit, mitigates the effect. In order to guard entirely against pressure rises with field switches, it is usual to use a non-inductive discharge resistance, which is connected across the circuit to be broken at the instant of rupture. The inductive energy stored in the winding can then discharge through this resistance without danger. Very serious pressure rises can be obtained if inductive continuous-current circuits be broken by means of oil switches. Under these circumstances the current is broken very rapidly, and a rise of, say, 10,000 volts on a 220-volt circuit is possible. For this reason the use of oil-break switchgear on continuous-current circuits is not to be recommended.

Suddenly Switching on of a Condenser ; Cable Charging.—If an uncharged cable be suddenly switched on to a generator, then, in the general case, the pressure across the cable may rise momentarily to a maximum of twice the generator pressure. This is analogous to the case of the ballistic galvanometer, in which, when the damping is small, the initial deflection on switching it into circuit is twice the steady deflection. If the switch happens to make contact at the maximum value of the E.M.F. wave (supposing the supply to be an alternating-current one), then the theoretical maximum rise, which is, however, never reached in practice with a good switch, is up to 2·8 times the root mean square voltage as measured in the voltmeter. This voltage, however, only endures for less than one-half period, and with modern machinery is quite harmless.

The pressure rise on switching on an unloaded cable may be accentuated by the use of a bad form of switch, which makes intermittent or imperfect contact on closing. The explanation of this is as follows : If at the first contact the cable is left charged at potential $+E$, and then contact is made again at the middle of the following half period when the generator voltage is $-e$, the change of voltage applied to the condenser is $E+e$, and the first swing may amount to $2(E+e)$. The extreme case is when E equals e—*i.e.*, when the cable was left fully charged as the result of the first contact. The pressure rise about zero caused by this extreme swing from positive to negative is $2(e+e)-e=3e$. We thus see that simple cable charging, even with an imperfect switch, cannot give a greater pressure rise than 4·2 times the root mean square voltage as measured on the voltmeter, this rise, moreover, not lasting more than one-half period.

Some [illegible] of pressure rise by using cable charging gear. The best form [illegible] through the cable as [illegible] rarely called for. This is especially the case if good oil switches be used that close cleanly without any chattering of the contacts.

Making and Breaking a Circuit containing both Self-induction and Capacity.—In general the capacity of the cable is in parallel with the self-induction of the load, the simple case being represented in Fig. 2. If the points *a* and *b*, having been connected to a generator, are suddenly separated therefrom without any sparking, the whole of the energy stored in the magnetic field of the coil L is transferred to and stored in the condenser. If the current which had been passing through the self-induction were I, then the stored energy in the coil was $\frac{1}{2}LI^2$.

Assuming that the condenser of capacity C was not appreciably charged before the circuit is broken, and becomes charged to the voltage E as a result of the transfer of energy from the coil L to the condenser C, then the amount of energy stored in the condenser is $\frac{1}{2}CE^2$. Now, if the transfer occur without loss, these two energy quantities must be equal to each other—*i.e.*,

$$\frac{1}{2}LI^2 = \frac{1}{2}CE^2, \text{ or } E/I = \sqrt{L/C}.$$

Knowing, therefore, the ratio of self-induction to capacity in any given case, we can calculate the voltage rise for the

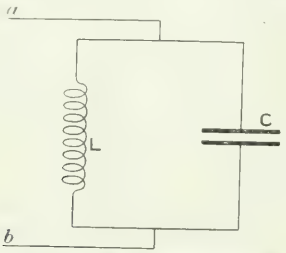


Fig. 2.—Diagram illustrating general case of Capacity in Parallel with Self-Induction.

rupture of any particular current. If the self-induction be very considerable as compared with the capacity, a large rise is to be expected. This is what happens with field coils of machines as mentioned above.

When considering cables or transmission lines we can reduce the different cases to the two extremes—viz., the very short cable or the very long. In general, the underground cables and power lines in this country come under the first category, and may be electrically represented, according to Dr. Kennelly, by the arrangement shown in Fig. 3, in which the capacity of each of the two condensers is equal to one-half of the capacity of the cable, and the self-induction and resistance of the coil between them are equal to the self-induction and resistance of the actual cable.

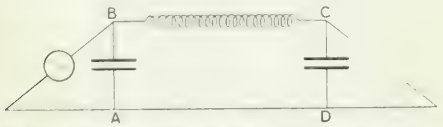


Fig. 3.—Diagram illustrating Electrical Representation of Short Cable or Transmission Line.

Very long cables cannot be represented so simply. If such a cable, open at the far end, be suddenly connected to a generator a wave of current flows down the line and is reflected back from the far open end; at this reflection at the far end the [illegible] is doubled. The reflected wave on reaching the generator is reflected once more, but this time without increase in amplitude but reversed in phase. It will thus be seen that the wave will travel backwards and forwards. If it should happen that the transmission line is of such a length that the reflected wave just arrives back at the generator when the rotor has completed half a period, the wave will start off again reinforced with another impulse from the generator. That is to say, if the length of line is equal to one quarter of the wave-length corresponding to the frequency, a building-up of the voltage at the far open end of the line can take place. In an ordinary cable the velocity of propagation of the wave is about 86,000 miles per second. With a periodicity of 50, therefore, in half a period (*i.e.*, 1/100 of a second) the wave could travel to the far end of a cable 430 miles long and back again. Thus a cable 430 miles long on 50 periods would show this effect. Naturally no such cables of this length are likely to be used in this country. With overhead lines, as the velocity of propagation is very much quicker, being nearly equal to the velocity of light, the length necessary to give this form of resonance with the fundamental frequency is much greater.

On the other hand, if we consider the higher harmonics, then the length of cable necessary to produce the effect is much smaller, and, as a matter of fact, considerable rises of pressure due to this cause are on record. Likewise high-frequency oscillations caused by sparks, faults, &c., may also be the cause of such phenomena with short cables.

It should be added that with loaded lines the effect is not present.

Conditions Necessary for an Aperiodic Discharge.—If an electric discharge occur, for example, across a spark gap connected between a circuit and earth the discharge may be of an oscillatory nature, exactly like the discharge from a condenser. If, however, the ohmic resistance in series with the spark gap be high enough the discharge ceases to be oscillatory and becomes an aperiodic one, the current flowing gradually decreasing to zero without any reversal. The value of resistance necessary to have this result may be calculated from the constants of the circuit concerned. If "C" be the electrostatic capacity of the circuit and "L" the self-induction, and "R" the resistance through which the discharge passes, then if $R=2\sqrt{L/C}$ the discharge just becomes aperiodic in nature (*see* Graham, "Calculus for Engineering Students," 1896, p. 238).

If we are considering a discharge from a transmission line we may set in the above equation the values of self-induction and capacity per mile of the line. Now, $\sqrt{L/C}$ is known as the surge impedance of the circuit. If, therefore, the resistance be double, or more than double, the value of the surge impedance no oscillation whatsoever can occur.

It is wrong, however, to argue from this that the size of the series resistance of a horn lightning arrester must have this high value if danger of voltage rises are to be avoided. A discharge can be oscillatory and yet be quite harmless. The oscillation is only dangerous if the frequency of the same happens to coincide with the natural frequency of a part of the circuit and thus gives rise to resonance phenomena. Some writers have made some rather elaborate calculations and deductions based on this fallacy. The great thing is that the oscillation should be rapidly damped out. This will occur with values of resistance much smaller than the critical value given above.

3. Pressure Rises due to Arcs and Sparks.—The chief physical fact in connection with arcs and sparks which renders them a source of danger of pressure rises is their electrical instability. This instability is due to several causes. In the first instance, and speaking generally, if the current be increased through an arc, its resistance, or back E.M.F., decreases. This allows more current to be forced through with further decrease of resistance of the arc. If a steadying device be not used the current goes on increasing indefinitely. On the other hand, if the current be decreased, the volt drop across the arc increases and thus there is a tendency to suppress the arc altogether. In other words, the current through an arc either tends to increase suddenly to infinity or to suddenly suppress itself. It is more especially this property of suddenly suppressing the current which is the really dangerous feature of arcs and sparks.

At this point it may be mentioned that in this connection the characteristics of arcs and sparks are very similar. In fact, Duddell (*see* "Proceedings" Inst. Elec. Eng., Vol. LII., 1913, p. 10) states that the electric spark possesses the same instability as the arc, but in an enhanced degree.

It is obvious that the quicker the [illegible] between two contacts in a circuit containing self-induction is broken the higher will be the potential rise. The maximum possible value of the rise for an instantaneous rupture may be obtained as follows: To fix matters, a numerical example may be considered (*vide* Duddell *ibid*). A mile of two 0·5 sq. in. cables laid in non-metallic ducts at 4 in. centres has an induction of about 1·6 millihenries, a capacity about 0·1 mfd, and a resistance of 0·176 ohm. Neglecting the self-induction of the machine and regarding the circuit [illegible] way shown in Fig. 3 we get

$$E = \sqrt{\frac{L}{C}} \, I = \sqrt{\frac{1{\cdot}6 \times 10^{-3}}{0{\cdot}1 \times 10^{-6}}} \times [\text{illegible}]$$

That is to say, if we assume that a current of 500 amperes be instantaneously ruptured, then the whole of the stored electromagnetic energy is transformed into electrostatic energy charging up what capacity is available, and the maximum possible pressure rise in this case is 252 times 500 volts, viz., 126,000 volts. The fact that breaking currents through such cables does not result in such rises is due, of course, to the fact that a break approaching an instantaneous one is rarely obtained. The large current arcs produced on the operation of direct-current circuit breakers are not generally dangerous, in that they do not fulfil the condition of instability set forth at the beginning of this section; that is, with increase of current through them, the voltage across them goes up rather than decreases. If magnetic blow-outs be used, pressure rises running into hundreds of volts may be obtained, but, of course, such rises with decent machinery, are harmless On the other hand, it often happens that a short circuit arc in cable systems, whether of continuous or alternating current, is suppressed very suddenly with consequent trouble, which shows itself by the breakdown of insulation in other parts of the system. What actually happens is that electric waves, or impulses having steep wave fronts, start from the scene of the disturbance and travel in all directions. Where they impinge on the windings of machinery there is a tendency to breakdown the insulation between the end turns. Reflection may also occur with doubling of the amplitude of the wave.

The causes of this sudden breaking or quenching of the large current arcs may be the strong magnetic field produced by the current itself, which, of course, tends to rupture the circuit: again with insulated mains in enclosed spaces gases are produced from volatilisation and splitting up of the insulating material: the cooling effect of large masses of metal would also be contributory. It must be understood that this sudden cessation of the arc is a different phenomenon to the electric instability which may be introduced into a circuit by means of an arc. With arcs formed between horns, and which gradually increase in length as the arc ascends, both phenomena may exist. There is a tendency to break the arc when the current is a maximum and also the arc as it increases in length may render the whole circuit unstable, as naturally the longer an arc is the less steadying effect has the resistance which is in series with it. Another cause of instability of an arc is to shunt it with a condenser, "because should the current through the arc decrease due to any cause, the P.D. between the terminals of the arc will increase. This will tend to cause the current to flow into the condenser shunting the arc, which current will be diverted from the arc. It should tend, therefore, to reduce still further the current through it, rendering the conditions more unstable than without the condenser as a shunt" (*vide* Duddell, as above).

It must not be concluded from this that the installation of electrostatic condensers at the terminals of outgoing lines is dangerous. These in a sense shunt the arc formed in the oil switch. As a matter of fact, such condensers [illegible] valves, absorbing high frequency surges and lessening the steepness of the wave front of the incoming travelling waves. It is also extremely difficult to get a dangerous pressure rise with a good oil switch on alternating [illegible] providing, of course, the oil switch functions properly.

Arcs and sparks in electric circuits may [illegible] tions in a similar manner to the production of such oscillations in a wireless telegraphic transmitting circuit. Such a transmitting circuit consists of a spark gap shunted by a condenser and self-induction in series. If the supply be alternating the condenser charges up each half wave, and if the voltage is high enough to break down the spark gap, one or more oscillating discharges occur from the condenser through the spark gap each half period. A similar result can occur with a continuous current supply if the conditions be suitable. These high-frequency oscillations travel about the system and give evidence of their presence by breaking down the end turns of the windings of the machines or transformers.

One fruitful origin of such dangerous oscillations is the arcing ground, that is, a spark between an otherwise insulated high-tension system and earth. Such a system can be regarded as a vast wireless aerial transmitting system, which is excited with a spark between it and earth.

(*To be continued.*)

PHYSICAL SOCIETY.

At the meeting held on May 28th, at King's College, Strand, London, W.C., Dr. A. RUSSELL, M.A., Vice-President, in the Chair, a Paper on

"Numerical Relationships between Electronic and Atomic Constants"

was read by Dr. H. S. ALLEN, M.A.

It has been pointed out by Jeans that ch, where h is Planck's constant and c is the velocity of light, has the same physical characteristics as the square of an electric charge. Lewis and Adams have suggested a relation between the quantities of the form

$$ch = \sqrt{\frac{\pi}{15}} \, 4\pi e.$$

This may be written

$$\frac{2\pi e^2}{hc} \cdot \frac{(15\pi^3)^{\frac{1}{4}}}{(4\pi)^2} = q,$$

where $q = 7{\cdot}28077 \times 10^{-3}$. The square of this numerical constant is $p = 5{\cdot}30096 \times 10^{-5}$. The charge e on an electron in E.S.U. is found to be, within 0·1 per cent., $9p \times 10^{-6}$. The ratio e/m of the charge to the mass is found to be $p \times 10^{22}$, with the same order of accuracy. The occurrence of powers of 10 in these expressions, may be accidental, or may depend on the way in which the units of length, mass and time were originally defined. Derived quantities, depending on e, m and c, can be expressed in terms of simple integers (2, 3 or 4), powers of 10, p and π. The "atomic mass of an electron" is approximately 10^{-27}.

Prof. O. W. RICHARDSON said it was curious that the value of e and e/m should happen to be simple multiples of the quantity p. These two quantities were the key to the situation, as the other relations followed more or less directly from them.

Mr. S. D. CHAMBERS said it was possible almost with any set of quantities to obtain striking numerical relationships. It was only when a physical significance was sought for that it could be seen whether they were anything but coincidental.

Dr. W. WILSON said that if the units of mass, length, temperature, electricity, &c., were so chosen as to make the universal constants such as Planck's h, the gravitation constant, &c., each equal to unity, the unit of mass which had to be adopted was 10^{-27} gram.

Prof. ZELENY emphasised the importance of searching for the physical significance attached to the new relationships.

A Paper on

"A Method of Calculating the Absorption Coefficients of Homogeneous X-Radiation"

was read by Mr. H. MOORE.

The action of X radiation when passing through a gas is to liberate electrons from the gas. The number of electrons emitted by a stream of X rays is proportional to the fourth power of the atomic weight (or possibly the atomic number) (Moore, Proc. Roy. Soc., May 1914). Thus equal numbers of atoms of different elements, when subjected to similar X-ray beams, will liberate amounts of electronic radiation proportional to the fourth powers of the atomic weights of the elements. The absorptions, on the other hand, are proportional to the amounts of electronic radiation liberated, and, therefore, the absorptions of two elements, when equal numbers of atoms are present, will be proportional to the fourth powers of their

atomic weights. The corpuscular radiation liberated in the vapour of an element if it could be obtained as a monatomic vapour at 76 cm. can be expressed as $1{\cdot}05\times10^5\times(\text{atomic weight})^4$, taking the corpuscular radiation in air as unity. The absorption coefficient of such a vapour would, therefore, be this number of times the coefficient of absorption of air for the same type of X-radiation. The absorption of any element is proportional to the number of atoms present, and having calculated the absorption in a hypothetical vapour of this type, the absorption in the same element in any condition can be calculated by a simple density law. This is done in the Paper for several elements (metals), and also, assuming an additive law, it has been calculated for some compounds. The agreement between the calculated values and the values obtained by different observers by direct experiment is quite close over a considerable range of radiations and absorbers. When, however, the atomic weight of the absorber is higher than that of the radiator, so that the K series is absent from any secondary radiation excited in the absorber, the agreement ceases. A possible explanation of this is suggested in the Paper.

Prof. O. W. Richardson thought the Paper made a considerable addition to our knowledge of the process of ionisation by X-rays. The primary rays in being absorbed produce some ionisation, and, in addition, excite secondary radiation, which in turn produces more ions. The Paper helps to make clear the part played by these two causes in the production of the total ionisation.

Dr. S. Russ felt that the Paper conveyed the impression that one would find in practice the same value for the absorption coefficient as obtained by calculation. The phenomenon of selective absorption must surely set severe limits to the range of wave-length over which these relations hold. This range should be specified. How would the author calculate the absorption coefficients, say, for aluminium and water? If there were no selective absorption λ/ρ should be constant, but he had recently found it to vary over a wide range.

Prof. Nicholson said the results were of interest to those engaged in the attempt to construct models of atoms and molecules. The phenomena appeared to be atomic in nature, thus bearing out the idea brought forward by Bragg that the atom preserves its identity in the molecule. In connection with the law connecting the absorption with the fourth power of the atomic weight, it would be interesting to know whether it was really the atomic weight or the atomic number that should be employed.

The Author replied as follows: The formula should only be used where all the types of radiation excited in air are also excited in the material. He had had considerable trouble in getting reliable coefficients owing to the large and uncertain scattering corrections which had to be applied. In one case he believed an observed value of 0·42 had to be corrected to 0·2 or less. He had calculated some coefficients for gases, and with SO_2 the agreement was as good as for solids. It should be possible to calculate the true absorption coefficient for water and aluminium, but he could not say how near these would be to values actually determined on account of the uncertain scattering. He had experiments in progress which should determine whether the atomic weight or the atomic number was the significant quantity.

Two experiments illustrating

"Novel Properties of the Electron Currents from Hot Metals"

were shown by Prof. O. W. Richardson, M.A., D.Sc., F.R.S.

The first experiment demonstrates the cooling of a tungsten filament when an electron current is allowed to flow from its surface. This effect is analogous to the cooling due to latent heat when a liquid evaporates, or to the similar phenomenon due to the heat of reaction when a gas is emitted by chemical decomposition of a solid. An experimental lamp containing a fine filament of double tungsten is placed in one arm of a balanced Wheatstone bridge actuated by the current which heats the wire. When the electron current is allowed to flow, by completing a side circuit from an electrode inside the lamp to a point in the adjacent arm of the bridge, the galvanometer is deflected in a direction which corresponds to a reduction of the resistance (and temperature) of the hot filament. The precautions necessary to eliminate fully disturbances due to various sub-[illegible] phenomena are considered in Papers by H. L. Cooke and the speaker in the Phil. Mag., Vol. XXV., p. 624, 1913, and *ibid*, Vol. XXVI., p. 472, 1913. The second experiment, in which a similar experimental lamp is used, demonstrates the flow of [illegible] through a [illegible] cylinder [illegible] the [illegible] Phil. Mag., Vol. XXVI., p. 773, Vol. [illegible], p. [illegible].

A short account of recent experiments on

"High Permeability in Iron"

[illegible] by Prof. Lyle and Mr. [illegible].

When [illegible] in a strong magnetic field [illegible] the [illegible] [illegible] the [illegible] [illegible] for given values of the magnetic induction. The effect can be largely removed by careful demagnetisation. It was thought that the earth's magnetic force might also have a polarising influence upon exposed iron, and an effort has been made to remove it by placing the specimen in a magnetic shield, and carefully demagnetising it. The permeability corresponding to small values of the magnetic induction is thereby considerably increased, and the hysteresis loss diminished. After a long period of rest in the shield the permeability has somewhat diminished, and on taking the specimen out of the shield it maintains its high value. Next as regards higher forces. The specimen in this case is not shielded, but is subjected to a magnetising force during the time that it is allowed to cool through the temperature of recalescence, either with an alternating or steady magnetic force. a maximum value of the permeability of over 10,000 is obtained. In these experiments the material has been tested on the form of laminated squares or rings. With straight strips 8 cm. long, 1·5 cm. wide and 0·053 cm. thick, built into the form of test pieces, the effect though produced could not be maintained, and the specimen with ordinary handling was reduced to the normal state.

An experiment showing

"The Difference in Width of the Spectrum Lines of Neon and Hydrogen"

was shown by Mr. T. R. Merton.

For accurate measurements of the widths of spectrum lines an interference method must be employed, in which the optical difference of path between the interfering beams can be varied, the widths being calculated from the limiting difference of path at which interference fringes can be seen. By [illegible] a Fabry & Perot etalon with a single prism spectroscope it is possible to discriminate between lines arising from different elements, by the "visibility of the fringes." In the experiment shown a vacuum tube containing neon and hydrogen is examined in this way. The neon lines being narrow show sharp interference fringes, but for the hydrogen lines, which are broader, the limiting order at which interference can be seen is too low for fringes to be visible.

ASSOCIATION OF CONSULTING ENGINEERS (INCORPORATED).

The annual general meeting was held at Caxton Hall, Westminster, on Monday, May 31, 1915, Mr. G. Midgley Taylor presiding.

The Honorary Secretary (Mr. A. H. Dykes) having read the notice convening the meeting and the minutes of the last ordinary general meeting, and the said minutes having been confirmed,

The Chairman moved the adoption of the report of the Committee, and stated that the Association had recently elected several prominent engineers to membership, and from what could be gathered by conversation with consulting engineers generally, the Association was held in high esteem, and it was confidently anticipated that in the near future a large accession to the number of members would take place.

It was evident that the Association occupied a very strong position, and in course of time, when the usefulness of the Association became better known, it was anticipated that it would include in its ranks not only the majority of the consulting engineers in Westminster, but also in the United Kingdom.

It was somewhat difficult to convey to the consulting engineers in the country all the work being performed by the Association, but a perusal of the report would indicate that much useful work had been done in the past year, and that the Committee were active in furthering the interests of its members.

One of the heaviest [illegible] by the Committee was a consideration of the model General Conditions of Contract issued by the Institution of Electrical Engineers, and to which considerable objection had been taken.

It was felt that general conditions of contract should be applicable to contracts generally, and that works pertaining to the electrical branch of the profession should not require any special treatment. Accordingly the model General Conditions put forward by the Institution of Electrical Engineers have conformed with those generally adopted in other branches of engineering, and as a consequence strong objection was taken to some of the provisions of the model form. The objections were communicated to the Institution of Electrical Engineers, and the Association were thanked for their views.

During the past year the Book of Professional Rules and Scale of Fees had been revised, and, judged by the number of applications received for the book, not only from members of the Association, but from Government departments and the engineering profession generally, it had been found of great general utility.

The Committee took every means in their power to maintain the best traditions of professional conduct, and in every case where advertisements appeared inviting engineers to send in applications and fees for carrying out engineering works, the Committee communicated with the authority advertising, and stated that by the rules of the Association its members were prevented from answering advertisements of the nature referred to.

In one instance an advertisement inserted by the Eastern Valleys (Monmouthshire) Joint Sewerage Board was dealt with by the Association, and it is satisfactory to learn that the Institution of Civil Engineers also took this matter up, and issued a special circular on the subject, calling the attention of the members of the Institution to the impropriety of engineers competing against one another in the manner described.

There were many matters which would engage the attention of the Association during the coming year, amongst others being the question of whether it was proper for members of the Association to enter into competitions for schemes for public authorities. The chairman stated that there was a divergence of opinion upon the subject, and it was probable the Committee might decide to approach the Local Government Board and have the benefit of their views upon the subject. There was much to be said in favour of competitions to enable junior members of the professions to present schemes to local authorities, but the chairman stated his strong views that there was very much to be said against competitions as usually at present conducted, and the methods by which the successful competitor frequently obtained his work. It was thought, however, by certain members of the Association that if competitions were conducted on proper lines there might be no objection raised by the Association to its members entering for them, and the matter would be carefully considered and a report would be made to the members.

The Chairman referred to the fact that although membership of the Association was confined to principals of firms, there were no less than five of its members serving with his Majesty's forces. He viewed this as an extremely satisfactory condition of affairs.

The adoption of the report was seconded by Mr. W. J. E. Binnie, and carried unanimously.

The hon. treasurer, Mr. S. R. Lowcock, then presented his report, showing a balance in excess of expenditure of £64. 16s., as compared with £13. 4s. 8d. last year.

The adoption of the accounts was seconded by Mr. H. J. Rofe, and carried.

Four London and two country members of the committee having retired by rotation, the result of the ballot for the new members of the committee resulted as follows :—

The four London members elected were :—

Mr. W. Ll. Preece, M.Inst.C.E., M.I.E.E.
Mr. W. J. E. Binnie, M.Inst.C.E.
Mr. Ernest L. Mansergh, M.Inst.C.E.
Mr. E. Brough Taylor, M.Inst.C.E., M.I.Mech.E.

The country members elected were :—

Mr. Walter Emmott, Halifax, M.Inst.C.E., M.I.E.E.
Mr. F. W. Hodson, Loughborough, M.Inst.C.E.

The CHAIRMAN remarked that the committee would welcome the assistance of the new members, and he knew they would do good work.

A long discussion then took place on matters of great importance to the profession, in which the Chairman and Messrs. Binnie, Lowcock, Mordey and Campbell Swinton took part.

It is hoped to make a communication to the members with reference to these matters at [illegible]

Votes of thanks to the hon. auditors, Messrs. Cash, Stone & Co., and the hon. solicitor, Mr. F. E. Wright, of Messrs. Faithfull & Owen, were then carried unanimously, and on the motion of the Chairman the meeting closed with votes of thanks to the hon. secretary, Mr. [illegible] and the hon. treasurer, Mr. [illegible] during the past year.

We [illegible] an extract from the report of [illegible] Year 1914-1915 :—

The Committee [illegible] the [illegible] 1914-1915, and in so doing [illegible] year material advantage [illegible] matters of every day interest to engineers [illegible] interests of their clients, due to the fact that [illegible] had the advantage of the presence on the Committee of [illegible] influential members from all parts of the United Kingdom. [illegible] thus been able to do [illegible] work of a nature which was impossible [illegible] the formation of the Association, and it is hoped that the constitution of the Association as approved by the Board of Trade will enable it to continue its labours with even greater advantage to everybody concerned as its objects become better known, and as its general organisation improves with the experience that can only be obtained with the effluxion of time.

In the report for the year 1913-1914 members were invited to communicate with the Hon. Secretary in all cases where they considered that the Association could be of assistance, or where they had special information on matters affecting the interests of the profession. The Committee wish to draw attention to the fact that the scope of their usefulness is largely determined by the extent to which members avail themselves of their invitation, and they are glad to say that during the past year the response of members has borne fruitful results. There are naturally certain matters which come before the Committee that are more or less of a private and confidential nature, and these have all been dealt with in a suitable manner as they have arisen. In connection with matters of public interest which have been brought before the Committee, and as regards which during the past year steady and, it is hoped, valuable work has been done, may be mentioned the consideration of the Model General Conditions of Contract, and the drawing up and publication of a scale of fees.

MODEL GENERAL CONDITIONS OF CONTRACT.

It is common knowledge that for a long time past various bodies, representing different interests, have made proposals in this connection, and recently the Institution of Electrical Engineers issued "Model General Conditions of Contract for use in connection with Contracts for Electrical Work," in the hope that they might be found suitable in their entirety for the majority of contracts. As a result of this, requests were received from time to time from members of the Association for information as to whether these model conditions were approved by the Association, and as consulting engineers as a body, and their clients, are vitally interested in this matter, the Committee felt that it was of such importance as to call for the immediate consideration of the Association. It was recognised that a large amount of time had been devoted by those responsible for the publication of these model general conditions in an endeavour adequately to protect the interests of purchasers and contractors, and that very real benefit would result were it possible to agree a uniform set of conditions of contract acceptable to members of the Association and to contractors. The Committee therefore appointed a sub-committee to consider and report on the matter in question, each member of the main Committee being requested to formulate his views in writing for the detailed consideration of the sub-committee.

The sub-committee, composed of members having a long experience in civil engineering as well as of those engaged more particularly in electrical work, devoted a large amount of time to the consideration of the "model conditions," comparing them clause by clause with those used by various members, and considering any suggestions and criticisms received from the general body of members in the course of their communications with the hon. Secretary. After consideration of the conclusion of the sub-committee, the Committee reported that, in their present form, they were unable to recommend the proposed model conditions for general use in contracts for works carried out under independent consulting engineers. The report, which has been circulated amongst the members, deals in detail with certain clauses to which strong exception was taken, and indicates other clauses requiring alteration. A copy of the report was in January last forwarded to the Secretary of the Institution of Electrical Engineers for their consideration. The Council of the Institution have promised to give due consideration to the recommendations of your Committee, and this matter will, therefore, be considered further in the hope of ultimately agreeing model conditions which will be acceptable to all consulting engineers.

The remainder of the report deals with matters of professional remuneration and conduct and other matters to which the Chairman referred in his address. The total membership of the Association now stands at 74.

BOOKS RECEIVED.

[illegible] foreign books.]

"Proceedings" of the South Wales Institute of Engineers. (Cardiff : [illegible] Vol. XXXI., No. 2. Pp. [illegible]

[illegible] (London : E. & F. N. Spon.) Vol. XVIII., Part V., No. 209. Section A, Physics, pp. iv.+55; Section B, Electrical Engineering, pp. iv.+47.

[illegible] 1914.

[illegible] Jackson and E. Frankland Armstrong. (London : City and Guilds Engineering College.) Vol. XII. No. 36. Pp. 89.

[illegible] (New York : American Institute of Electrical Engineers). Vol. XXXIV. No. 5. Section I., Institute Affairs. Pp. 30. Section II., Papers, [illegible] Pp. 352–81.

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SPECIAL NOTICE.

In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY NOON, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Advertisements of all kinds of which no proofs are required before first insertion can be accepted up to FIRST POST THURSDAY MORNING.

TECHNICAL COMMISSIONERS.

We are led to make a few remarks on this subject by a Paper which has recently appeared in the "Journal" of the Institution of Electrical Engineers from the pen of Mr. W. Pollard Digby. We think it is now well recognised, at least in technical circles, that although our Consuls sometimes give valuable reports they often fail lamentably when technical matters are in question. Our Consuls are not even always British; they have sometimes even been German, and in any case their duties are commercial and multifarious, so that not only would they fail to appreciate technical points, but they would often fail also to take a truly British point of view. Commercial Consuls, pure and simple, even when British and with the best intentions to put the interests of this country before those of other countries, cannot deal adequately with details of manufacture which they do not understand, or with the advantages or disadvantages of English types of machinery as compared with those of other countries, or with the important bearing of local conditions upon the product that is required. Mr. Digby, therefore, advocates, and, we think, rightly, that we should appoint Technical Commissioners, able to appreciate the various questions that are involved. They should not only be in touch with developments in the countries in which they reside, but they should be placed equally in intimate contact with manufacturers of this country, whom they would visit from time to time and with whom they would confer so as to be sure of having a correct point of view.

Mr. Digby goes on to contend that the Technical Commissioner should have scientific and commercial imagination, as well as his other qualities. Here we are inclined to disagree. It may be just as well to have this quality of imagination, but it is much more important in the scientific investigator than in the Technical Commissioner. The half-watt lamp, the kenotron and many other devices have been largely due to the application of proper imagination, an imagination which showed the possibilities of each advance step by step, and what might be expected as a logical

conclusion. It is due to lack of [illegible] that many investigators have stopped short of the true goal, and have left it to others to reap the reward which should have been theirs.

Since the outbreak of war there have been many suggestions as to what should be done to improve the position of our trade at a later date; but what steps have been actually taken? Many schemes, some of them quite ambitious, have been put forward; but who is to move in the matter? It is just at this point that schemes fail. A scheme is of no value unless there is someone capable of carrying it to a conclusion. Moreover, there is no good waiting until after the war to mature plans of this kind. We were not prepared for war; let us at least be prepared for peace; for when that time comes there will be less money and fewer men than previously, and there will be harder work in order to obtain the same results. It must also be remembered that there is not merely one branch of engineering to be considered. All branches will require attention, and chemical industry in addition. Further, there are numerous commercial matters which are equally important, and we cannot expect one man to cover such an ambitious programme satisfactorily. In our opinion, it is partly a matter for the manufacturers to consider and to decide what they want and how far it is a question of organisation. It is also partly a matter for the Government to decide what they can do to foster British exports to foreign markets. That being so, we feel that the first step to be taken should be for the Government to appoint a strong committee to find, on the one hand, what is desired by the manufacturers of this country, and to decide, on the other, what can be done. But let us, above all things, avoid a policy of drift.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, [illegible] free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

The Mathematical Analysis of Electrical and Optical Wave Motion on the Basis of Maxwell's Equations. By H. BATEMAN. Pp. vi.+159. (Cambridge: University Press. 1915.) 7s. 6d. net.

At the present time the central problems of physics are those connected with the nature of electromagnetic radiations and the processes which govern their emission and absorption by matter. While the writer feels that the greatest advances in this direction will be the result of experimental investigation, it is essential that such work should have the advantage of adequate mathematical co-operation. For these, and many other, reasons Dr. Bateman's book is very opportune and will be heartily welcomed by theoretical physicists. It deals in a very complete way with the properties of a large number of functions which satisfy the equations, associated with the name of Maxwell, which govern the propagation of electromagnetic waves. By always working with one or two such functions of an elementary character the physicist is apt to forget that the number of functions which will satisfy the fundamental equation is indefinitely large. Perusal of the present work will quickly correct any misconception on this point. Although the book does not touch on the interesting questions of absorption and emission of radiation by matter, and confines itself to the solutions of the equations appropriate to the discussion of the imposed boundary conditions appropriate to particular problems, the treatment [illegible] of a very general character. The scope of the book may be indicated by the following (incomplete) list of some of the topics considered: The solutions of the equations in rectangular, spherical, spheroidal, cylindrical, ellipsoidal and toroidal co-ordinates; the application of the solutions to various types of electromagnetic oscillators and to absorption and scattering by small obstacles; the pressure of radiation; various important problems in diffraction; homogeneous solutions of the wave equation, and the extensions of Kirchoff's solution. The references to the literature are very complete and up-to-date, and on this account alone the mathematical physicist will find the book invaluable.

There is one chapter which deals with certain types of discontinuous solutions, which is largely the result of the original work of the author, and is of special interest. One of these solutions presents a remarkable resemblance to the filamentary structure of the electric field due to an electron, which was suggested by Sir Joseph Thomson in order to account for some of the properties of the Röntgen rays. It is shown that the electromagnetic field due to a point charge moving with a velocity less than that of light may be of the following character. Attached to the moving point charge there is a certain curve which becomes the locus of a series of moving point singularities whenever its form differs in any portion from a straight line or its direction changes. The form of the curve at any instant is subject to the condition that the points of the curve can be regarded as having been projected from the moving charge at different instants, the direction of projection being partly determined by the velocity of the point charge. An electron may be regarded as built up by the superposition of a number of such point charges, with the result that the final structure has a kind of thread attached to it along which a wave or kink runs whenever the motion of the electron is accelerated. The energy radiated from the electron spreads out in all directions, but is concentrated round the thread, so that the thread acts like a guiding wire.

It is interesting to know that such a structure does no violence to Maxwell's electromagnetic equations, but it does not seem likely that optical phenomena can be accounted for by endowing the ether with a filamentous structure. It is well known that the sharpness of interference fringes with weak light, as well as other phenomena, are difficult to reconcile with the filamentary point of view. On the other hand, Dr. Bateman's ideas have not yet been worked out very fully; so that it is, perhaps, rather premature to urge these considerations against them. It is possible that if the questions were thoroughly gone into they might lead to results practically identical with Fresnel's theory in these cases.

Whatever the physical importance of these speculations may turn out to be there can be no question of the intense mathematical fascination of the subject. In this connection it may be noted that the book contains a large number of problems which the skilled mathematician will find worthy of his powers.

O. W. RICHARDSON.

British Commerce: A Modern Survey. By H. H. BASSETT. London: Wm. Collins, Sons & Co. Pp. 263. 1s. net.

At the present time, when the future of our trade is a topic of increasing importance and interest, this small volume may be read with advantage. The author deals briefly with all the aspects of the question, and although it was written before the present war arose, we do not suppose that the opinions expressed need be materially altered. Chapter II. shows how enormous are the industries of this country. A chapter on transport deals with the railway systems and the waterways of this country and the difficulties with which the problem of satisfactory transport is beset. It is pointed out that the foreign trader is given better terms by the railways than the home producer, for the reason that the former is able to deliver his goods in bulk, so that they can be handled quickly at one time, whereas the home producer is continually sending a stream of produce which must take its chance. When we come to foreign trade the author sets out the usual shortcomings of the British trader, which, we trust, are becoming less pronounced. The latter part of the book deals with the difficulties which have been brought about by the struggles between

capital and labour and the possibility of eliminating these conflicts by means of co-partnership and other means, whilst, in conclusion, the author advocates a ministry of commerce, which would be in real touch with the commerce of this country, and an educational system which would take into account commercial needs. The author is of opinion that the Board of Trade should be relieved of all duties which concern the development of trade, and he points out the absurdity of expecting the average Civil servant, who has spent his best years at office routine, to deal effectively with commercial matters. In due time, let us hope, possibly as a result of the present war, the Government of this country will come to realise how important a part industry and commerce play as regards the welfare of the State.

THE DIFFERENTIAL EQUATIONS OF LONG-DISTANCE TRANSMISSION.*

BY GEO. R. DEAN.
(Professor of Mathematics, School of Mines, Rolla, Mo.)

(*Concluded from p. 320.*)

VI.—Given Voltage, Current and Power Factor of Receiver.

5. Taking voltage at receiver as zero vector, we have, when $x=0$,

$$I_1=I_0\cos\theta,\ I_2=I_0\sin\theta.$$
$$V_1=E_0,\ V_2=0.$$

Substituting in the general formulæ, we find

$$A_1=E_0,\ A_2=0,\ C_1=I_0\cos\theta,\ C_2=I_0\sin\theta.$$

B_1 and B_2 are found by solving the simultaneous equations

$$B_1\cos(\xi-\delta)-B_2\sin(\xi-\delta)=I_0\sqrt{\frac{Z}{Y}}\cos\theta \quad . \quad . \quad (75)$$

$$B_1\sin(\xi-\delta)+B_2\cos(\xi-\delta)=I_0\sqrt{\frac{Z}{Y}}\sin\theta \quad . \quad . \quad (76)$$

The solution gives

$$B_1=I_0\sqrt{\frac{Z}{Y}}\cos(\theta-\xi+\delta),\ B_2=I_0\sqrt{\frac{Z}{Y}}\sin(\theta-\xi-\delta). \quad (77)$$

Using the values of A_1, A_2, above, in (60) and (61),

$$D_1=E_0\sqrt{\frac{Y}{Z}}\cos(\xi-\delta),\ D_2=E_0\sqrt{\frac{Y}{Z}}\sin(\xi-\delta) \quad . \quad . \quad (78)$$

The general formulæ (54), (55), (56), (57) now become

$$V_1=E_0Q_1+I_0\sqrt{\frac{Z}{Y}}\{Q_3\cos(\theta-\xi+\delta)-Q_4\sin(\theta-\xi+\delta)\} \quad (79)$$

$$V_2=E_0Q_2-I_0\sqrt{\frac{Z}{Y}}\{Q_3\sin(\theta-\xi-\delta)+Q_4\cos(\theta-\xi-\delta)\} \quad (80)$$

$$I_1=I_0Q_1\cos\theta-Q_2\sin\theta)-E_0\sqrt{\frac{Y}{Z}}\{Q_2\cos(\xi-\delta)-Q_1\sin(\xi-\delta)\} \quad . \quad (81)$$

$$I_2=I_0(Q_1\sin\theta+Q_2\cos\theta)+E_0\sqrt{\frac{Y}{Z}}\{Q_2\sin(\xi-\delta)+Q_1\cos(\xi-\delta)\} \quad . \quad (82)$$

Numerical Illustration.

6. Let it be required to transmit 10,000 kw. at 60 cycles over a three-phase aerial transmission line 300 miles long, employing stranded aluminium conductors 0·63 in. in diameter, triangularly spaced with 9 ft. interaxial distance. The voltage at the receiving end of the line is to be 100,000 volts between conductors, with 85 per cent. power factor lagging. Determine the voltage impressed on the line, the entering current, the [illegible] and the efficiency of transmission.

The [illegible] is represented as single circuit with a perfectly conducting ground return and carrying one-

[illegible]

The voltage at the receiving end is 57,700 volts per phase, or $E_0=57{,}700$. The current per wire is 68·0 amperes, and the components are as follows:—

$$I_0\cos\theta=68{\cdot}0\times0{\cdot}85=57{\cdot}8$$
$$I_0\sin\theta=68{\cdot}0\times-0{\cdot}527=-35{\cdot}8.$$

Calculation of the Line Constants:

$$\tan\delta=\frac{pL}{R}=2{\cdot}46307,\ \delta=67^\circ\ 54'\ 12'',$$
$$\cos\delta=0{\cdot}37617,\ \sin\delta=0{\cdot}92657$$
$$Z=R\div\cos\delta=pL\div\sin\delta=0{\cdot}7935$$
$$\tan\gamma=pC\div S=28{\cdot}84,\ \gamma=88^\circ\ 0'\ 51'',$$
$$\cos\gamma=0{\cdot}03465,\ \sin\gamma=0{\cdot}99940,$$
$$Y=pC\div\cos\gamma=5{\cdot}772\cdot10^{-6}.$$
$$ZY=4{\cdot}60\times10^{-6},\ \sqrt{ZY}=2{\cdot}116\times10^{-3},$$
$$\frac{Z}{Y}=138{,}100.\ \sqrt{\frac{Z}{Y}}=371{\cdot}6.\ \sqrt{\frac{Y}{Z}}=2{\cdot}671\times10^{-3}.$$
$$\gamma+\delta=155^\circ\ 35'\ 03'',\ \xi=\tfrac{1}{2}(\gamma+\delta)=77^\circ\ 57'\ 32'',$$
$$\cos\xi=0{\cdot}2086,\ \sin\xi=0{\cdot}9780.$$
$$h=\sqrt{ZY}\cos\xi=0{\cdot}0000412.\ k=\sqrt{ZY}\sin\xi=0{\cdot}0002070.$$
$$hl=0{\cdot}13260,\ 2hl=0{\cdot}26520,\ kl=0{\cdot}6210,$$
$$2kl=1{\cdot}2420=71^\circ\ 10',$$
$$\cosh hl=1{\cdot}00890,\ \cosh 2hl=1{\cdot}0354,$$
$$\cos kl=0{\cdot}81329,\ \cos 2kl=0{\cdot}3228,$$
$$\sinh hl=0{\cdot}13298.\ \sinh 2hl=0{\cdot}2683,$$
$$\sin kl=0{\cdot}58186,\ \sin 2kl=0{\cdot}9465,$$
$$Q_1=0{\cdot}8203,\ Q_2=0{\cdot}0776,\ Q_3=0{\cdot}5872,\ Q_4=0{\cdot}1082.$$
$$\cos\theta=0{\cdot}85,\ \sin\theta=-0{\cdot}527,\ \theta=-31^\circ\ 47',$$
$$\xi-\delta=77^\circ\ 57'\ 32''-67^\circ\ 54'\ 12''=10^\circ\ 03'\ 20'',$$
$$\cos(\xi-\delta)=0{\cdot}98464,\ \sin(\xi-\delta)=0{\cdot}17460,$$
$$\theta-\xi+\delta=-41^\circ\ 50'\ 20'',\ \cos(\theta-\xi+\delta)=0{\cdot}7451,$$
$$\sin(\theta-\xi+\delta)=-0{\cdot}66695.$$

Substituting in (79), (80), (81), (82),

$$V_{1g}=0{\cdot}8203E_0+371{\cdot}6\{(0{\cdot}1082)(0{\cdot}7451)+0{\cdot}5872)(0{\cdot}66695)\}I_0$$
$$=0{\cdot}8203E_0+175{\cdot}5I_0=47{,}400+11{,}900=59{,}300 \quad . \quad . \quad (83)$$
$$V_{2g}=(0{\cdot}0776)E_0+(371{\cdot}6)\{(0{\cdot}1082)(0{\cdot}667)+(0{\cdot}5872)(0{\cdot}7451\}I_0$$
$$=0{\cdot}0776E_0+136{\cdot}0I_0=4{,}470+92{,}500=13{,}970 \quad . \quad . \quad (84)$$
$$I_{1g}=\{(0{\cdot}8203\times0{\cdot}85+(0{\cdot}0776)(0{\cdot}527)\}I_0$$
$$-\frac{2{\cdot}671}{1{,}000}(0{\cdot}1082)(0{\cdot}9846)-(0{\cdot}5872)(0{\cdot}1746)\ I_0$$
$$=0{\cdot}739I_0+0{\cdot}00001095E_0=51{\cdot}0+0{\cdot}63=51{\cdot}70 \quad . \quad . \quad (85)$$
$$I_{2g}=\{(0{\cdot}8203\times-0{\cdot}527)+(0{\cdot}0776)(0{\cdot}85)\}I_0$$
$$-\frac{2{\cdot}671}{1{,}000}(0{\cdot}1082)(0{\cdot}1746)+(0{\cdot}5872)(0{\cdot}9846)\ I_0$$
$$=-0{\cdot}366I_0+0{\cdot}00159E_0=-24{\cdot}9+91{\cdot}6=66{\cdot}70 \quad . \quad . \quad (86)$$
$$\text{Power input}=(59{,}300\times51{\cdot}70)+(13{,}970\times66{\cdot}70)$$
$$=3{,}070{,}000+930{,}000=4{,}000{,}000\text{ watts.}$$

Effective Values and Power Factors:

$$\tan\varphi_r=\frac{13{,}970}{59{,}300}=0{\cdot}2350,\ \varphi_r=13^\circ\ 14',\ \cos\varphi_r=0{\cdot}97350,$$
$$V_r=\frac{59{,}300}{0{\cdot}97350}=60{,}900\text{ volts.}$$
$$\tan\varphi_i=\frac{66{\cdot}70}{51{\cdot}70}=1{\cdot}290.\ \varphi_i=52^\circ\ 15'.\ \cos\varphi_i=0{\cdot}6127$$
$$I=\frac{51{\cdot}70}{0{\cdot}6127}=84{\cdot}40\text{ amperes.}\quad\text{Power factor}=0{\cdot}777.$$

Voltage at Receiver, No Load, and Generator Voltage 60,900:

When $I_0=0$ we have

$$V_{1g}=0{\cdot}8203E_0.\ V_{2g}=0{\cdot}0776E_0.$$

Then

$$\tan\varphi=\frac{0{\cdot}0776}{0{\cdot}8203}=0{\cdot}0942.\quad\varphi=5^\circ\ 23',\ \cos\varphi=0{\cdot}9956.$$
$$V_r=60{,}900=0{\cdot}8203E_0+5{,}760;\ E_0=73{,}700$$
$$V_i=60{,}900=0{\cdot}0776E_0+60{,}600;\ E_0=73{,}800$$

Current at Generator (No Load):—

$$I_{1g}=0{\cdot}00001095E_0.\ I=0{\cdot}00159\ E_0$$
$$\tan\varphi=\frac{0{\cdot}00159}{0{\cdot}00001095}=145{\cdot}0.\quad\varphi=89^\circ\ 36'.\quad I=117{\cdot}1\text{ amperes}$$
$$I_{1g}=0{\cdot}00001095\times73{,}800=0{\cdot}807,\ I_{2g}=0{\cdot}00159\times73{,}800=117{\cdot}3$$

Power loss (open circuit)$=(60{,}600\times0{\cdot}807)+(5{,}700\times117{\cdot}3)$
$=716{,}700$ watts.

Dielectric loss $=\dfrac{SE_0^2}{2}\left(\dfrac{\cosh 2kl+\cos 2kl}{\cosh 2kl-\cos 2kl}-1\right)\left(\dfrac{\sin 2kl}{2kl}-1\right)$

$=\dfrac{10\cdot10^{-8}\times(606)^2\cdot10^{-1}}{1{\cdot}3582}\left(\dfrac{0{\cdot}2683}{0{\cdot}0000142}-0{\cdot}09465\right)$

$=\dfrac{(606)^2}{1{,}358{\cdot}2}\,1{\cdot}064=288{,}000$ watts.

Conductor loss $=\dfrac{RYE^2}{2Z}\left(\dfrac{\cosh 2kl-\cos 2kl}{\cosh 2kl+\cos 2kl}\right)\left(1-\dfrac{\sin 2kl}{2kl}\right)$

$=\dfrac{0{\cdot}30\cdot5{\cdot}77\cdot10^{-2}\cdot(606)^2}{2\times1{\cdot}3582\times0{\cdot}7975}\{152\}=445{,}000$ watts.

In short lines the dielectric loss is much greater than the conductor loss, but the longer the line the greater the conductor loss. In the example above the value of S is about twice as great as any value which actually occurs.

7. *Tabulation of Current, Voltage and Power.*—The equations (83), (84), (85), (86) may be used for rapid tabulation for given power factor at receiver. For this particular set the power factor is 85 per cent.

If the power output is to be 3,333,333 watts, then $E_0I_0=3{,}920{,}000$. Taking $I_0=100$ amperes, we get $E_0=39{,}200$. Substituting in (83),

$$V_{1g}=(0{\cdot}8203)\,(39{,}200)+(175{\cdot}5)\,(100)$$
$$=32{,}200+17{,}550=49{,}950.$$

In (84)

$$V_{2g}=(0{\cdot}0776)(39{,}200)+(136{\cdot}0)(100)$$
$$=3{,}030+13{,}600=16{,}630.$$

In (85)

$$I_{1g}=(0{\cdot}739)(100)+(0{\cdot}000159)(39{,}200)$$
$$=73{\cdot}9+0{\cdot}4=74{\cdot}3.$$

In (86)

$$I_{2g}=(-0{\cdot}366)(100)+(0{\cdot}00159)(39{,}200)$$
$$=-36{\cdot}6+62{\cdot}2=25{\cdot}6.$$

The power input is

$$(49{,}950\times74{\cdot}3)+(16{,}630)\times(25{\cdot}6)=3{,}720{,}000+427{,}000$$
$$=4{,}147{,}000 \text{ watts.}$$

Efficiency of transmission=79·8 per cent.

If the power factor is 0·80, we get the following set of equations :—

$$V_{1g}=0{\cdot}8203E_0-185{\cdot}9I_0$$
$$V_{2g}=0{\cdot}0776E_0-119{\cdot}0I_0$$
$$I_{1g}=0{\cdot}00001E_0+0{\cdot}703I_0$$
$$I_{2g}=0{\cdot}00016E_0-0{\cdot}430I_0.$$

8. *Minimum Value of Power Input for Given Output.*—Since the power input is $I_{1g}V_{1g}+I_{2g}V_{2g}$, the equations above give for the power input

$$P=0{\cdot}0000132E_0^2-0{\cdot}732E_0I_0+80I_0^2.$$

If we take the power output constant, we have also, if output is 8,000,000 watts,

$$E_0I_0=10{,}000{,}000.$$

Differentiating, we have

$$0{\cdot}0000132\,E_0dE_0+80I_0dI_0-0{\cdot}732I_0dE_0-0{\cdot}732E_0dI_0=0$$
$$I_0dE_0+E_0dI_0=0$$

Eliminating the differentials dE_0 and dI_0,

$$132\,E_0^2=80{,}000{,}000I_0^2$$
$$E_0=778I_0$$
$$778\,I_0^2=10{,}000{,}000$$
$$I_0^2=12{,}810,\quad I_0=113{\cdot}0(1)$$
$$E_0=778\times113{\cdot}0=88{,}000 \text{ volts.}$$

Power input $=(0{\cdot}0000132)(88{,}000)^2-(0{\cdot}732)(10{,}000{,}000)$
$+80(113{\cdot}0)^2$
$=11{,}000{,}000-7{,}320{,}000+1{,}840{,}000$
$=9{,}520{,}000$ watts.

Efficiency of transmission=84 per cent.

Whether this result gives a maximum or minimum is best ascertained by tabulating a series for values of I_0 and E_0 such that $E_0I_0=10{,}000{,}000$.

9. *"Beating Down" of the Generator.*—If the impedance of the receiving circuit is 500 ohms the equations become

$$V_{1g}=(410{\cdot}15+185{\cdot}9)I_0$$
$$=596{\cdot}05I_0$$
$$V_{2g}=(38{\cdot}8+119{\cdot}0)I_0$$
$$=157{\cdot}8I_0$$
$$I_{1g}=(0{\cdot}005+0{\cdot}703)I_0$$
$$=0{\cdot}708I_0$$
$$I_{2g}=(0{\cdot}80-0{\cdot}430)I_0$$
$$=0{\cdot}371I_0.$$

If the impedance of the generator is $30+j40$, and the E.M.F. is 100,000, we have

$$100{,}000(\cos\varphi+j\sin\theta)=(V_{1g}+jV_{2g})+(I_{1g}+jI_{2g})(30+j40).$$

Separating reals and imaginaries,

$$V_{1g}+30I_{1g}-40I_{2g}=100{,}000\cos\varphi$$
$$V_{2g}+30I_{2g}+40I_{1g}=100{,}000\sin\varphi.$$

Substituting for V_{1g}, &c., in terms of I_0,

$$100{,}000\cos\varphi=(596{\cdot}05+21{\cdot}24-14{\cdot}8)I_0$$
$$=602{\cdot}49I_0$$
$$100{,}000\sin\varphi=(157{\cdot}8+11{\cdot}1+28{\cdot}32)I_0$$
$$=197{\cdot}2I_0.$$

Then $\tan\varphi=\dfrac{197{\cdot}2}{602{\cdot}5}=0{\cdot}3250$, $\varphi=18°\,0'$, $\cos\varphi=0{\cdot}9511$, $\sin\varphi=0{\cdot}3090$;

$$100{,}000\times0{\cdot}9511=602{\cdot}5I_0$$
$$I_0=95{,}110\div602{\cdot}5=158{\cdot}0 \text{ amperes.}$$

$V_{1g}=94{,}000$, $V_{2g}=249{,}000$, $I_{1g}=112{\cdot}0$, $I_{2g}=58{\cdot}3$

$\tan\varphi_v=\dfrac{V_{2g}}{V_{1g}}=0{\cdot}2650$, $\varphi_v=14°\,51'$, $\cos\varphi_v=0{\cdot}9666$, $\sin\varphi_v=0{\cdot}2563$

$V_g=V_{1g}\div\cos\varphi_v=94{,}000\div0{\cdot}9666=97{,}200$ volts

$\tan\varphi_i=\dfrac{I_{2g}}{I_{1g}}=0{\cdot}521$, $\varphi_i=27°\,31'$, $\cos\varphi_i=0{\cdot}8870$

$I_g=I_{1g}\div\cos\varphi_i=112{\cdot}0\div0{\cdot}8870=126{\cdot}0$ amperes.

9. *Effect of Frequency.*—In order to ascertain the effect of frequency on the efficiency of transmission, let us take the same line and constants as above, but let the frequency be 25 cycles per second.

We find $\delta=45°\,43'$, $\gamma=85°\,17'$, $\xi=65°\,30'$

$Z=0{\cdot}430$, $Y=2{\cdot}43\times10^{-6}$, $\sqrt{ZY}=420{\cdot}2$

$h=0{\cdot}000458$, $k=0{\cdot}001050$

$Q_1=0{\cdot}9598$, $Q_2=0{\cdot}0395$

$Q_3=0{\cdot}1208$, $Q_4=0{\cdot}3130$

$V_1=0{\cdot}9598E_0+133{\cdot}0I_0$

$V_2=0{\cdot}0395E_0+45{\cdot}7I_0$

$I_1=0{\cdot}851I_0+0{\cdot}000019E_0$

$I_2=0{\cdot}472I_0+0{\cdot}00008E_0$.

If $E_0=57{,}700$ and $I_0=68{\cdot}0$, we find

$V_1=64{,}250$, $V_2=5{,}390$, $V_g=64{,}600$

$I_1=59{\cdot}1$, $I_2=14{\cdot}16$, $I_g=61{\cdot}0$ amps.

Power factor at generator terminals=0·9886.

Frequency 60 gave $V_g=60{,}900$, $I_g=84{\cdot}0$, P.F.=0·777.

Power input 25 cycles=3,900,000

Power input 60 cycles=3,960,000.

Apparently the change of frequency makes little difference in output.

AN ELECTROMAGNETIC VACUUM BALANCE.*

BY JOHN S. ANDERSON, M.A., PH.D.

During the course of work [illegible] by the author on the [illegible] of [illegible] and giving upon [illegible], alcohol and [illegible] a vapour [illegible] of the [illegible] a balance was [illegible] to [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] under certain conditions, from time to time without removing it from [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

rapidly become filled with condensed vapour owing to capillary action. If the weight of the metal and the absorbed water can be rapidly and accurately measured from time to time the velocity of absorption may easily be determined. For this purpose an electro-magnetic vacuum balance was designed. The principle involved is that of the well-known Kelvin balance for "weighing" electrical currents.* One of the scale pans of an ordinary balance is replaced by a circular coil of wire whose axis is vertical. This coil is movable between two larger fixed coils of wire, which have the same vertical axis. The three coils are so connected that an electrical current may be passed through them in series, through the movable coil and the lower fixed coil in one direction and through the upper fixed coil in the opposite direction. Thus, when an electrical current is passed through the coils, the movable one is attracted towards the lower, and repulsed by the upper, fixed coil. These attractive and repulsive forces may be increased or decreased by increasing or decreasing the current passing through the coils; they are made use of to counterbalance the force of gravity acting on the substance to be weighed in the scale pan hanging from the other end of the beam of the balance. Should the weight of the substance vary from time to time, the variations can be determined by altering the current passing through the coils until equality of the forces acting on either end of the balance beam is obtained. The balance is enclosed in a bell jar which can be evacuated, so that the process of weighing can be carried out while the substance whose weight is required is in a vacuum.

The balance was constructed according to the author's designs by

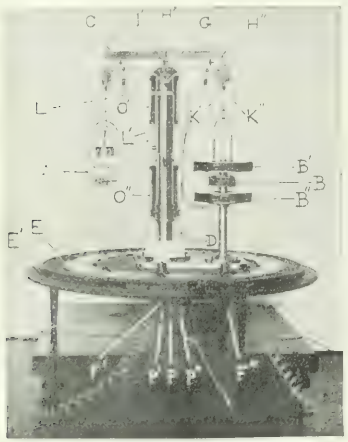


Fig. 1.

Messrs. Spindler & Hoyer, Göttingen, Germany. The beam of the balance and the parts appertaining to it were obtained from Messrs. Sartorius, Göttingen. Fig. 1 shows a front view of the balance, the bell-jar cover being removed. The chief metallic parts are nickel-plated. A is the scale pan in which the substance to be weighed is placed. B is the movable coil of wire which takes the place of the second scale pan. It hangs half-way between the fixed coils of wire B′ and B″ when the beam C is at rest—that is, when the pointer D is at zero. The knife edge at the centre of the beam C rests on a small plate of agate. The balance is fixed to a round glass plate, E, which lies on a steel table, E′, having three legs. This table rests on a wooden board, to which are attached three screws, the height of which may be varied at will. By adjusting the screws the plate on which the balance rests may be fixed in a horizontal position. The height of the beam C above the glass plate E is about 22 cm. The dimensions of the movable parts of the balance are such that the total surface exposed on either side of the beam is approximately the same. The reason for this is that when in an experiment water vapour, or other vapour, is introduced into the balance, there will be approximately the same amount of vapour absorbed by the metal,

The method of connecting up the coils of wire B, B′ and B″ with

* A similar instrument, depending on the same principle, but of different construction, was described by M. G. Urbain, "Comptes Rendus," 1905, 1941.

In order to prevent leakage of air at the terminals when the bell-jar cover is on the balance and the apparatus is evacuated, small leather washers are provided above the plate E, and the terminals are sealed below the plate by means of wax. A little rectangular box of ebonite, G (seen better in Fig. 2), is fixed to the beam C at the top of the pointer D. This box is divided into two compartments, each containing a little mercury. Above the box, and attached in a horizontal position to the centre of the beam, is a small rod of ivory, H′. Two small pieces of platinum, I′, I″, passing through this rod are fixed vertically in such a position that each of them dips into one of the mercury compartments of the box G. When the beam vibrates about its position of equilibrium the pieces of platinum move through the mercury, but friction is reduced to a minimum owing to the fact that the lower ends of the platinum pieces are very fine and are slightly flattened in the planes of motion. On the end of the balance beam from which the coil B hangs is fixed another small ivory rod, H″. Two very fine wires are stretched from the pieces of platinum I′, I″ over the rod H″, and pass down in the form of spirals K′, K″ to the two ends of the movable coil B. Wires connect the terminal F′ and one of the compartments of the box G, the terminal F″ and the coil B″, the coil B″ and the coil B′, the coil B′ and the other compartment of the box G. Thus there are electrical connections from the terminal F′ through the mercury in one of the compartments of G, the piece of platinum I′ and the wire K′ to the coil B and back through the wire K″, the piece of platinum I″ and the mercury in the other compartment of G to the coil B′, and thence through the coil B″ to the terminal F″.

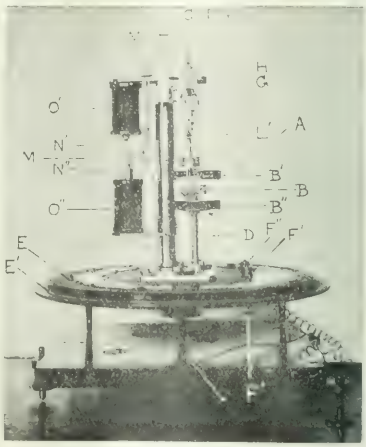


Fig. 2.

When the balance is not in use the beam C rests on the framework L. The method of releasing and fixing the beam may be seen from a study of Fig. 2, which gives a side view of the balance, the bell-jar cover being removed. M is a lever at the back of the balance. The outer end of it is connected above and below by two metal pieces to two cylindrical iron rods, N′, N″, which can move freely in a vertical direction inside the two solenoids O′, O″ fixed to the central upright stem of the balance. When a current of electricity is passed through the coil of the lower solenoid O″ the iron core N″ is drawn down into the solenoid. Thus the outer end of the lever M is drawn downwards, allowing the cylindrical shell L′ and the framework L, which is connected to it, to fall down a short distance, the balance beam C being thus released. The weight of the cores N′, N″ causes the lever M to remain down when the current is switched off. When an electrical current is now passed through the coil of the upper solenoid O′ the iron core N′ is drawn upwards. This action causes the outer end of the lever M to rise, thus raising the cylindrical shell L′ and the framework L. The beam C is, therefore, held fixed at rest again. A wire spring, M′, holds up the lever M when the current is switched off. Thus, in order to release or fix the beam of the balance, a current of electricity need only be momentarily passed through the lower or the upper solenoid.

Three wires, insulated from one another by means of ebonite, pass through the metal base of the balance and through the glass plate E. They end below the steel table G in three terminals, P, P′ and P″ (Fig. 1). One end of the coil of wire in the solenoid O′ is connected to the terminal P′, one end of the coil in the solenoid O″ is connected

to the terminal P″, while the other end of the coil is brought connected to the middle terminal P.

The electrical connections necessary for operating the balance are shown diagrammatically in Fig. 3. To the right of the figure are the connections for the movable coil B and the fixed coils B′ and B″. A is a key, F′ and F″ are the terminals on the top side of the glass plate E (Fig. 1). The connections below F′ and F″ are all outside the balance; the other leads have already been described. R is an amperemeter for measuring the current passing through the coils. The battery S′ gives a pressure of about 70 volts. T is a resistance box and T′ represents two slide resistances connected up in series. V′ is a key by means of which the circuit may be reversed, as will. To the left of Fig. 3 are shown the connections necessary for releasing and fixing the balance beam by means of the lever operated on by the solenoids O′ and O″ and their iron cores. As in Fig. 1, P′, P″ are the three terminals projecting under the metal table on which the balance rests. The battery S″ gives a pressure of about 10 volts. T″ is a slide resistance. V″ is a two-way key; when the lever is placed in the upper position (dotted line) the circuit through the upper solenoid O′ is closed, and when placed in the lower position (dotted line) the circuit through the lower solenoid O″ is closed. When the lever is in the middle position no current passes through either circuit.

The method of working with the vacuum balance is as follows: By way of example we may take the case where it is desired to make measurements on the rate of absorption of water vapour by a gel of silicic acid. Some small pieces of the gel are first of all dried carefully in a desiccator over concentrated sulphuric acid. They are then placed in a glass dish which rests on the scale pan A (Fig. 1) of the balance. Weights are then added to the scale pan until the total weight on this side of the beam is somewhat greater than the

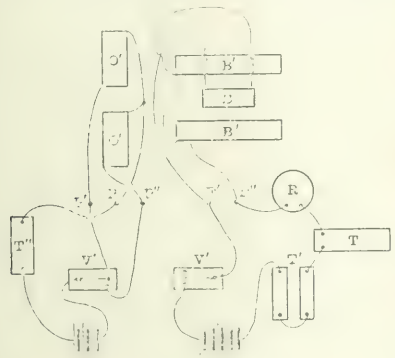


FIG. 3.

weight of the movable coil B on the other side. If this condition is satisfied, a small electrical current must be passed through the coils B, B′ and B″ in order to compensate for the extra weight, and thus bring the pointer D to the zero mark when the beam C is released. A bell-jar cover is next placed over the balance. The lower rim of the cover was originally ground on the glass plate E when the balance was constructed, before the balance was attached to the plate. When the rim is smeared with a little "Ramsay" fat and the cover is placed on the glass plate and turned round once or twice, a good seal is obtained between the rim and the plate. The bell jar is connected to a vacuum apparatus by a tube. In the case of measurements with water vapour, the vessel of the vacuum apparatus Y is first of all about half-filled with concentrated sulphuric acid. The whole apparatus is evacuated by means of a pump,* the pressure being registered on the mercury manometer. The weight of the silicic acid gel in the scale pan of the balance is found by measuring with an amperemeter the current that must be passed through the coils in order to bring the pointer to zero, the variation of current with weight being previously determined by calibrating the balance. The measurements are carried out from time to time until the necessary current reaches a steady minimum value, thus indicating that the gel is as dry as it is possible to obtain it [illegible] sulphuric acid. A tap between the vacuum vessel and the bell jar is then closed, and the sulphuric acid in the vessel is replaced by water. When the vessel has been connected to the

* In the experiment carried out by the [illegible] a Hyvac pump was employed.

as possible, the tap is opened, thus allowing the whole apparatus to be filled with water vapour. At fixed intervals after the tap is opened the current necessary to bring the pointer of the balance to the zero mark is measured. Owing to the absorption by the gel of water vapour, which condenses in the pores of the gel, the requisite current of electricity increases with the time until a maximum is reached. This maximum current corresponds to the condition that the pores of the silicic acid gel are completely filled with water.

The balance should be carefully calibrated before and after a series of experiments. This may be done by placing certain known weights in the scale pan of the balance and determining the strengths of the currents that must be passed through the coils in each case. A curve may then be constructed, giving the relation of electrical current to weight. From the measurements made in the case of the absorption and giving up of water vapour by the silicic acid gel, the weight of the gel and the water it contains at each time of measurement may easily be determined by reference to the curve. With the amperemeter used in the experiment a difference of 0·1 milliampere could be detected. This corresponds to a difference in weight of 0·35 to 0·7 milligram, depending on the portion of the range of weights used. If more care were to be taken in choosing the range of weights, and if a more accurate amperemeter were employed, it would be possible to increase the sensitiveness of the balance considerably. Although the beam of the balance is capable of carrying weights up to about 100 grams, only about 0·75 gram silicic acid gel was employed in the experiment. If a greater amount of the gel were employed, more water would be absorbed, and therefore a greater range of electrical current would have to be made use of. It is advisable to determine approximately before an experiment what the total variation in weight of the substance under examination will be, so that a convenient range of current may be employed. The maximum current applied should be kept fairly small in order to prevent heating of the coils.

CORRESPONDENCE.

MUNITIONS OF WAR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In this time of national stress, I suggest the immediate organisation of the workshops of the many electricity generating stations in the kingdom, both municipal and company owned, with a view to producing shells and other suitable munitions of war.

I suppose all these works have already lost some men to the Colours, but in every case they are compelled to retain enough men to deal effectively with any case of emergency that may arise in connection with their undertakings. These men could each do a certain amount of overtime for the good of the Empire. Moreover, they are for the most part skilled mechanics, and doubtless the Corporations and companies concerned would readily grant them the full use of their machine tools and workshops.

Possibly, also, additional service could be obtained from engineers resident in the towns or districts where the works are situated, and thus the plant could be maintained to practically continuous duty, excepting when required for the pressing needs of the power station itself.

In this way a considerable source of production will be immediately tapped which otherwise must apparently remain dormant. Presumably the scheme would be worked in conjunction with the various Munition Committees which are being formed in the manufacturing centres. I feel sure the authorities would find both the managers and men of the electric power stations willing and anxious to do all they can to help the common cause on such reasonable terms as the Government after a position to offer. I am, &c.,

Harrogate, June 7. GEO. WILKINSON.

SYSTEMS OF WIRING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your invitation in your last issue, I am disposed to support Mr. Gregbee's contention. For the past five years I have been in touch with electric wiring in Western Canada. The knob and tube work, which is extensively used,

seems to be admirably adapted for walls of studding and plaster and floor work, particularly while a building is in construction.

The floors, by the way, in quite cheap houses, are vastly superior to English work. They are nearly always double, and have damp-proof paper between, so that washing and cleaning will rarely if ever give rise to dampness near the wires.

The wires are well out of the reach of nails blindly driven in the finishing work; are well apart from possible damp surfaces (wet plaster) and from inflammable substances in case of moderate overload.

There is a roughness about the work which causes a bad impression. Wires in concealed places are rarely parallel or straight or evenly spaced. The knobs are secured by nails, not screws, and the whole thing is just "thrown in" by eye, and a poor one at that. The "electrician" is usually a youth barely out of his teens armed with a fearful and wonderful brace for boring in cramped and awkward places.

He will wire a five or six roomed bungalow without assistance in a morning or, at least, a day. There is in certain districts a slackness about soldering joints and the inspection of the same. There is, however, much ceremony about applications for inspection, &c., and prompt punishment at the hands of a magistrate for any reported infraction of the by-laws.

An important difference in the wiring as distinguished from English practice is the limit in the small sizes of wire allowed. Nothing smaller than No. 14 B. and S. gauge is permitted, and flex has to have a similar section. This allows for the temporary connection of electric irons, kettles and so forth to any fitting or suspension. The mains may be a little on the small side, but, allowing for a "diversity factor," this is reasonable.

Although the general work appears to be shoddy, one cannot seriously feel that it will fail its purpose or give trouble. It is the kind of work that any electrical engineer might put up with his own hands and be satisfied to live with, but he might hesitate to accept a fee for passing the same.

Two other points I should like to mention in connection with the subject. The first is the usual type of fitting, which has a loose sliding cover plate as a "base," allowing ample room for the joint to the fitting wires and easy inspection. The second is the location of the meter and main switch, which must be outside the building. This allows firemen or police to cut off the current in case of fire, and saves a vast amount of time to meter readers.—I am, &c.,

London, June 8. J. Rutherford Blaikie.

GYROSCOPIC COMPASS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to my letter concerning the Sea-Star compass published in The Electrician on the 28th ult., Mr. Denton writes that with the exception of a few lines it is either misleading or a confusion of words to nonsense. Such statements can only mean that, in his opinion, I am either ignorant of the subject on which I wrote or I attempted to mislead the reader when I stated and showed that the Sea-Star compass has no error due to latitude. In proving that his censures are unjust I hope to be able again to explain the difference in construction and behaviour of the Sea-Star from other types of gyro-compasses.

The second paragraph, Mr. Denton writes, is misleading, because in it is described "a gyroscope having three degrees of freedom." In paragraph (2) these words occur: "The wheel and the casing can turn freely about their respective axes, but their motion, with that of the inner frame, about the vertical axis is controlled in the way now to be described," and after describing the method of control the paragraph closes with this sentence: "Thus, motion about the vertical axis depends upon the position of the casing relative to that of the pendulum." If motion about the vertical axis takes place as stated, the Sea-Star has not, in the usual acceptance of the term, a degree of freedom about that axis. The description, therefore, is not that of a compass having three degrees of freedom, and consequently the statement is not misleading in the way stated by Mr. Denton.

In that paragraph, also, reference has the relative positions of the pendulum and casing can cause motion about the vertical axis, is also stigmatised as misleading. In what way it is not stated, but it is stated that from it a clever reader may possibly be able to draw an unnecessary inference; unnecessary, because the fact to be inferred—namely, that the Sea-Star has not three degrees of freedom—is stated in the second paragraph, as has been already shown.

The fourth paragraph is, according to Mr. Denton, a "mere confusion of words." From his comment on this paragraph it seems that the offending word is "meridian." He writes that it is used 13 times, but only once correctly. All I can say is that each time is is used it means a line, which at the given place is horizontal, and which is in the plane containing the axis of the earth, and, therefore, the poles. If this is incorrect, then I am afraid the thirteenth reference to the meridian will have to go the way of the other 12.

According to Mr. Denton this fourth paragraph leads him to infer that I have "not yet realised the nature of latitude error in any form of gyro-compass." Let me make a confession of knowledge. I know that at the equator a gyrostat, having its horizontal and diametral degree of freedom suppressed but being free about its vertical and diametrical axis, will ultimately set itself with its axle in the meridian. I know that at any other latitude such a gyrostat will set itself with its axle out of the meridian. I know that at the equator a gyrostat having three degrees of freedom will not set itself with its axle in the meridian, and at any other latitude it will not set itself at an angle with the meridian. Further, I know that if a gyrostat with three degrees of freedom is turned about its vertical axis in one direction a precession about its horizontal axis is generated in a definite direction; and that if the motion about the vertical axis is reversed, the existing precession is first reduced to zero and then reversed. Also I know that the Sea-Star compass behaves in the way similar to that just described for a gyrostat with three degrees of freedom, but that it differs from such a gyrostat in that the precessions about the horizontal axis by making contacts give rise to the motions about the vertical axis. Besides this I know that the gyrostat of the Sea-Star tends to remain parallel to its original position when moved by the rotation of the earth; also I know that the pendulum tends to remain vertical, and that this difference in behaviour between the gyrostat and the pendulum can give rise to rotation about the vertical axis in the same way as precession about the horizontal axis does. Moreover, I know that every time the gyrostat axle leaves the meridian, contact is made in such a way that the axle swings into the meridian again. This confession shows that I do realise the nature of latitude error in some forms of gyro-compasses; it also shows that I realise that the Sea-Star is not a compass necessarily subject to that error, and, moreover, that I realise the gyro-wheel on the prongs of a fork, as described by Mr. Denton, will not behave as the Sea-Star does.

The fifth and last paragraph of my letter is, Mr. Denton writes, nonsense. In it is stated that the Sea-Star is free to turn about the horizontal axis perpendicular to the axis of the wheels axle. This, Mr. Denton avers, has, in the second and third paragraphs, been shown to be impossible. The following extracts from these paragraphs will show that it is entirely wrong to assert that these paragraphs contradict the last paragraph. The first extract is from paragraph (2) and is as follows: "The Sea-Star compass consists of a wheel, which can rotate about the horizontal axis of its axle, and which is mounted in a casing which, in its turn, is mounted in a frame so that the casing and the wheel can turn about a horizontal axis perpendicular to the axle of the wheel, the axle being also a diameter of the wheel." This paragraph, therefore, agrees with the fifth one in stating that the Sea-Star is free to turn about the horizontal axis perpendicular to the axis of the wheel's axle. The second extract is from paragraph (5), namely: "When the roller is in contact with either of the strips, that is to say, when the axle of the wheel is not horizontal, there is, as explained above, motion about the vertical axis. The direction of this motion is arranged so that, by means of it, the axle of the rotating wheel tends to become horizontal." Paragraph (5) therefore states that in certain

conditions, the gyrostat must turn about the axis which in paragraph (5) is stated to be free. These extracts show that the second and third paragraphs do not contradict the fifth paragraph, the latter paragraph cannot, therefore, be nonsense.

In the last paragraph of his letter Mr. Denton has the following sentence: "The torque due to the meridian motor is first to left and then to right, an alternating torque whose average value is nil." Taken separately the two parts of the sentence are correct, but taken together they are incorrect. For the conclusion to be drawn is that the torques due to the meridian motor have the same magnitude though their directions are reversed. The resultant impulses of the torques about the vertical axis are the same in magnitude, but the torques due to the meridian motor are not the resultant torques. The meridian motor torques do not, therefore, necessarily average nil, although the resulting impulses of the torques do.

I have shown that my previous letter was not misleading, nonsense and a mere confusion of words. It still remains as a true description of the essential parts and of the behaviour, in certain circumstances, of the Sea-Star compass.—I am, &c.,

London, June 8. WALTER LONGLAND.

RADIATIONS FROM EXPLODING ATOMS.

In introducing his discourse on "Radiations from Exploding Atoms" at the Royal Institution on Friday, June 4th, Sir Ernest Rutherford, F.R.S., remarked that the spontaneous explosion of radioactive atoms liberated energies a million times more powerful

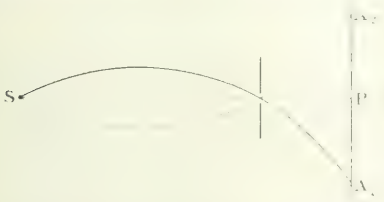


FIG. 1.

than those of modern explosives, and it was fortunate that these substances only occurred in very small quantities. The radiations observed during the disintegration or transformation of a radioactive substance were of three types, known as α, β, γ rays. Some transformations were characterised by one type only; thus RaB, gave only β-rays, but the β-rays were almost invariably accompanied by γ rays. The α particle became a helium atom when deprived of its two positive charges; the β particle was the same as the kathode ray particle or electron. The α-ray was shot out at a speed of 10,000 miles per second; the speed of the β rays approached that of light. To produce velocities of this order in vacuum tubes would require potentials of two to four million volts, and thus these researches had a high scientific value quite apart from the interest of the study of radioactivity. The investigation of the energy relations had necessitated very careful quantitative determinations.

Speaking first of recent researches concerning α-rays, Prof. Rutherford mentioned that there had been some discrepancy between the values of e/m for the α particle deduced from electrical measurements and the value for the helium atom deduced from electrochemical data. In radioactive measurements the deflections were measured which the particles underwent in magnetic and electric fields. A narrow period of rays issuing from a coated wire was used as source S for the magnetic deflection (Fig. 1); the particles moved in a curved path, and when the field was reversed, the particles were deflected in the opposite sense (dotted curve); thus the particles hit the photographic plate P to the right and left of the central line drawn through the source and slit, giving a total deflection between X_1 and X_2. For the electrostatic experiments two aluminium plates (charged from a battery), about 35 cm. long, 1 cm. thick, were fixed 1 cm. apart, the source was in the middle of the emanation; similar curves were obtained. Such experiments had been made by himself and others since 1902 with many different kinds of radioactive substances, and the two values for the e/m for radioactive and chemical work agreed within [illegible] per cent., the e/m (radioactive) for RaC being 1·823 [illegible] (velocity of α-particles) = 1·922·10⁹cm. sec. There was another way of checking these figures. The atom of the radioactive substance recoiled, at a much lower speed, of course, when an α-particle was shot off, and since the deflection of the particles depended upon their momentum, the residual atom should give the same kind of curve; that was found to be so, but the residual radium atom carried only one charge instead of two. To exemplify this recoil, Sir Ernest suspended a hollow ball [illegible] by a string; the ball was charged with hydrogen, a hole in the ball being plugged with cork. When the hydrogen was exploded by placing the ball between two spark electrodes, the cork was ejected, and the ball recoiled.

Similar measurements on β-rays had been carried out by O. Hahn, O. v. Baeyer and Liese Meitner, by J. Danysz, Chadwick, and by Rutherford and H. Robinson. When the rising conical beam of β-rays was deflected sideways, it spread out like a curved fan and produced, on a horizontal photographic plate, a kind of spectrum of curved lines superposed on a continuous spectrum. Figs. 2 and 3, details of which would be explained later. Danysz and he himself had also placed the emanation tube below the slit in the magnetic field; then particles of the same speed described circles of equal radius and gave rise to many distinct common lines (Fig. 4). All these experiments were made in a vacuum. In this way they had distinguished 48 lines in the "magnetic spectrum" of RaC. Calculations were based upon the observed $H\rho$, H being the magnetic field in gauss, ρ the radius of curvature being in centimetres, and upon the relation $H\rho = mv/e$, after the formula of Lorentz-Emstein. The question was: What did these many lines in the "magnetic spectrum" signify? A single atom was supposed to give only one particle at the time; but they observed nearly 50 homogeneous groups or lines. Before entering further into that problem, the lecturer referred to the γ-particles.

The γ-rays resembled X-rays of a very penetrating character, and they had recently been identified with the characteristic rays of Barkla. When X-rays fell on a metal like copper, the copper sent out radiations peculiar to itself, depending upon the atomic weight of the metal. The γ-rays thus represented the fundamental modes of vibration of the atom, not chance radiations. To examine whether the radiations were really the characteristic radiations, hard and soft radiations were separated by interposing increasing thicknesses of

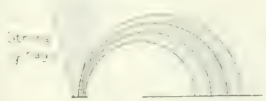


FIG. 2.

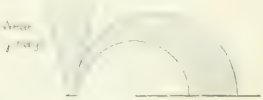


FIG. 3.

aluminium (up to 7 cm. and even 15 cm.) into the path of the rays. The experiments were tedious, and it had been ascertained that RaB and RaC and the other radioactive substances, uranium, thorium, actinium, &c., gave not only two types of characteristic radiations, known as the K and L series, but five or more series, which were in no way accidental. This had been found by the aid of another method of investigation which had been placed in their hands by the work of Laue and of Bragg on X-rays and crystal structure. For making wave-length measurements on γ-rays by this method he (Sir Ernest) placed an emanation tube in front of a long slit formed by two blocks of lead; through this slit the rays fell obliquely on a crystal of rock salt ($\frac{1}{4}$ mm. in thickness) and were reflected on to a photographic plate, the crystal and plate turning together so as to allow of measurements at different incidences. The whole apparatus was within a powerful magnetic field to exclude all β-rays, and very long exposures of a day or more were needed, since the γ-rays had very weak photographic effects. The spectrum thus obtained showed lines corresponding to deflections at 1 deg. or less, at 10 deg. and 12 deg., &c., and these lines agreed exactly with the lines which lead gave under characteristic excitation, thus confirming Soddy's assertion that RaB and RaC [illegible] differences in atomic weight. The shortest wave-length of very penetrating [illegible] was about 0·0046 Ångström units or 0·46 10^{-10} cm., and half of the shortest wave-length of the hardest X-rays previously determined. It was very remarkable that the structure of a thin rock salt crystal sufficed to resolve such short waves.

Prof. Rutherford then passed to "the most difficult part of his lecture," the connection between β and γ-rays and their spectra. [illegible] Wilson's well-known photographs X-rays loosened the electrons of the [illegible]

model of these effects Sir Ernest showed a large hollow copper sphere containing small loose balls; to the sphere was attached, by means of a rubber cord, a solid ball, which acted as striking projectile or bullet. When the cord was pulled out, the bullet hit the sphere, which then ejected a small ball through a hole on the opposite side; the more the cord was stretched, the greater was the speed at which the ball was ejected. Similarly, the energy of the electron seemed to be nearly proportional to the frequency (the evidence was not quite definite yet), and that would be in accordance with the quantum-theory of energy emission of Planck, as would presently be shown. On the other hand, the already alluded to relation between β and γ-rays was of the following kind. RaB or RaC gave a strong pencil of γ-rays and a line spectrum of β-rays (Fig. 2), whilst RaE gave a weak pencil of γ-rays and a continuous spectrum of β-rays at high speed (without lines, Fig. 3). There was, therefore, apparently a connection between the γ-rays and the lines of the β-ray spectrum. This had been studied by means of the arrangement indicated in Fig. 4, when the source of the radiations S was covered with lead and other metals, so that only γ-rays could get through the metal. The γ-rays then would excite β-rays or electrons in the metal, and the experiments proved that the two types of spectra—that due directly to β radiations from radium and that due to β rays excited by γ-rays—were of the same type, except that in the second case the lines (due to groups at definite speeds) were absent. The excited rays, it had been shown, were softer than the existing rays.

Proceeding to a study of the spectra, Prof. Rutherford pointed out that RaB gave only a few groups of lines, which, on a diagram exhibited, corresponded to numbers 1 and 2 printed underneath them, beginning with a lowest velocity line of the order 1, whilst the spectrum of RaC extended much further, to numbers 9 and higher numbers. These numbers indicated the multiples of Planck's quantum $h\nu$, where h was the universal constant and ν the frequency, and the actual experiments showed that the energies deduced were almost exactly integers of the quantum, the calculated coefficients being e.g. 2.015, 4.066, ... 13.97 instead of the integers 2, 4, ... 14.

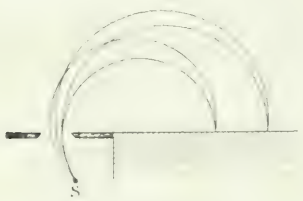


Fig. 4.

As the energy increased, the velocity of the radiations, expressed as a fraction of the velocity of light, increased from 0.75 up to 0.975.

It was not necessary, Sir Ernest continued, to assume that the swiftest β radiations were of a very high frequency. The quantum-theory admitted of other views. We really knew very little about radiation altogether, and we were more modest now as to these matters than we had been 10 years ago. Supposing the atom consisted of a nucleus surrounded by several ring-systems of electrons (model shown), if one electron were ejected, other electrons would fall in and start radiations giving a number of waves of the same frequency. The high velocity of certain β particles might be due to the fact that several γ particles were simultaneously acting upon the same β particle, thus producing higher velocity at the same frequency. As a statistical result of a large number of atoms the velocity of the escaping β particles would continuously be distributed within certain limits of speed; hence the continuous spectra. But there would also be certain regions of special electronic distribution which when disturbed would give rise to the characteristic γ radiations from the atom, and β particles passing through such regions would give rise to a line spectrum. The energy was absorbed in definite units by the different systems in vibration.

The [illegible] of the emission of energy in definite quanta did not imply of necessity that, when radiations were excited in vacuum tubes, the frequency should increase in accordance with Planck's law. Prof. Rutherford had quite recently found, in fact, that when the fluorescent rays yielded by the molybdenum in Coolidge tubes [illegible] to excite the γ-rays of the element with the atomic [illegible] but developed intensity between 40 about 40,000 volts. When the voltage was further increased, the intensity was less of and more from the atomic line and seemed to [illegible] a maximum at 145,000 volts or a somewhat higher voltage. Sir Ernest had not yet gone beyond 175,000 volts in his Coolidge tube experiments. Now RaC expelled β particles at an energy expenditure corresponding to several million volts. That, Sir Ernest remarked in concluding, suggested that radiations should exist which were far more penetrating than any yet known and which might indeed penetrate through the earth.

LEGAL INTELLIGENCE.

Adnil Electric Co. v. British Traders' Association and others.

By a majority, the Court of Appeal last week dismissed an appeal by the Adnil Electric Co. from orders by Mr. Justice Ridley staying actions brought by them against the British Traders' Association for money had and received, and against Audcole & Turner (Ltd.) for goods supplied. It appeared that in 1909 plaintiff company was formed to take over the business previously carried on by Marples & Leach (Ltd.). The shareholders were mainly German, and Mr. Marples and Mr. Leach were appointed joint managers. Solicitors were also appointed. The British Traders' Association were a debt-collecting agency, who obtained judgment against debtors in the name of plaintiff company. In respect of that judgment the present action was brought. The original action was against Audcole & Turner for goods supplied. The question was whether the solicitors acting for the company had authority to bring the action. They had been instructed by Mr. Marples and Mr. Leach, but since the war broke out they had received no particular instructions from the directors. There were three directors—a Dutchman and a German, both resident in Germany, and an Englishman, who was interned there.

Mr. Gore Browne, K.C. (for plaintiffs) argued that there was authority to bring the action.

Lord Justice Swinfen Eady said he agreed with Mr. Justice Ridley in that the evidence did not satisfy him that Messrs. Marples and Leach had authority to bring these actions.

Lord Justice Phillimore dissented.

Lord Justice Bankes concurred with Lord Justice Swinfen Eady, and the appeal was, therefore, dismissed.

Lips (Ltd.) v. Walter Cawood (Ltd.) and Others.

At Westminster County Court on Monday plaintiffs claimed from Messrs. Walter Cawood (Ltd.), the company organising the proposed Olympia Engineering Exhibition of 1914, and Messrs. C. H. Luke and F. W. Bridges, organising managers, the return of £9, which plaintiffs said they paid as a deposit on contract for the allotment of space, and they also claimed damages for the exhibition not being held in 1915.

Mr. Rankin (for plaintiffs) said that in July, 1913, defendants drew plaintiffs' attention to the exhibition, and they agreed to take space, paying £3 on Dec. 2, 1913, and £6 in June, 1914. In August it was proposed that the exhibition should be postponed until the summer of this year, and that was agreed to, but to a subsequent proposal to postpone it until 1916 or 1917 plaintiffs did not agree, and they now claimed damages for the exhibition not being held in 1915.

Mr. Hood, for the defendants, said that many of the largest firms were working night and day on Government work and could not possibly spare time to exhibit. The overwhelming majority of the exhibitors wanted the exhibition postponed, and practically the only people who objected were plaintiff company and the chairman (Mr. Bissell) who was also chairman of the Dutch section of the exhibition.

His Honour Judge Woodfall said he could not suggest that defendants had not acted from motives perfectly honest and bona fide. He would go further; he thought the extreme probabilities were that they had taken the wisest course, not only in their own interests, but in the interests of the exhibitors. The question as to how far the breaking out of war relieved one from the performance of a contract. So far as the law applicable to that problem was applicable to the present case, it was sufficient to say that because it made a burden and inflicted a hardship, that was not a ground to relieve defendants from their obligation. Accordingly he gave judgment for plaintiffs for £9, with costs, defendants being given leave to appeal.

Merchandise Marks Act Prosecution.

At the Mansion House (London) Police Court on Wednesday the adjourned summons against the British Thomson-Houston Co. for having applied a false trade description to the Stolze telephone was withdrawn.

Mr. Brookes (for the prosecution) said his client, Mr. Hammer, had been advised that he was obliged to take these proceedings in order to prevent the further dispersal of the instruments, but he would like to say that there was no express or implied reflection upon the British Thomson-Houston Co. for any part they had taken in the distribution of these articles.

For the defence, Mr. J. Hustler Grain said the statement made at the last hearing that the British Thomson-Houston Co. had a factory in Berlin was untrue. The instruments in question came from an English company, incorporated in this country who had a branch in Germany, and the instruments were made by them and sent to the defendant company.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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THE IRONMONGER AND ELECTRICAL APPARATUS.

A number of business exhibitions were arranged to be held during the present year with the object of promoting trade in what may be termed specialised industries. These exhibitions were planned before the war broke out, and the promoters have felt that the commercial and industrial condition of the country did not call for the cessation of exhibition business. One of these purely trade displays was opened in Manchester on the 3rd inst, and will close its doors to-morrow. It was promoted by the Ironmongers' Federated Association, which is the representative organisation of the hardware trades throughout the country. This class of trader has been in the habit of handling goods from practically every manufacturing country in the world. The German manufacturer found him a ready distributor of Continental products, though it must be said in fairness to the ironmonger that wherever possible he preferred to handle indigenous manufactures. On another page of this issue we refer in some detail to the electrical appliances on view at the exhibition. A considerable quantity of this apparatus is of new design, and was shown to the trade for the first time at the exhibition. Electric cooking apparatus was made a prominent feature by two big firms, who also showed a number of designs in electric [illegible] to take the popular eye. An electric vacuum cleaner was also on view, and it is instructive to note that as the price of these useful machines falls the interest of the ironmonger in them increases. Much the same may be said for certain lines of cooking and heating apparatus. Arrangements were made with the Manchester Corporation for the supply of energy to the various stands, and services of sufficient capacity were installed to enable cooking equipments of considerable size to be shown in operation. With commendable enterprise one of the manufacturers succeeded in placing a large electric grill in the dining room so that exhibitors and visitors were able to sample the tasty and appetising products of this apparatus.

From a commercial point of view the exhibition should open a new stage in the relations of the ironmonger and the electrical manufacturer. That it is desirable to improve these relations is demonstrated by the fact that the two large manufacturing firms referred to above have been in business as ironfounders and producers, in the first place of coal ranges and fires, and secondly of gas fires and gas-heated appliances; now they have turned to the manufacture and marketing of electrical apparatus, and are just as anxious to do business with ironmongers and hardware dealers in the electrical lines as in coal and gas appliances. A few years ago, when these firms were making their experiments, the idea was prevalent that they were wasting their time. However, they had sufficient confidence in the future to continue this work without interruption, and the Manchester Hardware Exhibition has clearly justified their optimism. Wholesale ironmongers who have visited the exhibition expected to find electrical apparatus of some kind or another on the exhibits of the large ironfounders. They would have been surprised if such apparatus were not on view. In many respects the ironmonger deals with an entirely different class of public to that which forms the customers of the electrical contractor. The ironmonger with an electrical department can and does appeal to individuals who have a latent interest in electrical affairs, but who do not think of going to an electrical contractor when they are in a position to show this interest in a tangible form. As the price of cookers and other electrical apparatus comes within reach of the purse of the general, rather than the luxurious, public, so the ironmonger, who like other traders, is a cautious individual, will become more active, and will educate his particular public into coming to him for various electrical lines. The matter is not one in which technicalities enter, it is just simple trading. The manufacturer standardises the various lines of goods, and the ironmonger handles them just as he does other engineering product. For the reason there is no occasion for any feeling or resentment as between the electrical contractor and the ironmonger. Certainly this is the age of co-operation, and no harm will be done if the Electrical Contractors' Association and the Ironmongers' Federated Association were to get together with a view to defining a proper [illegible] and strengthening the business relations between contractors, dealers and manufacturers; also with the object of making more widely known in the various electricity supply areas the advantages of the subsidiary uses of electric service.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week May 31, 1915, to June 5, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

Belgium.—[illegible]

France.—[illegible]

Italy.—[illegible]

London.—*Switzerland:* Carbon candles, £390; unenumerated, £53. *U.S.A.:* Carbon candles, £1,305; elec. machinery, £3,612; elec. lamps, £840; telephone material, £2,346; elec. motors, 17 pkgs.; unenumerated, £480—135 pkgs. *Denmark:* Machinery, £230; unenumerated, £254. *Holland:* Elec. lamps, £2,133—29 pkgs.; unenumerated, £341. *Sweden:* Wire and cable, £22; unenumerated, £1,176. *Italy:* Wire and cable, £1,180. *Spain:* Lamp parts, £110.

EXPORTS.

To Australasia.—*Auckland:* Elec. machinery, £35; unenumerated, £53. *Melbourne:* Elec. machinery, £278; unenumerated, £694. *Sydney:* Elec. machinery, £657; wire and cable, £349; unenumerated, £688. *Wellington:* Elec. machinery, £211; wire and cable, £33; unenumerated, £1,062. *Adelaide:* Unenumerated, £978. *Brisbane:* Wire and cable, £127; unenumerated, £1,098. *Dunedin:* Unenumerated, £10. *Christchurch:* Wire and cable, £87; unenumerated, £204. *Perth:* Unenumerated, £114. *Blenheim:* Unenumerated, £124. *Newcastle:* Elec. machinery, £174. *Hobart:* Unenumerated, £337. *Lyttelton:* Elec. machinery, £108; wire and cable, £36; unenumerated, £65.

Africa.—*Durban:* Machinery, £581; unenumerated, £110. *Port Elizabeth:* Unenumerated, £299. *Cape Town:* Unenumerated, £100. *East London:* Elec. lamps, £410; elec. machinery, £101; unenumerated, £153. *Kilindini:* Unenumerated, £12. *Delagoa Bay:* Elec. machinery, £20; elec. meters, £70; elec. fans, £57; unenumerated, £64. *Beira:* Unenumerated, £93.

Egypt.—*Alexandria:* Wire and cable, £316; unenumerated, £335. *Port Sudan:* Unenumerated, £33.

Russia.—*Vladivostock:* Unenumerated, £25.

Norway.—*Christiana:* Unenumerated, £90.

South and Central America.—*Buenos Ayres:* Wire and cable, £4,903; elec. machinery, £271; unenumerated, £1,291. *Monte Video:* Wire and cable, £176. *Colon:* Unenumerated, £22. *Santos:* Elec. machinery, £408. *Petotas:* Elec. machinery, £460; wire and cable, £36; unenumerated, £83. *Rio de Janeiro:* Wire and cable, £221; unenumerated, £1,259.

British Guiana.—*Demerara:* Unenumerated, £47.

Holland.—*Amsterdam:* Wire and cable, £2,565; unenumerated, £218. *Rotterdam:* Wire and cable, £536; unenumerated, £11.

U.S.A.—*New York:* Unenumerated, £137.

Japan.—*Kobe:* Unenumerated, £13.

China.—*Hongkong:* Elec. machinery, £20; unenumerated, £23. *Shanghai:* Elec. machinery, £423.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Elec. machinery, £172; wire and cable, £592; unenumerated, £1,352. *Calcutta:* Elec. machinery, £444. *Colombo:* Unenumerated, £205.; *Madras:* Unenumerated, £128. *Singapore:* Elec. machinery, £139; unenumerated, £212. *Ipoh:* Unenumerated, £88.

Java.—*Surabaya:* Unenumerated, £42.

Canada.—*Montreal:* Wire and cable, £27; unenumerated, £241. *Toronto:* Elec. machinery, £21; unenumerated, £550. *St. John's, N.F.:* Unenumerated, £1,400.

France.—*Dieppe:* Machinery, £43; unenumerated, £130. *Boulogne:* Elec. machinery, £634; unenumerated, £43. *Paris:* Wire and cable, £230; unenumerated, £66. *Havre:* Wire and cable, £2,558.

Gibraltar: Unenumerated, £42.

West Indies.—*Barbados:* Wire and cable, £24; unenumerated, £83.

FOREIGN GOODS (duty paid and free).

Christchurch: Unenumerated, £34. *Gibraltar:* Unenumerated, £20. *Malta:* Unenumerated, £32. *New York:* Unenumerated, £302. *Rotterdam:* Unenumerated, £20.

In Transit.—*Bombay:* Elec. lamps, &c., £1,400. *Karachi:* Elec. lamps, &c., £230.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

At an extraordinary meeting of the Electrical Power Storage Co. last week resolutions were passed in favour of amalgamating the business of the company with that of Messrs. Pritchett & Gold Ltd., under the style of Pritchett & Gold & Electrical Power Storage Co. (1914), Ltd., and also in favour of winding up the company voluntarily, with Messrs. James Cox and W. A. Reid as liquidators, in order to carry out the scheme of amalgamation.

Messrs. Neville, Williams & Co. have disposed of that part of their business relating to Enamelled cooking utensils to Messrs. Bun & Ends (1914), Ltd., 17, Marylebone-lane, London, W.C., and their Vitrolac varnishes, lacquers and colouring lacquers, &c., to Bi-Metals (Ltd.), 57, Lant-street, S.E. Outstanding liabilities will be paid by Messrs. Neville, Williams & Co.

Increase of Prices. Messrs. Ercole Marelli & Co., 19 and 20, Garlick-hill, E.C., announce that they are increasing all their prices by 10 per cent. owing to the increase in the cost of raw materials.

Retort Carbon for Sale. The Bristol Gas Co. advertise for sale [illegible] tons of carbon from vertical retorts at their Saltford-road works. Offers to the secretary, Mr. John Phillips, Colston-street, Bristol, by June 19.

Patent Development. The proprietor of patent No. 15,951 of 1913 for "Improvements in and relating to electric conductors," desires to make arrangements for exploiting same in the country. Particulars from Messrs. Wheatley & Mackenzie, patent agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

The proprietor of patent Nos. 12,353 of 1905 and 10,980 of 1910, relating to "Automatic switchgear," desires to make arrangements for exploiting the inventions in this country. Particulars from Messrs. Wheatley & Mackenzie, Patent Agents, 40, Chancery-lane, London, W.C.

BANKRUPTCY.

The discharge of Jas. Wm. and Tom W. Tattersall, electrical engineers, Kimberley-road, Willesden-lane, London, N.W., has been granted as from June 2, 1915.

A receiving order has been made against Trevor Duesbury, engineer, electricity department, Sutton Coldfield.

ELECTRICITY SUPPLY.

EXTENSIONS.

Batley. The L.G. Board have sanctioned the borrowing of £3,391 for cable extensions to Heckley, Carlinghow and Bradford-road West. There was a profit of £634 on the electricity department for the past year, making, with the credit balance of £138 from 1914 a total of £772. Four years ago a new switchboard was purchased at a cost of £1,142, and it is intended to pay off the whole of the outstanding debt on that account, after which the credit balance (£57) will be carried forward.

Chesterfield.—On Tuesday the Council accepted tenders for a 400 kw. alternator, boiler, superheater, &c., at a cost of £2,705.

A letter was received from the Chesterfield Tube Co. (who are engaged on Government work), stating that as the Corporation were meeting their present demand for power they did not consider that the expenditure of £5,000 which the Corporation found necessary need be undertaken on their account alone. The Corporation would reap considerable benefit in the reduction of costs by installing a turbo-alternator in place of converting the supply now delivered to them.

Mr. W. H. Edmunds said he would like an assurance from the chairman of the Electrical Energy Committee (Mr. J. Clayton) that the scheme now proposed was only an instalment of a larger scheme, so that the town's manufacturers could rely on the Corporation letting them have a cheap and unlimited supply of motive power.

In reply, Mr. Clayton said that with the complete scheme carried out there would be an ample reserve for some time to come. He regretted that the Council had shelved the £15,000 extension scheme which was passed in February, 1914, and he warned the Council they would have to embark upon that scheme in the near future.

Ald. C. P. Markham said while great credit was due to Mr. Acland, the borough electrical engineer, for the manner in which he had conducted the works, the time had come when they should remove them nearer the town, so that they could have plenty of room and reduce their coal bill.

Luton.—The electrical engineer (Mr. W. H. Cooke) has reported upon the necessity of providing additional generating plant at the electricity works.

At present 10 of the largest consumers are engaged on War Office and Admiralty contracts, and are entirely dependent upon the electricity undertaking for power. The present boiler plant and buildings are sufficient for the time being. Mr. Cooke reports that the first difficulty he experienced was in obtaining generating plant before next winter, as makers had had practically all the available plant now being built commandeered by the Government, and they were so busy on other contracts that they were unable to quote for delivery this year. He managed, however, to secure an option on a 3,000-3,750 kw. Lungstrom turbine which was partly completed. The Brush Electrical Engineering Co. were prepared to supply and erect the machine within six months for £11,175. It would also be necessary to instal an additional air filter, cooling tower, steam and water pipings, &c., and the estimated total cost is £14,450. Further, it will be necessary to proceed with the erection of a sub-station which was provided for in the last extension, and he advises that about 23 poles of land be immediately secured and a sub-station erected thereon to contain two 500 kw. converters with the necessary switchgear at a cost of £5,200. The sub-station could provide accommodation for an additional 2,000 kw. converting plant which would probably be required at some future date. Mr. Cooke advises that immediate application be made to the L.G. Board to borrow £14,450 for generating plant in the main station, £5,200 for sub-station and converting plant, and £6,000 for h.t. and l.t. cables, &c.

The Electricity Committee recommends the acceptance of the Brush Company's offer and that application should be made to the L.G. Board for sanction to borrow the £25,630 specified in the report.

Middlesbrough. The L.G. Board have sanctioned a loan to cover expenditure on laying electric supply mains to works engaged on making munitions of war, but not to ordinary customers.

Rotherham. The Treasury has sanctioned the borrowing by the Corporation of £8,400 for the purchase of two water tube boilers for the electricity works.

Shipley. The formal inauguration of the recent additions to the electricity generating plant took place on the 2nd inst.

It has been decided to increase the charge for electricity for lighting from 4½d. to 4¾d. per unit and for power by 10 per cent.

Stalybridge.—The Stalybridge, Hyde, Mossley and Dukinfield Joint Tramways and Electricity Board are applying for sanction to a loan of £4,000 for transformers and mains to give supplies of current to munition factories.

Stretford.—The Parks Committee has approved of a proposal to lay an electric main to Longford Hall, for lighting and power. The output of the generating station for the year ended March 31 was 2,782,600 units, compared with 2,726,355 units in 1913-14.

Watford.—The L.G. Board is prepared to issue its sanction in respect of works carried out by the electricity department prior to the Board's letter restricting expenditure.

The Lighting Committee recommends the following increases in the charges for the current: Lighting 12½ per cent., power, &c., 10 per cent.; slot meters, rent to be charged at present rates. As regards public lighting, the Committee reports that although 12½ per cent. increase would be necessary under normal conditions, they recommend that the present charge be maintained under existing lighting conditions.

GENERAL.

Bangor.—Last week the Corporation decided to increase the charges for electric current owing to the increased cost of coal.

Belfast.—At a meeting of the Tramways and Electricity Committee last week reference was made to a case of alleged defective wiring.

It was stated that the wiring had been done in a negligent manner; that telephone wires had been used instead of lighting wires, and that those had been tied to the lead gas pipes either by string or bare non-insulated copper wires. Ordinary bell wires also ran in the same ducts, and the gas and electric meters had been disconnected. After discussion the Town Solicitor was asked to report on the electric supply department's responsibility and powers in relation to the wiring of premises generally.

The reorganisation of the electricity department again came up for consideration, and it was resolved that the sub-committee to whom the question is to be referred should consist of the whole of the members of the Tramways and Electricity Committee, together with the following additional members of the Corporation, who were nominated at the monthly meeting: Ald. Moore, Councillors Stirling, English, Gilliland, Gaffikin, James Johnston and Riddell.

Bolton.—The Electricity Committee have decided owing to the higher cost of fuel, to increase the charge for electric current for lighting from 3½d. to 4d. per unit, and the power charge will be increased in proportion to the demand and according to the extra price of fuel, but it will mean an increase of about 10 per cent.

Bury (Lancs).—The salary of the engineer and manager of the electricity department (Mr. S. J. Watson) has been increased from £550 to £650 per annum.

Colchester.—Last week the Corporation decided to carry the profit on the past year's working of the electricity department (£812.17s.7d.) to suspense account, and also, in view of the increased cost of fuel, to increase the charge for current to ordinary consumers for lighting by ½d. per unit as from July 1.

Doncaster.—The Board of Trade have intimated that they cannot sanction at present the borrowing by the Corporation of £8,550 for extensions of the light railway undertaking.

Dublin.—The Electricity Supply Committee again recommend an increase of ½d. per unit for current used for lighting and ½d. per unit for power.

The Committee report that, even if the revised charges be adopted, there will be a small deficit of £230. On the present basis the Committee estimate a deficit of £21,334. The past year's accounts disclose a serious falling off in consumption, and it has been found on investigation that in every direction there is a strong effort by consumers to economise the cost of lighting. Although 830 additional consumers were connected during the year ended March 31, and in ordinary times these would mean a substantial increase in consumption, the results show a serious decrease in the lighting units sold during the March quarter compared with the corresponding quarter of 1914. In the late closing establishments, principally made up of licensed houses and clubs, there was a decrease for the quarter of over 26,000 units, and in the early closing establishments there was a decrease on the quarter of over 15,000 units. The most serious effect of the war was, however, shown in the domestic use. Although the greater part of the new consumers put on during the past 12 months were of the domestic class, the consumption for the quarter by that class of consumer showed a decrease of over 21,000 units. There was a small increase in the use of electricity by theatres, picture houses, offices, &c., but the net result showed a serious falling off. The power units showed a substantial increase for the three months, but that was chiefly owing to an increase in the use of current at the main drainage pumping station, from which no financial profit was derived. Taking into account the whole 12 months, the units sold, compared with the estimates submitted, showed a drop of 284,000, and against the estimated income there was a decrease of £8,987. The actual drop compared with the estimate was £8,276. The Committee estimated a profit of £9,024, but that profit had been brought down to £748. They do not think that Council will consider the question of throwing that large deficit on the general ratepayers.

Dundee.—The Corporation have increased the price of electric current by 10 per cent. for lighting and traction and 15 per cent. for power consumers. Gas has also been increased 7d. per 1,000.

Eccles.—The Electricity Supply Committee has fixed the minimum wage of shift engineers at 40s. per week, rising to 42s. at the end of six months, the wages of shift engineers in the Council's service being advanced accordingly.

The profit on the electricity undertaking for the past year (£634) has been transferred to reserve.

Epsom.—At the last Council meeting it was reported by the Acting Electrical Engineer that there had been 13 applications for the supply of current since the last report (seven new customers and six extensions), equal to 600 8 c.p. lamps. The service cable to Messrs. H. F. Foster & Co.'s works has been replaced by a larger one, owing to the greatly increased load.

Fareham.—The salary of the electrical engineer (Mr. A. Blake) has been increased by £25 per annum.

Kendal.—The Council have increased the charges for electric current and gas by 16⅔ per cent. owing to the high price of coal, &c.

Gas has been increased 5d. a thousand and electric current 1d. a unit to consumers for lighting, ½d. a unit for kinemas and power consumers, and ¼d. per unit to consumers taking power at a flat rate.

Loans for Electrical Plant.—The Finance Committee of the London County Council have revived the proposal for the reduction of the outstanding periods of certain 42-year loans on the St. Pancras electric generating plant.

The County Council's Committee are prepared to recommend the sanction to the borrowing by the Borough Council of £15,000 for a 5,000 kw. turbine set, but the St. Pancras Finance Committee recommends the Borough Council to adhere to their previous decision in regard to the proposed reduction of outstanding loan periods for the reasons already given, and to inform the County Council that as the proposed £15,000 expenditure is considered to be urgent, and inasmuch as they have already incurred liability for the amount they desire to receive sanction to the borrowing thereof at the earliest possible date.

The Finance Committee consulted the Electricity Committee in regard to the present position of the contract for four new boilers at King's road station in respect of which the London County Council's sanction to the borrowing of £22,530 has been received and the loan agreed to be taken up from the Ecclesiastical Commissioners, at 4½ per cent. interest. There has been delay in the completion of the contract, mainly due to the fact that the foundations for the boilers were not ready, but one boiler will now be received, and another will follow very shortly. The Treasury have been asked to allow the loan to be completed.

London Linking-up Scheme.—Battersea Electricity Committee have been in negotiation with Fulham and Hammersmith Councils with a view to linking up the three undertakings.

The borough electrical engineer (Mr. F. A. Bond) has reported as to the present capacity of the plant at the generating station and the estimated load during the ensuing winter, also the advantages of linking up the electricity undertakings for reciprocal and stand-by supplies. The estimated cost of laying two 0·15 sq. in. mains between Battersea and Fulham and between Fulham and Hammersmith is £17,441, and it is proposed that this expenditure shall be borne equally between the three Councils concerned. The Committee recommends an agreement being entered into with Fulham and Hammersmith Councils, and the Finance Committee, in their report upon the question, concurs in the recommendation, and also recommends application being made to the London County Council for the advance of £5,814, the Council's share of the estimated cost of laying the connecting mains.

Northampton.—The Finance Committee has reported the proposals of the Northampton Electric Light & Power Co. to construct a new generating station on the south side of the river.

The Committee reports it has no desire to hamper the operations of the Company, but in view of the fact that the greater part of the receipts of the undertaking are, and will continue, to be derived from consumers in the Borough, the Borough funds will receive no benefit from the rating of the proposed station, which will be virtually situated outside the Borough. Under these circumstances the Town Clerk has been instructed to notify the Board of Trade that the proposals are open to objection from this point of view.

Poplar (London).—The Finance Committee which has considered the report of the Electricity Committee on disposal of the net surplus of the electricity undertaking for the past year, has postponed its decision on the report of the Committee, but they think that the proposal to refer £3,500 to the credit of the general fund should be approved.

West Bromwich.—At the last meeting of the Corporation it was reported that there was a profit of £877 on the electricity undertaking for the past year, and it was decided to make an increase of 20 per cent. in the price of electric current to all consumers to meet the extra cost of materials and wages.

In the course of the discussion on the Electricity Committee's report

Councillor Bell asserted that the Committee were selling current to consumers for power at less than cost price.

Councillor Kenrick denied that they were selling below cost price. If they increased their charges for power they would lose their customers. His own firm was putting down plant to generate their own electricity because they could produce it cheaper than they could buy it from the Corporation.

Wimbledon. The Board of Trade has refused to make an order permitting the Corporation to supply electricity to 18 houses at Cuddington and Epsom.

The Board do not consider that sec. 6 of the Electric Lighting Act, 1909, should be used for developing a general supply of electricity outside an authorised area, and suggest that, if the Corporation desire to give a supply of electricity the Council should apply for an order to extend their area of supply. The consideration of the matter has been deferred by the Electric Lighting Committee.

LIGHTING, POWER & HEATING NOTES.

Electricity in Iron Works. In the report of the Rhymney Iron Co. for the year ended March it is stated that there was an expenditure during the year on the electric power installation, which had now been completed, of £3,794.

Factories and Electric Power Supply.—At the last meeting of the Birmingham Tame & Rea District Drainage Board, Ald. Edwards, who presided, said the principal business related to the sale by the Board to the Dunlop Rubber Co. of land near Bromford for the erection of works.

The Works Committee, reporting on this subject, stated the negotiations were necessarily prolonged owing to the many considerations, apart from the price, which were involved. Among the questions which had to be settled were the electric power and telephone line, and facilities for access to the river Tame, &c. The Company required to be satisfied of the capacity of the Corporation electricity department to supply the necessary current for power. The various questions were ultimately settled and 7¼ acres were sold subject to the approval of the Board.

Ald. Sayers, in moving the adoption of the report, said the Board were not desirous of parting with any of their land, but they recognised that the Dunlop Co.'s industry was a large and important one, and they desired to place facilities in their way for acquiring a site.

The motion was seconded and agreed to.

Infirmary Lighting. Bognor Guardians have decided to adopt electric lighting at the new infirmary, and inquiries are being made of the Council as to rates for supply.

TRACTION NOTES.

Baker-street Waterloo Railway.—The new station in Elgin-avenue, to be known as Maida Vale, was opened for traffic on Sunday, thus completing the extension of the Bakerloo line from Paddington to Queen's Park.

Glasgow. The general manager (Mr. J. Dalrymple) has issued a further appeal to the male employees to join the Army.

Mr. Dalrymple states that there are still in the department 868 men between 18 and 30 years, including 361 single and 507 married men. There are 2,183 between 18 and 41. In view of the possible early introduction of conscription the general manager thinks that those members of the staff should now consider the claims of duty and come forward. The Tramway Battalion is now full, except as to [illegible] and the very cheerful to the tramwaymen at the front to know that they are to be reinforced by their mates in the department. Since the appeal was [illegible] 200 have joined the Army.

Light Railway. The Board of Trade have sanctioned the Chesham & Marlow Light Railway Company's Time Order, 1915.

Newcastle-on-Tyne. The Tramways Committee have abolished half-penny fares because of the great overcrowding of the trams in the early morning and the late evening.

Sheffield. The Corporation are recommended to grant leave for a Bill promoted by the Sheffield District Light Railway Company for powers to construct a light railway from Sheffield to Dronfield, Eckington, Killamarsh, Beighton, Mosborough, Norton, Dore, Totley, Bradway, Ecclesfield, Grenoside, Chapeltown, Thorpe Hesley, Wadsley, Hillsborough, Owlerton, Stannington, Crookes, Walkley, Broomhall, Ranmoor, Fulwood, Crosspool, Millhouses, Ecclesall, Abbeydale, Beauchief, Greenhill, Woodseats, Meersbrook, Heeley, Intake, Handsworth, Woodhouse, Tinsley, Attercliffe, Darnall, Carbrook, Brightside, Wincobank, Shiregreen, Wisewood, Lodge Moor

is now prepared on the Continent and [illegible] Hence the substitute poisons.

2. It, however, the wound be first [illegible] there is a greater affinity for albumen than metallic [illegible] and any blood or pus, and other metallic chlorides would [illegible] and [illegible] especially one which gives a granular [illegible] and [illegible] the wound with water, and, finally, with a [illegible] bi-chloride, not left in too long, the antisepsis is perfect, and there are no bad after effects. The albumen seems to [illegible] with the mercury.

3. That [illegible] to chloride as a much greater antiseptic value than to other antiseptics than is stated in the text-books.

4. That [illegible] mixed with oils or fats [illegible] loss than [illegible] when used alone.

U.S. Navy Radiotelegraph Service.—The U.S. Navy Department [illegible] from Panama to the radio station at Arlington, Va., during daylight hours. The distance from Panama to Arlington is about 2,000 miles, and hitherto the only service had been at night.

TENDERS INVITED.

Galvanised Iron Wire.

The Deputy Postmaster-General, Adelaide, [illegible] tenders until 2 p.m. July 14 for the supply of Galvanised Iron Wire for the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department. Specification, &c., may be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W.

Electrical and General Stores, &c.

LONDON County Council Asylums and Mental Deficiency Committee require tenders by 11 a.m. June 14 for [illegible] supply of Electric Sundries and Lamps, &c. Forms of tender from the Clerk, 6, Waterloo-place, Pall Mall, London, S.W.

KIRKCALDY Corporation invite tenders for about 100 Half-watt 1,000-c.p. Lamps and Lanterns. Tenders to Burgh Electrical Engineer by June 14.

HULL Guardians require tenders by noon June 14 for six months' supply of Electrical Requirements, &c. Forms of tender from the Clerk, St. Mary's-chambers, Hull.

WEST HAM Guardians require tenders by noon June 24 for three months' supply of Electric Fittings, Oils, &c. Forms of tender from the Clerk.

Turbo-Alternators, Motor Generators, Condensing Plant, &c.

EDINBURGH Corporation invite tenders for the supply and erection of two 5,000 kw. Turbo-Alternators and Condensing Plant at their new electricity supply station at Portobello. Specifications, from the engineer, Mr. F. A. Newington, Dewar-place, Edinburgh. Specifications, can be seen at, but not obtained from, the offices of the consulting engineer, Sir Alex. Kennedy (Messrs. Kennedy & Donkin), 17, Victoria-street, London, S.W. Tenders to town clerk (Sir Thomas Hunter, W.S.) by June 12.

MANCHESTER Guardians want tenders to June 14 for supply and erection of 40 kw. Steam Dynamo at [illegible] Styal, near Manchester. Specifications, &c., from Mr. F. W. Page, 14, St. Ann's-square, Manchester.

Tenders are invited for the supply and delivery in MELBOURNE of one 1,000 kw. direct-current Generator with Field Regulator and accessories, one Liquid Starter with [illegible] with one spare set of Carbon Brushes and one spare Field Coil for generator. Tender form, with specification, &c., from the agents for Melbourne City Council (Messrs. McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-bldgs., London E.C. Tenders to the Chairman of the Electric Supply Committee, Town Hall, Melbourne, by 10 a.m. Aug. 11.

The NEW SOUTH WALES GOVERNMENT RAILWAYS AND TRAMWAYS DEPARTMENT require tenders by noon July 21 for supply of a 250 k.v.a. Direct coupled Turbo [illegible] from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

SYDNEY (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

WEST Electricity Committee want [illegible] July 21 for Two Water-tube Boilers with Mechanical [illegible] &c., from the Borough Electrical Engineer.

Wiring and Fittings, Lamps, &c.

WEST HAM Education Committee require [illegible] for the Light Wiring of Knox road [illegible] from Mr. Wm. Jacques, 2, Fen-court, Fenchurch-street, E.C.

BELFAST Guardians want tenders by June 15 for the Electric Lighting of the Guardians' Offices, Board Room and adjacent buildings. Specification, &c., from [illegible]

AYLESBURY Urban Council want tenders to 10 a.m. June 14 for the supply of 60, 100 and 400 [illegible] Lamps for street lighting. Tenders to the Clerk.

Switchboard.

REDDITCH Urban District Council invites tenders for a High tension Three-phase Switchboard. Specifications from the consulting engineers (Messrs. Handcock & Dykes), 11, Victoria-street, Westminster, S.W. Tenders by June 14.

Meters and Maximum Demand Indicators.

CHRISTCHURCH (N.Z.) Council want tenders by noon July 3 for [illegible] supply of House Service Meters. Specification, &c., from the City Electrical Engineer.

SYDNEY Municipal Council require tenders by 3 p.m. July 19 for supply of Electric Meters and Maximum Demand Indicators. Specifications from the City Electrical Engineer. (The Council will grant 10 per cent. preference on British made goods and 5 per cent. preference on those of the allied countries during war.)

Telephone Exchange.

The Director-General of Telegraphs, Madrid, will receive tenders until noon June 19 for the construction and working [illegible] extension of 20 years of a Central Telephone Exchange at MONFORTE DE LEMUS, Province of Lugo, Spain. The "Madrid Gazette" of May 24, containing particulars regarding the [illegible] of the necessary plant and material, may be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

Submarine Cable.

The SPANISH POSTS AND TELEGRAPHS DEPARTMENT want tenders by June 22 for the laying of a submarine cable from Cadiz to Laraiche and for the repair of certain cables. The "Madrid Gazette" of April 23, containing the conditions of tender, &c., can be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

[illegible] The Electric Lighting Committee have decided to [illegible] the tender recommended as [illegible] Sealing Parker Co., [illegible] for the [illegible] power station at Portobello, at £32,286.

[illegible] The Council have accepted the following tenders:

Callender's Cable & Construction Co., heavy cables; Fyfe, Wilson & Co., small cables; Bat Motor Co., [illegible]; Chamberlain & Hookham, [illegible]; Brayson Mfg. Co., electrodes; [illegible]; W. F. Hemsley, [illegible]; Wardle & Co., hinge screws; Peirano (Ltd.), three [illegible]; Alexander Stones, Ltd., [illegible] lamps; Dowsett Engineering & Construction, Ltd., [illegible]; Vacuum Oil Co., oil; Pumps, Ltd., [illegible]; and [illegible].

[illegible] The following [illegible] have been accepted by the Electric Supply Committee:

[illegible] Supply and erection of mechanical [illegible] Newport, 3 p.c. Reinforced concrete [illegible] Hydraulic [illegible] Co., Ltd., Cardiff; [illegible] Taylor (Derby), [illegible] Hyde, 21 p.c. [illegible] Co., Ltd., [illegible] and [illegible] Co., Ltd.

Furnace Contracts. The Morgan Mfg. Co., Ltd., Wednesbury, [illegible] Co., Ltd., Wednesbury, [illegible] Co., Ltd., Wednesbury, [illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bradford.—The accounts of the tramways department for the year ended March 31 show total capital expenditure of £1,052,000, of which £440,000 has been paid off.

Income was £305,000 (increase £8,000) equal to 11¾d. per car-mile (against 11¼d.). The expenditure included £2,800 for allowance to dependents of soldiers, but rates and taxes showed a decrease of £2,000 as a result of the re-assessment. On the rail-less system the increased traffic was £2,800, following on the opening of new routes. The year's income was £4,316 (slightly over 5¾d. per mile run). Working expenses on the rail-less system were 6¼d. per car-mile, including interest and sinking fund, and net deficit for year was £1,700 (against £414). The City Treasurer calls the attention of the Council that these figures have no regard to the feeding value of the rail-less service to the remainder of the undertaking, and adds that although it has been considered necessary to give facilities along the routes concerned an income of less than 6d. per car-mile would not justify the laying of a tramway where the total expense would exceed 1s. per car-mile, compared with 8d. per car-mile on the rail-less system.

The parcels department showed a profit of £1,070 (compared with £850).

Grimsby.—The accounts of the electricity department for the year ended March 31 show capital expenditure £135,090 (increase £3,571), of which £37,355 has been repaid.

Revenue was £24,202 (against £24,016 in previous year), working and general expenses were £13,399 and bad debts £66, leaving £10,738 gross profit. Interest required £3,408 and instalments of loans £4,560, the net profit being £2,812 (against £4,061). Average price obtained was 1·89d. (1·90d.) per unit, total costs were 1·083 (1·045d.). Units sold were 2,787,298 (2,781,128).

In the report of the borough electrical engineer (Mr. W. A. Vignoles) it is stated that there was an increase of £951 in revenue from private consumers, but unless the conditions change a serious loss of revenue from this source must be expected this year. The maximum load dropped from 1,662 kw. to 1,524 kw., owing to the exceptional conditions of the past winter. Cost of coal averaged 6s. 10d. per ton, compared with 8s. 1d. in previous year, but the saving was more than counterbalanced by the increased cost of labour in the station, the total generating costs being up £63. The destructor supplied steam for the generation of 137,577 (134,260) units, and the amount paid to the destructor committee was £143 (£140). The first few months of the year confirmed Mr. Vignoles' estimates, and the failure to achieve the results anticipated was entirely due to the altered conditions caused by the war. It is recommended that the policy of limiting the number of new consumers be adhered to.

Huddersfield. The accounts of the electricity department for the year 1914, show capital expenditure £267,407 (increase £11,984), of which £112,712 has been repaid or placed to redemption fund.

Income was £52,518 (compared with £49,886 in 1913), working expenses were £32,423 (£31,671), leaving surplus of £20,096 (£18,216). Interest required £7,952 (£7,245) and redemption fund and repayments of capital £8,118 (£7,336), net surplus being £4,026 (£3,635), of which £2,100 is to be devoted to relief of rates. In addition to the net profit the various items of maintenance include £6,500 provided out of revenue for capital expenditure.

Leeds. The accounts of the tramways department for the year ended March 31 show total capital expenditure £1,678,814 (increase £107,648). The total amount set aside for sinking fund is £590,121. The amount applied in reduction of debt is £446,533 and surplus profits handed over for relief of rates (from 1894 to 1915) is £993,766.

Revenue was £433,940 (compared with £427,455 in previous year), working expenses were £228,134 (£226,383), and after providing for insurance, interest, sinking fund, &c., the net surplus was £81,567 (£70,005), which is being applied to relief of rates. Passengers carried were 95,639,268 (93,679,774), car-miles run 9,522,737 (9,204,331), and units used 18,862,847 (17,175,710). Total revenue per car-mile was 10·936d. (11·145d.), working expenses (including total power cost and permanent way renewals) were 6·671d. (7·455d.).

Mr. J. B. Hamilton (general manager) reports that the construction of the rail-less tramway route to Otley and Burley from White Cross [illegible] in a forward condition. Over [illegible] of the tramway, 860 [illegible] poles have been erected and 125 [illegible] have been welded on reconstruction works, a total of 1,033. The 25 period rotary converter plant at Bramley and Horsforth sub-stations has been replaced with 50 [illegible] supply from the electricity department at Whitehall-road. Owing, [illegible] a 3,000 kw. British Thomson-Houston Co. turbo-alternator, which will be in operation about the end of July. Concurrently, the Committee have been authorised to purchase a 6,000 kw. set for the electricity department. The Guiseley depot has been completed, the sub-station equipped with converters for supplying the Otley and Burley rail-less routes and a large portion of the Guiseley route. During the year 23 new cars (with vestibule fronts) built in the Kirkstall-road car works, have been added. 14 rail-less car bodies have also been constructed and 10 chassis purchased from Bradford Corporation for the Morley route. Vestibule fronts have been fitted to eight cars, 138 cars have been fitted with the Leeds type of side lifeguards, and the Maley electro-mechanical brake has been added to 15 cars. The new central depot in Swinegate was completed at the end of July, 1914, and shortly after war was declared the Tramways Committee placed it at the disposal of the War Office for recruiting purposes. It was afterwards opened for traffic, but in November the War Office selected it as the most suitable building for a cloth and clothing depot for the Midlands and North of England. A depot and sub-station at Morley for the rolling stock on the Morley route and the rail-less cars on the Morley and Ardsley routes is in a forward state of construction, and will accommodate 14 cars and 16 rail-less cars.

Swansea. The total income of the electric supply department for the past year was £33,297, against £32,986 in 1913-14.

The works expenditure was £18,965 (against £18,562), and included allowances of £397 to employés on active service. The net profit was £1,786, compared with £2,212. The difference is mainly due to an increase of £1,400 in loan charges. Although there was a larger number of consumers, such economy had been displayed owing to the war that the total income had hardly moved. The profits for the year are to go in reduction of rates.

COMPANIES' MEETINGS AND REPORTS.

ELECTRICAL POWER STORAGE CO. (LTD.)—An extraordinary meeting was held on the 3rd inst., Mr. James Gray presiding. The chairman said the business before them was to consider a provisional scheme for the amalgamation of the company with Messrs. Pritchetts & Gold (Ltd.), who carried on a similar business, with works at Dagenham Dock, Essex. Before dealing with the scheme itself it was necessary that he should explain to the meeting the reasons which prompted the Board to consider the proposal made to them by Messrs. Pritchetts & Gold. For some years the company had been seriously handicapped by having to carry on operations in London, where rent, rates and taxes were so much higher than in the provinces. During the last few years changes had been made in the management, and many economies effected which had partially counteracted those drawbacks. Their principal drawback had, however, been the lay-out and condition of their present works, which effectively precluded the economical and rapid handling of goods necessary in these days of keen competition. Having considered the position fully and carefully, the Board had come to the conclusion that the abandonment of the existing works was necessary, and negotiations for securing new works were proceeding when Mr. Pritchett approached him with a proposal to amalgamate the company with his concern. Messrs. Pritchetts & Gold for many years carried on operations at Feltham, Middlesex, but about two years ago they removed to Dagenham Dock, where a large and convenient site was held. Realising that it was possible for Pritchetts & Gold to provide accommodation for the company for a much lower outlay than they could have obtained new premises for themselves, and realising also that great economies could be effected by combining the two organisations, the directors resolved to enter into the provisional scheme of amalgamation which they submitted for confirmation. The larger shareholders whom they consulted cordially approved of the scheme and had granted proxies in its favour. It was intended that the amalgamation should take effect by the sale of substantially the whole of the property and assets of the company to Pritchetts & Gold (Ltd.) for shares and debentures of the latter company. The company would retain its book debts and cash and discharge its liabilities. It would transfer to the amalgamated company (*a*) investments at market value; (*b*) its plant, tools and furniture valued at £8,000; (*c*) its stock-in-trade upon terms; and (*d*) its patents, goodwill and benefit of contracts for £13,658. The purchase price would be satisfied by the issue of the following securities of the amalgamated company—viz., (*a*) £10,000 first mortgage debentures (part of an issue of £30,000) carrying interest at £5 per cent.; (*b*) 18,658 ordinary "B" shares of £1 each; (*c*) 4,000 deferred shares of 1s. each; and (*d*) preference shares or debentures for the balance. It would be necessary for the company to go into voluntary liquidation, and the name of the amalgamated company would become Pritchetts & Gold & Electrical Power Storage Co. (Ltd.). The purchase price to be paid by Pritchetts & Gold would enable the debenture holders of the company to receive an exactly equivalent amount of debentures of the amalgamated company—viz., £10,000—bearing the same rate of interest and redeemable on the same date as their present debentures. It was

anticipated also that the liquidators would be enabled to distribute to the shareholders one 10 per cent. non-cumulative "B" ordinary share of £1 of the amalgamated company for every ordinary or founder's share of £5 of the company, and, in addition, one deferred share of 1s. of the amalgamated company for every five ordinary or founders' shares of the company. The writing off of £4 per share was, he confessed, very drastic, but under the circumstances it was unavoidable. In their last balance-sheet the item of patents and goodwill stood at £67,885, notwithstanding that the principal patents had long since expired. Moreover, a good deal of their plant and tools was now practically obsolete, and, in fact, as he had already said, they were valued at the date of the provisional agreement at £8,000. The capitalisation of Pritchetts & Gold was very conservative, and, having regard thereto, they considered the exchange offered to the shareholders of the company fair and reasonable. Indeed, they had in contemplation the writing down of the capital by £4 per share before the scheme of amalgamation was suggested, as it was quite apparent that no new capital could have been obtained for new works until that was done. Under the scheme of amalgamation it was anticipated that the dividend on the "B" ordinary shares would be earned without difficulty, and after the indemnity of £5,000 against maintenance contracts had been provided there would be a very substantial dividend on the deferred shares, rendering those shares of real capital value. A resolution was then passed that it was expedient to effect an amalgamation of the company with Pritchetts & Gold (Ltd.), and that the company be wound up voluntarily; Mr. James Gray (4, Great Winchester-street, E.C.) and Walter Alexander Reid, C.A. (3, Fenchurch-street, E.C.) were appointed liquidators. The agreement of Dec. 4, 1914, between the company and Pritchetts & Gold (Ltd.) was approved, and the liquidators were directed to carry same into effect, &c.

NEW GENERAL TRACTION CO. (LTD.)—The revenue for the year ended March 31 was £20,357. 19s. 6d., general expenses (including directors' fees and legal charges) were £1,892. 14s., and Debenture interest was £7,023. 7s. 11d. The profit was £11,059. 6s. 3d., making with £6,501.13s.6d. brought forward the available total of £17,560. 19s. 9d. The directors recommend that £10,480 be appropriated to payment of a 4 percent. dividend, the balance (£7,080. 19s. 9d.) being carried forward. The accounts of the Norwich Electric Tramways Co. show an increase in traffic receipts and in expenses; a dividend of 3 per cent. was paid for the year 1914. The Douglas Southern Electric Tramways (Ltd.) paid 1½ per cent. on its preference shares for the year ended Oct. 31, 1914. The income from the Philadelphia undertaking for 1914 was £13,911. 11s. 9d

REUTER'S TELEGRAM CO. (LTD.)—The Hon. Mark F. Napier presided over the meeting last week, and stated that the directors had considered it wise to write off the whole of the goodwill account, and they had also written off the premium on the bank shares, £10,000 off investments account and £5,000 off freeholds. The year's net profit was £5,936. The company had not escaped the universal and malign influence of that gigantic crime against humanity, the war. Among the many untoward events of the year was the death of Baron de Reuter. The expenses had been considerably reduced, and, assuming that hostilities would cease within a reasonable time, he thought they could contemplate the future with confidence.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE ELECTRIC POWER CO.—Mr. W. L. Madgen, who presided at the meeting on Monday, said that while the company had been incorporated for some years it was thought desirable that certain local arrangements as to subsidiary power should be sufficiently matured before work upon a large scale was undertaken. Those arrangements had been gradually accomplished during the past two years, and it might be said that in 1914 it was that their electric supply business began to assume considerable dimensions. The stage reached was that they were supplying current for power, traction and lighting in the boroughs of Smethwick and Dudley, also in the districts of Oldbury and Halesowen, while they held the principal share interest in the Kidderminster undertaking which would in due course be connected up to the main system of supply. Their high main power station was situated upon a suitable site on the canal at Smethwick, where there would be a present capacity of 19,125 kw., including the extensions approaching completion. The smaller generating stations at Dudley and Kidderminster were of a different category, and as developments took place in those districts the dynamos which they contained would be displaced by [illegible] turbine sets of ample capacity to utilise to the best advantage the capital represented by the boiler plant, buildings, &c. Those subsidiary generating stations would supplement the main supply and increase the capacity and safety of the system. Their expenditure on fixed buildings, machinery, &c., at the close of the past year amounted to £208,[illegible] including £180,991 expended during the year. The item in their balance-sheet for "cost of special Acts and Orders, preliminary expenses, &c." stood at £23,079, which might be regarded as a very moderate expense, especially as it included the Inland Revenue fee upon the capital authorised. Much of their capital expenditure during the construction period had not yet fructified but the business done enabled them to recommend a dividend of 3 per cent. The policy of the company [illegible] the electric supply in the district under one management promoted cheap production, distribution and administration, and thus enabled business to be done upon satisfactory terms. The conditions of supply were favourable, mainly because the industries in the district varied considerably in size and character, and the commercial advantages of electric supply for power, traction, lighting and other purposes were now well understood and appreciated in the district. They had [illegible] plant capacity and mains sufficient for dealing with a considerable increase in business, and they looked forward to improved returns.

CITY NOTES.

MEMORANDA (June 10).—Bank rate 5 per cent. (since Aug. 8, 1914. Consols 66 $\frac{25}{32}$xd. Consols Pay Day July 1. Stocks and Shares Ticket Days June 24 and July 13. Pay Days June 25 and July 14. Price of silver, 23½d.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—Mr. J. G. B. Stone has been elected to fill a vacancy on the board of the company, rendered vacant by the death of Mr. Thomas Ed. Ivens.

MARCONI-POULSEN RUMOURS.—The "Financial News" of June 8 had the following note:—

"The presence of Mr. S. F. St. J. Steadman, of Messrs. Steadman, Van Praagh & Gaylor, on the board of the new Poulsen Wireless Co. is very significant. The Poulsen was originally organised by a well-known Stock Exchange firm, and the interests were largely among South African magnates, together with certain Danish elements. In spite of its influential backing, however, the company was not a success, so that the new development in the history of the enterprise is well worth close observation, especially if it be remembered that Mr. Steadman is the private legal adviser of Mr. Godfrey Isaacs, and accompanied him to the United States on an occasion too famous to need specification.

"Mr. Steadman's new directorship coincides most remarkably with the reports that the relations between the Government and the Marconi Co. are by no means as intimate as they were, and that in future the Poulsen system is likely to occupy a much more prominent position than heretofore. But if, as Mr. Steadman's directorship suggests, the Poulsen people are tending to coalesce with those who control the Marconi Co., the centralisation of wireless interests may be nearer than we suppose.

"The big Marconi action is being held back by the war and associated complications."

PROVINCIAL TRAMWAYS CO.—An interim dividend of 8d. per share has been declared on the ordinary shares.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared the third quarterly interim dividend of 3s. per share (tax free) for the year ending 30th inst., being at rate of 6 per cent. per annum. The transfer books will be closed from June 16 to 23 inclusive, and the dividend will be payable on June 24

YORKSHIRE (WEST $\frac{1}{2}$ RIDING) ELECTRIC TRAMWAYS (LTD.)—An interim dividend of 3 per cent. (being at rate of 6 per cent. per annum) has been declared on account of the dividend accrued on the 6 per cent. cumulative preference shares.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, June 9. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	NAME.	Price, Wed. June 9.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7	Bournemouth & Poole E. L. Ord.	9¼	7 3 8	Mar, Sept
10	3½	Do. 4½% Pref.	9¼	4 13 6	Feb, Aug
1	7	Do. 5½% Pref.	1 ½	5 17 9	Feb, Aug
1		Brighton & Hove Corp. Ord.	24	5 19 1	Mar, Sept
St.	4	Central Elec. Supp. C. Deb. St	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	94	4 5 5	Jan. July
5		Do. 4% Pref.	4¼	5 9 10	..
		Do. Ord.	4	6 0 0	Apr, Oct
10		City of London Elec. Lt. Ord.	14	6 8 7	Feb, Aug
1		Do. 6% Pref.	12½	4 17 0	Mar, Sept
St.		Do. 5% Deb. St.	110	4 10 11	Jun, Dec
1		Do. 6% Pref.	11½	5 4 5	Mar. Sept
10		Do. Ord.	11½	8 1 3	Feb, Aug
St.	4½	Do. 4½% Deb.	94	4 12 9	May, Nov
St.	4½	Edmundson's Elec. Supp. 4½% Debs.	94	5 12 6	Jan. July
		Kensington and Knightsbridge Ord.	24	6 4 2	Feb, Aug
St.		Do. Deb. St.	94	4 13 6	Jan. July
5		London Elec. Supp. 6% Pref.	84	5 19 3	..
1		Do. Ord.	8	4 11 11	Jan, July
	4½	Metropolitan E. Supp. Ord.	84	5 13 7	Mar, Aug.
St.	4½	Do. 1st Mort. Deb.	94	4 15 3	Jan, July
		Newcastle & Dist. E. L. 6% 2nd Dbs	64	6 1 10	Mar, Sept
St.		Newcastle-on-Tyne E. S. 5% 2d Mt. Db. St.	110	5 0 0	Mar, Sept
1		North Metropolitan E. P. Supp. 6% Pref	1	5 4 9	Apl, Oct
St.		South London E.S. 1st Mort. Debs.	95	5 3 3	Jan, July.
St.	4½	Urban Elec. Supp 4½% Db. St.	94	5 1 7	Apl, Oct
		Wenvoe & District Ord.	1	7 15 0	Mar. Aug
		Westminster E.S. Corp. Ord.	7	6 8 4	Mar, Sept
3		Do. 4% Pref.	4¼	4 14 1	Jan, July.
		Electric Railways & Tramways.			
		British Elec. Traction 5% Debs.	94	5 15 7	Apl, Oct
1		Do. 6% Cum. Pref.	11	11 6	Feb, Aug
1		Do. 7% Cum. Pref.	24	5 4 1	..
1		Do. do. Assented Def. Ord.	24	5 13 3	..
1		Do. Ord.	4	4 15 3	May, Nov
1		Do. 5% Pref.	9	5 11 1	Feb, Aug
1		London Electric Ry. Ord.	14	7 1 0	Jan, July
		Do. 4% Pref.	6	6 7 3	Mar. Sept.
		Do. 4½% Pref.	9	4 14 2	Jan, July.
		Metropolitan Ry. Con. Ord.	7	3 6 2	Feb, Aug
		Do. 3½% Pref.	7	4 19 6	Feb, Aug
		Do. 4% A Pref.	24	4 14 3	Feb, Aug
		Do. 4% B Pref.	24	4 4 9	Jan, July
		Do. 3½% Debs.	94	4 4 1	Jan, July

†Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

SHARE	LAST DIVIDEND	NAME.	Price, Wed., June 9.	RATE PER CENT. YIELDED.	DIVIDEND DUE.
		Electric Railways and Tramways —*cont.*	£ s. d.		
		Metropolitan Electric Tramways			Feb, Aug
	4	Do. 4% Pref.			May, Nov
	4	Do. 4% Deb.			Feb, Aug
	4	Do. 4% Deb.			Jan, July
	4	Do. 4% Debs. (1903-5)	87		Jan, July
	4	Do. 5% Pref.			May, Sept
		United Electric Tramways			
1		Do. A Ord.			
5	6½	Do. B Ord.	11	5 11	May, Sept
	6½	Do. 6% Inc. Bds., with coup. 15		8 4 11	Mar, Sept
	4½	Do. 4% Deb.		4 13 1	Jan, July
		Yorkshire Electric Tramways			May, Nov
		Electric Manufacturing, &c.			
		British Insulated & Helsby Cables	2	4	Apl, Oct
	1/0	Brit. Aluminium Ord.	1	15	May, Nov
10	5%	Do. Pref.	9	5 11	Jan, July.
	1	Do. Def.	1	2 1	Jan, July
		British Insulated Wire	11	6 11 1	Apl, Sept
	5	Do. Pref.		4 15	Jan, July
		British L.M.Ericsson Mfg. Co. 6% Pref.	1	6 12 11	May, Nov
		Brit. Westinghouse Pref.	1	7	April
		Do. 6% Prior Lien Debs.	1	5 7	Apl, Oct
		Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
		Do. Ord.	1	4 3	Jan, July
		Do. 5% Pref.		4 17	Feb, Aug
		Do. Def.	3	4 11	May, Nov
		Dick, Kerr & Co. 6% Pref.		6 17 2	Sept
		Edison & Swan U.Elec.Lt.A. £3 pd.			Feb, Aug
		Electric Construction	1		May, Nov
		Do. 7% Cum. Pref.	1	6 11	Jan, July
5	4	Do. 4% Debs		5 15 1	Jan, July
1		General Electric 6% Pref.	1	6	Jun, Dec
		W. T. Henley's Telegh. Wks. Co. Ord	2	7 4	Feb, Aug
		Do. 4½% Pref.	4	11	
5	4½	Do. 4½% Deb.	95	4 14 11	Jun, Dec
11		India Rubber, G. P. &c., Ord.		5 12 8	Feb, Aug
		Do. Pref.		5 15 11	Apl, Oct
1	4	Do. Deb.	97½	4	Apl, Oct
1		Telegraph Manufacture	37	6	Mar, July
1		Do. Def.		4 4 3	Jan, July
		Vickers Ord.	1	4 11 1	May, Aug
	1½	Do. Pref.	1	4 11 1	May, Aug
5	4	Do. 4½% Deb.	93	4	Jun, Dec
10	4½	Do. 4½% Deb.	101	4 5 11	Jan, Dec
		Telegraphs.			
		Anglo-American Tel. Co. Ord.		3	Jan, July
5	5	Anglo American 6% Pref. Ord.	10	5 15	May, Nov
10	5	Do. 5% Pref.	2	6 12 7	May, Nov
		Do. Def.		5 0 0	Jan, July
1		Cuba Submarine Ord.	1		May, Nov.
1		Do. Pref.	1		
		Direct Spanish 10% Pref.	4	13	
		Direct United States			Ja, Ap, Jly, O
5		Eastern Tel. Co. Ord.	132		Jan, July
		Do. Pref.		11	Jan, July
2	5	Do. 4% Debs.	90	4 11	May, Nov
1		Eastern Extension Tel. Co., 4% Debs.	99	4 11	Feb, Aug
		Do. Ord.	11	5 8 3	Ja, Ap, Jly, O
1		Ct. Northern Tel. Co. with Coup. 7			May, Nov
		Indo-European Ld and bonus		4	May, Nov
		Marconi's Wireless Tel. Co.	1	10	April
1	1/4	Do. Pref.	1		July
1		West Coast Ord.	1	11	May, Nov
1		Do. Pref.	1	4	May, Nov
		Western Telegh. Co.	13		Mr, Jly, O, Dec
5		Do. 4% Deb. St.			Jan, Dec
		Telephones.			
		American Telephn. & Telgh. $100 Cap.	1	6 6 7	Ja, Ap, Jn, O
		Do. Pref.	7		Jan, July
		Do. Def.	52		Nov.
	4½	Do. 4½% Deb.			May, Nov
1	10%	Do. 10% Pref.	1		Apl, Oct
5		Do. 5% Deb.			
5		Telephn. Co. of Egypt Db. St.	5	5 2 3	
		United River Plate Ord.			Apl, Oct
	5	Do. 5% Cum. Pref.	4		Jan, July
	4½	Do. 4½% Deb.			
		Financial and Investment.			
		Anglo-American Corporation	1		Ja, Ap, Jly, O
		Do. Def.			Sp, Dec, Mr, Jn
10		Do. Pref.			Ja, Apl, Jly, O
1		Do. Def.	1		Ja, Ap, Jly, O
		Colonial and Foreign Railways, Tramways, &c.			
5		Antofagasta			Jun, Dec
		Barsi Light Railway			
		Do. 5½% 1st Pref.	1		Jan, July
		Do. Def.			Jan, July
1		Brazilian Traction Ord.		11	
1		Do. Pref.		6 10	Ja, Ap, Jly, O
		Brisbane Trams Ord.		5 8	
		Do. Pref.			
		Buenos Ayres Great Southern			Mar, Sep
2		Buenos Ayres Western			Feb, Aug
		Do. 6% Cum. Pref.			
1		Callao Tramways			Jan, July
		Do. 5% 1st St.			
		Do. 4½% Debs. (1922)	100		Feb, Aug
		Do. Def.			Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
		Anglo-Argentine Tramways			May, Nov
		Do. Pref.	103		Jan, July
		Barcelona Traction	1		
		Do. Def.			Apl, Oct
		Bengal Electric Supply			
		Buenos Ayres Electric Tramways		4 17 7	June, Dec
		Do. Pref.		4 19 0	Apl, Oct
		Do. Def.			Jan, July
		Buenos Ayres Lt. & Power			
		Do. Pref.			
		Buenos Ayres Northern Ry.			
		Do. Pref.			
		Buenos Ayres Pacific Ry.			
		Do. Def.			
		Buenos Ayres Tramways			
		Do. Pref.		5 1 11	May, Nov
		Calcutta Electric Supply Co. Pref.			

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date June 9, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	14½d.	Antimony	£120 0 0
Solid Drawn Copper Tubes	13½d.	English Lead	£27 0 0
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	14½d.	**Old Metals.**	per ton.
Brass Wire	14½d.	Clean Scrap Copper	£75 0 0
Copper Wire	14½d.	Bracketty Copper Scrap	£70 0 0
Rolled Brass	14½d.	Clean Scrap Brass	£56 10 0
Brass Sheets	14½d.	Soft Lead	£25 0 0
		Soft Zinc	£24 0 0
	per ton	Hollow Pewter	£120 0 0
Copper Sheets	£136 0 0	Black Pewter	£85 0 0
Spelter	£31 0 0	Gun Metal	£64 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date June 9, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£95	Old Lead	£23 0 0
Clean Mixed Brass	£60	Pure Lead	£20 10 0
Clean Copper	£75	Old Zinc	£68 0 0
Brazlery Copper	£70	Hollow Pewter	£120 0 0
Gun Metal	£65	Shaped Black Pewter	£80 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ending	Receipts for week	Inc. or dec.	Aggregates. No. of weeks	Aggregates. Amount	Inc. or dec.
		£	£		£	£
Aberdeen Corporation	May 29		+ 335	52	86,599	2,330
Anglo-Argentine	June 5		— 2,937	52	1,134,081	13,112
Ashton-under-Lyne				62	4,876	+ 74
Ayr Corporation				63	992	— 180
Bath Electric Trams, Ltd						
Birkenhead Corporation		1,372		52	12,744	— 172
†Birmingham Corporation	May 29	15,076		52	111,005	+ 2,005
Blackburn Corporation	June 5	1,245		52	13,064	— 309
Bolton Corporation			— 1,149	52	9,654	1,390
Bournemouth { Trams				52	24,986	3,418
Bournemouth { Trams & Buses			543	52	19,366	+ 193
			31	52	172	+ 30
Bradford Corporation		6,420	— 1,261	52	63,513	+ 762
Brighton Corporation		1,030	— 263	52	9,892	753
Bristol Trams { Trams		5,067	— 1,528	52	100,224	1,568
Bristol Trams { Buses, &c.		5,179	— 532	52	100,413	+ 20,885
Brighton, E. Trams & Lig		£4,087	— £1,265	52		£42,556
Burnley Corporation		1,565	— 431	52	16,081	1,600
Burton Corporation		261	—	52	2,724	217
Bury Corporation			— 56	52	13,462	424
Caledonian Tramways Co.						£85,188
Camborne-Redruth					2,866	141
Carmarthen Corporation						1,705
Cork Electric Trams Co.				52	10,390	200
					9,269	+ 729
Croydon Corporation	May 29	2,252		52	15,382	+ 174
*Derby Corporation	June 5			52	9,985	+ 212
Dover Corporation				52	2,814	+ 105
Dublin & Lucan Railway			44	52	3,051	
Dublin United		6,226		52	130,095	1,755
Dundee Corporation		1,350		52	3,372	47
East Ham Council		1,245			12,503	1,455
Erith Urban Council						
Exeter Corporation					3,481	
Glasgow Corporation					22,821	200
Glossop Trams					2,666	14
Gloucester Corpn.					2,970	16
					20,413	22
Halifax Corpn.						17
Hastings Elec Trams Co.	June 5				17,921	
Huddersfield Corpn.						2,521
Hull Corporation					29,037	
Ilford District Council					6,154	1,284
Ilkeston Corporation		119				76
Ipswich Corporation		538			4,560	43
Isle of Thanet Co.		413			11,172	3,279
Lanarkshire Trams Co.						1,983
Lancashire United					35,785	
					84,169	3,185
					2,373	
Liverpool Corporation						
London County Council			—33,152		332,281	
Lowestoft Corporation					5,836	
Maidstone Corporation						
Manchester Corporation					170,855	
Mersey Railway						
Nelson Corporation						315
Newcastle-on-Tyne Corpn		6,260			58,043	1,797
Newport (Mon.) Corpn.						363
Northampton Corporation		731			6,998	132
					33,084	
		2,328			24,423	
Portsmouth Corporation	May 29				21,719	
	June 5				8,603	
Rotherham Corporation		1,126				1,100
						1,574
†Sheffield Corporation					87,141	5,495
Southampton Corpn.					11,418	116
Southend Corporation					8,122	1,004
Sunderland Corporation					13,857	
					16,922	1,122
Swindon Corporation					1,761	139
Taff Vale Railway	May 29				11,437	143
Wallasey Corporation	June 5				11,[illegible]	369
Walsall Corporation					11,[illegible]	1,094
						938
Warrington Corporation					4,051	11
West Hartlepool Corpn.		2,837			28,394	1,172
Wolverhampton Corpn.		1,052				219
Yorkshire W.R. Trams					35,227	1,680

(a) Three weeks. (b) Four weeks. (c) Five weeks. (d) Six weeks. (e) Seven weeks. (f) Eight weeks. (g) Nine weeks. (h) Ten weeks. (i) Eleven weeks. (j) Twelve weeks. (k) Thirteen weeks. (l) Fourteen weeks. (m) Fifteen weeks. (n) Sixteen weeks. (o) Seventeen weeks. (p) Eighteen weeks. (q) Nineteen weeks. (r) Twenty weeks. (s) Twenty-one weeks. (t) Twenty-two weeks. (u) Twenty-three weeks. (v) Twenty-four weeks. (w) Twenty-five weeks. (x) Twenty-six weeks. (y) Twenty-seven weeks. (z) Twenty-eight weeks.

† Tramways and services, &c. ‡ Mileage 2 days. § Mileage 4 days. ¶ Mileage 3 days. * Partly electrical.

** Compared with corresponding period last year.

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NOTES.

The I.M.E.A. Convention.

DURING the present year we must expect technical, as well as non-technical, affairs to be somewhat abnormal, and thus we must not be surprised that the Convention of the Incorporated Municipal Electrical Association this week has not been much more than a Convention in name. On the present occasion the Convention has been shorn not only of its social functions but also of the technical Papers. Since the war began there has been some question whether the technical societies should carry on their proceedings as usual, or whether their meetings should not be held. Generally it has been felt that technical meetings should be continued, and that the activities of such societies should not be restricted more than can be helped. In the case of the I.M.E.A. it was decided that any technical matters that were considered should be more in the nature of business developments, and consequently the technical part of the Convention has been restricted to the presentation of a report on the Point Five Tariff and one upon Electric Vehicles. The Association is not officially concerned with the Point Five Tariff, but this method of charging is necessarily of very great interest to all its members. On the other hand, the Association is very closely identified with the electric vehicle movement, as it has a Committee which has done a great deal to foster this development. It may be said, therefore, that although the Convention this year has lacked the conviviality with which it is generally associated, and has left on one side the broad questions which are generally discussed, the present meeting nevertheless has been one which should be eminently useful in its results.

Municipal Plant Extensions.

THROUGH the courtesy of the engineers of the undertakings concerned, we are able to describe in this issue work in the extension of municipal electricity supply, which may be regarded as typical of the progressive spirit of public service schemes of this character. The erection of a 10,000 kw. temporary plant by the Birmingham Corporation is a noteworthy achievement, both from the fact that the constructional work has been put through in record time, and that the Treasury has sanctioned the borrowing of the capital wherewith to complete the installation. There are a number of interesting engineering features in this plant which we have briefly described in our account this week, and one of these is the type of foundation adopted with a view to the transfer of the whole of the equipment to the permanent station, the foundations of which have been laid down and, it is hoped, will be completed shortly after the war is over. The very existence of the temporary station is a striking testimony to the part which electric power supply is playing in the production of munitions and war material. Many years ago Birmingham manufacturers became convinced of the merits of the electric motor drive for all classes of their productive machinery, from the heaviest rolling and wire drawing mills to the lightest automatic lathes. No surprise need, therefore, be expressed at the exceptional demand for electrical energy for war material in the Birmingham area during the present crisis. Mr. CHATTOCK and his staff are to be complimented upon the foresight and ability with which they have carried through the provision of modern and adequate generating plant to meet this need.

THE other two undertakings with which we deal are those at Derby and Salford. Both these districts are of an important character, an importance which has assumed a national tone at the present time. Mr. WILMSHURST, at Derby, has always ranked among the progressive municipal electrical engineers, and he has succeeded in embodying in a practical manner his views as to the general character of electricity supply, not only within the congested area of a town, but also in the rural districts immediately bordering upon it. His 4,000-volt overhead transmission lines

to the outskirts of Derby are of considerable interest. He has succeeded in conferring the undoubted hygienic advantages and domestic convenience of a cheap electric service upon the outskirts of his area, and in a manner which we feel sure will not fail to raise the value of those districts. Mr. ROBERTSON, at Salford, has had to tackle engineering problems differing somewhat from those of the preceding undertakings. He has found that the local demand has been increasing at an almost alarming rate, and the demand at the present moment is, as we have already pointed out, one of national urgency. The site of the Frederick-road station is extremely cramped, and the modernising of the plant can only be undertaken with considerable difficulty. The means which Mr. ROBERTSON is adopting are referred to in the article on another page, and his Committee must feel gratified that the work which he is doing is reducing the operating costs and in every way justifying the policy which he has successfully recommended them to adopt. Not the least interesting fact of the Salford area is the large number of firms who are engaged in the production of munitions of war. Here, again, the electric power service is proving its efficacy on electrical and mechanical grounds to cope with every requirement of the power user, no matter what class of industrial machinery he requires to drive.

The Mobilisation of Invention.

AN interesting discussion has been started by Mr. H. G. WELLS in "The Times" upon the subject of the mobilisation of invention. It has probably been felt by many laymen, including some who certainly know what is taking place, that insufficient use is being made of the scientific powers of this country. On the other hand, it is felt that in Germany scientific men are probably organised to help forward the cause of their country, the organisation being of that thorough kind which is so characteristic of Germany. Unfortunately, in this country organisation of this kind is absolutely lacking. What is more, we fear that men in the services even feel a certain contempt for the scientific layman because the latter happens not to be acquainted with military or naval duties. Yet, as Prof. J. A. FLEMING remarks in a letter, which we reproduce elsewhere, there must be any number of scientific men who would only be too pleased to do investigation work for the Government at the present time. The effort merely requires directing. Without direction it is valueless. As Prof. FLEMING says, "it is not enough to make vague suggestions as to the detection of submarines or the destruction of Zeppelins." It takes long and patient work, as a rule, to get from the crude idea to the practical device; yet we go on complacently doing nothing in the development of these newer methods which are likely to play a most important part in the present war. In fact, it has been stated that as soon as war was declared an order was given for all experimental work to cease on the part of naval and military departments. [illegible] the very reverse of the policy which should be adopted and as we are not assured it is not the policy which has been adopted by Germany. This is evident from the course of events. From time to time it is noticeable that new German developments arise, but here we correspondingly developments in progress on our side, or do we merely wait for developments on the part of the enemy before taking steps to counteract them?

THE suggestion is made by Principal E. H. GRIFFITHS that a small Inventions Committee should be formed, constituted somewhat as follows: A chemist, a physicist, a mechanical engineer, a representative of the naval service and a representative of the military service. The work of this Committee would be to receive and consider any suggestions that are made of a scientific kind, to reject those which are deficient through lack of scientific knowledge, and to consider the possibilities of the remainder. If any suggestion appeared to be sound it would be forwarded to the Government Department concerned. Such a scheme would no doubt relieve the Government departments from the bombardment to which they are being subjected at the present time by inventors, many of whom, we fear, have not sufficient knowledge at their command. Failing the formation of a Committee of this kind, Principal GRIFFITHS suggests that each University might act in a similar capacity by means of their own staffs. This suggestion also is worth considering, though it suffers from the fact that it would inevitably lead to a certain duplication of work. As a result of the present correspondence, it is to be hoped that some serious attempt will be made to mobilize the scientific forces of this country, which are not one whit inferior to those of Germany, for the purpose of investigating the many problems that must require solution at the present time.

The Coal Position.

ACCORDING to a note which our readers will find in another column, the deputation representing the gas and electrical interests attended the House of Commons on Wednesday, the 9th inst., and laid before a meeting of about 200 members of Parliament the serious difficulties which they were experiencing owing to the shortage of coal. This deputation was, of course, the outcome of the conference held at the Institution of Electrical Engineers on May 6th. We need scarcely reiterate the importance of the whole matter. It was rightly pointed out by the deputation that electrical undertakings led to a very great saving in the use of coal, and that this was a material advantage in saving one of our greatest national assets at this time. If the supply of electricity had to be curtailed or stopped the result could only be calamitous. Indeed, this point of view should be so self-evident as not to require to be seriously supported. Various means of improving the present situation were suggested by the deputation. Amongst these was the limitation of recruiting among miners, suspension of the operation of the Eight Hours Act in respect of collieries, fixing a maximum rate of freight for all interned vessels, and the increase of facilities generally for the transport of coal. We only trust that these suggestions will not fall as seed upon stony ground. A further conference took place on Tuesday last, when representatives of other firms consuming large quantities of coal, also shipowners, coal masters and miners, attended. A committee of 12 (of which we understand 11 are members of the House), representing the various interests in equal proportions, was appointed to

interview the President of the Board of Trade, and to make specific recommendations at a further conference to be held next week. What makes us fear so much for the future is the extraordinary lethargy on the part of Government Departments in dealing with important matters of this kind. Here we are in June, and we shall soon be half-way through the summer, and yet, so far as we are aware, no steps have been taken to bring about a change in the present position. The summer months are all-important from the point of view of replenishing the stores of coal which will be required in the winter time. To wait until, say, September will be to render such measures as may be adopted almost abortive, and yet the policy seems to be one of drift!

Honorarium or Increase of Salary?

From time to time the question arises of giving a municipal engineer an honorarium for special work. Usually this occurs when an undertaking, originally in low water, has been brought to a satisfactory financial position. We must confess that we have considerable sympathy with the recognition of services of this kind. Two cases have just arisen—namely, one at Barrow, where the committee suggested that Mr. H. R. Burnett should be granted an honorarium of £100 owing to the very satisfactory progress that had been made, and the other at Newport, where it was proposed to give similar sums to Mr. Nichols Moore and to the General Manager of the tramways. At Barrow the view was held that an engineer receiving £550 per annum was sufficiently well paid, and that if he wanted something better he could go elsewhere. At Newport, on the other hand, we are glad to see that the honorarium was granted. It must be remembered that, as a rule, municipal electrical engineers are by no means well paid. It is, therefore, only right and proper that their services should be suitably recognised when their efforts are successful. If such a course is not followed town councils must only expect a mediocrity which is far from desirable.

Central Munitions Works for London.—We understand that a proposal made by Mr. W. A. Harper, of Messrs. Harper Bros. & Co., consulting engineers, with regard to the establishment of a central munitions works in the metropolitan area, has been approved by the Munitions Committee at the War Office. This important decision was arrived at during the private meeting at the Institution of Civil Engineers on Saturday last, and a committee was formed to place under one central administration the workshops and stations of all available companies and public authorities, light, gas, power and water companies, and arrange them in districts for the manufacture of war munitions. The Committee is composed of the Presidents of the Institutions of Civil, Mechanical and Electrical Engineers and leading engineers concerned with public works. The meeting appointed Mr. F. J. Walker, managing director of St. James's & Pall Mall Electric Light Co., as [illegible] secretary of the Committee, which is taking immediate steps to ascertain what engineering plants in the metropolitan area are available.

Stowmarket Explosion. In a report issued last week by Major Cooper Key, Chief Inspector of Explosives, on the explosion which occurred on May 10th in a nitro-glycerine final washing house at the factory of The New Explosives Co. at Stowmarket, a remarkable conclusion was reached as to the cause of the explosion. It was thought that a bag of cordite paste was being wiped down to remove guncotton dust from the bottom, prior to its removal from the building, by a man wearing stout rubber overshoes. The bags were of rubber impregnated canvas and on a dry morning, such as it was on the morning of the explosion, a man with a naturally dry skin would, it was stated, become sufficiently electrified by the friction, that when he came near an earthed object a spark sufficient to ignite the explosives present would pass. In support of this theory reference was made to similar phenomena in Canada, where, it is stated, it is possible in cold weather to generate sufficient electricity on one's body by shuffling the feet on the carpet to light the gas by means of a spark from the end of a finger. A case was also quoted where a workman in rubber shoes fired acetone vapour by a spark from his finger after merely allowing the thin light strands of rifle cordite to pass over his hand.

Dry Battery Electrolytes.—The shortage of flour in Germany has necessitated the use of substitutes for the wheat or rye flour commonly used for thickening the electrolyte in dry batteries for pocket lamps. According to the "Engineer," the following materials are recommended for this purpose: Glass-wool, sawdust, gelatine, starch, Kieselguhr and waterglass. The following instructions are given for compounding the electrolyte: 140 grammes of well-powdered salammoniac, 40 grammes of zinc chloride, 10 grammes of ammonium sulphate are mixed together in a porcelain bowl with 10 grammes of thick refined glycerine. The mixture is then covered in small quantities with distilled water at a temperature of 40°C. and energetically stirred until the materials are dissolved into a concentrated solution. This mixture is allowed to soak into the binding material, and the paste so formed is filled into the cells, which are closed with a paraffined card top sealed with bottle-wax. In the cover two small glass tubes are provided for the escape of such gases as are generated within the cell. In compounding the electrolyte, calcium acetate can be mixed with advantage with equal parts of the salammoniac. Such a solution possesses excellent conductivity, is hygroscopic and does not crystallise or creep.

Mobilisation of Invention.—This is a question very much in the air just now, and Mr. G. H. Wells has recently contributed an important letter on the subject to "The Times.". Supporting Mr. Wells the following letter from Dr. J. A. Fleming, F.R.S., to the Editor of "The Times," will be read with interest:—

It would be difficult to overstate the importance of the discussion on the above subject in your columns which was initiated by the letter of Mr. Wells. At the present moment the scientific ability of this country is in the position of the magnetic molecules of iron as regards external magnetic effect. They produce no result until some external magnetic force compels them all to orient themselves in the same direction.

There is no want of ability, but there is an entire absence of external directing power. Nay, rather, special steps have been taken to inhibit scientific activity in directions which might assist the nation.

Take, for instance, the subject of electric waves, which might be used as an implement of warfare in certain ways I forbear to point out for obvious reasons. It was unquestionably right of the General Post Office to put a stop at the outset of the war to all amateur wireless telegraphy, to prevent German spies conducting their communications with antenna wires put up a chimney.

Is it, however, an advantage to the country that all the expert knowledge on this subject outside certain official circles should be cast on one side and neglected?

A few days ago an eminent electrical engineer was sitting in my room here, and said to me, "I am too old to enlist or even to do manual work in the manufacture of shells, but I have a considerable scientific knowledge which I am just yearning to employ in the service of the country, yet I cannot find any person in authority who will [illegible]."

This sentence expressed concisely not only my friend's feelings, but my own, and I am confident that of [illegible] At the present moment, after 10 months of scientific warfare, I myself, although [illegible] Fellow of the Royal Society as well, have not received one word of request to serve on any committee, co-operate in any experimental work, or place expert knowledge, which it has been the work of a lifetime to obtain, at the disposal of the forces of the Crown. It is not enough to make [illegible] Zeppelins. Rough ideas have to be hacked into shape, reduced to practice, and tested on a large scale. All this means organisation,

expenditure, assistants, and definite practical experiments. It seems to demand a special Government department, which shall enlist in its service trained and experienced investigators for definite ends. This war will be won in the laboratories and workshops almost as much as in the field, and it will only be won when the Government organise the scientific intellect of the country as well as the manual labour with that single purpose.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Mr. G. G. Bell contributes an article on the "Storage of Coal" (p. 382).

We publish an article by Mr. R. T. Mitchell on "Recent Progress of the Electric Battery Vehicle" (p. 384).

We give a full report of the I.M.E.A. Convention, held yesterday, at the Institution of Electrical Engineers, London (p. 378). Abstracts of two reports are given, the first on the "Practical Results of the Point Five Tariff," by Messrs. A. S. Blackman and T. Roles, on p. 378; the second on the "Use of the Electric Vehicle in Municipal Service," by Mr. F. Ayton (p. 379). The discussions on these reports, together with an account of the electric vehicle parade, which followed the second report, are given on pp. 403-406.

Our Leading Article deals with the Report on the Point Five Tariff (p. 394).

We describe theNechells Temporary Power Plant of the Birmingham Corporation (p. 388).

We also describe the "Development of the Derby Electricity Undertaking" (p. 392).

We publish an article dealing with "Electric Power Supply in War Time" (p. 397).

A description of the recent extensions of plant at Salford appear on p. 399.

Companies' Meetings and Reports.—Meetings of the Devonport and District Tramways Co., United Electric Tramways of Montevideo and Trowbridge Electric Supply Co. are reported, and the directors' reports abstracted include those of the British Electric Traction Co., Deutsch Sudamerikanische Telegraphen-Gesellschaft, GlobeTelegraph & Trust Co., India Rubber, Gutta Percha & Telegraph Works Co., James Keith & Blackman Co., Rangoon Electric Tramway & Supply Co. and Royce Limited (pp. 416, 417).

OBITUARY.

Killed in Action.—We regret to record the deaths of the following, who have been killed in action :—

John Corbett Browne.—Mr. Browne, who was, until the outbreak of the war, one of the engineers attached to the export department of the British Westinghouse Co., is reported to have been killed while serving as a sergeant in the Honourable Artillery Company in Flanders.

E. L. Baddeley.—Mr. E. L. Baddeley, secretary of W. T. Glover & Co. (Ltd.), is also reported killed.

J. D. Boote.—Mr. J. D. Boote, formerly employed in the offices of Messrs. Dick, Kerr & Co. at Preston, and who was serving as a private in the 3rd Loyal North Lancashire Regiment, has also been killed in action.

PERSONAL.

Signor G. Marconi has been made a lieutenant in the Italian Engineers (on the staff of General Cadorna), superintending the wireless service.

Mr. T. H. U. Aldridge, electrical engineer to Shanghai municipality, left for England via the United States on May 29, and hopes to be in London [illegible] July. While he is in London specifications will be drawn up and tenders invited for additional generating plant, transformers, cables, &c.

[illegible] that one of our readers has an opportunity of making [illegible] in the columns of The Electrician. This however has been possible in the case of Prof. Pieter Zeeman. We must excuse the mistake in our issue of May 28 [illegible] that there were two [illegible] Prof. P. Zeeman (Utrecht) [illegible] Prof. Zeeman who had [illegible] Laboratory of Mathematics in the [illegible] Dr. H. A. Lorentz, [illegible] Leyden. He [illegible] We [illegible] Prof. Pieter Zeeman, the [illegible] Zeeman-Effect, [illegible] still we have

APPOINTMENTS VACANT AND FILLED.

A demonstrator is required in the physics department of the Birmingham Municipal Technical School. Commencing salary £125. Applications to the secretary, Mr. Geo. Mellor, Suffolk-street, Birmingham, by June 30. *See an advertisement.*

A junior assistant is wanted at once on the editorial staff of The Electrician. *See advertisement.*

An assistant is wanted in the testing department of a cable works in the Manchester district. *See advertisement.*

A capable superintendent of meter department, with technical training, is required by an advertiser.

A meter repairer is required for a Midland electricity undertaking. *See advertisement.*

An instrument maker is wanted at once for large works in the Manchester district. *See advertisement.*

Prof. W. H. Bragg, F.R.S., has been appointed to the Quain chair of Physics at the University College, University of London, in succession to Prof. F. T. Trouton.

Mr. A. C. Bertoli, electrical engineer to Swan Hill (Victoria) Council has been appointed engineer to Rochester (Victoria) Shire Council, in succession to Mr. W. T. Chaplin. Mr. W. W. Aulsebrook succeeds Mr. Bertoli at Swan Hill.

INSTITUTIONS AND SOCIETIES.

Institute of Radio Engineers.—At the June meeting of this Institute held on Wednesday, June 9, at Columbia University, New York, a Paper on "Engineering Precautions in Radio Installations," was read by Mr. R. H. Marriott, in which the results of much experience with methods of installing radio apparatus for safe operation was given. An address on "Static Elimination—Some Suggested Methods," was read by Dr. Alfred N. G. Goldsmith. The address contained much material of interest to those working at the question of minimising atmospheric disturbance of received signals.

Franklin Institute.—The first awards of the Franklin medal, the highest award of the Franklin Institute, have recently been made to Prof. H. Kamerlingh Onnes and Mr. T. A. Edison—to the former for his long-continued and indefatigable labours in low temperature research, which has enriched physical science, not only with a great number of new methods and ingenious devices, but also with achievements and discoveries of the first magnitude; and to the latter for the numerous basic inventions and discoveries forming the foundation of world-wide industries, signally contributing to the well-being, comfort and pleasure of the human race.

EDUCATIONAL NOTES.

University of Manchester.—In the Faculty of Science complete courses of study (extending over three years) are arranged for the University Degrees in civil, mechanical and electrical engineering. Good facilities are provided for laboratory and research work; the civil and mechanical engineering laboratories have recently been equipped with new plant and apparatus, and the electrical engineering laboratory is housed in a new building. Particulars of courses can be obtained from the Registrar. The new session commences on Oct. 7.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses, giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

ARRANGEMENTS FOR THE WEEK.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Friday, June 18th (to day)

10 a.m. Annual general meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C.

FRIDAY, June 25th

Physical Society

5 p.m. Meeting at the Imperial College of Science, Imperial Institute road, South Kensington, London, S.W. Agenda: Papers on "A Theory of the Electrical Resistance of Metals," by the President, Sir J. J. Thomson, O.M., F.R.S.; and "On an Unbalanced Alternating Current for Cable Telegraphy," by Lt.-Col. Squier.

THE CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

London, June 17th.

The annual Convention of the I.M.E.A. this year has differed from all previous conventions in many ways. Following well recognised precedent, the Convention should have been held at Dundee, since the President is Mr. H. Richardson, the city electrical engineer of that undertaking, but the war has altered many things in these days, and among the incidents to be taken into account in this connection must be recorded the fact that Mr. Richardson is at present on active service. It has, therefore, been necessary to find a substitute for the President on more than one occasion. Consequently, at the request of the Council, the duties of President are being discharged by Mr. A. C. Cramb, borough electrical engineer of Croydon and senior Vice-President of the Association

Again, it was felt that the Convention had better be held in London rather than at some provincial centre, more particularly as the programme has been restricted simply to the presentation of two reports, and the idea of social functions has been entirely abandoned. In many respects, therefore, the Convention is not one in the usual meaning of the term. It is rather a business affair with a programme of one day devoted to the technical discussion of two important subjects, and a second day devoted to business affairs.

Notwithstanding the unusual conditions, a considerable number of members were in attendance, including: Messrs. S. T. Allen (Wolverhampton), F. Ayton (Ipswich), A. S. Blackman (Sunderland), J. W. Beauchamp (West Ham), J. H. Bowden (Poplar), S. E. Britton (Chester), R. A. Chattock (Birmingham), J. Christie (Brighton), C. S. Davidson (Barnes), S. E. Fedden (Sheffield), E. E. Hoadley (Maidstone), W. W. Lackie (Glasgow), F. M. Long (Norwich), A. Nichols Moore (Newport), S. L. Pearce (Manchester), W. G. Pickvance (Wrexham), H. Faraday Proctor (Bristol), J. A. Robertson (Salford), T. Roles (Bradford), A. H. Seabrook (Marylebone), W. C. P. Tapper (Stepney), Lieut. H. M. Taylor (Middlesbrough), S. J. Watson (Bury), F. H. Whysall (Greenock), G. Wilkinson (Harrogate), W. Wyld (Hampstead) and C. H. Yeaman (Stoke-on-Trent). Among the visitors were Mr. C. H. Wordingham and Mr. W. B. Woodhouse (Yorkshire Electric Power Co.).

The proceedings, which opened in beautiful weather, were not marked by any presidential address. Mr. A. C. Cramb, who occupied the chair, referred briefly to the effect which the present terrible war had immediately after its outbreak upon the affairs of the Association. The bye-laws required the Convention to be held, but it had been decided not to invite visitors, except the co-opted members of the Electric Vehicle and the Development Committees, whose work had been of great value to the Association.

Mr. Cramb then called upon Mr. T. Roles to present a report by himself and Mr. A. S. Blackman on the subject of the "Practical Result of the Point Five Tariff." This report has been written on behalf of the Point Five Association. An abstract will be found in next column, and an account of the discussion which followed it is given in a later part of the present issue.

In the afternoon a report was presented by Mr. Frank Ayton, borough electrical engineer of Ipswich and hon. secretary of the Electric Vehicle Committee of the I.M.E.A. An abstract of this report will also be found on p. 379, and from this will be seen some of the important results which are following the energetic work of this Committee.

Later in the day there was a parade of a considerable number of electric vehicles on the Embankment, which aroused a deal of interest. A description of the vehicles at the parade will be given in our next issue.

THE PRACTICAL RESULT OF THE POINT FIVE TARIFF.*

BY A. S. BLACKMAN AND THOS. ROLES.
(Chief Electrical Engineer, Sunderland, and Chief Electrical Engineer, Bradford.)

The authors first deal with the development of the Point Five tariff historically. The metropolitan borough of Poplar was the first to adopt such a tariff (in 1909), and was followed at intervals by 21 others. The essential of the tariff is that the secondary charge is 0·5d.; the primary charge has been based on either the kilowatts connected, or upon rateable value, but might be made to depend upon any other suitable basis.

So far as the writers are aware, the two methods cited above of arriving at the fixed charge (where made) are the only ones which have been adopted up to the present in connection with Point Five tariffs, and the difference between these methods is but one of convenience in the working of the tariff, the fixed charge per kilowatt being more strictly correct in individual cases, whereas the apportionment upon the size of the house is an average result.

It should be recognised that the rateable value basis is only made use of as a means which is ready to hand of determining the fixed charge approximately in accordance with the electricity consuming capacities of the premises supplied, and any other readily available basis might be adopted, as, for instance, the cubical capacity of the premises or the total floor area.

The percentage of the net rateable value decided upon varies in different towns, being usually between 10 per cent. and 15 per cent. per annum, the amount generally being apportioned between the four quarters of the year, sometimes equally and sometimes in approximate proportion to the lighting hours, as, for instance, one-third for each of the two winter quarters and one-sixth for each of the two summer quarters. In at least one case (Sunderland) the percentage is varied between 10 per cent. for a house rated at £30 to 15 per cent. for a house rated at £70 and upwards, the reason for this being that a large house generally furnishes a worse load factor than a small one.

For the purpose of reviewing Point Five tariffs generally it is a matter of regret that both writers have obtained their experience under the rateable value system, as the results herein recorded for Bradford and Sunderland would, no doubt, have been different had a Point Five tariff under some other method of charging been adopted. The writers fully recognise that the rateable value system has its disadvantages as well as its advantages, and any success which has been attained in Bradford and Sunderland is, in their opinion, due to the fact that under the conditions prevailing in these towns the advantages considerably outweigh the disadvantages. Of course, it does not follow that the system would be equally successful in other towns.

In both Bradford and Sunderland no scheme of hiring out heating and cooking apparatus is in existence.

In the application of a Point Five tariff, based upon rateable values, a discretion should be exercised in favour of the consumer who, in consequence of living in a house with an abnormal amount of ground attached to it, is rated out of proportion to the size of the house. So far as Sunderland is concerned no difficulty whatever has arisen in dealing with these cases; the rating department have simply been asked to say how much of the rateable value could properly be apportioned to the excess of ground over and above a normal allowance, and such amount deducted from the rateable value in fixing the charge under the tariff. In Bradford, on the other hand, the rating authorities, when approached, have only deducted a sum from the total equal to the rateable value of the surrounding land as it would be assessed at used for agricultural purposes, and state that they cannot say what increased value can be put upon the land by reason of its being attached to the house. It follows, therefore, that a reduction made on the above is practically nil, and, therefore, cases arise in which this point has to be decided, the practice adopted will probably be to base the fixed charge on what is being paid for houses of similar size with similar allowance of land.

A marked advantage of the rateable value basis is the facility

* Report read at the Convention of the Incorporated Municipal Electrical Association.

with which an accurate estimate of the consumer's bill can be prepared. Once the fixed charge for a house has been ascertained, a wide error may be made in assessing the consumption that will be used, and the estimate still remain reasonably correct.

This facility for estimating has been found in practice to be a very useful asset to the canvassers in towns where a cheap supply of gas has to be competed against.

It likewise follows that the importance of any error in metering is correspondingly lessened.

Numerous other advantages have attended the adoption of a Point Five tariff based on the rateable value system, amongst which the following may be cited :—

Electric light is more likely to be adopted for the whole of a house. Further, carelessness on the part of members of households in leaving lights burning while rooms are not in use does not result in the amounts of the accounts being unduly inflated.

In addition to this, under a flat rate of charge the lighting of most houses using electricity compared unfavourably with that of houses illuminated by gas, especially where the mantles in the latter were kept in good condition. The reason for this was that, on the score of economy, lamps of only small candle-power were generally in use. The making of the fixed charge in a house of any given rateable value quite independent of the number and size of the lamps installed, coupled with the supply of current at a cheaper rate, has resulted in consumers using lamps of considerably higher candle-power, thus obtaining an illumination at least equal to that of gas-lighted premises. As a matter of fact, it is now usually quite easy to determine whether or not a house is on the Point Five tariff by the brilliancy of the light proceeding from the windows of premises taking a supply under this rate. It may, of course, be argued that the additional maximum demand caused by this increase of light must adversely affect the supply undertaking. Against this must be put the fact that, owing to the houses being almost invariably wired throughout, the diversity factor of the installations is higher, which tends greatly to increase the load factor of this class of supply.

No additional charges can be made against the increased amount of lighting on account of services or distribution mains, as the cables used for these purposes are generally standardised to two or three sizes, and the cost of trenching, cutting away of walls, &c., is practically independent of the size of cable used. In many cases both mains and services were already in existence on the Point Five tariff being adopted, and in a large number of other cases mains had previously been laid in front of the premises.

Taking this class of supply altogether, therefore, the additional expenses to the undertaking consist of the cost of increasing the capacity of the generating plant—which can now be done at far cheaper rates than in the days when the flat rate for lighting purposes was decided upon—and the provision of extra feeder cables. No additional management charges can be debited against the extra lights, as whatever the size of the installation the cost of service inspection, meter reading, rendering of accounts and general management of the undertaking is practically the same.

It is, of course, possible that under Point Five tariffs based on the rateable value system, the increased capital expenditure incurred on account of new plant causes a reduction in the profits, but the writers are firmly of opinion that any such reduction in profits from quite a limited number of consumers is soon far more than counterbalanced by the profits derived from the additional consumers gained by reason of the excellent advertisement obtained in consequence of the improved lighting.

In both Bradford and Sunderland it has been found that the majority of new domestic consumers adopt the rateable value tariff ; houses are, as a rule, wired from cellar to attic ; the domestic load factor has improved ; the illumination of rooms has in almost every case been considerably increased ; and no complaints are now received as to the inefficiency of electric lighting as compared with lighting by means of gas.

Dealing with Point Five tariffs generally, it may be mentioned that such tariffs lead to an increased heating load. Since current has been supplied at ½d. per unit, not only has the number of electric heaters [illegible] but the capacity of the individual heaters has also increased, so that fires taking 3 kw. and 4 kw. are [illegible] ; [illegible] ing the figures that follow, bearing on the growth of [illegible]

to the fact that at December 31st last 1,298 private house consumers were connected to the supply, whereas prior to the introduction of this method of charging on July 1, 1910, the number of such consumers was but 511, representing the result of nearly 21 years' working. It will thus be seen that during the 4½ years the Point Five tariff has been in force the number of domestic consumers has increased by 787, or over 150 per cent ; 403, or more than half, of these consumers, have elected to be charged on the special rate, the houses being in practically all cases electrically lighted throughout.

Three hundred and eighty-three of the 511 private house consumers on the supply at June 30, 1910, have adopted the Point Five tariff in place of the lighting flat rate of 4d. per unit under which they were previously charged. Owing to changes of tenancy and alterations in other conditions the comparison given below relates to only 138 of the consumers changed over, the periods covered being the year prior to the introduction of the Point Five tariff and the year ended Dec. 31, 1914.

Load Factor.—Based on the total kilowatts installed the average load factor of the 138 consumers in question has increased from 3·38 per cent. to 4·34 per cent., equivalent to an increase of 28·4 per cent.

Units Sold for the Complete Year.	
Under old tariff	93,880
.. Point Five tariff	182,872
Average per house under old tariff	680
.. .. Point Five tariff	1,325
Increase	94·9 per cent.

Revenue.	
Total under old tariff	£1,566 0 0
.. .. Point Five tariff	1,358 0 0
Average per house under old tariff	11 5 6
.. .. Point Five tariff	9 16 10
.. price under old tariff	3·98d.
.. .. .. Point Five tariff	1·78d.

The figures given above relative to the old tariff are inclusive of separate charges made for meter hire. Under the Point Five tariff the rental of the meter is covered by the fixed charge. On this score the figures are, therefore, strictly comparable.

The following table gives details as to the number of units sold, revenue obtained, &c., in the case of consumers supplied under the flat rate of 4d. per unit and under the Point Five tariff respectively, the comparison applying to all domestic consumers connected for the complete 12 months ended December 31 last.

Tariff.	No. of consumers.	Total units sold.	Average No. of units per house.	Total revenue.	Average revenue. per house.
4d.	340	124,742	367	£2,005	£5 18 0
0·5d.	566	612,502	1,082	4,312	7 12 4

Diversity Factor.—The particulars given below illustrate the effect the Point Five tariff has had on the diversity factor, the periods compared being the 12 months ended June 30, 1910, and the 12 months ended Dec. 31, 1914 :—

12 months ended.	Maximum load on L.T. feeders for residential areas only	Total kw. installed in private houses.	Diversity factor.
June 30, 1910	158 kw.	420 kw.	2·65
December 31, 1914	290 kw.	853 kw.*	2·94

In conjunction with the above table, it may be mentioned that the 420 kw. of consuming devices installed at June 30, 1910, in private houses in the residential areas dealt with were almost exclusively for lighting purposes. As at that date the number of consumers affected was 233, an average of 1·8 kw. per house is obtained.

At Dec. 31, 1914, the consuming devices in connection with the installations in these particular areas had increased to 853 kw. and the number of consumers to 367, giving an average of 2·32 kw. per house. Of the total of 853 kw. connected, 545 were for lighting purposes and 308 for heating and cooking purposes, the average per house being 1·48 and 0·84 kw. respectively.

The annual percentage of the rateable value debited to a consumer in Bradford adopting the Point Five tariff is 15, and in this connection it may be stated that based on the rateable values obtaining in the city it is estimated that such percentage, coupled with a charge

* This is the total for which application has been made. It has, however, been found since the introduction of the Point Five tariff that heating and cooking apparatus, particularly the former, has been connected in private houses to a considerable extent without the electricity department being notified. Consequently the figure given is very much on the low side, and this naturally reflects on the diversity factor, which is undoubtedly greater than 2·94, as stated.

of ½d. per unit, brings in a revenue equivalent to what would be earned for an average supply of current for lighting purposes at a flat rate of 4d. per unit. All energy required for heating and cooking purposes is under these conditions obtained at the ½d. rate.

Although in Bradford domestic consumers have not been approached individually for the purpose of explaining the advantages they would enjoy by changing over from the flat rate to the Point Five tariff, more than half of such consumers have elected to be charged on the latter system, and have introduced electric heating or cooking apparatus. This is all the more remarkable when it is borne in mind that no general attempt has been made to induce consumers to instal heating and cooking apparatus, the staff of the business development department having been fully occupied in dealing with power supplies.

Many consumers have introduced heating and cooking apparatus, although there has been no general attempt to push this class of supply. Also the electricity department's canvassers do not call upon gas consumers with a view to persuading them to take an electricity supply; and the gas department have been exceedingly active during the past few years in advocating the use of gas for heating and cooking purposes.

Sunderland Results.

At the introduction of the Point Five tariff there were 337 private houses connected to the supply, the majority partially lighted only as the result of 16 years' working. Since the tariff was introduced upon Jan. 1, 1912, three years' working has resulted in 162 more private houses being connected; 100 of these elected to be put on the Point Five tariff and are lighted throughout, and 62 upon a flat rate of 3·6d. per unit.

Of the 337 houses that were on the supply at Jan. 1, 1912, 105 have changed over from a flat rate of 3·6d. per unit to the Point Five tariff, and of these 105 houses 87 have, owing to there being no change of tenancy, been taken for the following comparison, the periods being the year preceding and the year following the adoption of the Point Five tariff.

Load Factor.—The average of consumers' load factor on kilowatts installed has been increased from 2·44 per cent. to 4·05 per cent., an increase of 66 per cent.

Units Sold for a Complete Year.		
Under old tariff		44,827
,, Point Five tariff		93,327
Average per house under old tariff		512 (354)
,, ,, ,, ,, Point Five tariff		1,073
Increase		109·5% (203·1%)
Revenue.		
Total under old tariff	£672 0 0	
,, ,, Point Five tariff	616 0 0	
Average per house under old tariff	7 14 5	(£5 5 9)
,, ,, ,, ,, Point Five tariff	7 1 7	
,, price under old tariff		3·6d.
,, ,, ,, Point Five tariff		1·58d.

For the purposes of comparison it must be remembered that the units and money values in black type refer almost entirely to carbon lamp conditions, and our experience with pure lighting installations that have remained upon our mains unaltered over a term of years, save for the transition from carbon to metal filament lamps, shows that for purposes of comparison under modern conditions the figures in brackets should be substituted for those shown in black type, and this has been done for the purpose of the following comparison.

The comparative results obtained from alternative tariffs for all private houses connected for the year ended Dec. 31, 1914, are as follows:—

Tariff.	No. of consumers.	Total units sold.	Average No. of units per house.	Total revenue.	Average revenue per house.
3·6d.	212	75,032	354	£1,121	£5 5 9
0·5d.	286	298,563	1,044	1,803	6 6 11

The average size of the houses in these two groups is about the same, so that the heavier unit consumption under the Point Five tariff is in no way attributable to larger houses.

Diversity Factor.—The following table shows the effect of the Point Five tariff upon the diversity factor, the periods being "A," just before the introduction of the tariff, viz., December, 1911, and "B," December, 1914, and the maximum load figures being taken at the time of the peak load at the low tension bus-bar.

	Maximum load on L.T. feeders for residential areas only	Total kw installed in private houses.	Diversity factor.
"A"	141 kw.	461 kw.	3·25
"B"	227 kw.	1,152 kw.	5·00

It will be noted that the results shown in the two foregoing tables as between the 3·6d. and the Point Five tariff, and as between the periods "A" and "B" are very considerable, and as touching the current selling propensities of heating and cooking apparatus it will be useful to point out that these results have been obtained by the following consuming devices:—

"A" 161 kw. installed upon consumers' premises, almost exclusively for lighting...Average per consumer = 1·36 kw.

"B" { 650 kw. installed upon consumers' premises for lighting.....Average per consumer = 1·30 kw.
{ 502 kw. installed upon consumers' premises for heating and cooking.....Average per consumer = 1·009 kw.

The report is followed by tabulated statements of procedure and results at some of the Point Five undertakings. From these tables, which are distinctly valuable, the following points may be noted:—

In regard to the fixed charge on a rateable value basis, this varies from 10 per cent. up to 15 per cent. At Blackpool it is 12½ per cent., but houses rated at over £100 are charged at 10 per cent. In Sunderland, on the other hand, the percentage starts at 10 per cent. and if the rateable value is over £70 it rises to 15. Out of 17 Point Five undertakings, five are inclined to make reductions in the primary charge for consumers having gardens, and two of them actually do so. Some figures are given in regard to load factors of consumers, but such information is refused by St. Marylebone on the ground that it can only be misleading owing to the varying nature of the apparatus installed. Out of 15 undertakings replying, six have the advantage of hiring powers, namely, Carlisle, St. Marylebone, Southampton, West Ham, Wolverhampton and York. The effect is shown in the units sold and revenue secured. Practically no difficulties are reported due to increased load on mains through heating and cooking except at West Ham, and to a small extent at Wrexham. In reply to a question as to the percentage charged for rental of heating and cooking apparatus, the replies show that Carlisle charges 20 per cent. on capital cost per annum for both, St. Marylebone 30 to 35 per cent. on cooking apparatus, and about 50 per cent. on heating apparatus, Southampton 25 per cent. on both, West Ham 20 per cent. on both, Wolverhampton 15 per cent. on both, and York 10 per cent. on cooking apparatus and 25 per cent. on heating apparatus.

We give an account of the discussion on this report on a later page.

In the afternoon the following report on Electric Vehicles was read and discussed:—

THE USE OF ELECTRIC VEHICLES IN MUNICIPAL SERVICE.*

BY F. AYTON.

The electric battery vehicle is eminently fitted for employment in practically all cases of municipal service, since the work to be done lies almost entirely within the proper sphere of this type of vehicle, namely, short-distance haulage at moderate speeds. The mileage capacity for charge is sufficient for almost every duty which the municipal vehicle has to perform, and, moreover, it can easily be increased by means of a high rate boost taken during the day. The main reason for urging the adoption of electric vehicles by municipalities is the degree of economy which attends their use in substitution for horse haulage. There is plenty of evidence of this statement in the experience of municipalities in this country. In Glasgow the first electric van employed which was of one ton capacity did the work of two horses with saving expense and greater efficiency, while compared with a petrol van previously employed the saving of about £240 per annum was effected. The durability of the electric vehicle is another feature in its favour and experience in the United States has shown that 10 years at least can be obtained from an electric. The reliability is such that the average working days of the year for an electric is about 97 to 98 per cent. of the maximum possible. Apart from economy a municipality should not lose sight of the influence that the use of the electric may have upon the health of the population and the amenities of the locality. An immense improvement could be effected in any city if every self-propelled vehicle were of the electric battery type. For those municipalities that own electricity supply undertakings there is the further and very pertinent reason for urging the development of the electric in that the general use of electric vehicles will add greatly to the revenue of the electricity undertaking. The electricity department should employ every possible means to build up the electric vehicle business, and to do this every possible use of the electric in municipal service must be made. An undertaking that wishes to develop its business but yet employs a horse or haulage or petrol motor transport for its own work

* Abstract of a report by the Electric Vehicle Committee of the I.M.E.A.

is on a par with an electric supply undertaking that lights its generating station and offices with gas. Apart from the economical and advertising value of the electric vehicle there are many special advantages obtained by employing the electric. For breakdown work it is invaluable as it is ready to go out at a moment's notice, and it is so simple to drive that almost anyone can take it out. The permanent driver can be a mere youth and this has the advantage that it attests the ease and simplicity of the control.

Delivery vans are now in use or on order by the electric supply departments at Glasgow, Edinburgh, Derby, West Ham, Croydon, Blackburn, Bootle, Hereford, Ipswich, Grimsby, Brighton, Wolverhampton, Southampton, Liverpool and the Borough Councils of St. Marylebone, Stepney and Poplar. The van at Glasgow is a covered one of 1-ton capacity, fitted with an Edison battery. The vehicle has been in constant use since Aug. 6, 1913, and up to April 28, 1915, had covered a total mileage of 22,284 with an energy consumption of 13,752 units, including battery losses, which is equivalent to 0·62 unit per vehicle-mile. New tyres have recently been fitted in substitution for a set which had done over 11,000 miles. The van being to some extent an experimental vehicle, the cost of maintenance and repairs includes some items which are really improvements. The results obtained with this van, in the way of economy and reliability, were so convincing that the department had no hesitation in taking a further step in the general adoption of electric vehicles by placing an order for three more vehicles of ½, 1½, and 3 tons' capacity respectively, which have now been delivered and will shortly be at work.

The vehicle at Brighton is a two-seater car used by the engineer and manager of the electric supply department for business purposes, including journeys to the power station, a little over 4 miles outside Brighton. Its speed is about 16 miles per hour on the level; weight 22¼ cwt., average daily mileage 25; while the energy consumption is about 0·5 unit per mile. At 1d. per unit this is only about ½d. per mile. The vehicle has run close on 1,000 miles at the time of writing, and, so far, beyond the cost of cleaning, it has cost nothing for maintenance, the tyres showing little or no signs of wear. The battery is of Tudor make.

The West Hartlepool supply department has a vehicle for carrying [illegible] and has used it for general carrying work. It was put into service on Nov. 21, 1914, and up to [illegible] 1,788 miles with a consumption of electric [illegible] per mile. The cost per unit is ½d. per [illegible] per mile. The battery is an A 6 [illegible].

The Wandsworth electric supply department has one of the [illegible] equipped with Edison batteries. It is used for the purpose of [illegible] and has run about 240 cwts. for a total of [illegible] miles per fortnight, or about 10 miles per day. Up to the end of April the mileage had been about 3,000, and the [illegible] of running is [illegible] per mile, exclusive of [illegible] and [illegible].

The vehicle belonging to the Croydon supply department is a two-seated runabout fitted with an Edison battery. There is a third seat which may be used if required. The car is used by both the distributing engineer and the sales superintendent, and during the five months in which it has been in use it has given no trouble; the expenditure in repairs and general upkeep has been nil. The total mileage covered in this period has been 2,156 or an average of 24 miles per day. The borough electrical engineer, Mr. A. C. Cramb, gives the following interesting figures as to the cost of operation, the cost of tyres being based upon the assumption that an average of 5,000 miles will be obtained before they require renewal, there being ample justification for this assumption in view of the very small wear so far observable.

Running costs.	Total cost.	Pence per mile.
Electric energy at 1d. per unit	£4 11 8	0·510
Oil and grease	0 1 5	0·007
Washing, cleaning, &c.	3 10 0	0·388
Tyres (£35 per set for 5,000 miles)	15 0 0	1·660
Total running costs	...	2·565d.
Depreciation—		
Battery (five years)	14 8 4	1·600
Vehicle (10 years)	14 13 4	1·620
Total fixed charges	...	3·220d.

Total cost per mile=5·785d.

The daily mileage is, of course, somewhat low for such a car, being equivalent to a little over 5,000 miles per annum. A total of 10,000 miles per annum is frequently covered by petrol cars used for "about town" work; on such a mileage the total cost per mile would be reduced to 4·175d.



Fig. 1.—An Electric Tractor hauling Special Wagon carrying Refuse in the service of a Municipality on the Continent.

Besides their use for delivering goods, answering "breakdown" calls and carrying the supervising officials about from place to place on the outside work, there are other ways in which the electric vehicle may be made use of in the service of electric supply undertakings. They may be fitted with motor-driven winch gear for use in drawing cables into underground conduits, an electrically operated pump may be fitted for clearing water from manholes, while a telescopic tower ladder can be provided for trimming arc lamps and for overhead work generally. Where a motor winch is provided, the addition of a simple derrick enables the vehicle to be employed in the erection of street lamps and trolley posts. Where the generating station is not provided with rail or water facilities for the direct delivery of coal, so that the latter has to be carted from the railway depot or from a wharf, an electric wagon of suitable capacity should soon pay for itself. The same vehicle could be used for carting away ash and clinker. Considerable use is made of electric vehicles for these purposes in the United States.

In demonstration work connected with the obtaining of new business, the electric vehicle promises to be a useful aid because of

the supply of electric energy which it carries with it. By the aid of a flexible cable carried through the front window of the house, from the vehicle standing outside in the roadway, the canvasser will be able to demonstrate before the housewife at home the transcendant utility of the electric iron, the labour-saving and, no less, the hygienic value of the vacuum cleaner, the comfort and cleanliness of the electric fire, the refreshing breezes of the electric fan, the convenience of the electric kettle and the smaller pieces of cooking apparatus, while last, but not least, he will be able to show that electric light is next in quality to daylight.

The Collection of House Refuse.

The collection of house refuse is work which is particularly trying for the ordinary steam or petrol-motor vehicle, on account of the many stops and starts. The well-known advantages of the electric for this class of work are dealt with, the chief points mentioned being easiness of starting and stopping and the absence of any waste of power during stops. It should be obvious that in the replacement of horse-drawn vans or carts by motor vehicles, the latter will show the best results where the refuse destructor is at a distance from the area of collection, the saving, of course, being in the higher speed at which the motor vehicle can traverse this distance, and its greater carrying capacity. It is quite possible, on this account, that, in some towns, the best economy might be obtainable by a combination of ordinary horse-drawn vehicles for the districts in propinquity to the destructor, with the use of electric vans for the districts further away. Possibly in the latter districts, also, the local collection could be best done by horse vehicles conveying the material to a central



Fig. 2.—Special Small Refuse Van with tip body.

depot from whence it would be transported to the refuse destroyer by large electric vehicles. An arrangement of this latter sort has been in successful operation in a large Continental city for some time. The horse carts are provided with removable box bodies, so that when the cart arrives at the depot, the body is lifted off it by an electric crane, and placed upon the flat platform of a large electric vehicle which, when it has received its full complement of these full boxes, proceeds on its journey to the destructor. In the meanwhile empty box bodies are placed upon the tumbrils which once more proceed upon their rounds of collection.

An alternative method to that described above is the employment for local house-to-house collection of a special type of small electric vehicle with tipping box body. In this machine, which has the advantage of possessing a low body, there is no seat for the driver; the latter stands upon a driving platform a few inches from the ground. The saving of time in getting on and off the vehicle, when compared with the ordinary type of vehicle, is obvious. For districts some distance from the destructor these small wagons could tip into a hopper, at a district depot, from which large capacity electric vehicles could be loaded for transit to the destructor, or the small vehicles could have removable bodies which could, by means of a crane at the district depot, be placed [illegible] on a large vehicle for the same purpose.

Electric vehicles have been employed to a considerable extent on the Continent for refuse collection. The largest installation is in Paris, where the municipality possesses a fleet of 100 electric refuse collecting vehicles. The total load of the full vehicle is not less than 5 tons. The vehicles perform their work during the night hours, each covering about 25 miles nightly, with an average consumption per vehicle-mile of from 1·5 to 1·7 units. This system of collection was adopted as the result of a very careful trial made by the civic authorities which showed that considerable economy would be obtainable by the use of electric vehicles.

Reference is made to the reports of trials made to the Barnes and the Heston and Isleworth District Councils for vehicles for refuse collection, in both of which cases the result was the purchase of of electric vans.

Ambulance Work.

By reason of its smooth and silent running, the uniform and jerkless accelleration, the electric is an ideal vehicle for ambulance work in our towns and cities. It has for some time been employed for this purpose by the City of London Corporation, by the Port of London Authority and the Metropolitan Asylums Board. While the advantages just now mentioned are all important ones for this sort of work, the feature of economy should not be forgotten; while the promptitude with which calls may be answered is just as valuable an attribute as in the case of fire brigade service. The simplicity of operation also enables several ordinary attendants to be trained to drive, so that a call may never find the van in want of a driver.

In regard to the City Police Ambulances the electric motor ambulance service was commenced in May, 1907, with one electric ambulance. In May, 1909, a second ambulance was obtained, and both have since proved very satisfactory indeed for removing cases of accident or illness in the streets to hospitals. The initial cost of the ambulances, with surgical fittings, was, approximately, £569 and £552 respectively, and the total cost of the service is, approximately £2,000 per annum. The cost of working is about 5·1d. per car-mile, including expenses such as tyres, necessary repairs to cars, charging of batteries, &c., but excluding wages and rent. Tyre costs account for about 2¼d. in the cost mentioned per mile.

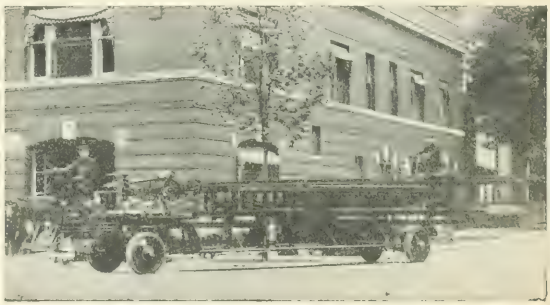


Fig. 3.—Electric Fire Escape Vehicle with steering at each end, in use in an American City.

The Port of London Authority possesses four electric motor ambulances, and these have been in use since September, 1912.

Electric ambulances are also in use in the United States. The New York Hospital, for example, has seven such vehicles.

Fire Brigade Work.

Electric battery vehicles have been in use to a considerable extent for fire brigade work. Notable examples of their use are to be found in London and Liverpool; while, up to the outbreak of war, they were known to be employed in several Continental cities, one having no less than 24 in use. Several towns and cities in the United States employ electrically-propelled fire engines and escapes, and there can be but little doubt that electric battery traction offers special advantages for fire brigade work, which may be summarised as follows:

Ease of Operation and Promptness of Action.—Unlike the petrol driven type, there is no preliminary starting of the engine before the vehicle itself can be got on to the move. All that is necessary with the electrically-driven type is for the driver to get on the seat, throw off his brake, move the controller and the vehicle is under way. That the latter secures a promptness in answering calls is fully confirmed by the experience of the London Fire Brigade, which possesses a total of 15 electrically propelled vehicles, the latter having been put into commission in 1911.

The Liverpool Brigade has had four electric vehicles in use since 1907 [illegible] a period of some eight years. Three of them weigh about 6 tons, while the fourth scales 2½ tons; all four have a speed of 20 miles per hour on the level, and a mileage capacity on one charge of 30. Mr. Alex. W. Weir, the Chief Superintendent of the Brigade, writes

in regard to these vehicles: "They have given every satisfaction, and are inexpensive to run, the cost working out at 2½d. per mile. The main features which commend this class of machine for fire brigade work are the practically instantaneous starting; rareness of failure on the road; the ease with which defects may be remedied in consequence of the fewness of the working parts; the ease with which the vehicle may be driven, and the short time in which a man can be taught to drive."

Statements made by the engineers of fire brigades in America relating to the reliability of electrically-driven engines and escapes under the most adverse conditions show that the electric is ahead of any other form of traction in this respect.

Lieutenant-Commander Sladen stated that, in the London Brigade the electrically-propelled appliances cost, on the average, about 1s. per mile to maintain, this figure not including drivers' wages, capital charges or depreciation, whereas the similar figure for the brigade's petrol vehicles is 1s. 3d. He also went on to say: "When one takes into account the first cost and the depreciation, the cost of maintenance of an electric fire escape and of a petrol fire-escape are about the same—namely, about £150 a year, allowing for interest and depreciation. The annual cost of repairs for an electric escape van that runs about 800 miles per annum is £40, that is allowing for renewals of batteries and so forth."

Further information supplied to the committee in May of this year shows that the cost of repairs to accumulators for the previous 12 months worked out at an average price of £22 per vehicle, including a complete renewal of one battery and extensive replacements to three others. As to speed, ample can be obtained; vehicles for this purpose have been built to run up to 30 miles per hour, and, as a set-off against this feature have, of course, a correspondingly smaller radius of action on one charge, usually from 30 to 35 miles. The vehicles of the London Brigade can run up to 27 miles per hour on the level, while up a gradient of 1 in 19 the speed is 15 miles per hour.

No difficulty has been experienced in converting horse-drawn steam fire engines and other fire-fighting apparatus, the application of the front wheel drive to which the electric motor so readily lends itself, making the problem quite an easy one. This method of driving is also claimed to have the further advantage of avoiding the risk of skidding to a considerable extent.

The General Work of Upkeep and Cleansing of Streets and Roadways.

The electric vehicle is in use on the Continent and in the United States in connection with street cleaning and brushing machines and for watering, one important Continental city having about 30 in use. In the city referred to, each electric watering van waters about 40,000 sq. yds. of road surface per day of eight hours, as against 30,000 yds., the best average of a horse-driven van. The saving stated to result from employing "electrics" in place of horse-drawn vans for this purpose by the municipality mentioned is about £80 per electric van per year. The electric vehicle is also employed for carrying materials used in the making and repair of roadways, and a 3-ton waggon with tipping body has just been put into service for this purpose by the Corporation of Ipswich. In reality, this waggon will be a "double-purpose machine," since the tipping body is removable, and can give place to a water-tank (which is now being constructed) to enable the vehicle to be used for street watering.

It has been suggested that an electrically-driven road roller would be an improvement upon the noisy steam roller generally in use. Although, as far as the committee's knowledge goes, no electrically-propelled rollers have yet been introduced, there appear to be obvious advantages in that method of working and no difficulties in applying it. As weight is an essential requirement, a battery of as large a capacity as necessary could be fitted.

The Tramways Department.

It is satisfactory to be able to chronicle that there are now three municipal tramway undertakings making use of the electric battery 'bus as an adjunct to their tramway services—viz., Southend-on-Sea, South Shields and York. In all three instances, it is understood that the vehicles are giving satisfaction.

The 'bus which the Southend Corporation Tramways Department [illegible] since June 26, 1914, is similar to those employed at West Hartlepool. The experience at Southend, however, is perhaps a little more valuable for the reason that other 'buses of the petrol and petrol-electric type, and of the most modern make, have also been put through the electric 'bus. As to cost of operation, after three years' trials the cost is ascertained up to date, certain items in connection with each type of vehicle which are incidental to the inception of a 'bus service, Mr. Birkett gives the actual average cost per 'bus mile (including capital charges) for each type as follows:—

Petrol	8·56d.
Petrol-electric	8·31d.
Electric	7·52d.

Mr. Birkett further points out that, in his opinion, the results would be still further in favour of the electric battery 'bus if a fleet consisted entirely of the latter. The consumption of energy on the hilly route is at the rate of 1·55 units per mile, while on a route which is more or less level, the figure comes down to 1·1. The 'bus receives a short boost while waiting at one terminus, the boosting current being about 300 amperes. The average speed including stops, is about nine miles per hour. Up to date there have been no repairs needed to the electric vehicle.

The Ilford Council Tramways Departments employ an electric tower waggon which has now been in service for over 12 months. The electric vehicle for this work possesses several special advantages.

Another use of the electric is in the emptying of cesspools where such exist. It is possible to construct an electrically propelled vacuum tank waggon—the usual capacity required is about 350 gallons—fitted with an electrically-driven air pump. As such a pump will only need some 2 H.P. to drive it, the ordinary size of battery such as fitted to a 3-ton waggon, would easily supply the energy required while the waggon is standing. The advantages would be that ordinary labourers could work the plant, the cost of working and up-keep would be small, and the plant would operate with absence of noise.

We give an account of the discussion on this report on a later page.

THE STORAGE OF COAL.

BY G. G. BELL.
(Borough Electrical Engineer, Hammersmith.)

During the last year or two the transport workers' strike, the coal miners' strike, and now the congestion of the railways and the scarcity of colliers have all emphasised the importance of large stocks of coal being maintained at the power stations if panic prices are to be avoided and continuity of the supply to be maintained. In the early days of central stations the question of coal storage was frequently entirely neglected, and, even in the case of such an important undertaking as the Manchester Corporation electricity works, the storage capacity was so limited that the author remembers in 1896 it was necessary to obtain additional barges of coal, and anchor them in the adjoining canal, in order to supply the works over the Whitsuntide holidays. Storage of coal is a very simple matter, and has been very easily solved by the railway companies, who seem to be quite satisfied with spreading the coal in shallow heaps over a large area of ground; but this cannot be an economical method, and is not at all suitable for the small coals so largely used by electricity works, and could not be adopted in most cases, due to lack of space near the works.

The great advantage that is to be obtained by burning freshly mined coal is not, perhaps, generally recognised. Nearly all coals undergo a rapid loss in calorific value during the first two or three weeks after removal from the pit, and any system of storage or bunkers which tends to delay the passage of the fresh coal to the furnaces must in itself be uneconomical. It is quite possible that on this account alone the fuel bill may be raised some 5 to 10 per cent., so that the scheme for handling the coal becomes a detail well worth careful consideration.

In connection with the Hammersmith undertaking a great deal of trouble has been experienced in the past with the coal stocks overheating, and if this were not promptly attended to active combustion would follow. The same trouble was experienced with both best Welsh free burning coal and semi-anthracite dry coal. These coals are exclusively used as a mixture for the hand-fired forced draught furnaces. Since mechanical stokers have been fitted this overheating has occurred with the small Midland coals stocked for these stokers. It evidently makes very little difference whether the coal is stored out in the open air and subject to the sun, wind and rain, or stored in bunkers under cover, as overheating has been experienced under both conditions. All the above-mentioned

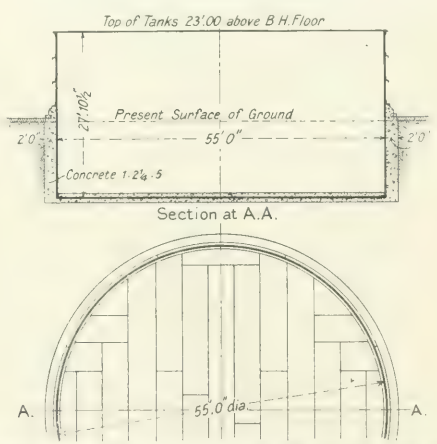
coals contain very large percentages of fine slack, which naturally offer a comparatively large area for contact with the atmospheric oxygen, much more so than the lumps of coal generally stocked by the railway companies, and this is, no doubt, the cause of the trouble. Once overheating is noticed in a coal stack it is extremely difficult to prevent combustion taking place, as no amount of water, short of actual submerging, appears to have any permanent effect, and the only procedure is to send it to the furnaces as early as possible before it is entirely ruined by active combustion. As this trouble increases with additional stock, it is evident that large masses offer much more favourable conditions for overheating and spontaneous combustion than small masses ; and in view of the necessity of very largely augmenting the coal reserves, it did not appear practical to increase the store of coal in a dry state, and the only alternative method that presented itself was to submerge the coal in large tanks constructed at the generating station. There does not appear to be any record of trouble having been experienced with coal stored under water, but there are not many examples in this country of such a method of preserving coal stocks. I believe the first example of such a coal storage tank to be put into commission in conjunction with an electric generating station is one built by the Underground Railways of London at their Lot's-road works. This store consists of a steel tank, capable of holding about 15,000 tons of coal. It can be filled and emptied by means of their existing coal handling plant, and is in addition to their large overhead bunkers forming the dry store.

Two years ago the Hammersmith Borough Council decided upon a similar scheme, but upon a more modest scale—viz., to deal with a total of 7,500 tons of coal stored in five separate tanks, each tank to deal with only 1,500 tons of coal. A single tank could not be used, as it was necessary to deal with three different classes of fuel, mechanical stokers not being yet fitted to all the boilers. To divide the storage space into several divisions is also an advantage, so far as maintenance is concerned, especially when steel plate tanks are used, as it is possible, within reasonable time, to entirely empty one tank each year for examination and anti-rust treatment without serious interference with the permanent stocks. If sufficient stock is carried for (say) four months' supply at full load, and only one tank were installed, it might take six months to empty at summer load. The details of the tank are seen in the accompanying figure. The scheme of working the tanks at Hammersmith is as follows :—

Coal will be delivered to the tanks by means of a pipe line, the coal and water being pumped in together, the surplus water being returned to the coal and water mixing tank at the riverside wharf. Three of the five tanks will be maintained at maximum capacity and held purely as coal reserves, only to be drawn upon in case of emergency. The remaining two tanks will act as acceptance tanks, and will be used for receiving from the pipe line the new coal from day to day as it is delivered at the riverside wharf by barge. When the coal has been delivered into the tanks, the level of the water in the acceptance tank will be lowered to allow the water to drain off, and in 24 hours the coal will be sufficiently dry for use. The daily coal requirements will be extracted by means of a grab worked by a jib crane, and naturally the latest deliveries will always be nearest the top of the tank, and in this way the most recently mined coal will always be delivered to the furnaces in preference to older coal, and be consumed before it has time to lose any of its calorific value. It is possible that the coal in the lower portion of each acceptance tank, amounting to about 1,000 tons, will be very seldom disturbed, as the variation of the amount of coal in the acceptance tanks will depend upon the regularity of the contract supplies.

The cost of such a scheme is necessarily heavy, as there is not only the capital expenditure on the tanks and coaling appliances, entailing heavy annual charges for interest and depreciation, but also the locking up of much working capital upon coal itself. In an ordinary business it is advisable to keep the working capital as liquid as possible, and not lock it up in large permanent stocks of one article, but a statutory electric supply authority is in a different position, and is almost compelled to maintain its supplies of energy so long as fuel is obtainable, without reference to the cost, whereas an ordinary trader is not under any such obligations. There are, however, very substantial returns to be obtained from this expenditure, and it is more than possible that the balance will be decidedly on the side of the large storage scheme. For instance, as the continuity of supply is of vital importance to any undertaking engaged in the supply of power to industrial concerns, the knowledge that very large reserves of fuel are held at the works is of very great value in obtaining and keeping consumers at, perhaps, a higher price per unit than they would otherwise be prepared to pay. Such a guarantee of continuity of supply, and the removing of this responsibility from the manufacturer to the supply undertaking, is a point that cannot be too strongly impressed upon all possible consumers, and carries great weight with them. This is proved by the many anxious inquiries that have always been made by all classes of consumers upon the outbreak of any labour trouble as to the stocks of fuel at the works, and I have not forgotten to mention the steps we are taking in this direction when negotiating the extension of electric supply contracts. Thus, increased business at an increased profit, is a substantial result of such a policy.

It is not necessary to state that with such a reserve there is any need to pay panic prices for supplies upon the outbreak of



Section and Part Plan of Coal Storage Tank designed by Mr. H. Maie, Borough Surveyor, Hammersmith.

any special labour trouble or dislocation of traffic ; such extra prices will frequently be equivalent to the interest on very large sums locked up in coal stocks.

The extra cost of a submerged storage scheme over a dry scheme is more than repaid by the maintenance of the calorific value of the coal. Coal stored in a dry state will lose as much as 10 per cent. of its value in less than 12 months, and the loss increases year by year, but at a decreasing rate, whereas tests made with submerged coal show that there is practically no difference in the calorific value after nearly 12 months in the tank.

There is very little use in storing coal unless it is in a good and proper condition when it is required for use. According to Brame, in his work on "Fuel" tests taken in Germany on some Rhur coal gave a loss for gas yield of 1 to 7 per cent. after 14 days' exposure, 3 to 12 per cent. after 150 to 180 days' exposure, and from 8 to 17 per cent. at the end of a year's exposure. Some English coal tests at the Köningsburg gas works showed a reduction of 8½ per cent. in gas yield at the end of seven months. This loss of gas with mechanical stoker coals is more serious than the loss of calorific value, as it may make the coals more difficult, if not impossible, to burn with some classes of stokers. There is also a decided loss of weight when coal is stored in the open, due to the gradual disintegration of the

surface of the lumps which is carried away by the wind as dust, or washed away by the rain, neither of which can happen when the coal is submerged. With a large reserve properly arranged, it is possible to deliver the fresh coal straight to the furnaces, and so obtain the full calorific value before some of the hydrocarbons have had time to distil off.

The arrangement of coal bunkers which has found most favour in electric generating stations up to the present is the system of overhead coal bunkers supported on stanchions above the firing space in front of the boilers. The coal is delivered to the top of the bunkers, and gradually works its way downwards as the coal below it is drawn off through the bottom valves and delivered to the stokers. The time taken by each delivery to reach the stokers may be long or short, but during the delay the coal is subjected to a certain amount of artificial heat from the boilers, and any ventilation it receives is by means of the hot air from the boiler house, such conditions being ideal for the rapid deterioration of the fuel, and it is probable that such a system is responsible for an increase of more than 5 per cent. in the fuel bill.

One very desirable result to be obtained by the general adoption of coal storage on a substantial scale by all large consumers of fuel is the steadying if not the lowering of the price of coal, as these stocks would tend continually to "bear" the coal market. Strikes, lock-outs, &c., would have to continue for a much longer period before having any effect upon the consumers, and there would be an absence of panic buying at high prices upon the outbreak of any labour trouble. It is more than probable that the high prices frequently obtained under these circumstances by the coal owners for their colliery stocks more than compensates them for the disturbance, so the present hand-to-mouth system gives them less reason to guard against such disturbances. The remedy is, therefore, to a large extent in the hands of the coal consumers.

RECENT PROGRESS OF THE ELECTRIC VEHICLE.

BY RAYMOND J. MITCHELL.

Introduction.

The record of most advances ought to be and, in fact is, in the main a history of progress in geometrical ratio, a fact which is well supported by the remarkable strides made in Great Britain by the accumulator vehicle since the official beginning of its new lease of life was inaugurated by the I.M.E.A. Convention at Kingston just two years ago. It is no exaggeration to assert that when electric automobiles were discussed at that meeting, hardly any engineers in this country realised that the electric had then definitely arrived, both technically and commercially, to a point of development which made its employment in lieu of petrol, steam, or horse traction a matter of immediate practical politics. The formation of the Electric Vehicle Committee and the energetic co-operation which ensued between that body and the commercial electrical interests has, however, borne the excellent results that can only be gained [illegible] such working in parallel. Upon a well balanced policy of open-minded yet cautious enterprise on the part of engineers in municipal and corporation services the future of the electric vehicle undoubtedly will greatly depend. It is therefore necessary for the fullest success to be attained that every atom of the technical, commercial, administrative and educational ability within the British electrical industry should be mustered and maintained on active service, until there is not a generating station in the country but what uses at least one electric for its own service, and at the same time makes the advocacy of electrics just as much a definite part of [illegible] the putting down of an electric motor on its [illegible] the supplying of energy for lighting, heating and [illegible]. The [illegible] practice does not minimise the [illegible] that in time all our [illegible] will be conducted electrically, and that even within 20 years all these transport will be handled by accumulator electrics. We ought, therefore, to take every energetic step that is possible towards a full realisation of the success which is within our reach—now! The electrical engineer has within his grasp the control and development of the two keys of civilisation, power production and transport. Let him unlock the possibilities of the road vehicle with the same energy he has shown already in so many other fields

Field of the Electric in the British Isles

Contrary to the experience of American development in the electric vehicle industry, where, for some years, the pleasure car was predominant and only lately has the commercial vehicle begun to be produced in numbers approximately equal to the output of passenger vehicles, development has, right from the start, been along utility lines in Great Britain and seems likely to be confined to that sphere for some considerable time to come.

This is quite natural when the very different conditions between America and Great Britain are taken into account. In America the electric is recognised as an ideal town passenger vehicle and employed accordingly. Its use is hardly ever contemplated for journeys of the long distance or touring type, since its limitations in this respect are quite realized, and, moreover, since the roads are generally bad outside the urban limits, automobiles are used less in proportion for touring than they are here. In England, on the contrary, we have magnificent roads and the car owner generally wants a double purpose vehicle to fulfil the functions of both a town carriage or runabout, and of a touring car. Hence, for the time being, it is the writer's opinion that enterprise in the field of the electric passenger car should be rigidly confined to the production of a vehicle intended only for town runabout service and all those lesser journeys which come within that category.

For this reason also discussions as to battery interchange stations and various devices for popularising touring by electric cars are not worth serious attention.

The logically justifiable field of the commercial electric, on the contrary, is an enormous one, including as it does, an immense variety of trades, industries and commercial activities generally.

Broadly, the uses of the industrial electric may be classified under the following principal headings :—

1. Public service 'buses, including hotel 'buses and the like.
2. Delivery vans from $\frac{1}{2}$ ton to $1\frac{1}{2}$ tons loading capacity.
3. Heavy lorries from 2 tons to 6 tons capacity,
4. Various special vehicles, such as tower wagons, dust carts, ambulances, water carts and municipal vehicles generally.

In addition to this classification there is the important function fulfilled by the industrial electric truck, a small type of vehicle designed to be operated from a standing position and run in either direction. These little machines have a short wheelbase and generally no body work beyond a flat platform, enabling them to perform valuable service on railway platforms, dock sides, in factory yards, along the floors of dock sheds, warehouses, factories and other rather congested areas, where numerous very short distance journeys are necessary, in transporting large quantities of material from point to point. In contrast to the road type of electric vehicle, these machines are spoken of as "indoor electrics," or industrial trucks.

Commercial Electrics in Actual Service.

An analysis of the figures on the lines of these presented in the last number of the "Electric Vehicle" shows that electrics are already in use to the extent of nearly 500 vehicles all told—that is, including vehicles, chiefly pleasure cars, in use before June, 1913. Assuming quite conservatively that these take an average of 20 units per diem and are in service 275 days per annum, this would entail an energy consumption of 2,750,000 units for that period, or, say, £11,400 in revenue at 1d. per unit. Although not a staggering sum for a whole industry it nevertheless indicates what a splendid source of legitimate income lies available to those energetic stations which really set out to push electrics wherever possible. Many stations in London could accommodate 100 electrics on their mains, or more if necessary.

The operative conditions involved in what we may call the renaissance of the electric are very diverse and include users amongst the following trades :—

Number of Electrics placed in Service to Date (since June, 1913).—Art, fabric and furniture, 3; bakers 2, breweries 3, bacon curers 2, co-operative societies 8, chemists 4, confectioners 3, department stores 55, distillers 1, dairies 24, dyers and cleaners 3, electric supply authorities 28, haulage contractors 6, food contractors 8, electrical manufacturers 18, grocers 2, gear cutters 1, hosiery makers 1, hospitals 7, hotels 1, municipal authorities 22, omnibus companies 20, steel makers 4, tramway departments 14, railway companies 43. Total, about 283 machines. [All put into service since June, 1913, excepting 16 'buses at Brighton, some now not regularly running.]

As will be seen, the list, though not by any means inclusive of all the trades and conditions wherein electrics are potentially useful, yet by its variety shows a promise of great events in the near future. For obviously, if one big department store chooses this system of traction and finds it satisfactory, it is only a question of time (and a short time only) before rivals in the same business follow the lead in this respect. Moreover, it is particularly noticeable as a feature of the sales progress in this field that repeat orders quickly follow the original commission to supply one trial vehicle "to see how they go." In no single instance with which the writer is acquainted during the last two years has any firm been known to place an electric



Fig. 1.—View of a 3 ton Edison Lorry used by Messrs. Wilman & Sons, Pudsey, Yorkshire.

in service and subsequently to find it wanting in any essential particular such as reliability, power up hills, mileage capacity per day and so on, and above all economy of operation. On the contrary, one discovers a quite special enthusiasm alike on the part of owners and operators at the sturdy, simple, trouble-free working of their machines under all conditions of weather and loading. When such eminent commercial concerns as Harrod's, Lyons', Liberty's, Walker's, the Great Western Dairies, B. T.-H., Hay's Wharf Cartage Company, the Midland Railway, Great Western Railway (names selected for their variety) have each and all adopted the electric vehicle on a considerable scale—having commenced in every instance with one vehicle to feel their way—little doubt can remain as to the validity of their choice as against manual, horse, steam, or petrol haulage.

Electric 'Buses.

Equally satisfactory—considering the shortness of the period of time under review—is the progress in the field of the passenger omnibus. The pioneer electric 'bus user in this country was the Southend-on-Sea Corporation, who, on the advice of Mr. R. Birkett, the borough electrical engineer, ordered a 22-passenger, single-deck Edison 'bus in the summer of 1911. The results of experience gained with this vehicle were exceedingly satisfactory and in spite of the hills and somewhat rough local roads, the 'bus ran uninterruptedly during the season and proved its ability to hold its own with petrol and petrol-electric vehicles of higher rated power. By a system of intermittent boosting from a special feeder terminating in charging leads housed within a protected pillar, it was demonstrated that in emergency a distance as great as 115 miles per working day could be achieved, and that the normal requirements of 85 miles per day were easily maintained, and at an average speed of 9 miles per hour.

The engineer of South Shields (Mr. Robson) was equally impressed with the future of the electric omnibus, and ordered two vehicles of a similar chassis type to those at Southend-on-Sea, but equipped with a special side entrance single driver-conductor type of body in order to save labour charges. Excellent service is reported of the South Shields 'buses, which have run over 20,000 miles, whilst even in the roughest weather

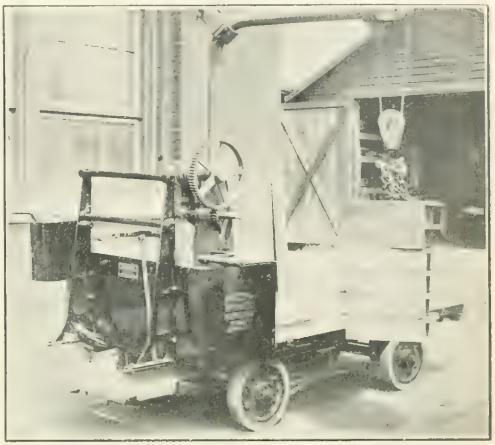


Fig. 2. View of Edison Automatic Truck with Crane attached.

of last winter, they continued to run, although on one occasion the snowfall was over 1 ft. deep. Service breakdowns have been few and not serious, and replacements confined simply to details of a minor character. The interest created by these pioneer ventures has encouraged the Corporations of York and West Bromwich each to order four similar Edison 'buses. The Loughboro Road Car Company has also decided to try electric 'buses, being convinced that "there is something in it." Others are intending to follow shortly in this field as records of operation become more generally available.

Municipal Electric Vehicles.

The abnormal rise in the cost of horses and fodder—not to mention labour—have induced many municipal bodies to

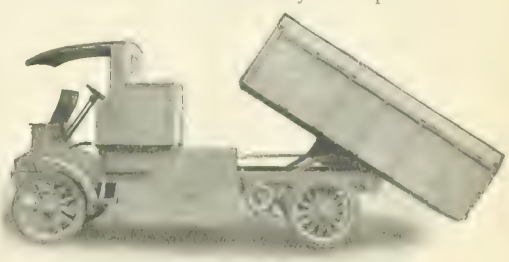


Fig. 3.—A 2 ton Edison Automatic Tip Waggon.

inquire closely into the possibilities of electrics for their work, particularly in connection with the collection of house refuse and its subsequent disposal at the destructor or tip. Many trials have been made and cost schedules worked out with a view to getting an inclusive all-in cost comparison of horses versus electrics for this work. Such experiments have been made in great detail at Barnes, and gave results which proved that one 2 ton Edison electric automatic tip waggon will

perform the work of over three horses and carts, and with a further saving of 30 per cent. in labour. An order for four electric waggons of this type from Barnes resulted on account of the evident saving able to be effected, whilst the Dover Corporation followed suit by ordering six such machines immediately afterwards. Cleansing departments all over the country are investigating this problem, and it is a safe prediction to assert that in the majority of instances the electric will ultimately displace horses or petrol vehicles. The figures in Table I. are interesting as a precis of a week's work performed in mid-winter by an Edison automatic tipping dust waggon. The road conditions were bad—that is, hilly, muddy and none too smooth.

Table I.

[illegible]	1st in 6 days
Average [illegible]	27·2
[illegible]	32
Average [illegible] collected per day	5·3
,, [illegible]	7·3
,, [illegible]	49·5 minutes
,, unloading time	10·0 ,,
,, [illegible] per day	10 hours
,, [illegible]	2·55 miles
,, [illegible] per journey	37
,, Average time for resting per day	50 minutes
Total weight collected for week	70 tons 13 cwt.
Average weight [illegible]	11 tons 15 cwt.
Total energy used for week's work	159 units
[illegible]	0·975d.

Number of horses and carts replaced, rather less than 3
Loaders' time averaged 40 hours per week actually loading
,, ,, 10 ,, road sweeping.

The operating cost of such a machine would come out somewhat as shown in Table II. Due to the small annual mileage, an effective life of 12 years might safely be counted upon. Assume a 2-ton waggon somewhat similar to the above and costing initially £955 with electric self-tipping steel body and tyres.

Table II.

	Per annum. £	Per mile. Pence.
Fixed charges.		
Depreciation at 8·33 per cent. per annum on complete vehicle, minus tyres	76·3	2·26
Interest on capital at 4 per cent. on average outstanding capital	18·2	0·54
Insurance (special policy), including third party risk	10·0	0·29
Running charges.		
Wages of [illegible] at 35s. per week	91·0	2·70
Tyres (guaranteed life of 12,000 miles)	27·0	0·80
Electrical energy at 1d. per unit and allowing a margin for contingencies	13·0	1·04
Battery (Edison) upkeep and distilled water	12·0	0·35
Repairs, replacements and chassis maintenance (not exceeding maximum over whole [illegible]	15·0	0·45
Painting, small stores, lubrication, &c., not [illegible]	7·5	0·22
License	0·25	0·07
	292·25	8·72

The cost per mile thus works out at a little short of 9d. per mile, a quite reasonable figure for such relatively short mileage. This figure is a very conservative one, and would in most cases be substantially reduced. It corresponds to a sum of 1s. 8d. per ton for the material handled, obviously a most favourable result [illegible] Lowestoft [illegible] amount [illegible] petrol [illegible] 2·[illegible] the same [illegible] costs [illegible]

Mention should be made of an interesting system of dust and refuse collection by means of electric vehicles which is the invention of Mr. W. H. L. Watson, who had occasion to [illegible] which indicated that an extraordinary difference of local conditions [illegible] which [illegible] a reasonable economy [illegible] whilst making the operations more expeditious and far less offensive to the residents along the various roads traversed.

The basis of the Watson system depends upon the employment of a series of small electric trucks, each of about 10 cwt. capacity, each being allotted a certain number of minor streets, arranged preferably so as to communicate with some main artery. By suitably arranging the work of the smaller trucks it is possible to plot a time table by which, according to arrangement, the small trucks will periodically take their gradually accumulated load to some point of meeting on the main road, where a large capacity electric truck is met. This latter machine is supplied with an automatically tipping body, operated electrically, and also with a light electric gantry jib, which lifts the body of the smaller vehicles bodily from their chassis and transfers the contents into its own dumping body. In this manner far greater mobility is assured to the collecting units, which, being small vehicles, can easily be both driven and filled by one man, whilst the total capital involved for an installation is substantially less than that required on the system of using the large type of vehicle for the whole of the system. A number of municipalities are considering the adoption of such a system.

Cost of Operation.

Since the advent of the commercial electric vehicle some hot squabbles have raged in the technical press, mainly directed by the petrol interests against the frequent assertions made by electrical engineers as to the cheapness of operation of accumulator vehicles. It will be admitted quite frankly by everyone at this stage that there must be some very well-established and basic reason for the electric vehicle movement having advanced so rapidly as has been shown, and, moreover, this reason must ultimately be a commercial one. It is superfluous to point out to the engineer that the mechanical simplicity and ruggedness of the power units and transmission of an electric vehicle, consisting as it does of details all of which have reached practical perfection, are obviously far less likely to break down under strenuous service conditions than the equivalent engine, clutch, gear box, magneto, cooling system, lubrication pump, valve gear and other rather complicated mechanism of an internal-combustion vehicle.

In addition to this technical aspect there is an economic point of view favouring the electric, on account of the much more uniform speed of this type of vehicle, for the rate of wear connected with speed of a motor vehicle is admitted roughly to follow a square law, this on account of the severe kinetic effects occasioned by the almost universal relative bumpiness of the road surfaces encountered.

The differences between maximum and average speed with an internal-combustion propelled vehicle may be very great; in fact, in the ratio of 3 to 1 in extreme cases. With an electric, however, this ratio is reduced to about 1·5 to 1, thus entailing far greater longevity of the already much simpler mechanism with which it is equipped. Hence an electric chassis, although initially considerably more costly than one propelled by petrol, has been already proved by at least 10 years' experience to be, for its own particular purpose, far longer lived, and hence a better investment. Further points conducing in the direction of lower cost of running are that tyres, on the average, give far greater mileages, and are, in fact, in one instance, guaranteed for 2,000 miles more service than is obtainable for any petrol-propelled machine. From the standpoint of fuel consumption the electric again scores, as, taking energy at 1d. per unit, it is generally possible to get 4 gross ton-miles (G.T.M.) of work from every unit of electrical energy input to the accumulator. Comparing this with petrol at, say, 1s. 6d. per gallon, and giving on an average not more than 30 ton-miles of service on such work as that for which electric vehicles are suitable, we find that 1d. gives a road service of only 1·66 gross ton-miles. Moreover, it must not be forgotten that energy is frequently available at less than 1d. per unit, and in some special instances, where firms generate their own power, the cost has, in the writer's experience, been as low as ½d. per unit. The working experience of Messrs. Liberty's may

be quoted in this connection, who found that at 1d. a unit ½-ton capacity electric vehicles cost them only 0·4 of a penny per mile to run, as against 1½d. per mile for petrol vans *doing the same delivery*. Messrs. Lyons, the well-known caterers, have a similar experience to record, to the effect that ½-ton vans averaging 220 miles per week cost for electricity 0·45d. per mile, the cost for 2-ton and 5-ton vehicles being 0·73 and 1·3d. respectively for mileages of about 200 per week. The fact that Messrs. Hay's Wharf Cartage Co., who frequently handle 1,000 tons of dock consignments in 24 hours, find



FIG. 4.—FLEET OF G.V. 2 TON ELECTRICS EMPLOYED FOR SUBURBAN SERVICE.

electric vehicles suitable for their suburban and near-country service affords an additional point as to their economy and reliability; whilst Messrs. Harrod's decision up to date to use over 50 electrics to displace their horse services shows very obviously the trend of practice in the immediate future, where the most economical system of town and suburban transport is desired. Gibes have been cast at the enthusiasm of certain promoters of electric vehicles because of their alleged inability to present "all-in" running costs applicable to average conditions. Experience shows that the element of

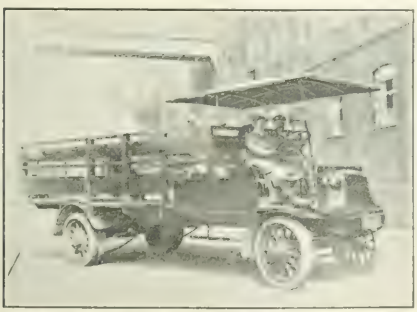


FIG. 5. A 5 TON EDISON WAGGON USED BY M[illegible] COBBOLD & CO. BREWERS, IPSWICH.

management and overhead charges is such an exceedingly diverse and variable one, whilst so seldom is it realised or known beforehand how many miles a proposed vehicle may be required to operate, that predetermination of cost of operation is almost meaningless in the majority of cases. There is, however, already an ample volume of practically ascertained data in support of all the cardinal arguments adduced by sponsors of the electrics, whilst the variety and relatively numerous character of its fields of operation created in England within the short space of two years, should afford a sufficiently convincing proof to even the most sceptical that this new type of transport has not only "arrived," but is likely to take a status of premier importance in a very few years from now. Apart from the commercial aspect, the electric has social advantages in its silence, cleanliness, mobility, small space occupied, safety and freedom from fire risk, also smoke and smell, which are by no means negligible. Numerous complaints have arisen lately as to the growing noisiness and smelliness of the streets of London. These conditions, coupled with the inevitable increased wear and tear of roads, and consequent expense and inconvenience occasioned thereby, all combine to form an extremely strong case for this newest infant of the electrical engineer's creation.

ELECTRIC VEHICLE CHARGING FACILITIES.

Perhaps the commonest objection raised against the electric vehicle is the alleged difficulty (it is even sometimes asserted as an impossibility) to obtain an adequate supply of energy for charging purposes. That this view is totally unfounded—at any rate as applying to those districts where the use of electrics could be reasonably advocated — will be self-evident from a perusal of the list of battery charging stations recently given in this journal and analysed in the "Electric Vehicle." On the whole the progress made is not unsatisfactory, there being at the present moment over 100 stations willing to charge vehicles at a rate of 1d. per unit, making no other charge for the service above that for the actual current consumed. Certain quite reasonable restrictions as to a special charge if energy be urgently required during peak-load periods are, of course, imposed in many cases. This, however, would be no serious bar from a practical standpoint, as it is generally quite



FIG. 6. AN EDISON STEEL SPRINKLER.

an easy matter for an electric to be charged in the "off-peak" night hours, taking energy in the daytime only for boosting purposes.

In addition to the stations willing to charge at 1d. per unit, about another 60 have expressed their ability and willingness to render this service on a sliding scale varying from 1½d. up to 3d. per unit. The writer feels that a reference to this subject would be incomplete if he failed to utter a protest against

a few stations, some of them well known, who are proposing to make their minimum charge 5s. for the service in question. This is an altogether unreasonable proposal, and one which will simply have the effect of driving any possibility of electric vehicle business away from that particular area. It is essential and vital that the charging question should be handled by everyone concerned in a spirit of broad optimistic enterprise. If this be done the future and commercial aspect of the question will undoubtedly take care of itself, very greatly of the advantage of those engineers who are sufficiently imaginative and long-headed to encourage—nay, welcome—this type of business. The function of the electrical engineer will, in the long run, be practically universal so far as power problems are concerned, and it is high time that the idea that electricity is only meant for lighting purposes and to be supplied in "trickles" of 3 or 4 amperes should be stamped out.

In contrast to the unprogressive attitude thus alluded to, should be mentioned such pleasing enterprise as has been shown by Mr. Ayton, at Ipswich, where an all-electric garage for 10 vehicles is being erected; also by Mr. Beauchamp, at West Ham, and Mr. Cramb at Croydon, both of whom have placed ample facilities for charging at the disposal of the casual electric vehicle caller. Many other engineers are taking similar definite and practical steps, whilst the preparation of an electric vehicle charging map, such as was issued by the "Electrical Times" some years ago, is in active contemplation, only awaiting the completion of records at present being compiled.

As mentioned, suggestions have been made as to battery interchange stations, where an electric might run in and exchange its own accumulator for one freshly charged. This is not a good idea, and would in practice be totally impracticable and altogether too expensive if organised on a really wide and complete scale. The whole tendency is, in fact, to improve accumulators so as to make them not only capable of running an average vehicle under normal conditions a sufficient number of miles per diem on a single charge for average requirements, but capable in emergency of taking in charging energy at very high rates. Some modern vehicle cells can, in fact, be boosted for short periods sufficiently quickly to add another mile to their radius capacity for every minute (up to, say, 10 minutes) the car is on [illegible].

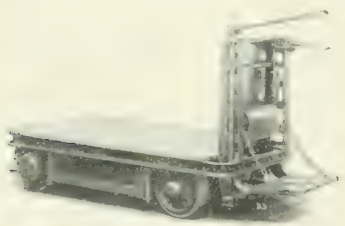


Fig. 7.—Electric Baggage Truck by the Railway Truck Supply Co.

Standardisation.

The Electric Vehicle Committee should be congratulated on the energetic manner in which they have sought to interest all concerned in the potentialities of the electric vehicle, and particularly, the writer thinks, ought their most energetic secretary, Mr. Frank Ayton, M.I.E.E., to be thanked by the whole industry for his great labours in performing the secretarial duties of such a necessarily onerous post. Although in the main the Committee's work has been along quite necessary and useful lines, it does not appear yet to be a matter of very practical politics to discuss standardisation, excepting from a [illegible] point of view. The design of electric vehicles is still in a transitional stage, and, as in other departments of engineering, it will be best to allow that individualism and interchange of ideas will [illegible] the perfect machine [illegible] and finally evolved. For example, [illegible] several worm, chain, epicyclic and variations of these systems, is now available, and each has its own peculiar advantages. No doubt, in the long run, certain types will be found best for comparatively light vehicles, whilst others of a totally enclosed design will find their best sphere of utility in the heavy class. The same remarks apply to accumulators, controllers, and in fact to all the important details of electric automobiles. The writer believes even that considerable improvements are possible in the traction motors used in this connection, particularly along the lines of attempting to design a variable-speed motor having better hill climbing characteristics than either the straight series or shunt machines possess. It is certainly useful to have standardised the charging plug, as this is an item which could cause great confusion if manufactured in many designs and sizes. The plug as recommended by the Committee is of a very sturdy design, a concentric pin plug designed to carry 150 amperes, the centre connection being negative. Suitable provision for earthing the frame of the vehicle has been made, a precaution which is undoubtedly wise.

Manufacture in Great Britain.

During the past two years five separate organisations have grown up in Great Britain for handling electric vehicles, three of which are selling vehicles made in the United States, whilst another manufactures to its own designs, and yet another is just passing through the shops its first series of chassis, designed by a Continental engineer of repute. The eminence of all these five firms in other branches of engineering is sufficient guarantee of their realisation of what an important future lies before them.

Sufficient has been said, when supported by a glance at the various types of electric vehicles already in operation and shown in the illustrations herewith, to support amply the optimism with which we may regard the future of this industry.

THE NECHELLS TEMPORARY POWER PLANT OF THE BIRMINGHAM CORPORATION.

We have from time to time recorded in our pages the developments of the Birmingham electricity undertaking, and particularly so in recent years, when it has progressed at an exceptionally rapid rate. The growth of the power load within the city limits necessitated the erection some years ago of a large central plant at Summer-lane, a point near the centre of the city, this plant exceeding in capacity anything which had previously been put down in the district. The extension in 1911 of the corporate boundary of the city beyond the limits at which it had stood for many years imposed upon the electricity department the task of still further consolidating the sources of supply and of planning a scheme of distribution for a total area of 68 sq. miles. Within this area, now known as Greater Birmingham, there are many hundreds of both large and small factories requiring electrical energy in some form or another. Consequently, the prospects of obtaining a permanent load aggregating many thousands of horse-power were in every way excellent. Mr. R. A. Chattock, the city electrical engineer, who has been responsible for a generally progressive policy in the undertaking for the past 12 years, was called upon to submit a scheme of power generation based upon an estimated growth of the demand for the electric service within the Greater Birmingham area during the next quarter of a century. Having regard to the existence within the area of three generating stations of more or less modern character, of a total capacity of 46,500 kw., Mr. Chattock advised his Committee to make plans for the erection of a 100,000 kw. station in the Nechells district, this mammoth plant to be built by degrees and linked up with the existing system. The electricity department has been progressively successful under Mr. Chattock's management, and he had no difficulty in securing the co-operation of his Committee, whose recommendations were unanimously passed by the City Council.

The preliminary work upon the Nechells station site had been

in progress some months previous to the outbreak of the war. This international calamity of war necessitated a change of plans, particularly as the financial situation required considerable adjustment. The Treasury were unable to sanction the loan for the completion of the first section of the station, but a sum of £105,000 was agreed to in respect of contracts that have been already let, and with this it will be possible to carry out the whole of the foundation work, the canal basin, cooling ponds and the steel framework of the building. The progress of the war, however, brought with it the pressing need for more munitions, and in this important respect Birmingham is contributing a considerable proportion of the national pro-

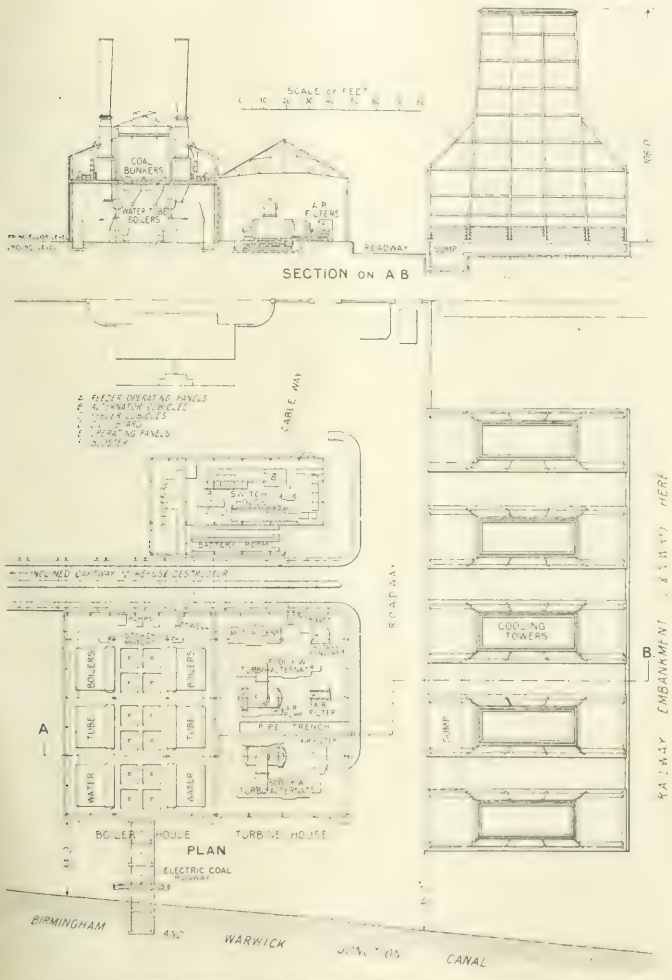


Fig. 1.—Plan and Sectional Elevation of Nechells Temporary Power Plant.

duct. It was absolutely essential that there should be no failure on the part of the Corporation to supply electric power to those firms who are under contract for the production of war material, whether of munitions or otherwise. It was also desirable to keep pace with the normal growth of the demand for electricity supply within the Greater Birmingham district, and this service could only be guaranteed by some form of extension of the existing generating plants. It was not found possible to instal additional generating machinery at any of the existing stations within the city limits, and it was decided that something would have to be done upon the Nechells site. Standing at one corner of the latter is a large destructor station which has been in operation for some years. Adjoining this was sufficient land upon which, with proper care and planning, a temporary station of considerable output might be laid down. Permission was obtained from the Treasury to borrow upwards of £100,000 for the installation of plant having a normal aggregate capacity of 10,000 kw., and after the work upon the preliminary plans had been got through and contracts let for the plant, operations were commenced on the site in February last. The anticipated growth of the demand for power supply necessitated the completion of this temporary station by the winter of 1915, and the contracts were placed with this end in view.

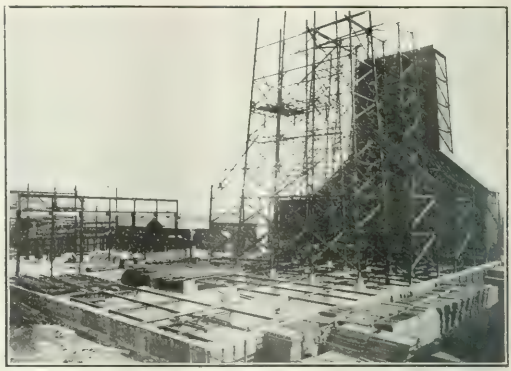
It was agreed that whatever arrangements were made the plant installed in the temporary station should be utilised in the permanent power house. The buildings also were designed for re-erection on the permanent site so far as possible. In these circumstances it was desirable to economise as much as possible upon the foundations of the temporary station, and with this object in view reinforced concrete rafts were floated over the available ground, the subsoil of which comprises 5 ft. to 7 ft. of ash which had been steadily consolidating over a period of years. These rafts are made up of steel grillages and reinforced concrete varying in depth from 1 ft. to 2 ft. 6 in., according to the nature of the load to be carried. The design is such that the weight of the steel superstructure is evenly distributed over the steel grillages. The disposition of the buildings on the site was decided by the existing roadway, which leads to the destructor. The site is bounded by the Birmingham and Warwick Junction Canal, a branch line of the L. & N.W. Railway, on a high embankment, and by the existing dust destructor. From the entrance gates a broad roadway 32 ft. wide runs as far as the canal. At right angles to this road is an inclined cartway carried on arches, which is used for the delivery of refuse to the tipping platforms of the destructor. Neither of these roads could be disturbed in any way, and their existence decided the disposition of the various sections of the plant. The boiler house and engine room have been erected on one side of the inclined roadway, and the switch house, battery room and offices on the other side; between the railway embankment and the road forming the horizontal of the T there was room to accommodate the cooling towers. The lay-out of these buildings and the ensemble of the site will be understood by reference to Fig. 1, which shows the station in plan and elevation. It will be seen that the control gear and the engine room and boiler house are connected up by a passage way which traverses one of the arches under the inclined roadway. The main cables between the generators and the switch house pass through another and shallower arch located near the foot of this roadway.

The photographs shown in Fig. 2 depict the progress of the preliminary work on the site from February 1 to May 31, 1915, and they testify to the expeditious character of the operations. A complete photographic record has been kept of the station as the work upon the site has proceeded, and it certainly shows that no time has been lost on any portion of the site.

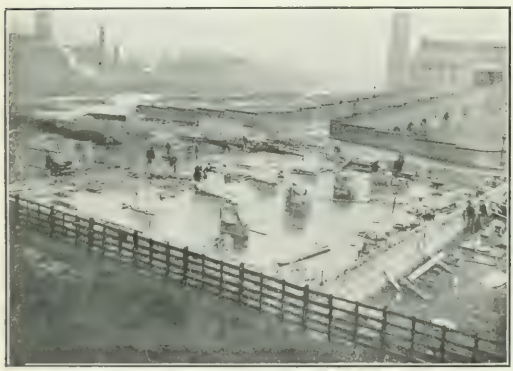
Turning, now, to the various buildings which make up the station, these consist of a steel framework covered with asbestos composition corrugated sheeting, which forms the walls and the roof. This material was used in order to save the high boilers, each having 5,336 sq. ft. heating surface. They are placed in two rows of three boilers each, with a central firing floor between. Under each boiler are two chain grates of the drop-link type, each 14 ft. long by 8 ft. wide. Integral super-



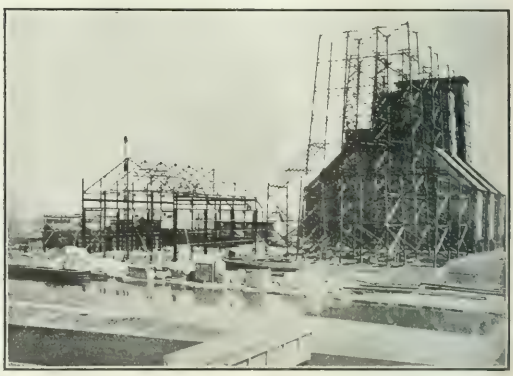
Feb. 1.



May 3



March 1.



May 25



March 20



May 31.

PHOTOGRAPHS SHOWING THE PROGRESS IN THE CONSTRUCTIONAL WORK UPON THE STATION.

engine room combined measure 89 ft. 2 in. long by 124 ft. wide, of which 65 ft. 9 in. is appurtenant to the boiler house. This latter is designed to contain six Babcock & Wilcox marine type heaters are fitted to each boiler, and these have 1,924 sq. ft. heating surface, and are designed to raise the steam temperature by 250° F. The working pressure of the boilers is 205 lb. per square inch. Carried upon transverse girders and placed

immediately over the firing floor opposite each boiler is a large coal bunker having a storage capacity of 20 tons. Above each row of bunkers is an electrically-operated telpher, which is designed to grab coal from the canal barges and run it in directly over the bunkers. The grab will pick up 10 cwt. at a time. This telpher is run out from the boiler house building over the open space between the boiler house and the canal, on a gantry which stretches well out over the canal basin. At the back of each row of boilers is a passage way in which there is a runway; the ash will be raked out from the back of the grates on to trolleys on the runway and wheeled out into the open for carting away. The upper staging of the boiler house, which supports the coal bunkers, also carries the induced draught plant. This plant has been designed by Mr. Louis Prat, and comprises four steel chimneys, each having its own fan driven by a 65 H.P. motor. Each chimney is arranged to deal with the flue gases from two boilers. Three feed-water pumps are installed at one end of the boiler house, one being a reciprocating pump of 25,000 gallons per hour capacity, and the other two steam turbine driven centrifugal pumps, each of 25,000 gallons per hour capacity. The exhaust steam from these turbines, together with that from the turbines driving the condenser auxiliaries, is turned into ejector heaters fixed in the feed-water tank, which is close to the feed pumping plant. Owing to the necessity for reducing the weight upon the foundations of the building, it was not found possible to instal any overhead economisers, but the permanent Nechells plant will include economisers, and in that station these will be mounted immediately above the boilers.

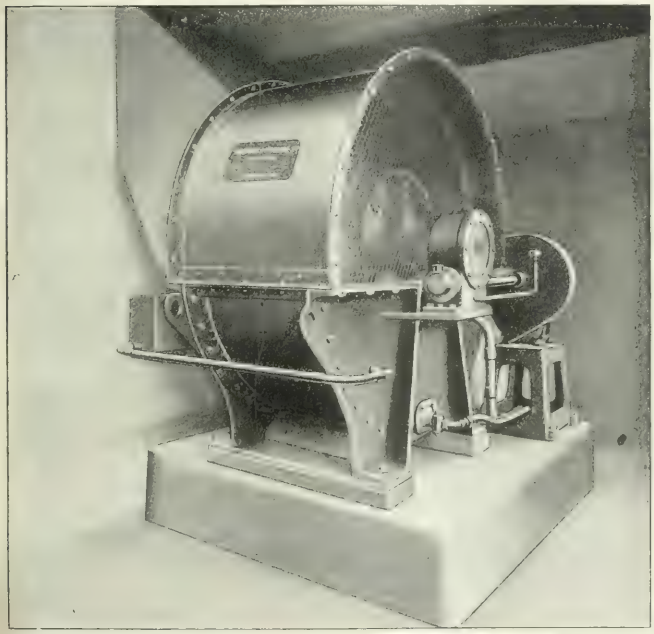


Fig 3. View of Heenan & Froude Rotary Wet Air Filter.

The engine-room plant comprises two 5,000 kw. turbo-alternators, three phase, 5,500 volts, 25 cycles. The turbines are designed for a steam pressure of 205 lb. per square inch, 250 deg. superheat and 28 in. vacuum. These machines are placed at right angles to the boiler house, and are so located that the floor space between them is occupied at the turbine end by the condensing plant and at the generator end by the air filter equipment. The condenser auxiliaries are placed 4 ft. below the normal level of the engine room. The exhaust from each turbine is taken by an overhead pipe into the condenser, and each condenser is complete with circulating pump, air and water extraction pump, these being driven by a small steam turbine of the impulse type run at 2,500 revs. per min. The exhaust from these auxiliary turbines may be utilised in a lower stage of the main turbines, or it may be turned into the ejector heaters in the feed tank for heating the feed water. Each condenser contains 14,000 sq. ft. of cooling surface, and the temperature of the circulating water inlet is 75°F. This water is cooled by means of five towers, which have been erected on a ferro-concrete raft on the opposite side of the road, which runs across the power house site. This raft forms the bottom of the cooling water pond, which is about 4 ft. deep. Each tower is capable of cooling 200,000 gallons of circulating water per hour, from 100°F. to 75°F. They are wooden structures about 100 ft. high, and each weigh approximately 114 tons. The water inlet is placed 18 ft. above the foundation, and the height of the chimneys of the coolers is 108 ft. The circulating water is drawn from a sump in the cooling pond by a pipe which passes under the roadway into the engine room. The sump in the cooling tower basin measures 56 ft. by 15 ft. by 11 ft. The circulating pumps are driven from condenser auxiliary turbines through gearing, and run at a speed of 525 revs. per min. They pump the water through the condensers, and through a system of overhead piping to the cooling towers. Each of the turbo-alternators is capable of delivering 6,250 kw. on overload, and the machines are cooled by modern patterns of wet air filters. One of these is of the rotary type, and is capable of dealing with 25,000 cubic ft. of air per minute, offering a resistance of 0·4 in. to 0·45 in. water gauge. The rotating member of the filter is driven by a 1 H.P. motor, which is placed on a small stool and which drives through suitable spur and worm gearing, which runs in oil in a totally enclosed case.

An illustration of a filter of this pattern is shown in Fig. 3. The other filter is of the mist type, and deals with a similar quantity of air. The water supply to the sprays for producing the mist in the latter filter is delivered to the apparatus by a 4 H.P. motor-driven centrifugal pump. The alternators run at 1,500 revs. per min., and have a normal capacity of 5,000 kw. and a kilovolt-ampere capacity of 7,500. Exciting current is supplied by small direct-current generators placed at each end of the generator shafts. Each alternator can be operated in conjunction with reactance coils having a voltage across terminals approximately 5 per cent. of the normal star voltage of the alternator. These reactances, which are located in one corner of the switch house, consist of three single-phase choke coils per machine of the oil-insulated self-cooled type, with outer construction similar to that of a shell-type transformer.

The engine room is spanned by a 17-ton crane, this being the maximum capacity of crane which could be installed commensurate with the design of the steel structure of the building. It is of the hand-operated type, and is suitable for lifting the lighter generating plant. All the heavier pieces will be worked into position by hydraulic jacks. The natural lighting of the engine room is obtained from roof skylights, and the artificial lighting is by a number of half-watt lamps. On the side of the engine room nearest the inclined cartway a motor-generator and a rotary converter have been put down for the supply of direct current required for driving the induced draught fans, the coal-handling telphers and the stoker motors, also the lighting of the station and the charging of the auxiliary battery.

As has already been explained, the three-phase cables and the exciter leads from the generators are taken through one of the arches near the foot of the inclined roadway into the switch house. This latter forms an independent structure on the opposite side of the inclined cartway from the boiler and engine room. The building is of light steel construction carried on a reinforced concrete raft. The disposition of the reactances, switchgear, battery and offices will be noted from the plan view. The switchgear, which is of the remote-control pattern, is of standard cellular construction. There is only one set of bus bars, as the station is never divided up in any way. Motor-operated oil switches are used on the generator circuits, and solenoid operated switches are used for the two trunk feeders and the six ring main feeders; the former are of 300 amperes capacity and the latter of 200 amperes capacity. Standard synchronising apparatus and modern type engine-room indicators are installed. The switch structure is made up of moulded stone cubicles provided with steel doors, and the operating panels, which are of enamelled slate, are placed in a separate portion of the switch house. The battery supplies energy for the trip circuits of the switchgear, and it also serves as a stand-by for the lighting of the station. One end of the switch building is divided up into offices for the resident engineer, the shift engineers and a workman's messroom, together with the necessary lavatory accommodation.

The principal contractors for the installation are given in the following list:—

Coal-handling telpher ...	Herbert Morris (Ltd.), Loughborough.
Boilers and chain-grate stokers	Babcock & Wilcox, London.
Structural steelwork, coal bunkers, &c.	E. C. and J. Keay (Ltd.), Darlaston.
Feed pumps	Clarke, Chapman & Co., Gateshead, and Worthington Pump Co., London.
Ejector heaters.....	Holden & Brooke, Manchester.
Turbines, generators and condensers	British Westinghouse Electric & Mfg. Co., Trafford Park.
Wet air filters	Sturtevant Engineering Co., London, and Heenan & Froude, Worcester.
Pipe work	Foster Bros. (Ltd.), Wednesbury.
Switchgear	B.T.-H. Co., Rugby.
Cooling towers	Davenport Engineering Co., Bradford.
Foundation work	J. J. Shardlow, Leicester.
Walls and roofing.....	Thompson & Hughes-Jones, London.

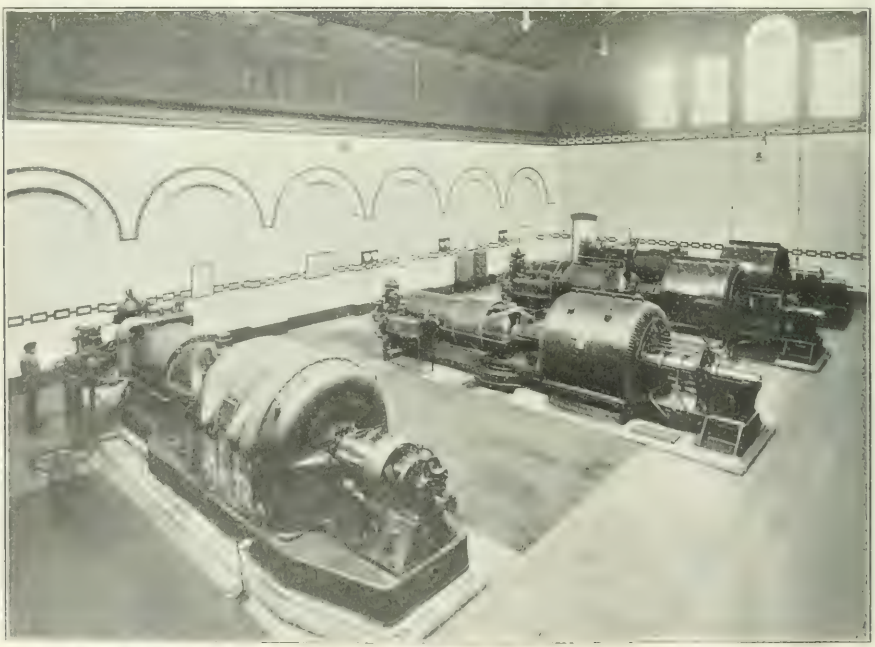
As previously stated, it is anticipated that the station will be in service on October 1st next, and, should this date be worked to, the plant will have been erected and put into commission in the record time of eight months.

We are indebted to Mr. R. A. Chattock, the city electrical engineer, for his courtesy in showing us over the plant, and also to his constructional engineer, Mr. L. S. Carr, for the supply of the drawings and data upon which the foregoing article is based.

THE DEVELOPMENT OF THE DERBY ELECTRICITY UNDERTAKING.

The electricity undertaking of the Derby Corporation dates back to the year 1894, when a single-phase supply, one of the earliest in the country, was put down, with that array of diminutive and inefficient units which were so fashionable in

In 1904, when an extensive tramway system was laid down in the town and outskirts, advantage was taken of the opportunity to lay a three-wire direct-current network in the main shopping area. The plant laid down for the dual purpose consisted of four Parsons direct-current sets, one of 500 kw. and three of 300 kw. Owing to the extremely rapid rise in the demand for energy for all purposes a new station became necessary, and the first instalment, consisting of three 750 kw. Parsons



[illegible] Derby. Another Unit has been added since this View was taken.

direct-current sets, which could be used both for lighting and traction purposes, was put into commission in 1908. The steam raising plant consisted of three Babcock & Wilcox boilers, each of 24,000 lb. capacity. It was still found necessary, however, to operate the original station for the single-phase supply, and a reconstruction was recently decided upon, which would permit of the shutting down of the old station for the greater portion of the year. The Committee have accordingly installed two 2,500 k.v.a. Parsons turbo-alternators and two additional boilers. These units are designed to run at 3,000 revolutions, and are of the impulse reaction type. The steam consumption at full-load is 14 lb. per kilowatt-hour. Parsons surface condensers are used, and each plant is fitted with a Lea water recorder for continuous observation of the efficiency. The condensing water for the station, which is drawn from the River Derwent, passes through two Brackett revolving screens, which, we understand, have given every satisfaction. The alternators are three-phase 50 periods 6,600 volts.

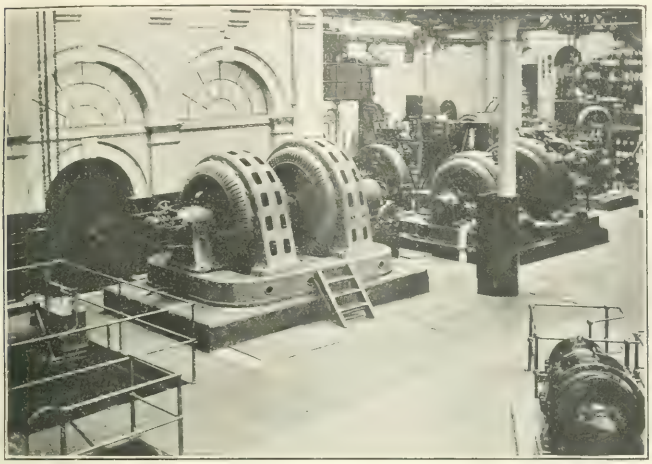


Fig. 2.—Motor Generator and Rotary Plant in Old Station, Derby.



Fig. 3. The Kitchen attached to the Showroom of the Derby Electricity Department.

A B.T.H. rotary converter of 500 kw. to deal with the traction load, and two 750 k.w. motor-alternator sets have been put down in the old engine room, the latter to provide the single-phase demand, which is still of considerable proportions. One of these motor-alternators was made by Newton Bros., of Derby, and the other by the General Electric Co.; this latter machine is being fitted with a Kapp phase advancer to bring the power-factor up to unity. The three-wire direct-current switchgear was supplied by the Electric Construction Co., and the extra-high-tension gear by the British Thomson-Houston Company. All main oil switches are of a standard size, guaranteed to break a load of 12,000 kw. continuously. There are also two B.T.H. rotary converters, which are now used as a stand-by, but which have been run inverted—*i.e.*, direct current to three-phase—for the last three years.

These extensions have only been in use for a few months past, but the economy resulting therefrom has, we gather, already been most marked. For instance, while about a million additional units have been sold, the coal consumption shows a decrease of 1,500 tons. The total capacity of the two stations is now about 9,500 kw., and the present site will provide ample room for more than double the plant installed. The distribution system is an extensive one, measuring some nine miles across. The supply to all residential outskirts is single-phase two-wire 200 volts, and to one large manufacturing district, the Osmaston estate, a three-phase supply at 200 volts 50 periods is given. The Derby Corporation have gone considerably outside their original area, which was that of the borough, and they now furnish energy under provisional order to the villages of Littleover, Normanton, Quarndon and Duffield, and also Kedleston Hall, the residence of Lord Scarsdale. The illustrations

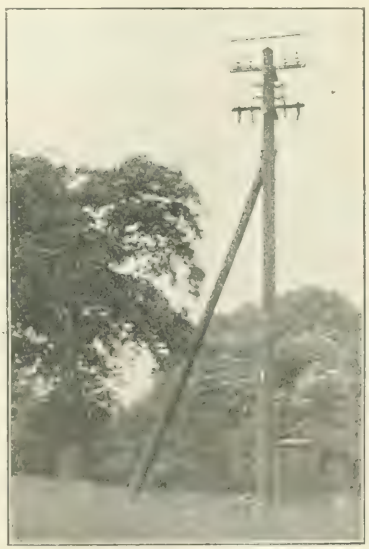


Fig. 4. [illegible]

show the single-phase transmission lines, which are operated at 4,000 volts. The lower conductor is earthed at one point—namely, at the [illegible] sub-station.

(*Concluded on page 396.*)

The Electrician.

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In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY NOON, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Advertisements of all kinds of which no proofs are required before first insertion can be accepted up to FIRST POST THURSDAY MORNING.

THE POINT FIVE TARIFF.

We are among those who have always favoured the Point Five tariff for the domestic user as being a simple tariff which would lead to satisfactory expansion in this direction of electricity supply. We are aware that it has been severely criticised, but in our opinion it is being fully justified. Undoubtedly, the advantages of such a tariff are many. First of all, it is essentially simple for the consumer. Again, an error in computing the energy that is taken by a consumer will not make a great difference in the total sum paid for light (owing to the influence of the fixed charge), and an error in metering, for the same reason, is not so important. With a heating and cooking load, however, the fixed charge has less effect. Further, this tariff leads to the extension of lighting, the tendency being to illuminate the whole of the house instead of only the more important parts, lamps of higher candle-power also being used; and consumers become less careful in switching off the light, so that the load factor becomes higher. These remarks refer to a purely lighting load.

All these advantages, and much more besides, are set forth the report by Messrs. A. S. Blackman and T. Roles on the "Practical Result of the Point Five Tariff," which report was presented on behalf of the Point Five Association and was read before the Incorporated Municipal Electrical Association yesterday. As it happens, neither Bradford nor Sunderland, the undertakings for which the authors are respectively responsible, is a good example for showing to the full the great advantages of the Point Five tariff, for the simple reason that in neither of these towns has a great point been made of electric heating and cooking, and neither undertaking has the advantage of hiring powers. The report, therefore, is largely a consideration of the Point Five tariff as compared with the flat rate tariff for lighting only. Merely in its restricted operation in this direction the Point Five tariff has points in its favour, but in our opinion the really serious advantages are in connection with the develop-

ment of the heating and cooking load, and in this direction its influence is far more important than any other. Assuming however, that a sound start has been made with lighting, and that the revenue in this direction has been secured, then, provided the units for heating and cooking can be supplied at a flat rate of 0·5d., all must be well.

In the figures given for Bradford it is rather surprising to note, in one of the tables, that the revenue per house under the Point Five tariff is less than the revenue under the flat rate, having regard to the fact that the fixed charge was put at such a value as to make the revenue approximately equal under the conditions then existing. We can only conclude that the difference is due to the advent of metal filament lamps, because there must be something faulty if a change of this kind leads to a reduction in revenue under the conditions assumed. Moreover, contradictory figures are given elsewhere.

We also notice that figures are given for the diversity factor of domestic consumers. These figures are based upon the maximum kilowatts installed by each consumer instead of the maximum demand. We have on previous occasions pointed out that figures obtained in this way do not give the true diversity factor, and we think they can only be misleading. Moreover, there is great difficulty in knowing what apparatus consumers have on the mains to an accuracy which will permit a deduction of diversity factor to three figures. It is really not possible.

There are many interesting points set out in the report, and among these we notice that there is some tendency to permit a variation in the assessment value where this is used as a basis, in order not to penalise those householders who happen to have gardens. This is certainly a move in the right direction, and we hope it will become better recognised. As to the actual percentage that is taken on the rateable value, this varies considerably, and it is sometimes argued that it should be a higher percentage for large houses than for small, the idea being that large houses give the lower load factor. This may be so as regards light, but we do not think it is the case for other uses, and it is significant that, whereas in Sunderland the percentage increases with the size of the house, in Blackpool the percentage decreases. Evidently there are differences of opinion in this matter.

It is interesting to note the great differences between various undertakings in the number of units consumed by houses of a given rateable value. Thus, at Blackpool the number of units is about three or four times as large as at Barnes. There are a few cases where hiring powers have been obtained, and in such instances the increase in the number of units sold is very noticeable. Again, the revenue per house varies very considerably, and we notice that St. Marylebone occupies the enviable position of obtaining a yearly revenue of £36. 12s. per house, whereas York only obtains a modest £6. 6s. Mr. Seabrook evidently has a good recipe for meeting his high capital charges.

There have been not a few engineers who considered that many difficulties would crop up through the adoption of a Point Five Tariff owing to heavier mains being required to carry the resulting load. So far, however, judging by the replies received from a number of the undertakings, very little difficulty has been experienced in this direction.

In conclusion, we may say that the future of the Point Five Tariff appears in every way to be satisfactory. There may be differences of opinion as to what primary charge should be adopted, and in some undertakings it may even be felt that a secondary charge as low as 0·5d. would not be justified, or even that tariffs of this kind might be unsuitable to the needs of the locality; but such differences of opinion must always arise in these matters. On the whole, however, we feel that progress in domestic electricity supply in the near future will be made largely on the lines of the Point Five Tariff.

REVIEWS.

Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Dynamometers. By Rev. F. J. Jervis Smith, F.R.S. Edited and amplified by C. V. Boys, F.R.S. (London: Constable & Co., Ltd.) Pp. xvi.+267. 14s. net.

Wearers of the cloth manifesting an intelligent interest in engineering work are by no means uncommon, but those classed outside the ranks of amateurs—those possessing engineering instincts amplified by specialised knowledge of engineering practice and possibilities—are rare indeed. Undoubtedly the author of this book was one of the rare ones.

The author's natural aptitude for scientific investigation received considerable impetus on his appointment to the headship of the Millard Engineering Laboratory, Trinity College, Oxford. There he was in a position to conduct research and to contribute Papers upon many subjects to the Royal Society and other institutions. It would seem, however, that for quite a long time his energies were specially directed to one subject—dynamometry—so laying the foundation of this book. Owing to his decease before the completion of the manuscript, Prof. Boys' name appears on the title page as editor.

As a whole the subject is well handled. In order to show the lines along which development has proceeded quite a large portion of the book is historical and descriptive in character. The magnitude of the work, even from this standpoint, must come as a surprise to the average reader; yet on consideration, it need not occasion surprise, since all engineers are very directly concerned in the measurement of energy in some form or other.

The first three chapters are introductory, dealing with friction and planimeters. In the second chapter it seems as if no really practical end is gained by considering at length the "method of least squares"; results obtained by plotting observations on squared paper are generally more in keeping with the accuracy of the observations, whilst the time saved must be appreciable. It is doubtful whether devoting five pages to simple graphical work, presumably already well known to probable readers of this book, is justifiable; apparently it would have been better to utilise these five pages in augmenting the matter upon aeronautic dynamometers, a subject upon which no very great amount of data is readily obtainable. Three pages of printed matter, two drawings and two photographs seem somewhat insufficient for aeronautics. Also, the eight pages given to ship model dynamometry, excellent though they are, are too few to give more than a very general idea of a [illegible] branch of engineering work.

For large powers, but on power measuring machines—transmission dynamometers—came into being with the application of steam turbines to marine propulsion. A quotation is made on page 230 from the account of Mr. Denny's experiments conducted at his works and on board the "Queen Alexandra" as recorded in the "Transactions" of the Institution of Naval

Architects, 1907. The author's interpolation, in brackets, on page 205, seems to be quite wrong in deduction. It may be well to point out for the sake of future editions that reciprocating steam engines, running at 750 revs. per min., for the purpose of ship propulsion are extremely rare. The "Queen Alexandra" was the second passenger steamer fitted with Parson's steam turbines (in lieu of reciprocating engines) for propulsive work. In this chapter five forms of torsion meters are considered.

A reasonable treatment of absorption and transmission types of dynamometers using electrical and optical means to reach the end in view, as well as the usual mechanical methods, is found in the remaining chapters. One very good chapter treats of the testing of internal-combustion engines for motor car and aeroplane service, and mention is made of Lanchester's ingeneous worm-drive method. A. C.

THE DEVELOPMENT OF THE DERBY ELECTRICITY UNDERTAKING.

(*Concluded from page* 393.)

The power supply has developed most encouragingly in recent years, owing to low prices and easy hire terms for motors. The Corporation have out on hire alone over 600 motors of all sizes. The output in every direction (except street lighting)

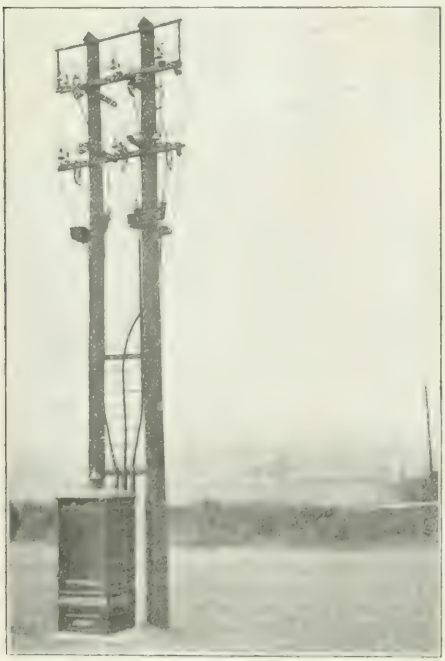


Fig. 5.—[illegible]

[illegible]

room and demonstration kitchen in London-road are centres of attraction in the town, and it is principally due to that fact that Derby has made such excellent progress in electric cooking and heating. Since the domestic consumer has the option of taking his whole supply on the rateable value basis of 10 per cent., plus a running charge of ¾d. per unit, coupled with low terms of hire for cookers and radiators, there is every encouragement for him even to be lavish in his uses of electricity.

The reconstruction scheme above described in outline has, we understand, already justified itself; the total costs (excluding capital) charges have dropped from the high figure of 0·89d. per unit sold to 0·73d. in the past nine months, and a further great improvement is anticipated in the current year, in spite of prevailing abnormal conditions.



Fig. 6.—1,000 volt Line Terminal Pole to take Cable Underground to Wood Block of Telegraph Wires.

The Corporation has also given a strong lead to the townspeople in the electric battery vehicle line. The electricity department has in daily use a 5-cwt. Mossay vehicle, and the tramways department uses an Edison electric tower waggon, while the question of electric motor buses is under consideration by the latter department.

The foregoing passes briefly in review the successive stages of the development of an interesting electricity undertaking. In great measure it serves to illustrate how, by a close study of local conditions and the character of the prospective load, a pioneer electricity works can be remodelled while yet in service, and its operating cost consequently brought down to the level of those of completely modern plants. The credit for this none too simple achievement belongs to Mr. T. P. Wilmshurst and a loyal staff. Mr. Wilmshurst's appeal for electricity supply is of that practical character which achieves results, and in thanking him for showing us his new plant and transmission line and supplying the material and illustrations for the foregoing article, we would like to compliment him upon the substantial progress which he has made since he took control of the undertaking.

ELECTRIC POWER SUPPLY IN WAR TIME.

The call for munitions has been heard and answered throughout the length and breadth of the land. If the saying is true that this is an engineers' war, electrical engineers must claim a considerable proportion of the credit, for to their efforts must be attributed the completion of much that the purely mechanical engineer has begun. We realised in the early stages of the war, that the electricity supply undertakings throughout the country, both company and municipal, would experience an exceptional demand for the electric service for power purposes to drive machinery employed in the production of war material of every description. In response to a circular letter which we sent round to a number of the principal undertakings we had replies which could leave no doubt whatever in the mind that electric power supply has been and is playing a prominent and important part in this war. While the war continues it is not possible to publish specific information on the subject. For perfectly obvious reasons such facts must not be made known, even presuming them to be available.

The provincial electricity undertakings should have a fine record at the end of the war with which to prove conclusively the argument which for years they have been advancing, that the electric motor is the ideal industrial power agent, and in areas in which many manufacturing interests are congregated there is no more economical method of driving productive machinery. Practically all the great centres of industrial and commercial activity Bristol, Birmingham, Sheffield, Manchester, Liverpool, Glasgow, Newcastle-upon-Tyne, Hull, Nottingham, Leicester and Luton are able to record the employment of electric motors to good advantage in achieving the national aim and either piling up the munitions or of equipping the armies which we are putting into the field.

In London the tale is taken up in much the same strain and the electricity departments dealing with the connecting up of motors and power services have been busier than ever they were before the war.

We are unable to go into details on this interesting matter but some idea of the extent to which electric motors have been in demand for purposes may be gathered from the records of the Stepney Borough Council electrical department which show that during March last upwards of 600 h.p. of additional electric motors were connected to the mains. Mr. W. C. P. Tapper, the borough electrical engineer, classifies the trades among which these motors were used. The bakers claim 103 h.p., the biscuit manufacturers no less than 180 h.p., clothiers 29 h.p., engineers 24 h.p., laundries 18 h.p., brewers 28 h.p., prepared food manufacturers 50 h.p., and paper board manufacturers 30 h.p., &c. The demand throughout the district has been well above normal, and the electricity department, far from being slack owing to lighting restrictions, has been exceptionally busy catering for the new power load. Of course, the whole of the demand is not attributable to war conditions, because certain trades within this district, as in other places in London and the provinces, are in a quite normal state. The area adjoining that of Stepney on the east is supplied with electrical energy by the Poplar Borough Council, the system being presided over by a progressive member of the Point Fives Association, Mr. J. Horace Bowden. At the present time the Poplar electricity undertaking enjoys the almost unique distinction of having lowered its charges for electrical energy during the war. This policy is in itself an index of the character of the demand for the service for power purposes. Mr. Bowden informs us that in spite of the somewhat severe lighting restrictions, the output is still 20 per cent. above that of the corresponding period last year. He has kindly given us a few figures which record the activities of the department during six months under war conditions, these figures being compared with those of the six months preceding the war. For the production of small arms, rifles, &c., 196 h.p. additional has been connected up. The factories engaged in this work consumed upwards of 84,000 units during six pre-war months, and 412,000 units during six war months. Clothing factories are, of course, exceptionally busy just now, a fact which the figures relating to the Poplar factories illustrates. We understand that 95 h.p. in motors have been put in and the energy consumption was 34,000 units six months before and 111,000 units during the war. Foodstuff manufacturers have added approximately a third to their energy consumption before the war, and chemical works upwards of 30 per cent. Motors have also been installed, in some cases for temporary service, to supplement or displace gas and steam engines. Woodworking shops, turning out material for huts, rifle butts, &c., show an increase of 180 h.p. Tents and tarpaulins have demanded an additional 115 h.p., saddlery 5 h.p., pontoons 25 h.p., underclothing 15 h.p., and tailoring 20 h.p. There has also been a considerable increased output to report among ship-repairing yards, box and case manufacturers, saw mills, and general engineering shops.

While the municipalities throughout the country have been exceptionally busy in giving both ordinary and emergency power supply to various industries on their districts, the com-

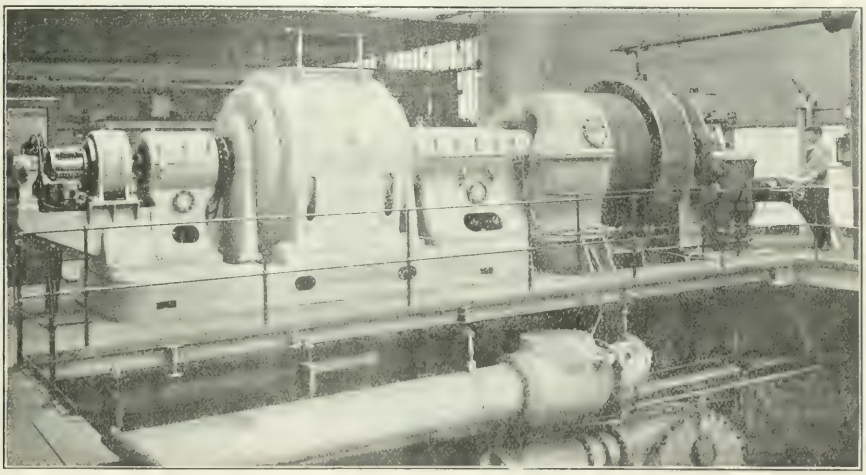


Fig. 1. General View of 5,000 kw. Vickers' Tube Alternator.

pany undertakings, both in London and the provinces, have also been contributing their share of the productive work upon war material. As in the case of the municipalities, we have experienced some little difficulty in obtaining specific information on this subject, but the experience of the Yorkshire Electric Power Co., as cited by Mr. N. B. Woodhouse, may be taken as typical. We gather from Mr. Woodhouse that the activities of the company have recently been mainly from the direction of extensions to existing power consumers on their mains, many of whom are engaged on Government work. Some of the factories have entirely changed the character of their product. The carpet manufacturer, for example, is now working day and night producing blankets and rugs. Mr. Woodhouse states

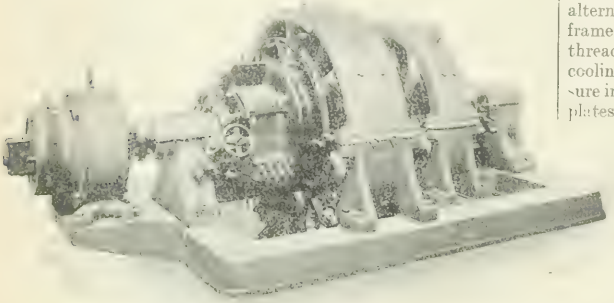


Fig. 2.—Vickers' 250 k.v.a. Rotary Converter and A.C. Booster Set.

that a number of emergency supplies have been given, notably to an explosive factory, 200 h.p., a woollen factory working on khaki cloth 50 h.p., the lighting and equipment of an alien and prisoners' camp 50 h.p., lighting of the new training camp for the Barnsley battalion 25 h.p., an engineering works producing trench pumps 150 h.p., and a chemical and explosive works 50 h.p.

A number of existing consumers have also taken advantage of the facilities which the electric service affords for extension in a rapid and economical manner. Amongst these may be cited the case of a rug manufacturer who installed 60 additional looms driven by a 40 h.p. motor and a further 60 h.p. in motors for preparing machinery such as carding and spinning. In another case woollen manufacturers built an entirely new mill, which is equipped with 500 h.p. motors. Munition bag makers installed 30 additional looms, and a silk waste preparing plant for the same, which required 60 h.p. in motors. Further, woollen manufacturers producing khaki cloth and blankets increased their 100 h.p. installation to 600 h.p., displacing a producer gas plant which had proved uneconomical and unreliable. Mr. Woodhouse states that upwards of 100 firms among the consumers of the company are engaged in the production of [illegible] shells, mines, transport material and [illegible].

In the case of [illegible] power supply there must have been [illegible] experienced not a little difficulty in collecting information [illegible] throughout the country. Messrs. Vickers [illegible] have already executed a number of orders for electrical plant directly and indirectly connected with the production of munitions of war. Their high-speed turbo-alternators have been in considerable demand, and these have ranged in output from 1,000 kw. at 3,000 revs. per min. to 5,000 kw. at 1,500 revs. per min. A number of these machines have been fitted with air filters both of the wet and dry type, these accessories being, of course, supplied by the purchaser of the generating plant. Slow-speed direct-current generators have also been delivered, and these have varied in size from about 200 kw. to 1,500 kw. Several of these are for direct coupling to steam engines of the high-speed enclosed type, and some of the larger are being gear driven from steam turbines. Illustrations of the standard pattern of Vickers' 5,000 kw. turbo-alternators are given herewith. In these machines the stator frame is of cast iron, the insulated steel stampings being threaded into it with suitable ducts arranged at intervals for the cooling air. The stampings are subjected to hydraulic pressure in batches as they are built up, and finally held between end plates secured to the frame by steel keys. The conductors are laminated copper moulded in micanite with leatheroid slot linings, and are retained in the slots by wedges. At the ends the coils are anchored to the frame to prevent movement under short circuits. The rotor is of the solid type made of Vickers' best axle oil-hardened steel, the rotor coils being of the concentric type insulated from each other and from the slots and secured by wedges. Ventilating air is forced through ducts in the rotor and stator, the arrangement being such as to ensure even cooling throughout the machine. In many cases the air filters are provided by the purchasers, but in one of the 5,000 kw. sets on order where they supply the filter, a wet-air type is being used.

Messrs. Vickers also inform us that where emergency supply of energy has been required they have furnished a number of rotary converters varying in output from 150 kw. to 500 kw. Upwards of 20 of these sets have been supplied. They are generally of the self-starting type and fitted with alternating-current boosters, where a wide range of direct-current voltage regulation is required. They have also experienced a considerable demand for direct-current and alternating-current motors of 100 h.p. and upwards. A number of these are used for driving hydraulic pumps through gearing, the pumps being used in conjunction with presses employed on munition work.



Fig. 3.—Rotor of Vickers 5,000 kw. Turbo-Alternator.

The Vickers' system of a planer drive have also been in considerable demand, and a number of orders have been executed for standard motors and equipments for the driving of planing machines used in connexion with munitions work. We gather that the work of the electrical department of the company has been taxed to its utmost to keep pace with the immediate requirements of the Admiralty for naval purposes, and the number of men employed in this connection has considerably increased since the outbreak of the war.

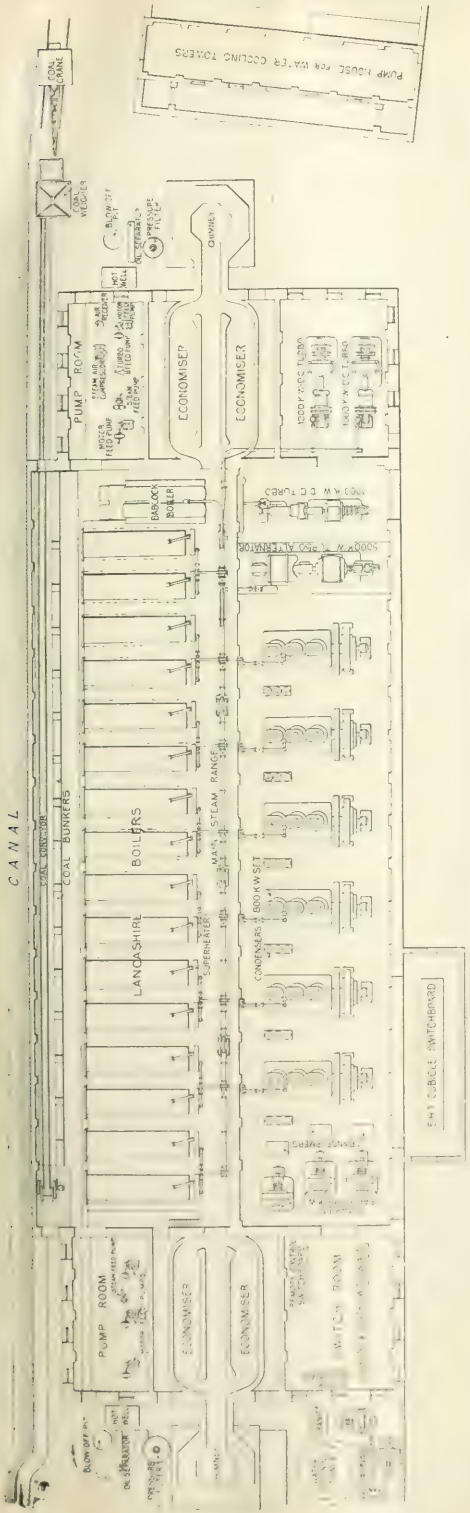


FIG. 1.—PLAN OF GENERATING STATION, SHOWING GENERAL ARRANGEMENT OF PLANT.

RECENT EXTENSION OF PLANT AT SALFORD.

The Salford electricity undertaking was one of the first single-phase installations put down in this country. The original plant was installed at a small station in Strawberry-road, and comprised a number of horizontal engines rope connected to single-phase Lowry Hall alternators. The station enjoys such distinction as may attach to the fact that the first Ferranti cellular high-tension switchboard was put in to control the supply from the machines. We do not propose to trace the development of the undertaking from these humble beginnings. At an early stage it was realised that the demand for electrical energy in the district, coupled with the fact that a comprehensive system of electric trams was being laid down by the Council, would not admit of an extension of the single-phase plant. When a direct-current station was decided upon it was built at a point some distance from the old station, and more conveniently located in respect of canal and railway facilities. At one time the engine room of the Frederick road station was considered in every way typical of good central station practice in reciprocating engines and direct coupled medium-speed multipolar generators. The march of engineering events has, however, placed the mark of antiquity

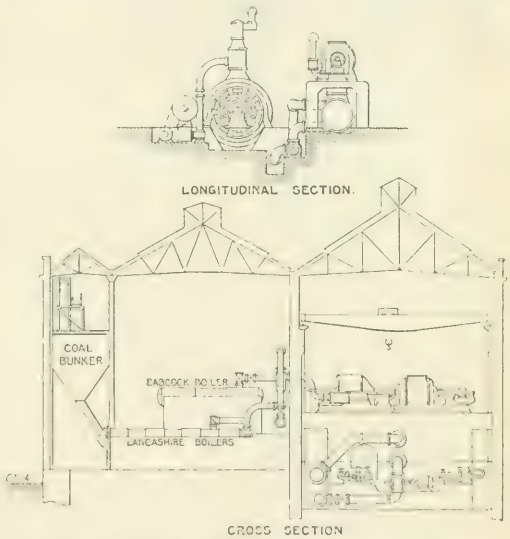


FIG. 2.—SECTIONAL VIEW OF FREDERICK ROAD STATION.

on this portion of the equipment, and the somewhat long and varied line of engineers who had charge of the plant have each had to grapple with problems of bringing it up to date. The present borough electrical engineer, Mr. J. A. Robertson, who came to Salford with an excellent record from the Greenock undertaking, was not long in discovering that it was necessary to increase the capacity of the station, and in a measure which would provide for the growth of the demand in the district for some little time to come.

In analysing the problems presented by the need for extension, Mr. Robertson was initially confronted with the difficulty of a restricted site, and the fact that all the available space was fully occupied with the eight engine sets and three direct-current turbo sets, having a total capacity of 9,400 kw. The immediate problem was to provide for the growing demand, and behind this was the question of placing the undertaking in a position to meet all future requirements. To solve the latter difficulty would require either the complete modernising and re-equipment of Frederick road works or the erection of a new station on another site.

When Mr. Robertson took control he decided that an extra high-tension system of generation should be adopted, and to meet the immediate requirements of the situation a 5,000 kw. turbo set was ordered. It was found that this set could be erected in place of one of the existing 800 kw. reciprocating units. The order was placed in June, 1914, and erection commenced at the end of August, the set being completed and finally put into commission on November 5, 1914. This probably constitutes a record for delivery and erection of a unit of this size.

The general lay-out of the entire site at Frederick-road is shown in the plant of Fig. 1. It will be noticed that at the end of the engine room, remote from the switchgear, three turbo-generators have been installed. Each of these has an output of 1,000 kw., and each is of the direct-current type. These machines were put down to supplement the early equipment of 800 kw. flywheel type units. It will be noticed from the plan that the first machine was put down at the far end of the engine room in the place of one of the 800 kw. units. The other two were installed in an extension building immediately adjoining the economiser house.

The manner in which this plant has been put down, complete with its condenser equipment, upon the same floor area as that previously occupied by one of the 800 kw. reciprocating sets, is shown in Fig. 2. In order to include the condenser upon the same floor area as the generator, the position of the latter had to be raised to the level of the gallery which extends along one side of the engine room. By adopting this course it was possible to erect a structure which contained the condenser equipment in its lower part, and which was surmounted by the turbine and alternator. The position of this unit in relation to the other portion of the plant is clearly shown on the plan in Fig. 1.

The extension unit comprises a 5,000 kw. three-phase 50-period [illegible] alternator running at 1,500 revs. per minute and having an overload capacity on emergency of [illegible]. The turbine is of the impulse type, in which the energy of the steam is converted into velocity energy in the nozzle blades, and thence into mechanical energy in the moving blades. The pressure is dealt with in a number of stages. The expansion of the steam from the boiler to the condenser is carried out in successive stages, the number of which depends upon the pressure range and relative steam and blade velocity. The longitudinal section through the turbine is shown in Fig. 3. The moving blades are shown at *aa* and the diaphragms with fixed blades or nozzles at *cc*. The nozzle blocks through which the steam is admitted are shown at *b*. There are three in number. One will pass all the steam up to half load, two up to full load, and the third is used for overloads and [illegible].

ing. Two of these nozzle blocks are arranged in such a way that they will be cut out when running on small loads for a long time. It should be noted that these operations are automatically performed by the governor. Special glands, *dd*, are provided at each end of the cylinder. The bearings *ee* are separated from the glands by small isolating chambers which divide the cylinder from bearing housings and casings in which the parts requiring lubrication are placed, and which need to be kept cool. The covers of the bearing housings can be easily and quickly removed without disturbing any other section of the machine. The spindle is maintained in its correct relation with the cylinder by registering block *f*. The main governor is driven through a worm and wheel from the main shaft. At the extreme end of the shaft is the safety governor *h*, and at the opposite end is the coupling *k*. The oil pump which delivers oil to the main bearings is driven by a vertical shaft through bevel gears from the main governor shaft. The oil from the pump is delivered direct to the cooler, whence the oil is forced through the various bearings; it returns by gravity from the bearings to the oil tank. An auxiliary oil pump is provided for purposes of starting.

The condenser, which, as has already been said, is placed immediately below the turbine, is capable of maintaining a normal vacuum of 27½ in. at full load of the machine. In connection with the condenser, two sets of air and extraction pumps are provided, each set being driven by a 35 H.P. steam turbine running at 2,500 revs. per min. One only of these sets of pumps is capable of doing the entire work. The circulation pump is independently driven by a 50 H.P. 475 revs. per min. motor.

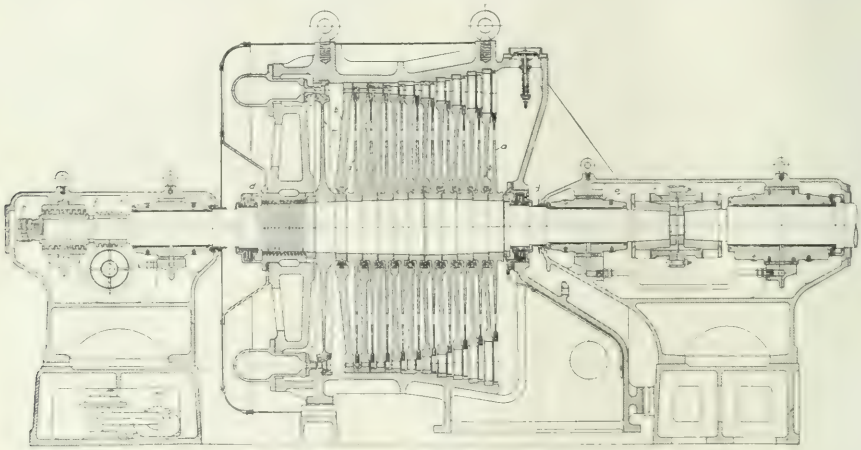


Fig. 3.—Sectional View of 5,000 kw. Turbine.

Fig. 4 is a general view of the alternator, which is of the compensated type, the end connections of the stator being strongly braced to withstand the very considerable mechanical stresses which are set up on excessive overloads or short-circuits. The exciting current from these machines is provided by a small direct-current generator direct connected to the alternator shaft. The alternator is cooled by air, which is drawn into the machine by two fans, one at each end of the rotor body. Thus, air enters the base of the machine through a cloth filter, and the intake is located outside the wall of the building, so that cool air is always being drawn into the machine.

As already explained, the site of the Frederick road station is conveniently adjacent to canal and railway facilities for the transport of coal. The latter is principally water borne, and reaches the station in barges having a capacity of 18 tons. It is raised from the canal level to overhead bunkers by continuous bucket conveyors. The hopper which feeds the conveyor is supplied by an overhead electric jib crane. The coal bunkers have an approximate capacity of 600 tons. The

steam-raising equipment comprises 16 Lancashire boilers, 30 ft. by 9 ft., each provided with its own superheater and mechanical stoker. Each of these boilers has an evaporative capacity of 9,000 lb. of water per hour. At one end of the boiler house is a Babcock & Wilcox boiler, which has recently been installed, and which has a capacity approximately double that of the Lancashire type. The position of the economisers, pump rooms and stacks in relation to the boiler house is clearly shown in the plan view of the station in Fig. 1. This portion of the plant, together with the water-cooling equipment, does not call for any special comment, the design and construction generally following standard lines.

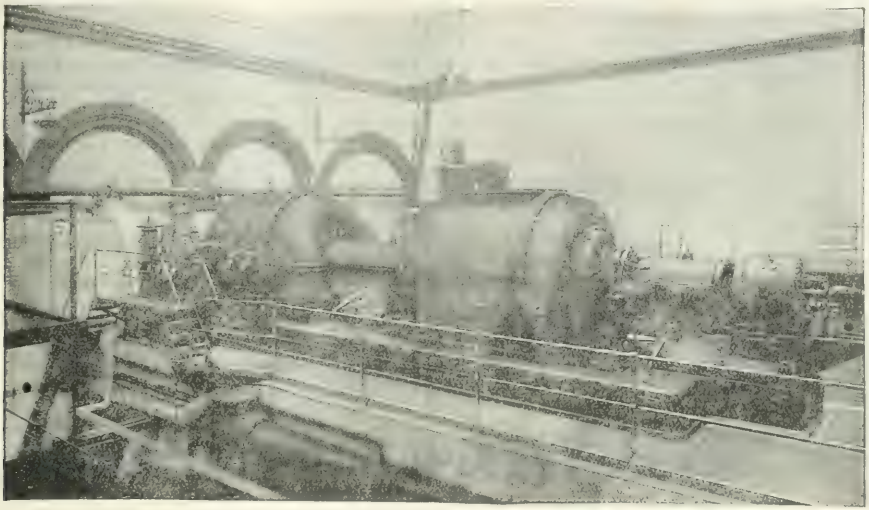


Fig. 4.—General View of 5,000 kw. Turbo Alternator.

The energy from the new alternating-current plant is controlled by a modern extra high-tension switchboard, which is housed in an outbuilding erected specially on piers and columns over the roadway which passes along the outside of the engine room. The switchgear is of the solenoid operated distance-control pattern, the switches and [illegible] mounted in brick and stone cubicles enclosed [illegible]. The general appearance of this gear is shown in Fig. 5. The main switch on the new alternator unit is capable of dealing with a circuit capacity of 7,500 kv.a.

The switchgear of the Feeder [illegible] is of similar design, but of lighter [illegible] only for the [illegible] the upper [illegible] the feeder [illegible]. There is an abundance of space at the back of the [illegible].



Fig. 5.—Front Elevation of Switchgear [illegible] Distributing and Feeder Panels.

seriously interrupted some years ago by a fire which practically burned out the whole of the controlling equipment. It will be seen from the plan that a separate switch room is provided at one end of the engine room, and this room gives out on to the latter both at the ground floor and the gallery levels. On the upper floor are installed the boards which deal respectively with the traction circuit, both generator and feeder, and the single-phase high-tension circuit, which are still in use for giving a supply for lighting purposes on the outskirts of the borough. These boards are of modern construction, and the apparatus installed upon them is of standard type. Special precautions have been taken against the possibility of fire amongst the cable connections. These latter are carefully separated, and they pass up near the wall of the switchroom through insulators through the floor from the room below. The controlling panels are set well forward from the wall and the cables are carried up and bridged over to their respec-

Much the same may be said for the direct-current lighting and power board, which occupies a portion of the lower floor of the switch house. This latter board stands near the centre of the [illegible] and is [illegible] for 12 generator [illegible] each of 2,000 ampères capacity and 6 feeder circuits

each of 1,000 amperes capacity. The generator panels are fitted with reverse current circuit-breakers at each pole, and the feeder panels have overload time limit circuit-breakers. The breakers themselves are mounted at the back of the board and operated through links and levers from the front. The general appearance of this board, taken as shown by the manufacturers' drawing, may be gathered from Fig. 5. All positive connection and apparatus are grouped together, and the same applies to the negative side of the system. The 'bus bars are in duplicate, there being a main and a hospital bar; the former has an equivalent section of 24 sq. in. and the latter of 12 sq. in. The connections from the board are made throughout in bare copper. Those leaving the top of the board are carried over to the wall, where they are supported on stone insulators and connected just above the floor level to lead-covered cables. The connections from the bottom of the board pass out from the floor through stoneware insulators. The most interesting feature of this board is that the 'bus bars are carried along the face of the panels and the laminated brushes of the circuit-breakers make direct contact on to the face of the bars. By this simple expedient heavy current connecting pieces are avoided. The whole of the iron framework of the gear is encased with fireproof insulating material, and particular care has also been taken with the small wiring, which is indispensable upon every switchboard. These sub-



Fig. 6.—Exterior View of H.T. Control Gear.

sidiary conductors are insulated with non-flammable material, and each is enclosed in a separate fibre tube. Space will not permit us to go fully into the details of this gear, but from an inspection of the switch house at the time of our visit we can testify to the efficiency of the existing control arrangement.

The extra high-tension control boards are also placed in the lower of the two floors of the switch house. This gear operates the solenoid switches with the new alternator which have already been referred to, and also the feeder circuits which control the supply from the Lancashire Electric Power Co. The special panels for the latter are also equipped with synchronising apparatus. The new plant is interlinked with the direct-current side of the station, rotary converters and motor generators.

Following on the adoption of a high-pressure system of generation, converting plant has been installed at Frederick-[illegible] and a new [illegible] has been erected at the Lodge Lane [illegible] Manchester Ship Canal Docks. A [illegible] 100 kw. capacity, supplying three [illegible] has been erected in the Ordsall district, and it is proposed to erect a converter sub-station in the Greengate district of 1,000 kw. capacity.

In view of circumstances arising out of the war, it appears certain that the Frederick-road works will require to furnish the whole output for a period of three or four years at least, and the Committee have recently recommended the placing of an order with the British Westinghouse Co. for a duplicate 5,000 kw. set. A set of similar capacity, with a turbine of the Zoelley type coupled to a Westinghouse alternator, is also on order from Messrs. Willans & Robinson, so that there will be a capacity of 15,000 kw. of modern generating plant available in the near future.

While the war at first adversely affected the output, the firms engaged on munition work (of which there are not less than 42 in Salford) have lately increased their demand, and the output for lighting and power shows an increase of about 15 per cent. over the corresponding periods of last year.

The effect of modern plant on works cost has already made itself felt, and the net balance for the year, after paying increased charges on account of interest and sinking fund, also increased taxation and payments to men on active service, amounted to £8,407, compared with the estimate of £2,210, a result on which the Electricity Committee are to be congratulated.

Our thanks are due to Mr. J. A. Robertson for furnishing the above information, and to Mr. E. H. L. Dickson, his deputy, for his courtesy in showing us over the works.

CORRESPONDENCE.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The Paper by Prof. Blondel, which you abstract in your current issue (page 344) is most interesting and instructive, and his ingenious apparatus has given us an experimental proof that we ought to write $N\frac{d\varphi}{dT}$, and not $\frac{d(N\varphi)}{dT}$, for the induced E.M.F.

But no one with a clear perception of the real nature of E.M.F. could ever come to any other conclusion. The discussion referred to in the Paper has arisen chiefly from the lack of insight into the very elements of the matter (probably hidden by overmuch mathematics) on the part of men whose knowledge has been very great indeed. As was pointed out in a former letter,* even such a master as Clerk Maxwell had somewhat hazy ideas on E.M.F., for he has given several definitions which are utterly inconsistent with one another. But the germs of the real idea are to be found in his works and in those of Kelvin, while a definite statement has been given by Ayrton in terms more or less equivalent to that below. In making our definition we must not select any particular kind of E.M.F., but seize on the fundamental fact that is *common to all kinds*, and that one is the interchange of energy when electricity flows. We may thus write:—

"If electricity would give out or receive energy on passing through a certain place, then there exists at that place an E.M.F. which is measured by the energy received by each unit electricity." The E.M.F. "assists" the flow where the current receives energy, and "opposes" it where the current gives out energy. The definition makes the former positive and the latter negative.

Now let us apply this definition to the problem in hand. There can only be an induced E.M.F. if the circumstances are such that a flow of electricity involves the receiving or giving out of energy through the agency of the magnetic field. There are but two possible sources of that energy: that already stored in the magnetic field (inductance E.M.F.) and the mechanical work done by an agent causing relative movement of the flux and circuit (motion E.M.F.). The mechanism by which the energy exchange takes place is probably identical in the

* "Electric Potential in Alternating-current Magnetic Fields." The Electrician, Vol. LXVIII., p. 934, March 15, 1912.

two cases, for we associate a change of the field with a movement outwards or inwards of the flux.

The energy stored in the magnetic field cannot be altered by any change whatever in a coil which does not itself exert an appreciable excitation, and is made of a material whose magnetic properties are the same as those of the medium in which it is immersed. If, then, the change be of such a nature that it only involves movements along the flux, and thus perpendicular to all possible electromagnetic forces, there can be no possibility of drawing on either the stored energy or mechanical energy, and consequently there can be no induced E.M.F. —I am, &c.,

Bristol, June 13. DAVID ROBERTSON.

We regret that lack of space compels us to hold over some correspondence this week.—ED. *E.*

COAL SUPPLIES.

As noted in our last issue, a deputation representing the gas and electrical interests attended at the House of Commons on Wednesday, June 9th, and laid before a meeting consisting of about 200 members of Parliament the serious difficulties which they were experiencing owing to the shortage of coal. The speakers were as follows: Sir Corbet Woodall, Sir John Snell, Alderman Kay, Mr. F. Bailey, Dr. Chas. Carpenter, Bailie Irwin and Bailie W. B. Smith.

Attention was drawn by the various speakers to the seriousness of the shortage of coal. This shortage was due to several causes, among which was mentioned particularly the enlistment in the Army and Navy of a large number of miners and the consequent limitation of output. To meet this, further and greater effort was necessary on the part of the miners and the coalowners, which might be stimulated by some limitation of the prices to be charged for coal. In addition, it was pointed out that a large proportion of coal was sent abroad, but a committee had been appointed by the Government for dealing with the export of coal, and the effect of the work it had done was already apparent. The action of the committee would doubtless meet with criticism from interested parties, and this meeting had been sought in order to help honourable members to weigh the respective claims against the evils that had to be dealt with.

The question of the all-round necessity and utility of gas and electricity was urged at length. It was pointed out that not only were gas and electricity used for lighting, cooking, heating and power purposes for both rich and poor, and for private and public buildings, including at the present time barracks, hospitals, camps and factories engaged in the manufacture of war materials, but they were also used in a vast number of industries, such as engineering works, shipyards and chemical and textile concerns in all the great industrial centres where Government work is proceeding night and day, and where it is absolutely essential that the necessary motive power should be continuously available. It was also pointed out that a number of gas and electricity undertakings had so adapted their plant that they were producing materials of vital importance to the Government, and, furthermore, that the residuals resulting from the manufacture of gas from coal, such as coke, tar and ammonia, were necessary to a great variety of important industries. Also that a considerable supply of high explosives was being obtained from the by-products resulting from the distillation of coal by gas undertakings. In Germany the Government were using every means in their power to restrict the use of coal except in closed vessels, such as retorts and ovens, so as to increase as much as possible the output of the valuable by-products above referred to. Similar action in the United Kingdom would be highly valuable. One large London gas company could increase their supply of these by-products by some 40 per cent. by using coal instead of oil for their gas production, and it was suggested that if the Government realised the importance of this aspect of the question they would help gas undertakings in every way to obtain supplies of coal.

In connection with electrical undertakings, it was pointed out that electricity had reached such a point of efficiency in the use of coal that it was of material advantage in saving the greatest asset of the nation at this time, and that if the electrical supply had to be curtailed or stopped there would be no electric l searchlights, and, in addition, the food supply of London and the country would be in danger owing to the stoppage of the refrigerating plant in the cold storage warehouses.

Generally speaking, it was an absolute impossibility to take in sufficient coal during the winter for the winter's requirements, and therefore a large stock had to be accumulated during the summer months, when the demand was not so heavy. This year it had, so far, been impossible to carry out this system, and if the stocks were not made up by the middle of October the public undertakings would be unable to continue their supply through the coming winter.

Various means of improving matters were suggested, amongst which were mentioned a limitation of further recruiting of miners, a suspension of the operation of the Eight Hours Day Act in respect of collieries in order to increase the actual output of coal, the fixing of a maximum rate of freight for all interned vessels, further facilities generally for the transport of coal, and a continued limitation of the export of coal. Finally, it was urged that if honourable members representing mining districts could induce their constituents to work full time a large part of the difficulty of shortage would be overcome.

A further conference was held on Tuesday last at the House of Commons, when representatives of firms using large quantities of coal, shipowners, coal owners and miners also attended. In the end a committee was formed to consider the position and confer with the Home Office and the Board of Trade as to what steps could be taken. The committee consists of 12 members, representing the various interests, as follows:—

COAL OWNERS.—Sir Alexander Henderson, Sir Arthur Markham and Sir Joseph Walton.

WORKMEN.—Mr. Charles Fenwick, Mr. Tom Richardson and Mr. Barnet Kenyon.

CONSUMERS.—Sir Daniel Goldie, Mr. Joynson-Hicks and Sir Corbett Woodall (chairman of the Gas Light & Coke Co.).

SHIPOWNERS.—Lord Claud Hamilton, Mr. R. P. Houston and Mr. R. D. Holt.

To these were added Mr. R. J. Nevill, who has acted as convener of the meetings.

The "Daily Telegraph" reports that the meeting did not seem very hopeful of securing any satisfactory result.

THE PRACTICAL RESULT OF THE POINT FIVE TARIFF.

The report on the subject by Messrs. A. S. Blackman and T. Roles will be found in abstract on p. 377 of our present issue. It gave rise to considerable discussion, of which the following is an abstract:—

Mr. G. WILKINSON HEDGES was glad the Paper was a statement of facts, not mere opinions. He appealed to those engineers who had data on the subject available, to contribute them either to the discussion or to the "Proceedings" of the Association for comparison with the authors' results. He found in examining the figures that the proportion of residential to total consumers was small, and though the Point Five tariff had increased the energy consumption by nearly 100 per cent. there was a fall in the revenue received from these customers. In Bradford there were 1,298 residential consumers out of a total of 4,000 odd; but the revenue from the former was £208 less under the Point Five tariff. Much the same was the case at Sunderland. At Sheffield the figures showed an increase. He regretted that the Paper had not included figures from a purely residential area to enable a useful comparison to be made. He had analysed the accounts of 918 consumers at Harrogate who, on the 6d. and 2d. per unit rate, produced £5,702 revenue. Under the Point Five tariff of 15 per cent. of 0·5d. per unit, they would have given him £7,000, after allowing an amount of £500 for the rateable value charge for large gardens. This showed that the rateable value charge properly applied was a sound proposition. Speaking of electric fires, much harm had been done by using too small a size. Frequently the small fire was useful in the spring and autumn, but in the winter was discarded for coal fires. Dealing with water heating, he said that 0·5 was too high a rate for domestic service, but he was prepared to pay 0·1 for one at a 100 per cent. load factor. This, with a ½-kw. heater, worked out at 4d. per day, and gave 65 galls. per day, and raised the water from 50° F. to 100° F. Concluding, he said that the saving of labour was of value, and if one domestic was saved it meant an economy of £40 per annum, which would go towards the cost of using electrical energy for all purposes in the house.

Councillor DYMOND (Hereford) said that the report conveyed two impressions to him. The first was that it was good things to cultivate the heating and cooking load, and that the Point Five tariff was a suitable tariff to do it. As regards the cultivation of the heating and cooking load the case depended upon the local conditions, and in some towns, such as Hereford, it would not pay. The heating and cooking load would start in the better-class houses, which, in his case, were situated outside the town, and would require a large capital expenditure in running mains and feeders. Also the load would come on at the time of the peak, as these were mostly late dinner houses. For instance, he had calculated that £4,000 in mains would be required to obtain the heating and cooking loads of [illegible] which only just cover the capital charges. Another point to consider was the difficulty of maintaining a constant pressure with a cooking load. Electric cooking required a very steady pressure. With regard to the Point Five tariff, he could not [illegible] when it included a rateable value primary charge. It might be suitable for certain towns, but for small towns it was unsuitable. He felt that it would certainly bring forward [illegible] against the undertakings. He had compared

two consumers, each of which paid at present a bill of £14. Under a Point Five tariff one would pay £8 and the other £20. As regards the simplicity of the Point Five tariff he would undertake to make any consumer think he understood the maximum demand system in five minutes. He advocated a Point Five tariff with a maximum demand primary charge, but even this was unsuitable for small towns.

Mr. C. H. Wordingham said that in 1893 the Hopkinson system was introduced in Westminster and Manchester, and it was not so easy as the last speaker had said to make a consumer think he understood a fixed charge plus a meter charge. The argument most effectual was to ask the consumer to wait and see the reduction in his account compared with the flat rate. He was convinced that all consumers should be treated alike. After the Hopkinson came the Wright, Madgen and Reason systems. They preached the doctrine of the maximum demand indicator, but their system was really the Hopkinson system, except that they lessen the maximum demand differently. The Point Fives had now re-discovered it, but they had mutilated it more than any others. He assumed that the "point" in Point Five meant a talking point. The only 0·5 system seemed to be Luton. At Bradford 0·5 meant 1½d., and at Sunderland a little over 1½d. The matter reminded him of the power companies who had talked of the fabulously low charges at which they were going to supply, but who forgot to add the distribution charges. He disagreed with the rateable value method. It was inequitable, and it was wrong from the suppliers' point of view. Its advocates had to hedge it round with exceptions. The question about how much garden a consumer had would provide a big loophole for discontent. A system could not be right which nearly doubled the consumption and yet reduced the revenue. The blaze of light which the authors said was obtained in the rateable value-charged house was obtained by bigger lamps. The fixed charge on the rateable value was based on the consumption and upon the lamps which they had fixed at the time the charge was made, and if the candle-power were doubled or trebled the maximum demand for the lighting was doubled or trebled, and it appeared, therefore, either that the original charge was too high or else that they were getting a much worse load factor than they expected. The load factor they got when they had applied the tariff was 5 or 6 per cent., and that was nothing to brag about. They ought to get a better load factor than that to justify the low charge per unit. The fixed charge should bear a proper proportion to what the fixed charges cost and the revenue charge should be in proportion to the running charges. They must make up their minds to a fixed charge per kilowatt plus a charge per unit. With regard to heating, one could not dodge the fixed charges upon the heating, and water could not be heated economically in sufficient quantities for domestic supply. He noticed it was stated that the capacity of radiators had been greatly increased so that the air was heated instead of the individual. He thought that was wrong. What was wanted was to keep the air cool and to warm the individual.

Mr. W. W. Lackie said that in Glasgow he used a domestic system of charging whereby the revenue per consumer was never less than what it had been previously. He was charged 3d. per unit for his original units and ¾d. per unit for all additional units. The charge for the original units was allocated over six monthly periods. The average price under this system worked out at 1·51d. In his own house he had 300 units charged at 2d. and 1,500 at ¾d., an average of 1·2d. per unit. He had 10,000 domestic consumers, of whom 2,300 had adopted the domestic tariff, and previous to that 1,000,000 units were sold, but under the new system an additional 600,000 units had been sold. A builder in Glasgow had put up some all-electric houses, which had 12·15 lamps, and 12·5 kw. of cooking and heating apparatus. He (the builder) had occupied one of the houses, and it had been rather lavish had consumed 16,000 units in the first year, 150 at 3d. and the rest at ¾d. The total bill was £51 8s., and an average price of 0·75d. The builder was quite satisfied and had done well over the transaction. The other houses would probably consume 10,000 units per annum. In Glasgow the diversity factor before the adoption of the Point Five rates had been 11 as against that given by the authors in their Paper. He agreed that a flat rate for domestic purposes could not be satisfactorily applied to large towns. He used an automatic boiler which cost £5 per annum. An electric heater with energy at ½d. per unit would cost £11. He noticed that at West Ham the charge of £10 per kilowatt and 0·5d. was made; in Glasgow he had a rate of £10+0·25d., and wondered if he could qualify for admission to the Point Five Association.

Alderman Stephenson (Edinburgh) said that the authors had not put forward sufficient facts to convince him of the value of the Point Five tariff, whose rate for Edinburgh, where the rates and rents were much lower than they were in Glasgow. He pointed out that reference had been made to the influence of the tariff in increasing the amount of lighting. As to the candle-power of the lamps [illegible] In referring to the rateable value basis in Sunderland and where the revenue [illegible] the Lamb was not made advantageous [illegible] a tariff by which [illegible] 162 new consumers [illegible] the 3d. rate, the number of new [illegible] He thought the Point Five tariff deserved [illegible]

Mr. J. H. Bowden (Poplar) said that the Point Five tariff in Poplar [illegible] 0·69 then [illegible] connected [illegible] He thought it was [illegible] Mr. John Snell [illegible] rather than at [illegible] which were [illegible] Mr. [illegible] in arriving at a fixed charge according to the size of the installation than by the rateable value method. The fixed charge system had the immense advantage of being applicable to the universal rather than to purely domestic supply; it also gave the consumer the benefit of an individual load factor without adversely affecting the undertaking. He gave the following figures as obtained at Poplar:—

Poplar.

Year.	Output.	Total Working costs.	Aver. price.	Profit.
1910-11	9,193,872 ...	0·659d. ...	1·200 ...	£3,774
1911-12	9,604,867 ...	0·714d. ...	1·231 ...	2,747
1912-13	12,014,794 ...	0·678d. ...	1·122 ...	3,170
1913-14	16,716,705 ...	0·55d. ...	0·971 ...	8,010
1914-15	16,899,548 ...	0·51d. ...	1·043 ...	14,750

Cookers and radiators should be hired out if the full scope of the Point Five system was to be realised. Poplar now made no charge for the hire of radiators, and this system would be extended to cookers when a reliable type was available. He thought that an annual fixed charge for demand governed by a diversity factor should be the ultimate system in view. The diversity factor should affect the consumers' bill only, and not the profit of the undertaking. The profit from an individual source should be proportional to the units sold. It was false to assume that services and distributors laid for lighting could carry the increased current for cooking and heating. The Poplar system avoided a loss by making the cost of the installation a basis of the charge. If the cooking and heating load could be imposed on existing lighting mains, then the original mains must have been heavier than necessary, and the supply impeded by exorbitant capital charges. The authors were incorrect in assuming that with the Point Five system there should be a reduction of profit by comparison with the old rates. The increased use of the service might reduce the charges from, say, 4d. to 2d., or even 1d. per unit, but it did not necessarily follow that the profit per unit should be less. The profit was probably considerably greater and the larger consumption rendered the individual consumer a better asset to the undertaking. It was unfortunate that the authors had dealt with the matter purely from the domestic supply point of view. If the Point Five system was correct it should have universal application. If electricity supply was to go ahead as a competitor of coal and gas in all its uses it was essential that tariffs be put upon a basis of equity and not of expediency. The charge of 0·5d. for energy should not be regarded as finality in cheap supply. The advent of the gas turbine would probably cheapen the actual cost of production, and the time would come when 0·25d. would be the running charge, although at the outset it might be necessary to increase the fixed charge. He foresaw the time in the near future when the average charge in an industrial area would certainly be not more than 0·3d. per unit sold, and how far distant that time might be was entirely dependent upon the present method of charging. A system which was adaptable to all purposes was, therefore, the one that would accelerate progress in the intervening period. The rateable value system, bristling as it did with inherent weaknesses, was not one to commend itself to progressive engineers.

Alderman Smith (Barrow) said that the reasons the Hereford representative and his engineer came to the conclusions that cooking and heating would not be a paying proposition were that the large houses would come on first; these were principally on the outskirts of the town where the drop in pressure would be felt, and it would mean an additional load on the existing peak. This was a mistake. Actually they would find that the smaller class of house would come on first, that increased costs of mains would not be incurred, and that the peak load would not be increased by this class of business, of which the load factor was excellent. Moreover, the advantages of electric cooking appealed more to this class of resident.

Mr. R. A. Chattock (Birmingham) said that he thought the speakers had been destructive rather than constructive in their criticism, and that they were too local in their outlook. The Point Five system might not apply to some towns, but in large industrial centres such a tariff could be put forward, even at a loss, as it attracted more business. A residential town with a small output could not afford to do this. The low power rates in industrial towns had justified themselves, and they could now afford to charge a low rate for heating and cooking. All these developments lead one to the conviction that all supplies should be combined into one by centralised supply, and in that way full advantage could be taken of the diversity factor of the whole country, and a supply given at the most reasonable terms possible. It was only in this way that they could reach the Utopian state of cheap electricity for everything.

Mr. W. H. Cooke (Luton) said that he did not believe in rateable value systems. In Luton they had a simple flat rate of ½d. per unit for the heating and cooking, and in arriving at that tariff he took into account that heating and cooking would not stand a higher charge. He agreed that the Hopkinson was the only sound system on which a tariff could be based. With regard to heating and cooking in business premises, this load was just as valuable as the residential one, but the high rateable value of business premises prevented them coming in on the usual 0·5 tariff. Although Luton was not so big as Bradford, yet they sold as many units for residential heating and cooking and half as many again for business heating and cooking. It might be stated that such a tariff could not pay, but since they had adopted it they had had larger net profits to a considerable extent, and 85 per cent. of the increase was due to the 0·5d. units. The largest amount of revenue came from the medium size house.

Mr. Crowther (Sheffield) strongly supported the rateable value system from the layman's point of view. It might even come to be applied

to business premises in due time. The cost of energy on the rateable value basis came out at about 1½d. for a house rated at £20, and rose as the assessment rose. This was not inequitable, and was akin to recognised water charges. The alternative was to halve the usual flat rate, say, from 4d. to 2d., which would bring in an enormous number of consumers, but this course required courage on the part of the undertakings. The public should be made at once aware of the advantages of money saving systems, even if there might be a temporary loss of revenue as the result. He thought Mr. Chattock was correct in urging a national supply.

Mr. NICHOLS MOORE (Newport) disagreed with the statement that progress could not be made except on a halfpenny rate. For example, at Cardiff there had been an increase in revenue at the 1d. rate from £615 to £1,083. Similarly at Newport, the units had increased during the past year from 70,000 to 166,000, the revenue from £293 to £692; the number of heaters had risen to 300 and the number of cookers to 26. It was interesting to note the difficulties the authors were already experiencing *-e.g.*, in regard to land. The best claim was that only a single meter was necessary. An important admission was the statement that the introduction of the system might first result in a loss. In dealing with tariffs it was essential to look at matters from the commercial point of view. He would like to suggest a way of looking at undertakings which he thought would appeal to those who knew nothing of the technical principles involved. The principle he would go on might be stated as follows: If the average price obtained was a rapidly decreasing quantity and the percentage of working costs to total receipts was shown to be a steadily increasing quantity, then if under these conditions the ratio of gross profit to total revenue was also found to be a decreasing quantity, the financial position should be considered to be unsatisfactory. Looking at the figures given for the Bradford results from this point of view, it was found that there had been an increase of 9·4 per cent. in units sold for domestic purposes, whilst there had been a decrease in the revenue obtained of £208. If the cost of supplying the additional units were assumed to be 0·25d. per unit, there was a further cost of £100, making a total adverse balance, as compared with the old tariff, of £308. The real question to be considered was, What was the net effect on the gross profit—*i.e.*, the net profit? Upon looking into the results of various undertakings, it was noticeable that there was a considerable drop in the percentage of the gross profit to total revenue in the case of residential districts working upon the Point Five tariff, whereas the industrial districts working the reduction was much less. Also in corresponding undertakings which were making progress, but which were not working on this tariff, this reduction was much less. It was evident that industrial towns could stand the strain of a tariff of this kind, but that residential districts might get into difficulties through it.

Mr. F. M. LONG (Norwich) said that he was disappointed in the results of the discussion. It was not a question of tariffs in general, but of the results of the Point Five tariff. It had nothing to do with rateable value or primary charge. What he had hoped for was the conditions under which a Point Five charge could be made, and what the effect of a Point Five charge would be on the financial side. Coal costs in the different towns which had adopted the Point Five tariff ranged from 0·56d. to 0·17d. per unit. It was easy to see that if coal cost 0·17d. per unit, current could be supplied at ½d. per unit, but with coal at 0·56d. per unit it was difficult to see that a Point Five tariff could be justified. He would like information on that point, and on the conditions under which a Point Five tariff would show a satisfactory result.

Mr. JONES (Kilmarnock) said that their experience in Kilmarnock did not justify a belief in the rateable value system as a just and reasonable method of charging. He instanced two cases of the same size of house, and probably with the same number of lamps, which had entirely different rateable values.

Mr. T. ROLES (in reply) said that he was also disappointed in the trend of the discussion. The majority of speakers thought that the rateable value and the Point Five tariff were synonymous, which was entirely wrong. The Point Fives, as a body, held the opinion that no great headway could be made in the supply of energy for domestic purposes at a price of over ½d. per unit was adopted in places where gas was less than 2s. 6d. per 1,000 cubic ft. It was stated that a good deal could be done with electricity at a price of over ½d. per unit, but this was only in special cases. The figures given on p. 11 of the Paper, only referred to 184 consumers who were on the supply before the Point Five tariff was started. After dealing with certain figures given in the Paper, he stated that they were making a good profit in Bradford on a Point Five tariff, but that result would not necessarily apply to southern towns where coal was not so cheap.

Mr. A. S. BLACKMAN (in reply) was also disappointed with the discussion. Mr. Wordingham said that no tariff could be right which doubled the output and at the same time reduced the revenue. He did agree with that. No one had ever contended that the system was right for all towns; it was a question of local conditions. The effect of the domestic load on his particular station, which had a large power load, was almost negligible. As to the cost, his estimate of these units was 0·12d. per unit.

A vote of thanks to the authors was proposed by the President and carried unanimously. The meeting then adjourned for the luncheon interval.

At 2:30 p.m. the proceedings were resumed, when Mr. Ayton presented his report on "Electric Vehicles" (which appears on p. 379).

THE USE OF ELECTRIC VEHICLES IN MUNICIPAL SERVICE.

An abstract of this report will be found on p. 379. Below we give an account of the discussion which followed the reading of the report by Mr. Ayton.

Mr. W. W. LACKIE remarked that it was significant the amount of work which could be done by an electric van; for instance, at Barnes, where the van did the work of 16 horses. A 1-2 van would do the work of 2 carts and 16 horses. He thought that the medical officer of health, the fire department and the borough surveyor should be made acquainted with the advantages of the electric. In Glasgow he used electric vehicles in the department for mains testing, with a motor generator which gave them 13,000 volts for pressure testing on the new mains. After three years' service of a 1-ton electric he had ordered more cars, including 1½- and 3-ton vehicles. He had placed an A6 (Edison) battery in the 1-ton van and increased the mileage from 40 to 60 miles. The revenue from a ½-ton vehicle for electrical energy was £20 per annum, and for a 3-ton £40 per annum. He had leased a building to garage accommodation of 10,000 sq. ft. for electric vehicles in Glasgow. In Glasgow with horse service at 11s. 6d. per day, it was costing £160 per annum for a horse and cart, and with a 1-ton electric van the work of two horses and carts was being done for £240 per annum, as against £320 for horse haulage. The drawback of the electric vehicle, that of first cost, would, he thought, be rectified in time. Dr. Steinmetz had emphasised this point when he said that the industry needed a light, cheap electric, something like the Ford petrol car; with energy at 1d. per unit this should be run at a cost for energy of £12 per annum. The standardising of weights and dimensions should immediately be undertaken. In Glasgow his 1-ton vehicle weighed 40 cwt., and the ½-ton car weighed 39 cwt.

		Weight, cwts.				
		Battery.	Chassis.	Body.		Total.
½ ton	A4	8	23	8½		39½
1 ton	A6	11¼	28¾	.....		40
1½ ton	A6	11¼	50½	7½		49½
3 ton	A10	20	47	10		77

	Dimensions.			
	½ ton.	1 ton.	1½ ton.	3 ton.
Overall.....	14′ × 5′ 6″	11′ 4″ × 5′	16′ 7″ × 5′ 7″	18′ 10″ × 5′ 10″
Wheel box.....	8′ 10″	7′ 1″	10′ 10	12′ 6″
Track	4′ 9½″	5′	4′ 9½″	5′ 8″

Mr. C. H. WORDINGHAM, speaking as the candid friend, said that the early history of electric battery vehicles on tramcars was so unsatisfactory that it was doubtful whether the present optimism regarding the electric battery road vehicle was justified. Even the ordinary electric tram, which was an ideal method of traction, could not always show favourable results.

Mr. R. A. CHATTOCK (Birmingham) said that since his connection with the electric vehicle he had come to the conclusion that it was the vehicle for general industrial use. He did not advocate its use for long-distance work. The electric vehicle which they would see to-day at the parade after the meeting was far ahead of the electric vehicle as they had seen it at the Kingston parade. The electric vehicle should not be judged by its speed, as Mr. Wordingham had done. The commercial vehicle had a speed of 12 miles per hour, which was quite sufficient. An electric vehicle on the lines of the Ford petrol car should have a large vogue among electricity undertakings for runabout purposes. Such a car must be light and cheap. He thought Mr. Wordingham's criticism by comparing them with trams was unfair. There were 70,000 battery vehicles running in America, and no such comparison was made there.

Mr. J. W. BEAUCHAMP (West Ham) said that in West Ham they only had four users, having 10 vehicles, at present. Six out of the 10 were repeat orders, and three of the four had had considerable experience with other forms of mechanical transport. Station engineers should use an electric as the most direct and obvious method of pushing the electric, and for this a commercial vehicle was better than a staff runabout. His experience of a 1-ton Edison used by the mains department was that in 148 working days with an average mileage of 17½, the energy consumption was 0·6 unit per mile. The revenue from mixed commercial vehicles at 1d. per unit should be between £20 and £30 per annum. He advised central stations not to concentrate on the big users of heavy vehicles at one upwards, as these people were quick to note any financial advantage. He thought it well to avoid confusing the people over with several types, and the effort of several makers was apt to do that. The purchaser so that it is quickly finished by his saying the electric vehicle was obviously in a state of development, and he had better wait a few years. It was worth any amount of trouble to get the first vehicle in a user, as the satisfaction given was so great that repeat orders always followed. It was worth noting that 100 mixed commercial vehicles would consume half a million units per annum, producing at 1d. per unit a revenue of over £8,000 per annum, which, as an off-peak load, would be mostly profit.

Mr. H. S. ELLIS (Shields) said they had two Edison buses running with considerable success. These were used as feeders to the tramway system, and were sent to outlying districts along narrow and bad roads which were quite unsuitable for ordinary traction purposes. The tramways manager and the committee were quite satisfied that the buses had done all they had expected. They were charged between 11 p.m. and 6 a.m.

in the car shed, where a motor generator was installed, the charge for current being ½d. per unit. He did not find this, and I thought he should not if there were 20. 'Buses had a beneficial effect on the load factor. At the end of the route there was a small charging station, where the 'buses received a boost. In this way they were able to remain in service all day, and travel some 70 or 80 miles. If there were no boosting station they would have to be content probably with only 40 to 50 miles. Referring to an inquiry from a brewery for a 3-ton vehicle, he said the cost question was a difficult one. If equipped with Edison battery, it would cost something like £1,100, and Bakers, he believed, could furnish a similar vehicle for about £700. A petrol vehicle would only be about £600. Another disadvantage was the question of speed. Electrics were excellent for town use, but before anything could be done in long-distance work electrics would have to have greater speed. It was up to the battery makers to increase the capacity of the battery, and enable the vehicles to run at a higher speed. These questions of cost and speed were against the electric. Generally considered, they were cheap to run, easy to handle and the maintenance cost was very low. He hoped the Committee would do all they could to influence makers to bring down the price and, if possible, to increase speeds.

Mr. COOPER (Wimbledon. Surveyor) criticised the design of the municipal vehicles shown in the Paper. In Paris and other cities in which battery vehicles were used for dust collection the vehicles were low, and the material could be raked directly without mounting the side of the vehicle. He felt there was a demand among surveyors for a battery vehicle which would carry 100 gallons of tar or a few yards of repairing material, and such a vehicle, if designed to carry men, would be very useful for the repair of pot holes in the road surface as soon as they made their appearance. A vehicle of this type would effect a saving of 30 per cent. over ordinary methods. His experience was that manufacturers of electrics at present were either unwilling or unable to deal with these vehicles. He also looked forward to seeing in the near future something done with an electric road roller, a machine for which he was sure there was a good prospective demand.

Mr. HAME (York) said that his electric 'buses ran 13,600 miles, and the energy consumption was 1·1 units per mile. The petrol 'buses did 7 miles per gallon or 180 galls. per week; they did 1,250 miles per week, and the cost was about £500. With electrical energy at 1·25d. per unit the cost was £365 per annum for the same service. If the same comparison was taken back to the coal at the station, the sum of £64 would pay for the coal to produce the amount of electrical energy to give this mileage. He had had no trouble with the electrical equipment of his 'buses, and he thought that on level routes the electric battery 'bus was ideal. The North Eastern Railway Co., York, were considering the question of utilising electric commercial vehicles.

THE CHAIRMAN of both the Surveyor's and Sanitary Committee, (Bristol) said they had 200 horses as well as several steam and petrol vehicles. He wished to avoid adopting a system from which he would need to make a change in the immediate future. He believed that electrics were the right type, and would in time be generally adopted for municipal work. He thought Mr. Wordingham's pessimistic remarks were comparable with those made by a certain professor who calculated and demonstrated on paper that a steamship could not be driven across the Atlantic.

Mr. WEBER (Keighley), said that his experience of petrol 'buses worked out at Is. 4¼d. per mile with the trackless trolley system, with which extensions were made. A remarkable reduction in the tyre cost resulted. The energy cost was 0·9d. per unit per mile as against 4¼d. per mile for petrol. He used the Cedes Stoll system with two and not four overhead wires. His cost for carting ashes was 10 per cent. of the cost of the coal.

Mr. J. K. BRYDGES (Eastbourne) said the object of the Paper should be to elucidate facts and to give the makers an idea of the requirements for municipal service and heavy traction work. In Eastbourne they had 14 petrol 'buses, double deckers. For general service 'buses should be double deckers, but for feeders single deckers would serve. The Paper appeared to deal only with the latter. The costs of the Eastbourne 'buses last year were 11d. per mile. He thought electric 'buses were too slow. In regard to commercial electrics, he thought 4½ or 5 tons a suitable capacity. They had a 4½ ton steam waggon to bring coal from the railway station to the works, a run of 2¼ miles to works and back to station empty. This employed three men, a driver, a steersman and a loader, and did six loads a day, the total cost per ton delivered to works being 11·1d., allowing a sum of [illegible] 7d. over the contractors' charge, at present day rates, of 1s. 6d. per ton. If the distance were greater, no doubt the saving would be greater. He went into the question of an electric coal waggon, but the price was excessive, and the load carried was limited. He would be pleased to consider an electric waggon again when the steam waggon was worn out, or he might dispose of it, because he quite agreed the electric was a good advertisement for the department.

Mr. A. H. SHAW (Ilford), said he was ordering a 4-ton wagon to haul coal a distance of [illegible] miles from the nearest railway siding for the works. [illegible] was conveyed [illegible] the coal arrived in 8 ton trucks. He [illegible] Mr. Bryden's figures of 11·1d. for hauling 6 tons 2½ miles out and home. He was doing it [illegible] at the cost of 10d. These figures [illegible] With the electric he would save £300 a year [illegible] and [illegible] would deal with 11,000 to 12,000 tons. The heavy steam wagon is to haul 18 tons, but [illegible] and had [illegible] every [illegible].

Mr. W. H. L. WAYNE (Hulme Accumulators, Ltd.) thought a wrong view had been taken of the question of speed. There was no advantage in having a high speed in towns, and economy in running was due to the low speed, which was not economical in petrol vehicles. As to price, the final financial result should be considered, not only the first cost. Notwithstanding the supposed disadvantages of price and speed, the railway companies found it worth their while to purchase electric vehicles, and if these companies did so electricity undertakings should also find it worth their while. Accumulator trams were by no means out of the question at the present day—they were giving every satisfaction.

Mr. BRYDGES, in reply to a question, said that his steam vehicle had been in use for 202 days per annum, and the men were otherwise employed when available.

Mr. JOHN CHRISTIE (Brighton) said that if progress was to be made it was essential that they, as engineers, should practice what they preached, and as far as possible use electrically-driven vehicles in their own service. He had had a vehicle in use for some 8 or 9 months, and found it very serviceable. It created a very favourable impression and interest among tradesmen, and he believed before long a useful number of electrics would be engaged in the delivery of goods. In Brighton there was a fleet of Tudor battery 'buses, which worked very well. He thought the biggest field for development was with the Works Departments. They should prevail upon surveyors to reorganise their fleets for dust collecting, street watering, &c. Last week he had an electric dust collector down for trial, and put it on every route in the town. There were some very severe gradients, but the vehicle proved capable of negotiating the heaviest route, and if it could do it in Brighton it could do it in any town in the Kingdom. Provision should be made to assist users with regard to charging at reasonable prices. In Brighton an old boiler house had been converted for this purpose.

Mr. MEAKIN (Wolseley Motors, Ltd.) said that his company were interested in both the petrol and electric machines. Too much attention had been given to the matter of speed. The electric had a field of its own, which was that of short hauls and frequent stops. He did not think the pleasure electric satisfactory, except for town runabouts, and at speeds of over 12 miles per hour the depreciation and maintenance charges increased rapidly. He was in agreement with municipal engineers as to price, which would have to be reduced considerably. There was much more work in the mechanism of the petrol vehicle than in the electric, yet they were produced and sold cheaper.

Mr. WYLD (Hampstead) in his own case had found a difficulty in getting his committee to purchase. As the result of an experiment the Works Department had found that they were able to do for 19s. 6d. what by horse haulage cost 35s. Finally, his committee had decided to purchase an electric vehicle and to hire this to the Works Department. They were quite satisfied that the arrangement would be financially satisfactory to both departments.

Mr. AYTON (in reply) thought that many of us were afraid of making mistakes, and therefore we failed to make the progress that should be made. On the other hand, there should not be irresponsible enthusiasm. He agreed that prices must come down, but even at present prices business could be done. It was a great mistake to make comparisons with experiments of years ago, such as accumulator trams. The Electric Vehicle Committee would certainly keep new designs in view, more particularly after the war. It was most important that municipal departments should use the electric vehicle, and should try to influence others. The trolley 'bus could not well be compared with the accumulator 'bus. He thought that insistence on the standard charging plug was almost important.

Mr. CRAMB proposed a hearty vote of thanks to Mr. Ayton, and this was carried by acclamation.

The meeting then adjourned to view the parade of electric vehicles which was held on the Victoria Embankment, immediately in front of the Institution. There were 17 vehicles shown, which were representative of all types of commercial and pleasure vehicles and much interest was taken in them. We shall give further particulars of these in our next issue.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Journal" of the Washington Academy of Sciences. (Baltimore: Waverly Press.) Vol. V., No. 10. Pp. 34. 80.25.

"Bulletin" de la Société Internationale des Electriciens." (Paris: Gauthier-Villars et Cie.) Tome V., 3rd series, No. 42. Pp. 30. 3 frs.

"The Philosophical Magazine." (London: Taylor & Francis.) 6th series. No. 174. Vol. XXIX. Pp. 110. 2s. 6d.

"Journal" of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. LIII. No. 249. Pp. 51. (London: E. & F. N. Spon.) 3s. 6d.

"Micrometers, Slide Gauges and Calipers: their Construction and Use." By Alfred W. Marshall and George Gentry. (London: Percival Marshall & Co.) Pp. 77. 6d. net.

Every Boy's Book of Electricity. Pp. 63. (London: Percival Marshall & Co.) 1d.

Proceedings of the Royal Society. Series A. Vol. XCI. No. A 630. Pp. 51. (London: Harrison & Sons.) 2s.

"Grinding Machinery." By James J. Guest. (London: Edward Arnold). Pp. xi.+444. 15s. net.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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THE SHANGHAI MUNICIPAL UNDERTAKING.

In our issue of May 1, 1914, we commented upon a report, which had been submitted to the Municipality of Shanghai, by Mr. T. H. U. Aldridge, the chief engineer of the electricity undertaking. This report indicated a degree of progress on the part of the electricity supply scheme which, for an undertaking in the Far East, was little short of remarkable. We reproduce in another part of this issue an abstract of this year's report, which is even more indicative of progress than its predecessor. It is apparent that the war has only affected the smooth running of the department in delaying the delivery of the plant, which was ordered many months ago, and which it was found necessary to instal to cope with the constantly increasing demand. It speaks well for the efficient character of the patrol of the seas by the Allied Fleets that no portion of the extension plant has been sent to the bottom by marauding pirates or ocean raiders, but it must be annoying for Mr. Aldridge to have to record, as he does, that "with regard to the second 5,000 kw. set, the greater portion of that shipment had to be brought, after considerable delay, from Manila, as the ship in which it was being carried took refuge in that port. Two more cases, one containing the field magnet rotor of the set, are being held up at Alexandria. Endeavours to obtain release of these have so far been without success."

Turning to the progress of the undertaking, the motors connected now aggregate over 12,000 h.p., there having been an increase of nearly 7,000 h.p. during the past year. The units sold for all purposes have increased from 20,000,000 to 33,000,000, and the load-factor has been improved from 30·8 to 37 per cent. It is significant that this latter figure is considerably higher than that which obtains in such large undertakings as those at Manchester, Glasgow, Birmingham and Liverpool. At present two stations are in operation which aggregate 14,900 kw., and but for non-delivery, the plant would have been increased by a further 5,000 kw.

The immediate future prospects of the undertaking are sufficiently encouraging to prompt Mr. Aldridge to recommend a 20,000 kw. extension scheme, and we understand that this is to be carried out next year, and in conjunction with it there will be a 30,000-volt system of trunk transmission by underground cables. Speaking of the commercial success of the undertaking, Mr. Aldridge points out that the Chinese consumers as well as the Europeans show a distinct liking for electric radiators. These are hired out to consumers at a monthly rental, and at the end of last year 871 heaters, representing a load of 1,700 kw., had been connected up; in addition, 52 electric cookers were in service. From the power supply point of view, the response on behalf of the local industries has been very encouraging. A number of Japanese cotton spinners who have mills in Japan are building additional plants in Shanghai because they can obtain the raw material more cheaply there than in Japan. Three of these mills have been added to the system during the year, representing an aggregate demand of 1,000 kw. Flour mills, amongst which is one of 600 h.p., are also amongst the industrial consumers. The units sold for power during the coming year will, it is expected, reach over 33,000,000, and for heating purposes over 500,000. It is instructive to note that Mr. Aldridge has consistently supported British manufacturers in the laying down and extension of this undertaking. It is true that orders had been placed for German plant, but on the outbreak of war these were cancelled and British machines substituted. Doubtless the experience of the Municipality with this plant, coupled with the fact that for patriotic reasons enemy countries can no longer solicit business, will be in every way gratifying and justify their further support of home industry. Judging by the manner in which the undertaking is being conducted, the Shanghai Municipality must feel gratified that they possess such a valuable public asset, and one which the growth of years must steadily appreciate. As on the previous occasion, we extend out congratulations to Mr. Aldridge upon another successful year's working.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week June 7, 1915, to June 12, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible] elec. carbons, £944; lamp parts, £74; elec. fans, 11 pkgs.; unenumerated, £1,865—65 pkgs. *Denmark:* Unenumerated, £127. *Holland:* Elec. lamps, £643—134 pkgs; unenumerated, £118. *Sweden:* Elec. machinery, £811; telephone apparatus, £540. *France:* Elec. carbons, £769; lamp parts, £130. *Italy:* Elec. wire and insts., 45 pkgs. *Canada:* Wire and cable, £99; unenumerated, £900.

SOUTHAMPTON.—*France:* Unenumerated, 6 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Elec. machinery, £92; wire and cable, £75; unenumerated, £230. *Melbourne:* Elec. machinery, £735; wire and cable, £5,158; unenumerated, £735. *Sydney:* Elec. machinery, £225; wire and cable, £2,129; unenumerated, £1,304. *Wellington:* Elec. machinery, £187; wire and cable, £1,036; unenumerated, £272. *Adelaide:* Elec. machinery, £182, unenumerated, £138. *Brisbane:* Elec. machinery, £181; unenumerated, £49. *Dunedin:* Elec. fans, £44; unenumerated, £44. *Christchurch:* Unenumerated, £60. *Perth:* Unenumerated, £88. *Hobart:* Elec. machinery, £155; unenumerated, £34. *Lyttleton:* Unenumerated, £130. *Fremantle:* Elec. machinery, £249; unenumerated, £1,037.

AFRICA.—*Durban:* Machinery, £631; telegraph material, £82; wire and cable, £591; unenumerated, £1,426. *Port Elizabeth:* Wire and cable, £128; unenumerated, £349. *Cape Town:* Elec. machinery, £312; wire and cable, £42; unenumerated, £186. *East London:* Unenumerated, £116. *Beira:* Telegraph material, £70; unenumerated, £25. *Kilindini:* Wire and cable, £26; unenumerated, £13. *Zanzibar:* Unenumerated, £10.

EGYPT.—*Port Sudan:* Elec. machinery, £92; telegraph material, £21; wire and cable, £28; unenumerated, £682.

RUSSIA.—*Archangel:* Unenumerated, £95. *Petrograd:* Unenumerated, £260.

ITALY.—*Genoa:* Unenumerated, £941.

SPAIN.—*Bilbao:* Wire and cable, £680; unenumerated, £93. *Cadiz:* Unenumerated, £72.

PORTUGAL.—*Lisbon:* Wire and cable, £26; unenumerated, £201.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £460; elec. machinery, £203; unenumerated, £494. *Santander:* Unenumerated, £67.

BRITISH GUIANA.—*Demerara:* Unenumerated, £35.

DENMARK.—*Copenhagen:* Wire and cable, £59; unenumerated, £343.

HOLLAND.—*Amsterdam:* Wire and cable, £1,564; unenumerated, £27. *Rotterdam:* Wire and cable, £536; unenumerated, £79.

U.S.A.—*New York:* Wire and cable, £40; unenumerated, £79.

JAPAN.—*Kobe:* Wire and cable, £35. *Yokohama:* Unenumerated, £210.

CHINA.—*Hongkong:* Elec. machinery, £330; wire and cable, £19; unenumerated, £155. *Shanghai:* Elec. machinery, £776. *Tientsin:* Unenumerated, £13.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Unenumerated, £136. *Calcutta:* Elec. machinery, £58; unenumerated, £163. *Colombo:* Wire and cable, £420; unenumerated, £95. *Madras:* Elec. machinery, £174; wire and cable, £28; unenumerated, £28. *Singapore:* Elec. machinery, £26; unenumerated, £369. *Penang:* Wire and cable, £30; unenumerated, £15.

JAVA.—*Samarang:* Unenumerated, £10.

CANADA.—*Toronto:* Unenumerated, £51.

FRANCE.—*Boulogne:* Unenumerated, £77. *Paris:* Elec. machinery, £56. *Dunkirk:* Unenumerated, £40. *Treport:* Unenumerated, £306.

FIJI.—Unenumerated, £28.

GIBRALTAR: Unenumerated, £22.

MALTA: Unenumerated, £17.

WEST INDIES.—*Trinidad:* Unenumerated, £30. *St. Vincent:* Unenumerated, £16.

FOREIGN GOODS (duty paid and free).

Alexandria: Unenumerated, £159. *Boulogne:* Unenumerated, £122. *Cape Town:* Unenumerated, £54. *Durban:* Unenumerated, £9. *Gothenburgh:* Unenumerated, £107. *Sydney:* Unenumerated, £35. *Wellington:* Unenumerated, £50. *Lisbon:* Unenumerated, £39. *Odense:* Unenumerated, £25. *Port Elizabeth:* Unenumerated, £107.

FOREIGN FREE GOODS, entered in transit on through Bills of Lading.

Adelaide: Elec. glow lamps, 4,730. *Christchurch:* Elec. glow lamps, 11,520; elec. lamp parts, £34. *Dunedin:* Elec. glow lamps, 280. *Lyttleton:* Elec. glow lamps, 440. *Wellington:* Elec. glow lamps, 4,200.

NOTE.—The large number of items in these official returns under the [illegible] "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Claim for Re-Laying Telegraph Lines.

[illegible] days, Mr. Pollock, Official Referee, gave judgment on the 10th inst. in the case of H.M. Postmaster-General [illegible] Council. The case arose out of the necessity to relay the telephone and telegraph cables consequent upon the construction by the Council of a subway beneath the cross roads at [illegible] and Strand.

Mr. Holman Gregory, K.C., and Mr. Brandon appeared for the Postmaster-General; and Mr. Hudson, K.C., with Mr. Frank Dodd, for the [illegible].

Mr. HOLMAN GREGORY, in the course of his speech at the close of the hearing, said that in all his long experience he had never come across a more unfortunate, or he might say a more scandalous, piece of litigation, [illegible] could not [illegible] had occurred [illegible] and [illegible] some of [illegible].

[illegible] under [illegible] had been [illegible] the work of the [illegible] Postmaster-General reserved the right to [illegible] the cost or to call upon the Council to do the work. In that case the Postmaster-General had done the work and had charged the Council with it, the total sum being £1,640. Of that all had been paid except the balance now claimed, as to which the Council contended they were not liable, as the cost had been increased by the Postmaster-General laying additional ducts. The question was whether more money had been spent in laying 22 ducts than would have been spent in laying the original 13 ducts, and the Council said that under the circumstances the Post Office should bear 9/22nds of the cost as representing the additional nine ducts and the Council 13/22nds as representing the original 13 ducts which had to be relaid. The Post Office engineers contended that so far from increasing the cost, the laying of the nine additional ducts would be a saving in cost, as the boring would have to be the same size for 22 as for 13 ducts and the additional nine would occupy space which would otherwise have had to be filled up with cement. There was no suggestion in the defence that the designs were wrong or wasteful, but it was alleged that the charges were excessive and unreasonable. On the other hand, it was contended that the question of design and the amount of work necessary to be done was entirely in the hands of the Postmaster-General. The only point was whether the Postmaster-General had incurred extra costs by making provision for 22 ducts instead of only 13.

The OFFICIAL REFEREE, in giving judgment, said he agreed that the case was a most unfortunate piece of litigation. By order of Mr. Justice Lush, he had to ascertain what would be the cost of the work upon the basis of 13 ducts and what would be the cost on the basis of 22 ducts. When notice of the construction of the subway was given to the Postmaster-General the latter decided that the work should be carried out by the Post Office. The alterations consisted of the abandonment of two underground telegraph lines containing 13 ducts and the construction of a new line comprising an underground conduit, the construction of a new manhole and the enlargement of the existing manhole. While carrying out the work the Postmaster-General increased the number of ducts to 22, which necessitated an increase of 1 ft. in the length and 1 ft. in the width of the new manhole, an increase of 1 ft. in the width of the trenching and of 1 ft. in the existing manhole over and above what would have been necessary if the conduit laid had contained only 13 ducts. Correspondence took place between the Postmaster-General and the Borough Council's engineer, and after discussion a plan was adopted, showing the general outline under which the Postmaster-General proposed to carry out the work. The Postmaster-General's officer, in carrying out the work, began upon the assumption that the subway was as close as possible up to the point where the new manhole was to be constructed, and that necessitated carrying down the manhole to a considerable depth so as to get below the subway. Originally a plan was put forward by which it was proposed that the manhole should actually be under the subway, but the engineers came to the conclusion that it was almost impossible to carry out that plan, and it was decided that a second plan was the better. Mr. Harrison was acting as engineer to the Council and was aware of the work going on. It was competent for him to have gone to Mr. Noble, who was doing the work for the Postmaster-General, and point out that he was doing more than was necessary, but he did nothing of the kind. The work was completed towards the end of 1911 when application was made for payment, and then certain objections were raised, it being suggested that the Postmaster-General had not done the work merely for altering the position and direction of the work for 13 ducts, but had done all the work to enable the Postmaster-General to carry 22 ducts. Mr. Harrison suggested that it would be reasonable that the Postmaster-General should pay 9/22nds of the cost. That would strike one as being a taking proposition, but it was one which would be absolutely improper because it was clear that the extra provision would not necessarily increase the cost of the work in proportion. The Postmaster-General had behaved handsomely in giving up some of the extra maintenance, as it was one of the incidental expenses for which he was entitled to be paid. Then came the question as to what were the extra expenses owing to the increase in the number of ducts: but as to that no evidence had been given. There had been, however, suggestions that there were faults in the design which had increased the cost, and in support of that a number of expensive models had been produced. The question then arose as to who was the proper person to decide as to the proper manner of carrying out the work rendered necessary by the construction of the subway, but he did not intend to take upon himself the duty of deciding that point. In fact, by the Act of Parliament he was precluded from doing anything of the kind. The Act said that the alteration was to be made as the Postmaster-General might deem necessary and expedient. No denial of the necessity or expediency of the work had been put forward in the defence, and, therefore, he could only deal with the matter as it came before him. Various questions had been raised in defence, but they were questions as to whether the expenses were such as ought to have been incurred having regard to the fact that the Postmaster-General had considered the work necessary and expedient. That rendered it quite unnecessary for him to go into the elaborate estimates and calculations made on behalf of the Council. Mr. Noble and Mr. Hardy had been called on behalf of the Postmaster-General, and they gave evidence in support of the view that the work was in substance necessary for the 13 ducts. Mr. Noble said it was necessary to carry down the manhole to the depth to which they did carry it in order to carry the pipes under the subway. He said that when they got down to a certain depth they met with a considerable quantity of water which rendered extra work necessary. He (Mr. Noble) also said that in carrying the hole down to a greater depth it was necessary to make it larger having regard to the health of the men who worked in it. It was, therefore, useless to suggest that the Post Office authorities had made the manholes deeper than was necessary. The Postmaster-General had taken the trouble to correspond personally

upon the matter, and he (the Referee) came to the conclusion that those who advised him had advised him properly. When it was said that the work was necessary and expedient, he was not in a position to contradict it in any way. He was satisfied upon the evidence of Mr. Noble and Mr. Hardy, that the work was properly done and that it was necessary and expedient—that it was work properly done on the basis of 13 ducts. When the Postmaster-General said that the work was necessary he could not in any way interfere. There must be judgment for the Postmaster-General for £259. 10s. 5d., with costs.

Light Railway Commissioners' Powers.

On Tuesday the Court of Appeal (Lords Justices Swinfen Eady, Phillimore and Bankes) delivered their reserved judgment on three appeals by the Great Central, Midland and North-Eastern Railway Companies from a decision of a Divisional Court on a point of procedure in connection with the Dearne Valley Light Railway scheme.

Lord Justice Swinfen Eady, in giving judgment, said that the appeal raised a short but important question under sec. 7 (6) of the Light Railways Act, 1896. In November, 1913, four urban councils in the West Riding of Yorkshire jointly applied to the Light Railway Commissioners for the construction of a light railway, which for convenience was divided into 23 sections. On March 18, 1914, the Commissioners communicated their decision to the parties. It stated that the Commissioners were of opinion the application for the order authorising a light railway should be granted, but certain restrictions were imposed as to certain sections. One section was postponed, and secs. 13 and 14 were refused. The promoters thereupon appealed to the Board of Trade with regard to the two sections refused, and that Board referred the matter back to the Commissioners. The latter proceeded to rehear the matter, but the appellants refused to take any part in the hearing, and obtained a writ of prohibition to prevent the Commissioners proceeding with the inquiry. Their ground was that there was no appeal, as there had been no refusal of the promoters' application. The prohibition was not upheld by a Divisional Court, and it was from the decision of that Court that the Railway Companies appealed. In his opinion it could not be said that an application for a light railway had been refused. The refusal had extended only to part of the application that was before the Commissioners, and in his opinion there was under the Act no appeal from a restriction imposed on the refusal of a part of a scheme. The granting of a part was the granting of the application within the meaning of the Act, and the section extended only to cases where the application had been refused. Under those circumstances the promoters had no right of appeal, and the present appeal must be allowed. The order of the Divisional Court would be discharged, and the rule of prohibition would be restored.

Lords Justices Phillimore and Bankes concurred, and the appeal was accordingly allowed, with costs.

Unlicensed Wireless Apparatus.

At Castle Eden (Durham) Petty Sessions last week Wm. R. Walker, school teacher, was charged with being in possession of wireless apparatus, contrary to the regulations under the Defence of the Realm Act.

Evidence was given that defendant had admitted he had wireless apparatus, but after the war commenced he took it down, as he could not transmit anything. The only thing he could receive was the time from Paris. He never had a proper aerial erected, and therefore he destroyed it.

Mr. H. DUNTHORNE, P.O. engineer, said the apparatus found in defendant's possession formed the component parts of a receiving wireless set dismantled. As it stood at present it was useless, but could possibly be put together for receiving messages in about two days.

Mr. MOSES (for defendant) said that while his client was on his holidays in August last he had something relating to wireless telegraphy. It was inspected by the postal authorities, and defendant then told them of what apparatus he had, but no further notice was taken.

The CHAIRMAN of the Bench said defendant had been foolish enough not to protect himself, and seemed to have been led into his position by one of the departments of the Post Office, who appeared to have been extraordinarily lax. They would only fine him £5. 5s.

Bristol Tramways Co. and Electric Supply.

Last week Mr. Justice Neville had before him a petition by the Bristol Tramways & Carriage Co. for the sanction of the Court to an extension of its powers including the supply of electricity to other firms.

Mr. CLAUSON, K.C., who (with Mr. Gordon Brown) appeared in support of the petition, said they had surplus electricity which they desired to supply to others.

His LORDSHIP expressed his approval of the proposed extension of objects, but thought that the notice convening the necessary meetings had not given the required seven clear days.

Under these circumstances Mr. CLAUSON asked that the petition should stand over in order that fresh meetings might be held and restored to the list for formal sanction, or, should the company think that they could persuade the Court of Appeal to take a different view as to the Companies Act notices, dismissed so that the opinion of the Court might be taken.

His LORDSHIP said the order might go in either way the Company desired.

Re Beck Engineering Co. (Ltd.).—A petition to wind up the above company compulsorily this company, presented by the Sloan Electrical Co., was before Mr. Justice Neville on Tuesday. It was, however, announced by Mr. Harrison (for the petitioners) that the matter had been settled, and the petition was dismissed, without costs.

PARLIAMENTARY INTELLIGENCE.

THE GOVERNMENT AND ENGINEERING WORKERS.

In the House of Commons on Monday, Mr. GEO. TERRELL asked the President of the Board of Trade whether any instructions had been given to newspapers restrictive of advertisements by manufacturers and employers seeking skilled labour.

In reply, Mr. RUNCIMAN said that no instructions had been given to newspapers on the subject, but the attention of certain associations of newspaper proprietors had been called to the restrictions on advertisements contained in the Order in Council of April 29. Arrangements had been made to enable advertisements to be submitted for the approval of the Board of Trade. There was no objection to a statement that labour was required for Government or War Office work.

Mr. NIELD asked the right hon. gentleman if he was aware that in the immediate vicinity of London important firms engaged on Government work—electrical engineers and others with large plants—were hopelessly unable to get skilled labour, and whether they were still prohibited from asking for that labour from a distance where it was not engaged on Government work.

Mr. RUNCIMAN: No, sir. Employers are not prohibited from asking for labour from a distance. If they will put their application through the ordinary channels, no doubt help will be given.

Royal Assent.—The Royal Assent to the Doncaster Corporation Act was read on June 9.

London Electric Railway Companies Facilities Bill.—On Tuesday this Bill was read a second time in the House of Commons.

Merchant Shipping (Convention) Act, 1914.—The King in Council made an Order on June 2 that the provisions of this Act shall be postponed from coming into operation until Jan. 1, 1916.

Lurgan Urban District Council Bill.—This Bill which provides for the transfer of the undertaking of the Lurgan Gas Light Co. to the Council and confers further powers on the Council with respect to the supply of gas, electricity and water, &c., has been read a second time in the House of Lords.

Provisional Orders.—In the House of Commons last week the Electric Lighting Provisional Orders (No. 2) Bill, which confirms the Haworth, Kingston-upon-Hull, Knaresborough, Normanton, Skipton and Stanley (Yorks) provisional orders was ordered to be read a third time.

The Electric Lighting Provisional Orders (No. 4) Bill, which confirms the Harrogate and Keighley orders, has been read a second time.

The Bill to confirm the Provisional Electric Lighting Order constituting a joint board composed of representatives of the urban districts of Wath-upon-Dearne, Bolton-upon-Dearne and Thurnscoe has also been read a second time.

The Bill, confirming the Boston district and Selby and district provisional electric lighting orders, has been read a second time.

BUSINESS NOTICES.

For the convenience of clients in the East of Scotland, Mr. John M. M. Munro, consulting engineer, of Glasgow, has opened a consulting office at 11, Randolph-place, Edinburgh. Telephone 356 Central.

Stocktaking.—On account of the annual stocktaking the stores of the Benjamin Electric (Ltd.), 14, Rosebery avenue, London, E.C., will be closed from July 1 to 4 inclusive, for both despatching and receiving goods.

Plant Wanted.—Messrs. Cramp & Frith, 33, Brazennose-street, Manchester, advertise for a rotary converter of about 150 kw., three phase, 50 cycles, to 110 volt d.c.) for a firm manufacturing war material.

Increase of Prices.—Owing to the rise in cost of materials and labour, Messrs. Kelvin, Bottomley & Baird have increased all prices by 10 per cent. as from the 1st inst.

Sale by Auction.—Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, on Thursday next, 24th inst., by order of the Secretary of State for War, a large quantity of serviceable and unserviceable stores, including quantities of iron, brass, copper, mixed metal, cupro-nickel, lead, zinc, platinum, &c., electric cable, machine tools, steam lorries, motor cars, motor cycles, &c. Lots may be viewed at the Royal Arsenal, Woolwich (except lots 242 to 260 and 265 to 272), which are on view at the Royal Albert Docks, on Monday, Tuesday and Wednesday previous to the conclusion of sale. Catalogues may be obtained at Imperial House, Tothill-street, Westminster; the Ordnance Office, Tower; and the Ordnance Office, Royal Arsenal, Woolwich. Several lots of [illegible]

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 6s. 10½d. will be payable on June 25 at the O.R.'s, Crypt-chambers, Eastgate-row, Chester, to creditors of Albert Whiteley, electrical and mechanical engineer, Tudno Works, Tudno-street, Llandudno.

Pintsch's Electric Mfg. Co. (Ltd.) is being wound up voluntarily, and Mr. H. W. Kirby, Bassishaw House, Basinghall-street, London, E.C., has been appointed liquidator.

Deed of Arrangement.—A deed of arrangement has been executed by Alfred Griffiths, electrical engineer, 146 and 185, Manningham-lane, Bradford. Unsecured liabilities are £512 and estimated net assets £229.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aldershot.—An inquiry will be held into the Council's application for sanction to borrow £85,000 for extensions of the electricity supply works.

At the meeting of the Council last week a motion by Mr. G. W. Collins in favour of the Council considering the question of the purchase of the undertaking of the Aldershot Gas and Electric Lighting Co. within the urban area was favourably received, but it was decided to consider the matter privately.

Bispham.—The Urban Council have received sanction to a loan of £3,586 for extensions of the electricity supply works.

Burnley.—The L.G. Board have intimated they are not prepared to sanction the raising of further moneys for laying ordinary service cables, but the Electricity Committee have authorised the connection of any small service cables necessary to comply with applications for the supply of electricity, the cost being met out of revenue.

Farnham.—The Council have approved the plans for the extension of the Farnham Gas & Electricity Co.'s generating station.

Swansea.—The question of extending the supply mains to the Isolation and Tuberculosis Hospital at an estimated cost of £3,000 has been deferred for further consideration by the Electric Lighting Committee.

The electrical engineer (Mr. J. W. Burr) is to report fully on the proposal to supply energy to the Morriston and Sketty districts.

Torquay.—The L.G. Board has written, relative to the application for consent to issue of stock for raising monies in connection with loans of £13,808 and £2,052 sanctioned by the Board for the electricity undertaking, inquiring what expenditure has actually been incurred and what is the present position of the works.

GENERAL.

Barnes.—The question of insuring the electricity works against air raids has been referred to the Council in Committee.

Barnsley.—The Council have increased the charge of electric current for lighting by a half-penny per unit, and for power by 15 per cent. as from July 1.

Barrow-in-Furness.—In moving the minutes of the Electricity Committee at last week's meeting of the Corporation, the chairman (Ald. Smith) said that the net profit on the working of the electricity undertaking had increased from £513 in 1913-4 to £3,163, and the units sold had increased from 2,000,000 to over 3,500,000, while the costs had gone down from 1.3d. to 0.9d. per unit.

They recommended that an honorarium of £100 be granted to the electrical engineer, Mr. H. B. Barnett, for extra services rendered by him in connection with the extensions carried out during the past two years, and he hoped the Council would permit it, as Mr. Burnett had carried out a great deal of extra work without increased expense or extra staff.

Coun. WHINNERAH said he felt, although Mr. Burnett had done very well for the Corporation, they had also done well for him, and he moved that the honorarium be not granted.

An amendment to the amendment was carried.

The formal inspection of the electricity works took place recently. In his report the electrical engineer, Mr. Barnett, reported upon the working [illegible] ended the preceding May 31. During the year a 2,000 kw. [illegible] Parsons-Belliss turbo-generator, switchgear, &c., condensing [illegible] and a 10,000 sq. ft. Mercy & Stirling water tube boiler, [illegible] were installed. The steam and feed pipes were [illegible] with the latest and most efficient insulating pipes [illegible] by the Limmer Asphalt Co., Ltd. In spite of many difficulties and [illegible] the new plant was put to work on March 12, or only [illegible] from the date of the contract. [illegible] to be proceeded with. Various extensions of mains and sub-stations have been carried out. Sanction has been obtained from the L.G. Board for the borrowing of £13,000 in connection with these extensions of plant, and of £8,000 for extensions of mains and other purposes. In addition to the extensions, some important repairs and renewals of plant had also been carried out. The cooling tower had been re-sheeted and No. 2 steam feed pump had been replaced by an electrically-driven centrifugal pump of much larger capacity by the Pulsometer Engineering Co. The mechanical stoker on a boiler had been replaced by a stoker supplied by the Underfeed Stoker Co., and an electrically-driven fan had been put down to provide forced draught for it. An economiser had been entirely re-tubed, the armature of a generator had been entirely re-wound, &c. Various extensions of mains and sub-stations had been made, over 9 miles of mains having been laid during the year; the street lighting had been improved, half-watt lamps having superseded the arc lamps. The units sold amounted to 3,597,410, against 2,081,317 in 1913-4; 937,185 units were sold for lighting and domestic purposes (against 743,821), 2,020,960 for power and heating (against 721,487), and 532,152 for traction (against 490,470).

After the inspection, light refreshments were served, and the Mayor, in the course of an address, eulogised the good work done by the chairman of the Committee (Ald. Smith), the engineer (Mr. Burnett) and his staff. The vice-chairman (Col. Wadham) was serving at the front, and they hoped that he and those serving with him would return safely.

In reply, Ald. SMITH said that it was a good thing that a chairman did not know too much of the technicalities of the business, as that might possibly have a tendency to attempt to interfere with the engineer, who knew best. Mr. Burnett and his staff had experienced two strenuous years. They had had an enormous increase in the output, and he was glad to say a decrease in the cost. Unfortunately, they had a rather bad time in front of them from the point of view of increased cost of coal, which was a big item, and, moreover, the rates had gone up very heavily.

Mr. BURNETT, in returning thanks, said the past two years had been an extremely strenuous time, not only for himself, but also for the whole of his staff. The difficulties had increased very much during the past few months, owing to labour troubles. Fortunately they had a few regular men who stood by them, prepared to do their best at all times, and but for them there would have been the greatest difficulty to maintain the required supply of electricity during the last few months, which was necessary both from a town and national point of view. He only hoped they should be able to continue to meet the necessary demands, but there were difficulties ahead, and unless steps were taken to get more labour and a better response from workmen there would be great difficulties in the future. They ought to be thankful that electricity was one of the few things that they had not had to pay more for since the war begun.

Bath.—At the adjourned meeting of the Corporation on Tuesday it was decided to adopt the recommendation of the Electric Lighting Committee to re-assemble the Diesel engine at a cost of £150.

Birmingham.—At the recent annual meeting of the Governors of the Birmingham and Midland Hospital for diseases of the nervous system, paralysis and epilepsy, an expenditure of £300 on electrical apparatus was sanctioned.

Blackburn.—Owing to the war the Corporation are unable to accede to the demand for a supply of electricity to Wilpshire district.

Brighton.—The Corporation have granted an increase of wages to the mechanics employed by the electricity department in order to prevent them from migrating to places where, owing to the demand for skilled workmen, they would earn much higher remuneration.

Darwen.—The Corporation have increased the charges for electricity by 10 per cent. for private and public lighting, and 20 per cent. for power, apart from special contracts and tramways.

Dewsbury.—At the last meeting of the Council it was reported that Mr. J. Passmore, shift engineer, had joined the Royal Navy as electrical artificer, and Mr. A. Greed meter tester, and J. Brooke, junior clerk, had joined the Royal Engineers.

Frimley.—The Yorktown and Blackwater Gas Co. recently asked the Council to acquiesce in an application to the Board of Trade for postponing the work of laying electric supply cables until after the war.

The company pointed out that in the present abnormal conditions it was inconvenient to open roads in a military district, and therefore postponement of action was most desirable from every point of view. The Finance and General Purposes Committee reporting upon the matter, pointed out that the company had the monopoly of gas and electric supply in their area and had not carried out their statutory obligations and agreement with the Council. They, therefore, recommended that the company's proposal should not be adopted, and this has been approved by the Council.

Great Harwood.—Owing to the war the Council have asked the Board of Trade to defer the question of the revocation of the provisional electric lighting order.

Hammersmith (London).—In view of the price of Welsh coal the Electricity Committee is of opinion that greater economy should be exercised and asks for authority to invite tenders for further mechanical stokers.

Hammersmith and Fulham Councils are under agreement whereby the latter authority undertakes to give a duplicate supply of energy to Olympia, on payment by Hammersmith of a minimum annual sum of £100. As the Olympia is now occupied by the War Office the duplicate supply is not required, and Fulham Council is prepared to waive the clause during

the period of the war, provided Hammersmith agrees to extend the period of seven years provided by the agreement for a further term to correspond with the duration of the war, Hammersmith, in the meantime, to pay for all energy supplied under the agreement at the uniform rate of 2d. per unit, as heretofore. Hammersmith Electricity Committee considers the request a reasonable one and recommends its acceptance.

Hove.—The Council have agreed to accept the revised terms of 5½d. and 1¼d. per unit for the first and succeeding hours, submitted by Brighton Corporation for the supply of electric current to Aldrington, in order to cover the increased cost involved (£93).

The charge for current to private consumers has been increased from 5d. to 5½d. per unit as from June 30.

Kirkcaldy.—The price of electric current has been increased by 25 per cent. for private lighting and power, and by ⅛d. per unit for traction.

Ilford.—The proposed new tariffs have been referred to a small sub-committee.

In accordance with arrangements made with the Police and the Office of Works, public lighting will be extinguished at midnight until further order.

The electrical engineer is in communication with a firm of accumulator manufacturers, respecting a supply of current for projected new works.

Tenders are to be invited for a generating set at the works.

Long Eaton.—Owing to the deficit on the past year's working (£752), and to the high price of coal, &c., the Council have adopted a new scale of charges for electric current as follows:

For private lighting the price will be 4d. per unit, less 5 per cent.; factories, 3½d. per unit for first 2,000 units, and afterwards 2½d. per unit; public lighting, 2d. per unit, less 5 per cent.; power, for first 1,500 units, 1½d. per unit; exceeding 1,500 units, 0·85d. per unit, less 5 per cent.; heating and cooking, 1d. per unit, less 5 per cent.

Newport (Mon.).—At the meeting of the Corporation last week there was a long discussion on the proposal to give a bonus of £100 each to the general manager of the electricity department and the electrical engineer.

The Electricity and Tramways Committee reported that they had considered the question of the organisation of the electricity and tramways departments by the general manager and the borough electrical engineer, and, having regard to their present salaries, thought the time for increasing them inopportune. It was, therefore, resolved that the general manager and the borough electrical engineer be granted a bonus of £100 each, and that a bonus of £30 be divided, as directed, between members of the staff who had worked overtime.

The chairman of the Committee (Mr. JOHN MOXON) having moved the adoption of the report,

Mr. W. E. ROBERTSON moved an amendment that the question of the bonus to the chief officials be omitted, but that the £30 be divided between members of the staff who had worked overtime. He criticised the accounts of the electricity department, and said that, if they compared the figures with those of the previous year, they would find that the gross profit was only £371 more, instead of £743, as had been alleged.

Mr. W. LINTON pointed out that that was the first year the electricity and tramways departments had shown a profit, but, notwithstanding the excellent services of the officials, that was not the moment to increase the payments either by salary or bonus.

In reply, Mr. MOXON said that, if there was one thing necessary in the electricity and tramway departments it was discipline, and it was largely because they had not had discipline that the undertakings had not paid in the past. The two officials in question had been appointed in order to pull the businesses around, and they had done really well. When they were appointed they were told that if they made the businesses a success their efforts would be recognised. It had been suggested that that result had been achieved by the officials working from 10 o'clock to five o'clock; but, as a matter of fact, they had often worked night and day and Sundays as well; and the result was that they had brought about a result that was very encouraging. The officials in question were the men who had the bulk of the work to do, and instead of the shortcomings of the past, they had now new sources of income. During the year they had lent the Alexandra Dock Co. as consumers a loan of £1,200. They had not carried out certain extensions because they had not got sanction to loans from the L.G.Board. The cost of generation was down to the extent of £1,832 on the preceding year. They [illegible] viewed the [illegible] close, personal attention given by the manager [illegible] both officials. The recommendation that the bonus should be paid to the two officials came after the advances to the [illegible] and [illegible] staff had been provided for.

Ultimately the amendment was rejected and the report [illegible].

St. Annes-on-the-Sea.—The Council have advanced the charges for electric current by half penny per unit for [illegible] and 10 per cent. for other purposes except cooking.

Salford.—The charge for electric current has been increased by 7½ per cent. for lighting, power and heating supplies.

Southwark (London).—It has been decided to increase the charges for electric current for power and lighting by 10 per cent.

Walsall.—Owing to the slow progress at the Birchills power house, together with other circumstances arising out of the war, the Electricity Committee has considered the question of how to meet the coming winter's demand in the event of the new plant not being ready.

The matter has been discussed with the consulting engineer (Mr. E. M. Lacey), and the Committee has decided that no further plant be provided at the Wolverhampton-street works. There is, however, a risk of the existing station being unable to cope with next winter's demand in the event of the new station not being ready, and it may become necessary for the tramway service to be restricted between 4 p.m. and 6 p.m. during the winter months. Every possible step is, however, being taken to get the new station completed at the earliest possible date.

The salary of the station superintendent (Mr. A. Prentice) has been increased by £25 per annum and that of the accountant and collector (Mr. C. W. Cookson) by £13 per annum.

At the Council meeting on Monday the accounts of the electricity undertaking were presented and showed a net profit of £1,385. The chairman of the Electricity Committee (Mr. D. HAYWOOD) said that the profit was less than had been anticipated, and that was due to the extraordinary expenses which had had to be met. In view of the increase in the cost of fuel, it might become necessary to revise prices and discounts. A good deal depended on whether the new power station was completed in time for the winter. Owing to the slow progress made at the new works a serious position had arisen, and it had now become a question whether the old power station would be able to cope with the demand upon it. The borough electrical engineer (Mr. H. A. Howie) declined to accept responsibility, and the Committee had either to take the risk involved or to purchase new plant for the old works at a cost of £1,000. They were not prepared to spend more money on the old works, and it was hoped, provided no accident happened, that the winter demand would be met.

The salary of the station superintendent (Mr. A. Prentice) was increased by £25 per annum.

Woolwich.—An agreement has been made with the Secretary for War for the supply of electricity to the Bostall Heath Camp.

Hitherto no meter rents have been charged to customers, except in special circumstances, but having regard to the fact that more than one meter is often required in a private house, and two or more per service in a business house it has been decided to charge 1s. 6d. per quarter for additional meters when more than one is required for a private house, and more than two for business premises.

The Electricity Committee have granted permission to Mr. H. Woodward, general assistant, to enlist in the Army Ordnance Corps, but, owing to the nature of his work, permission to enlist has been refused to Mr. E. Anderson, assistant engineer at the Plumstead works.

LIGHTING, POWER & HEATING NOTES.

Chichester.—The Council have agreed to accept the offer of the Chichester Electric Light & Power Co. to allow £100 on account of decreased lighting, and the contract for public lighting has been renewed for three years from June 30, payment to be based upon the number of lamps in use.

Electric Pumping.—The Wyndham Mining Co., of Egremont, Cumberland, is putting down duplicate electric pumping plant.

There will be two combined centrifugal pumps and motors, each capable of delivering 600 to 700 gallons per minute against a head of 1,300 ft., and two combined centrifugal pumps and motors, each capable of delivering 300 gallons per minute against a head of 360 ft. Three-phase current at 3,000 volts (50 cycles) will be supplied by the Cumberland Waste Heat Co., of Cleator Moor, and it will be used at this voltage for the large pumps and at 500 volts for the smaller pumps.

Frome. Edmundson's Electricity Corporation have made a rebate of £30 on the year's electric lighting account owing to the reduced hours of lighting.

Factory Lighting Regulations.—Additional regulations for the defence of the realm have been made, and extend the powers of the Secretary of State under sec. 150 of the Factory and Workshop Act (1901) to exempt from the operation of the statute factories employed during "public emergency."

Under the new rules for the control of lighting, the Secretary of State may order that all lights shall be extinguished or obscured between any hours and within any area, and if no police constable is available to see that the order is obeyed, "any soldier or sailor on sentry patrol or other similar duty" may enter premises or stop and seize any vehicle to extinguish or obscure the lights. No coloured lamp is to be carried on any vehicle other than a locomotive or railway carriage without lawful authority, unless such light is already authorised by law. Lights carried on vehicles are not to be capable of movement independent of the movement of the vehicle," and they are not to be fitted so as to throw light "in any direction other than that in which the vehicle is proceeding."

Middleton. The price of electric current for lighting has been increased by ½d. per unit and for power by 12½ per cent., as from July 1.

TRACTION NOTES.

Fire Brigade Motors. In the annual report of the Chief Officer of the London Fire Brigade (Lieut.-Commander Sladen) reference is made to the introduction of motor equipment.

[illegible] have been added: also two [illegible] which have been mounted on ladders, two electrically driven motor escape vans; two petrol driven motor escape vans; one petrol motor lorry; two petrol motor cars; one petrol motor instructional chassis and one petrol motor emergency tender. Motor pumps, motor escape vans or motor ladders have replaced similar horse-drawn appliances at Headquarters, Brompton, Euston, Red Cross-street, Whitechapel, Dulwich, Lewisham and Old Kent-road stations. A new motor "emergency tender" was put into commission. This appliance carries a number of smoke helmets and is fitted with a dynamo, portable searchlights and an electric blower for forcing air into places where dense smoke or poisonous gases exist. Nine petrol motor ambulances are in course of delivery. The present tentative scheme will probably need enlargement in future. It had been anticipated that the service would be inaugurated during the year, but the war delayed the delivery of the ambulances, the installation of the telephonic facilities, &c., at the stations.

Glasgow. In view of the scarcity of labour the Tramways Committee have decided not to proceed with the extension of the tramways to Millerston at present.

Hove.—The Council have decided to extend the time for the equipment of the through trolley vehicles routes until the expiration of two years after the declaration of peace in the present war.

It is propsed that neither Hove nor Brighton shall, prior to the expiration of a year from the declaration of peace, apply to the Board of Trade for the appointment of an Arbitrator under sec. 15 (*a*) (1) of the Brighton Corporation Act, 1912, or sec. 16 (*a*) (1) of the Hove Corporation Act, 1912; and that the parties shall take such steps as are required to extend the time provided under the Acts for the completion of the trolley vehicle equipment for five years from August 7, 1917.

London County Council.—At the meeting on Tuesday the Highways Committee presented a further report on the recent tramway strike.

The report gives a history of the strike, and mentions that, in order to run cars for munition workers, the Council had to rely on the services of those who remained loyal, and on a number of inspectors and regulators and of officials from the depots and offices. By that means a fairly and increasingly efficient service was provided throughout the strike for munition workers. Some instances are given of attempts which were made to delay the tramcars by tampering with the conduit and placing obstructions in the slot, but the offenders could not be traced. A number of men above army age reported for duty during May 31, and since that date the cases of men of military age applying for reinstatement have been investigated, and a certain number of them have been allowed to resume work. A large number of men produced certificates of unfitness for the forces. Before the strike great difficulty was experienced in maintaining a full service, but by June 10 about 80 per cent. of the normal number of cars were being run, and it was anticipated that in another week at least 90 per cent. of the normal number of cars would be in operation. The Committee add that they have expressed to the chief officer of tramways their high appreciation of the services rendered by him during the strike, and have accorded to him and the staff who so loyally assisted him their cordial thanks for the assistance rendered to the Council. It was proposed to give further consideration to the cases of those employés who had remained loyal to the Council.

York. At the last meeting of the Corporation Ald. Meyer, chairman of the Electricity and Tramways Committee, said that the receipts per car-mile from the electric omnibuses during April were 7·05d., and would not pay all expenses, but it was unreasonable to expect at the beginning of the service that the omnibuses would earn the entire expenses. Satisfactory arrangement has been made for [illegible] the Hull road route.

EMPIRE NOTES.

Australasia. The "Times" correspondent at Auckland [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

materials produced outside the Commonwealth and contracted for or purchased by the Railways Department during the year ended June 30, 1914. The total value of such purchases was £2,992,652, and included £2,262,949 for materials required in connection with the electrification of the Melbourne suburban railways. Out of the latter figure £2,255,364 was for goods not made in Australia and £7,585 for goods not obtainable locally in sufficient quantity. In other cases Australian prices were too high. With regard to £11,810 worth of imported wheel centres, it is stated that the price of the local article was 61 per cent. higher, lubricating oils were 145 per cent. higher and lubricators 27 per cent. A trial order has been given for Australian wheel centres.

The "Australian Mining Standard" says the Council of the Shire of Poowong and Jeetho (Victoria) will carry out the recommendations of Mr. V. J. Crowley as to the electric lighting of Korumburra. Mr. Crowley recommended the renewal of some of the mains, the overhauling of house services, and the purchase of a new switchboard and a booster for the power-house, at a cost of about £1,100. Mr. Crowley has been appointed consulting engineer at 52 guineas per annum, and tenders are to be called for.

On April 15 members of Melbourne City Council inspected the Spencer-street power-house, in order to commemorate the 21st anniversary of the inauguration of the undertaking on March 8, 1894, when Melbourne was first lighted electrically. The city electrical engineer (Mr. H. R. Harper) conducted the visitors, and a brief history of the scheme and its development was presented to each. The original plant was for public lighting only (650 arc and 1,200 incandescent lamps) while the power house contained four 300 H.P. engines of Australian make, with 24 dynamos, each capable of supplying 50 arc lamps. The total capacity of the plant will be about 31,000 H.P. when machinery on order has been installed. The first extension of plant took place in 1897, when the Council contemplated a supply to private customers (100 volts a.c.), and until 1901 distribution was effected solely by overhead wires, but in that year underground mains were substituted in the central portion of the city, to supply direct current at 230 and 460 volts. At the same time the Council arranged to take over the interests of the three private supply companies for about £50,000. In 1908 two steam turbines were installed owing to the extension of the single-phase alternating current supply to the outer portions of the city. To meet the expected demand of the winter of 1916 an order has been placed with the British Westinghouse Co. for a three-phase turbo-alternator of 7,300 H.P. A supply of three-phase current is being given to the municipalities of Brunswick and Port Melbourne and to the State Cool Stores, and a similar supply is to be given to the new freezing plant at the municipal abattoirs and to Williamstown municipality. Steps are being taken to discontinue the generation of single-phase current which is used at present in the outlying portions of the city and in Footscray. These districts will in future be supplied through transformers connected to the three-phase system. The gross capital expended is £867,703, but £157,807 has been recouped from depreciation and renewals funds. There are also balances to credit of sinking fund and depreciation accounts of £117,795 and £193,441 respectively.

Williamstown (Victoria) Council which had earmarked £18,000 out of the £35,000 proposed loan from the Government for a municipal electric lighting scheme, has decided to withdraw the amount, and the Finance Committee has been authorised to make other arrangements for floating a loan for the same purpose. It is explained that the object of the Government in offering to lend money to municipalities is to provide employment, and, as a large portion of the lighting loan will be sent abroad for machinery, that object would be defeated if the full loan were granted.

Mr. A. E. Grace (of Messrs. Grace Bros., Sydney), who is a debenture holder for the Mudgee Electric Light & Power Co. (in liquidation), has notified his intention to put in a duplicate set of engines for the improvement of the Mudgee (N.S.W.) electricity works.

East Fremantle (W. Australia) Municipality propose to borrow £1,428, to which is to be added £8,571 by the Fremantle Municipality for additions to power-house plant, boiler, &c., and also for mains and transformers and for tramway extensions and two cars.

Canada. The new electrically operated double-track swing bridge built by the Canadian Pacific Railway Co. over the Lachine Canal is of particular interest to railroad builders.

The new bridge, which is among the most up-to-date in North America, completes the double tracking of the Canadian Pacific Railway between Montreal and Brigham Junction. The total cost was £466,000.

Hong Kong. The United States Consul at Hong Kong says Japanese makers of electrical goods have taken advantage of the closing of the Hong Kong markets to German goods.

The Japanese factories have carried on an active campaign on behalf of their goods, which include practically all ordinary electrical supplies, apart from electrical machinery and the finer grades of electrical apparatus. Prices are much lower than those for American goods, though the American goods are [illegible] superior in quality. One company imports filaments from the United States and manufactures the lamps in Japan, the lamps selling for about 15 cents gold wholesale. These lamps lack the life and efficiency of the American and European lamp [illegible] with them, but [illegible] a considerable trade. The situation is similar as regards the trade in insulated wire, fuses, insulators and globes. The Japanese may almost be said to control the market in some of these lines at present. Some of these goods are almost 50 per cent. cheaper than goods from the United States or Europe. The trade [illegible] electrical goods generally in Hong Kong continues to increase.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says Cesar in municipality have received several tenders for the equipment of electric works.

The Government of the province of Buenos Ayres has authorised La Positiva Automatic Telephone Co. to instal the conductors of its lines on the telegraph posts of the province for two years.

The principal countries from which Argentina obtained her imports of electrical goods in 1912 and 1913 were as follows: Germany, $5,345,904 in 1912 and $5,069,988 in 1913; United Kingdom, $2,313,959 and $3,480,530; United States, $548,267 and $598,058; Italy, $423,867 and £531,860; Belgium, $303,092 and $64,782; France, $204,779 and $147,340; Holland, $93,637 and $116,965. The total values were $9,308,785 in 1912 and $10,110,088 in 1913.

Japan. The "Far Eastern Review" contains the following notes on the industries of Osaka:—

Metallic Filament Lamps.—The manufacture of tungsten lamps with imported filament has proved most profitable. The total output in Japan is from 5,000,000 to 6,000,000 lamps a year, of which the greater number are made in Osaka.

Hydro-electric Power.—The Ujigawa Hydro-Electric Power Co., whose works were completed in June, 1913, supplies power in Osaka and Kyoto. The power house is at Uji (9 miles from Kyoto and 22 miles from Osaka). Three-phase current (60 cycles) is transmitted by aerial lines to Osaka at 55,000 volts and to Kyoto at 11,000 volts. The plant includes six generators (one spare) of 4,500 kw. The principal customers are the two electric light companies of Osaka and Kyoto respectively. The maximum day load is 8,150 kw. and the night load 23,000 kw. The Osaka municipal tramways take 4,000 kw. The capital sunk in the undertaking is about £1,800,000. The charges for current range from 4½sen (1·1d.) to 3 sen (¾d.) per unit, though contract prices are lower.

Electric Railways.—The growth of electric railway systems continues. There are within a radius of 50 miles of Osaka nearly 250 miles of double track in operation, and 80 miles under construction or projected.

Municipal Tramways.—The municipality has 27 miles of double track.

Russia.—A consular report from Batoum states that the trade in electrical machinery had largely, if not entirely, fallen into German hands, but the activity recently exhibited by United Kingdom manufacturers should succeed in gaining a part of the trade for British-made goods.

There are few countries in the world possessing so many rivers adaptable for working hydro-electric works as the Caucasus, but up to now only about a dozen power stations exist there. A concession was granted by the Russian Government in November, 1912, to a British firm for the erection and equipping of power houses to supply electrical energy in the Northern and Trans-Caucasus. The concessionaires obtained permission to utilise the waters of the River Terek at Kazbek on the Georgian military road, and those of Lake Goktscha village of Elenofika, in the Government of Erivan. Some progress was made with the scheme during the first half of 1914. The financial side of the question has still to be solved, and it is not expected that this can be achieved before the close of the war.

A large electric power station to supply current for lighting tramways, refrigerating works in the central market, &c., are to be erected at Tashkent (Trans-Caspia).

Shanghai. The gross capital expenditure of the electricity department at Dec. 31, 1914, was £667,198.

Year's revenue was £169,625, working and general expenses, including depreciation (£29,214), were £122,915, and after providing for capital and other charges, the net profit was £11,090.

Mr. T. H. U. Aldridge, the chief engineer, reports that working expenses per unit sold were 0·684d.; motors connected are equal to 12,181 H.P. (increase 6,917 H.P.), and units sold were 32,633,671 (compared with 19,928,446 in previous year). The war has greatly delayed the delivery of some sections of the new plant, all of which was scheduled to be installed and in operation towards the latter part of the year. The four new Babcock & Wilcox boilers and the pipework was completed before the end of the year and put into commission. One of the A.E.G. 5,000 kw. turbo-generators was put into use on Dec. 11. The machine would have been in commission earlier but for delay in delivery of the main pipework by Messrs. Aiton & Co., of Derby, owing to shipping congestion after the outbreak of war. With regard to the second 5,000 kw. set, the greater portion of that shipment had to be brought after considerable delay from Manila, as the ship in which it was being carried took refuge in that port. Two more cases, one containing the field-magnet rotor of the set, are being held up at Alexandria. Endeavours to obtain release of these have so far been without success. Delay also took place with both the new switchgear for the underground feeders (from the British Westinghouse Co.) and with the 5,000 kw. generator switchgear which had been constructed by Messrs. A. Reyrolle & Co.

The plant capacity of the two stations is 14,900 kw., and but for the non-delivery of the second 5,000 kw. machine it would be 19,900 kw. Maximum load delivered to feeders for light, [illegible] was 11,190 kw., and including the load at Riverside for operating auxiliaries the maximum load was 11,500 kw. Last year the load factor was 30·8 per cent., but this year it reached 37 per cent. The load factor is considerably higher than those of Manchester, Glasgow, Birmingham and Liverpool. The four large central district sub-stations, each designed to accommodate 2,000 kw. of transforming plant, e.h.t. and low-pressure switchgear, were completed and put into service. The areas of the central district served by those four sub-stations were converted from single-phase to three-phase distribution with very satisfactory results. A new type of galvanised iron sub-station has been designed, some of which were constructed at Riverside for use in places where the cost of a brick or concrete sub-station would not be justified. Several of these have already been employed at various mills and have so far proved serviceable, although cheap in first cost. They are large enough to accommodate 1,000 kw. of transforming plant, and they can be substituted by a permanent brick or concrete structure, the galvanised iron one being transferred for use elsewhere.

In a letter accompanying the report Mr. Aldridge says, in regard to the proposed 20,000 kw. extension scheme which is to be carried out next year, it has not yet been definitely decided what pressure of transmission for the trunk cables will be adopted, but he expects 20,000 or 30,000 volt underground cables will be used, and will be fed through transformers at the Riverside generating station, stepping up from 6,600 volts, and at the Fearon-road generating station, which is being converted into a distributing station, the current will be afterwards stepped down to 6,600 volts. It is proposed to consider the step-up and step-down transformers as part of the trunk cables, and in this connection switching will be done on the 6,000 volt side only at both ends; on the e.h.p. side links will be provided for isolating the transformers from the cables. Tenders will be called for steel work for buildings, boilers, turbo-alternators, switchgear, step-up transformers, cable, &c., and the extension will form an addition to the existing Riverside station, and will bring the plant installed there up to 34,000 kw. Two 600 kw. Ferranti steam alternators will have to be taken out to make room for the new switchgear, &c., which will reduce the capacity of that station to 4,400 kw., making the total capacity of the two stations 38,400 kw. approximately. Electricity supply in Shanghai is going ahead well. In connection with domestic supply, heating has taken on during the last three years very satisfactorily, a large number of radiators being used by Chinese consumers as well as by Europeans. The success of this particular line is attributed largely to the fact that the department hires radiators out to consumers at a monthly rental. At the end of last year 871 electric radiators were connected, representing about 1,700 kw., whilst 52 electric cookers were also in use. The growth of the power supply is extremely gratifying. The district all round Shanghai is suitable for cotton growing, and a very large area is under cultivation. Japanese cotton spinners who have mills in Japan are now building mills in Shanghai, in order to be able to obtain the raw material cheaper. During the past year three additional cotton mills have decided to take bulk supply from the Council's mains, which will add, roughly, over 1,000 kw. demand. Amongst other important power users are several flour mills, in one of which 600 H.P. is installed. There is also a very large business done in hulling rice, and the load for that supply is considerable. Practically all the printing presses in Shanghai are driven electrically, whilst small motors (from 1 H.P. to 20 H.P.) are extensively used for various uses. The units sold last year totalled 32,885,000, and they are expected this year to reach 56,000,000, including private lighting 16,980,000, power 33,612,000, heating 554,000, public lighting 1,000,000, traction 4,000,000.

MISCELLANEOUS NOTES.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade have published lists 24 and 25 of articles inquirers desire to purchase but whose sources of supply or markets have been interfered with by the war. United Kingdom manufacturers and exporters of British goods can obtain copies from 73, Basinghall-street, London, E.C.

Enemy Patents. Some [illegible] have been made in the procedure under the Patents and Designs and Trade Marks Act, 1914.

The new rules provide that during the continuance of the war no patent will be sealed and no registration of a trade mark or design will be granted to subjects of any State at war with His Majesty. The persons to whom this applies will include (*a*) a firm which by reason of its constitution may be considered as managed or controlled by such subjects or the business whereof is wholly or mainly carried on on behalf of such subjects; (*b*) a company which has received its constitution in an enemy's State; (*c*) a company registered in His Majesty's dominions, the business whereof is managed or controlled by alien enemies or is carried on wholly or mainly on behalf of such persons.

As regards applications for patents, designs or trade marks, no distinction will in the first place be drawn between those made by alien enemies and those made by other persons. All proceedings thereunder will be carried on as usual down to and including acceptance, but in the case of applications by such subjects proceedings thereon, subsequent to acceptance, will be suspended until otherwise directed. As regards opposition to the grant of patents and the registration of trade marks after the commencement of the war, opposition by alien enemies in cases where the grant of the registration opposed is one to a British citizen or alien friend will not be entertained. In the case where the grant or registration opposed is a grant or registration to an alien enemy, the notice of opposition will be accepted, and will be suspended until the end of the war. As regards inventions communicated by alien enemies in respect of which patents are applied for by persons in this country, these will be treated in the same manner as if made directly by an alien enemy.

TENDERS INVITED.

Turbo-Alternators, Motor Generators, Boilers, Stokers, &c.

Halifax Tramways and Electricity Committee require tenders by noon July 1 for (contract No. 15) 5,000 kw. Turbo-alternator, with Condenser (No. 16), two Natural Draft Chimney-type Cooling Towers, and (No. 17) Water-tube Boiler, Superheater and Mechanical Stokers. Forms of tender from the Borough Electrical Engineer.

Sydney (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

Wigan Electricity Committee want tenders by June 21 for Two Water-tube Boilers with Mechanical Stokers. Specification, &c., from the Borough Electrical Engineer.

The New South Wales Government Railways and Tramways Department require tenders by noon July 21 for supply of a 250 k.v.a. Direct-coupled Turbo-generator. Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Tenders are invited for the supply and delivery in Melbourne of one 1,000-kw. direct-current Generator with Field Regulator and accessories, one Liquid Starter with accessories, together with one spare set of Carbon Brushes and one spare Field Coil for generator. Tender form, with specification, &c., from the agents for Melbourne City Council (Messrs. McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-bldgs., London E.C. Tenders to the Chairman of the Electric Supply Committee, Town Hall, Melbourne, by 10 a.m. Aug. 11.

Telephone Exchanges.

The Director-General of Telegraphs, Madrid, requires tenders by noon on the dates mentioned for the construction and working for 20 years of a Central Telephone Exchange at each of the following towns: Cabeza de Buey, Province of Badajoz (June 21); Guadix, Province of Granada (June 25); Haro, Province of Logroño (June 26); Tudela, Province of Pamplona (June 27); Baza, Province of Granada (June 28); and Vinaroz, Province of Castellón (June 28). The "Madrid Gazette" of May 25 and 26, containing particulars regarding the necessary plant and material, may be seen at 73, Basinghall street, London, E.C.

Wiring and Fittings.

The Walsall and West Bromwich Unions Joint Committee require tenders by 4 p.m. July 5 for the Electric Lighting of new buildings in Great Barr Park. Specifications from the Clerk to the Committee, 22, Lombard-street, West Bromwich.

Dublin Technical Education Committee require tenders by noon June 21 for Electric Lighting in the Technical Schools, 18, Rutland-square, Dublin. Particulars from Mr. J. Clarke, Technical Institute, Bolton-street, Dublin.

Glasgow School Board want tenders by 10 a.m. June 19 for Electric Lighting at Springbank Public School. Specifications from the School Board Offices, 129, Bath-street, Glasgow.

The Metropolitan Asylums Board require tenders by 2:30 p.m. June 30 for the Electric Lighting of blocks 3 and 11 and isolation blocks 19 and 20 at the Grove Fever Hospital, Tooting Graveney, London, S.W. Specifications from the Board's offices, Embankment, E.C.

Brighton Guardians require tenders by 10 a.m. June 22 for the supply of Electrical Fittings to the Poor Law Institutions and Warren Farm Schools. Forms of tender, &c., from the Clerk, Prince's-street, Brighton.

Bristol Corporation require tenders by noon June 21 for six or 12 months' supply of Electrical Fittings. Tender forms, &c., from the Clerk, St. Peter's Hospital, Bristol.

Galvanised Iron Wire.

The Deputy Postmaster-General, Adelaide, will receive tenders until 2 p.m. July 14 for the supply of Galvanised Iron Wire to the Commonwealth Government Postmaster-General's Department. Specifications and forms of tender obtainable at the Commonwealth Offices, 21, Victoria-street, London, S.W.

Tramway Construction.

The Tramways Power Works, Madrid, will receive tenders until [illegible] for the construction and erection complete of the Power House, Motor and Tram Premises at Hortaleza, including track required to commence working in three motor tramcars. An option on the Company's rail for [illegible] cars.

Electrical and General Stores.

Salford Corporation want tenders by noon June 28 for supply of Cables, Cable Accessories, Conduits, Pipes, Troughing, m.d. Indicators, Carbon Brushes, Tools, Engineers' Stores, Oils, &c. Specifications from the Electrical Engineer, Frederick-road, Pendleton.

Tenders are wanted by June 29 for 12 months' supply of Electrical Appliances, Rubber Goods, Packing, Oils, &c., to Devon County Asylum, Exminster. Forms of tender from the Clerk.

Eastbourne Electricity Committee require tenders by June 26 for about 160 ft. of 14 in. c.i. Circulating Water Piping and Valves. Specification, &c., from the Borough Electrical Engineer.

West Ham Guardians require tenders by 10 a.m. June 24 for three months' supply of Electric Fittings, Oils, &c. Forms of tender from the Clerk.

Meters and Maximum Demand Indicators.

Christchurch (N.Z.) Council want tenders by noon July 3 for two years' supply of House Service Meters. Specification, &c., from the City Electrical Engineer.

Sydney Municipal Council require tenders by 3 p.m. July 19 for supply of Electric Meters and Maximum Demand Indicators. Specifications from the City Electrical Engineer. (The Council will grant 10 per cent. preference on British made goods and 5 per cent. preference on those of the allied countries during war.)

TENDERS RECEIVED AND ACCEPTED.

Bradford.—The Tramways Committee have accepted the tender of the M. & G. Truck & Engineering Co. for 100 tramcar trucks at £87 each, and that of Brown, Boveri & Co. for 200 tramcar motors at £110 each.

For the supply of glass flooring (switchboard lights) at the Valley-road electricity works, the tender of Hayward Bros. & Eckstein (at £118) has also been accepted.

Chesterfield.—The Corporation have accepted the following tenders:—

British Westinghouse Co., 400 kw. alternator, £877. 10s.; Babcock & Wilcox, boiler £997, superheater £195 and mechanical stoker £280; Clay Cross Co., economiser, £359.

Leigh (Lancs).—The following tenders have been accepted by the Corporation:—

Bruce Peebles & Co., rotary converter, £895; Switchgear & Cowans (Ltd.), switchgear, £71; Stirling Boiler Co., boiler, £2,044; Underfeed Stoker Co., stoker, £408.

Salford.—The Electricity Committee has accepted the offer of the British Westinghouse Co. to supply and erect a 5,000 kw. turbo-alternator at the Frederick-road station for £16,200.

Swansea.—The tender of the British Westinghouse Electric & Mfg. Co. has been accepted by the Electric Supply Committee for the supply and erection of a 250 kw. rotary converter, transformer and switchgear for £970.

Wolverhampton.—The Electricity Committee recommends the acceptance of the following tenders:—

Underfeed Stoker Co., automatic stokers, £600 (work incident to installing stokers to be carried out by the electrical engineer at cost of £300); Ferranti Ltd., two sets of switchgear, £438. 4s. 3d.

Southend-on-Sea.—The Corporation is recommended to accept the tender of Edward Le Bas & Co. for the supply of ½ mile of overhead trolley wire at 11¾d. per pound, and that of E. Carrick & Sons (at £167) for a crane for the Leigh sub-station.

Cheltenham.—The Council have accepted the tender of the Medway Safety Lift Co. (at £368) for the erection of an electric lift at the Town Hall.

Railway Lamps.—The Caledonian Railway Co. have placed a contract for the supply of Royal Edison lamps with the Edison & Swan United Electric Light Co.

Redditch.—The Council have placed an order with Babcock & Wilcox for a water-tube boiler at £1,750, and with Wreting Bros. for a cooling tower.

Darlington.—The Council have placed an order with the British Thomson-Houston Co. for the supply of h.t. switchgear.

RUGBY.—The Council have accepted the tender of the Macintosh Cable Co. for the supply of cables.

CHELMSFORD.—The Education Committee have accepted the tender of E. C. Porter (at £73) for electric lighting installation.

SHEFFIELD.—The tender of Brown Bayley's Steel Works (Ltd.) has been accepted for the supply of 500 steel tramcar tyres.

MELBOURNE (VICTORIA).—The Electric Supply Committee have accepted the tender of British Insulated & Helsby Cables for 13 tons of bare copper cables, £1,294, and that of Johnson & Phillips for 13,560 yds. of insulated copper cables, £1,534.

The Abattoirs Committee have accepted the tender of Elder, Smith & Co. for an electric motor for lift at desiccating works, £42. 18s. 6d.

PERTH (W. AUSTRALIA).—The City Council have accepted the tender of Callender's Cable & Construction Co. (at £6,237) for underground cables, and have signed the agreement with Chas. Atkins & Co. for the supply of electric lamps.

WHANGAREI (N.Z.).—The Council have received the following tenders for wiring and fixing meters :—

National Electrical & Engineering Co. (accepted), £7,946 ; Turnbull & Jones, £8,287 ; A. & T. Burt, £8,114.

Meter Contracts.—Messrs. Chamberlain & Hookham have received contracts for annual supplies of meters to Paisley, Stoke-on-Trent and Wallasey Corporations.

Ferranti Limited have secured a contract from Wallasey Corporation for the supply of a.c. electricity meters for the year ending June 30, 1916.

Wallasey Council have placed a contract for 12 months' supply of single phase meters ; St. Anne's Council for 100 d.c. meters with the Electrical Apparatus Co. ; and Stoke Council for a portion of the d.c. meters required.

Wallasey Corporation have also placed an order with the British Thomson-Houston Co. for 12 months' supply of single-phase a.c house service meters.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bolton.—The total capital expenditure of the tramways department at March 31 was £570,981, of which £348,111 is outstanding.

Revenue was £141,410 (compared with £143,774 in previous year) and working expenses were £76,131 (£77,193), leaving gross profit (£65,279 (£66,581). After providing for interest, instalments of loans, &c., £18,339 (£18,357) has been set aside for renewals and £17,000 (£17,500) voted in aid of rate. Average fare charged per mile was 0·633d. ordinary and 0·336d. workmen's. Average total revenue per car-mile was 11·758d. (against 11·944d. in previous year), and working expenses, including power, were 6·33d. (6·412d.). Passengers carried were 31,370,166, car-miles run 2,886,180 and units used 4,514,010 (1·56 per car-mile).

Glasgow.—An abstract of the tramway accounts for the year ended May 31 has been issued.

The traffic receipts were £1,070,694 (against £1,078,691), and sundry receipts £6,183 (£5,155), a total of £1,076,877 (£1,083,846). Traffic expenses were £345,625 (£332,546), general expenses £142,020 (£134,034), maintenance and repairs £144,530 (£156,214), power £51,995 (£53,483), special expenses entailed by the European war were £51,816, a total of £735,987 (£676,277), leaving a net balance of £340,890 (£407,569). After crediting Dumbarton tramways receipts £126 (£180), and interest on investments £65,700 (£64,809), the total was £406,717 (£472,558). Deducting rent of Paisley lines £5,559 (£5,830), interest on capital £78,797 (£82,921), sinking fund £105,491 (£102,606), income tax £22,789 (£14,056), Parliamentary expenses £8,817 (£609), and renewal and depreciation £172,310 (£212,642), leaving £12,951 net, against £53,892.

Lincoln.—The gross capital expenditure of the electricity undertaking at March 31 was £84,202 (increase of £1,220 over 1914), of which £17,924 is outstanding.

Income was £15,021 (against £14,525 in previous year) and expenses were £7,190 (£7,733), leaving gross profit £7,831. Repayment of loans and interest required £4,668 (£4,077), and after devoting £2,000 (£1,500) to relief of rates and using £31 for war-service allowances, the net profit is £1,132 (£1,040). Revenue was equal to 1·570d. per unit sold, working and general expenses were 0·753d. (0·882d.), and total costs (including capital charges) 1·242d. (1·347d.). Total maximum supplies demanded were 100 kw. (100 kw.) for traction and 1,245 kw. (1,140 kw.) for lighting, &c. Consumers increased from 820 to 853, and total connections are equal to 121,853 (106,962) 8 c.p. lamps. Units generated were 2,674,871 (2,467,796) and sold 2,291,114 (2,105,047).

The capital expenditure on the tramway undertaking is £44,987 (no increase), of which £40,226 is outstanding. Revenue was £6,599 (£7,123) and working expenses were £3,941 (£4,050). Interest required £1,529 (£1,529) and sinking fund £1,071, and (£1,071) the net profit was £58 (£473).

Average total revenue per car-mile was 10·59d. (10·36d.), working expenses, including power, were 6·37d. (5·91d.). Average fare per mile was 0·428d. (0·428d.). Passengers carried were 17,135,42 (1,826,885), car-miles run 148,440 (164,499) and units used 173,895 (190,838).

Mr. Stanley Clegg (city electrical and tramway engineer) reports that new motors of 898 H.P. were connected during the year, and a large proportion of these were at the Co-operative Flour Mill, the remainder having been put in smaller manufacturing works which received Government orders for munitions and required extra power. In one works where, previous to the war, the only mechanical drive consisted of about 70 H.P. in motors, about 70 H.P. is now installed.

In regard to works costs, Mr. Clegg states there are substantial decreases under every head save repairs (the increase under which is due to mains failures), rates and taxes and interest and sinking fund. Cost of coal has been reduced by 26 per cent. compared with the previous year. By taking into account the three facts that entered into the saving—viz., reduction in the price of coal, increase in efficiency of plant and increase in units generated he found that the coal bill for the past year would have been £3,574, thus showing that they had made an actual saving in coal to the value of £1,133. Of that amount, £499 was represented by the reduction in price and £634 by the increased efficiency of the plant, the cost of mains renewal increased materially. In the past 10 years the units sold for lighting increased from roughly 400,000 units to 660,000, or about 65 per cent. increase. The plant required to supply the lighting (irrespective of any spare) was 413 kw., so that had no power load been developed in the interim, 700 kw. would have been required to supply the lighting only during the past year. Actually 1,245 kw. of plant was required to supply both lighting and power last year (exclusive of traction) so that where 700 kw. would have been required to supply 660,000 units for lighting only, an extra 545 kw. was necessary to supply the whole of the power load of nearly 1,500,000 units, and when the capital and other standing charges on the plant required to supply those different loads were taken into account, it conclusively showed why power could be supplied at a so much cheaper rate than lighting.

The tramway department has suffered considerably more than the electricity department from the effects of the war. Total working expenses are about £100 less than in 1913-14 on a total car-miles run of 16,000 less, all of which service reduction had taken place since the beginning of August. The consequence has been that the running costs per car-mile had increased from 5·91d. to 6·37d. The cost of repairs to G.B. equipment, while slightly less than last year, is considerably in excess of the average guarantee of £90 made by the company, and for the total period during which the system has been in operation, the actual average cost has now increased to £119, against £115 last year. In considering the question of the cost of G.B. repairs, it should be borne in mind that, as Lincoln was the only installation of that particular system, all stud replacement parts had to be made specially, there being no stock of them, and only one manufacturer who had any particulars of their manufacture. Car repairs had been somewhat heavier, due more or less to necessary repairs to armatures and G.B. bobbins. The failure of the bobbins was due, in large measure, to the wet winter, but that of the armatures was caused by the speeding-up due to the trial which was made during about a fortnight of accelerating the speed of the service.

Newport (Mon).—The following are abstracts of accounts of the electricity and tramways undertakings for year ended March last :

The revenue of the electricity department was £44,615, compared with £44,548 in 1913-14, and working expenses were £23,007 (£23,312), leaving gross profit £21,608, which, with accrued interest £1,852, makes £23,460. Capital charges, &c., required £22,716, leaving net surplus £743. 13s. 9d. (compared with a deficiency last year of £1,240). During the year the department lost one of its largest consumers, the Alexandra (Newport and S. Wales) Docks & Railway Co. Units sold for all purposes were 4,789,240. Consumers increased by 153. Enhanced cost of materials and increased wages materially affected the result of the year's trading. New meters have been purchased out of revenue. Notwithstanding increased output, generation costs show a decrease of £1,822, chiefly accounted for by a reduction in cost of coal and maintenance of plant.

The tramways traffic receipts were £41,752 (compared with £40,152 in previous year) and other receipts £952 (compared with £1,039). Working expenses were £30,956 (£34,493) and gross profit was £11,748 (£6,698), plus interest £858, making the gross profit £12,606. Out of this charges amounting to £10,188 have been met, leaving £2,417 (compared with a deficiency last year of £2,017). The increased revenue was earned on a decreased car-mileage of 3,629. Passengers carried increased 254,753. The estimated cost of putting the permanent way into order was £30,000, and it was decided that the Works and General Purposes Committee should undertake the work, which was to be spread over four years. The tramways department contributes £5,500 annually, but that amount proved insufficient for the past year. The total expenditure on permanent way was £9,955, of which £2,000 was paid out of the district fund, as representing the additional cost to the tramways department of maintaining and renewing the surface of the roads up to the required standard

St. Anne's-on-the-Sea.—The electricity department's accounts for the year ended March 31 show capital expenditure £54,918 (increase £499, [illegible]).

Revenue was £12,056 (compared with £11,726 in previous year), gross profit was £4,269 (£4,449), and interest, instalments of loans and sinking fund required £3,373, leaving net profit £939. Units generated were 1,312,490, and sold 1,194,703 (1,051,815).

The accountant's report states that the increased revenue for domestic and power purposes (£1,182, against £1,137) is satisfactory, having regard to the fact that the charge was 1d. all round, while in the previous year the first 200 units were charged at 2d. per unit. The charge for street lighting was 2¼d., compared with 2½d., but the decrease of revenue from £1,943 to £1,867 was due entirely to a decrease of cost of repairs and maintenance (£114), and additional lamps (£27). Average price obtained was 2·107d. (2·357d.) from sale of current alone, or 2·177d. (2·432d.) including all receipts, and working expenses were 1·320d. (1·417d.) per unit sold or 1·997d. (2·177d.) including capital charges, leaving net profit 0·180d. (0·255d.).

West Bromwich.—The accounts of the electricity department for the year ended M[illegible] show capital expenditure £99,721 (increase £5,234), of which £73,922 is outstanding.

Revenue was £20,251 (compared with £18,313 in previous year), working expenses were £13,648 (£12,519), and gross profit £6,605 (£5,795) Interest required £1,885 (£2,091), and instalments of loans £3,842 (£3,674), net profit being £878 (£30), out of which £536 has been appropriated for capital expenditure. Total working expenses were 0·789d. (0·846d.) per unit sold and interest and sinking fund required 0·331d. (0·389d.), while total revenue was equal to 1·171d. (1·237d.) The units generated were 5,154,334 (against 4,226,383) and sold 4,149,010 (3,552,762). Maximum load was 2,050 kw. (1,833 kw.) and load factor 23·3 (22·1) per cent.

Mr. W. A. Jackson (borough electrical engineer and manager) says, in his report, notwithstanding a decrease of 131,661 units in the supply for public lighting the total increase in sales is the greatest in any year since the traction supply was initiated in 1904. Motors connected are 349, increase 49 (=1,023 H.P.), and the total power connections are now 4,871 H.P. No additions have been made to the generating plant during the year, but a 500 k.v.a. motor alternator is being installed for giving an a.c. supply for electric furnaces and welders. All new feeders will give an e.h.t. three-phase supply, and this system has been adopted for the supplies for the electric furnaces of Steel Castings (Giles Foundry and T. Hackett & Sons).

West Ham.—At March 31 the gross capital expenditure on the tramways was £556,878, as in 1914.

Revenue was £154,037 (compared with £145,189 in previous year), and working expenses were £119,936 (£126,175). Interest required £20,456 (£20,056) and sinking fund, &c. £13,373 (£13,381), and net profit was £13,372 (£13,381). Average total traffic revenue per car-mile was 9·83d. (9·27d.), and working expenses (including power) were 7·65d. (8·061d.) Units used were 1·66 (1·85) per car-mile. Average fare charged per mile was 0·5d. Passengers carried were 42,667,561 (41,152,501), car-miles run 3,760,361 (3,756,354), and units used 6,306,731 (6,974,894).

The manager, Mr. J. S. D. Moffet, says in his report the cost of renewals amounted to £3,123. 14s. 11d., whilst the total cost of ordinary permanent way repairs was £17,241. 10s. 7d., making an expenditure on track maintenance of £20,365. 5s. 6d. (against £22,035). The expenditure is largely due to heavy vehicular traffic which passes over most of the roads. The high speed at which solid rubber-tyred vehicles, such as motor lorries and motor 'buses, are allowed to travel, is the cause of most of the damage. That tramways in and around London should be compelled to make good the damage done to the surface of the roads within track limits to a large extent by the vehicles of a combine, which is not only in competition with but openly antagonistic to municipal tramway undertakings, is a state of affairs which would not be tolerated in any other city in the World. On the outbreak of the war most of the services had to be considerably reduced, due to so many men being called to the Colours.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The report for the year [illegible] in regard to tramway and omnibus traffic and the sale of electricity for light and power continued to be satisfactory up to the time when war was [illegible] holiday traffics. On the other hand, the receipts of certain of the under- [illegible] An agreement has been entered into for the sale [illegible] to be added £17,129. 19s. brought forward, [illegible] debited with £11,191. 5s.

being dividends at same rate as those paid for the preceding year. This leaves £71,398. 17s 4d., and, in view of the directors' proposal to proceed with the reduction and rearrangement of capital, it is proposed to carry the whole amount forward. The item of investments and undertakings, after deducting the reserve for depreciation, stands at £4,771,842. 1s. 2d., and consists of shares and debentures in associated tramway, electricity supply, manufacturing and other companies, Government, municipal and sundry securities. The revenue from the investments and undertakings amounted to £217,184, compared with £209,045. The yield for the year on £4,771,842. 1s. 2d. was 4·55 per cent., compared with 4·47 per cent. on £4,672,458. Mr. J. S. Raworth, who has been a director since the formation of the company, has resigned his seat at the board, but his services have been retained as technical adviser. Mr. Alfred Shepherd has been appointed to fill the vacancy.

DEUTSCH SUD-AMERIKANISCHE TELEGRAPHEN GESELLSCHAFT.—At the annual meeting at Cologne on the 2nd inst. a dividend of 6 per cent. was declared for 1914, against 6½ per cent. in 1913. The cable between Borkum and Teneriffe was cut on Aug. 5, and on the night of Nov. 21-22 the section between Teneriffe and Monrovia was also interrupted. The wireless station at Monrovia was also shut down on Sept. 1 at the instance of the Liberian Government. The company acquired an interest in the Cia Telegrafica-Telefonica of Buenos Aires, but owing to the local depression the past year's working of the Argentine company resulted in a loss. The total receipts (including amount brought forward) were £216,000, compared with £219,000, and after paying expenses, providing for depreciation, interest, &c., the net profit was £59,100 (against £62,600).

DEVONPORT & DISTRICT TRAMWAYS CO.—At the meeting last week the chairman (Mr. C. S. Hilton) said that an agreement had been entered into for the sale of the tramways to Plymouth Corporation. The receipts showed a satisfactory increase of £3,300 over 1914. The directors had decided to distribute the balance on revenue account this year among the shareholders. They were to sell the tramways on Oct. 2 next instead of in August, 1919, and an arbitrator was to decide on the sum (if any) due to the company for profits between October, 1915, and August, 1919.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—The net revenue for the year ended May 31, after deduction of expenses, amounts to £209,164. 11s. 1d., and makes, with £25,723. 16s. 3d. brought forward, a total of £234,888. 7s. 4d. From this amount there has been distributed £129,122. 0s. 3d. in interim dividends, leaving £105,766. 7s. 1d. The directors now recommend payment of the following final dividends, viz., 3s. per share (less tax) on the preference shares, making, with previous distributions, a total dividend for the year at rate of 6 per cent. per annum (less tax), and 6s. per share net on the ordinary shares, making, with previous distributions, a total dividend at rate of 6 per cent. net for the year. These dividends will absorb £78,111. 0s. 4d. and leave £27,655. 6s. 9d. to be carried forward. During the year £11,200 Anglo-American Telegraph Co.'s preferred stock was sold, and the proceeds were re-invested in shares of the Great Northern Telegraph and Direct Spanish Telegraph Companies. Seventeen certificates of the Submarine Cables Trust, belonging to this company, have been drawn and paid off at £120 per certificate, producing £2,040; most of this has already been re-invested, and the remainder will be placed in suitable securities.

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—In a circular to the shareholders it is stated that it has been decided to abandon the half-yearly meeting, a course pursued by many other companies during the war. The works at Silvertown are very busy in many departments, and it is hoped that the year's results will be favourable, though the prices of labour and coal are considerably higher than last year owing to the war. The cable ship "Dacia" has had considerable employment, and the Board has reason to expect a continuance of it. The French works were closed entirely for several weeks during last year on account of the close proximity of the German army. As stated in the directors' report for last year, before the war broke out the organisation had been placed on a thoroughly sound basis, and the works, although greatly hampered by the shortage of labour, are now doing a sound and steady business. The directors have decided to distribute the following dividends: To the holders of preference shares 5s. per share (less tax), being the half-yearly dividend due on July 1, at the rate of 5 per cent per annum; to the holders of ordinary shares 5s. per share (tax free), being an interim dividend of 2½ per cent.

JAMES KEITH & BLACKMAN CO. (LTD.)—The accounts for the year ended March 31 show that, after providing for debenture interest and for [illegible] the net profit is £13,302. The directors recommend a dividend [illegible] on the ordinary shares, the writing off £377 on patents, [illegible] interim £5,408 forward.

RANGOON ELECTRIC TRAMWAY & SUPPLY CO. (LTD.)—The gross profit for 1914 was £62,453 (against £60,710 in 1913), and with transfer fees and interest (£1,168) the total was £63,621. Interest on debenture stocks absorbed £13 119, provision for redemption of 4½ per cent. deben- [illegible] £6,000, [illegible] in Rangoon £1,707, reserve for renewals account £12,500, transfer to special reserve for [illegible] £2,000, [illegible] £2,421, to which [illegible] £3,000 [illegible] The [illegible] declared [illegible] 1913.

ROYCE (LTD.) The directors' report states that after providing for liberal depreciation and after charging repairs and replacement to [illegible] £4,000, and [illegible] £1,063, the total [illegible] £5,063, [illegible] ordinary shares, transfer to reserve £4,000 and carry forward £1,000.

TROWBRIDGE ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the directors' report stated that the profit for 1914 was £437, which, together with £16 brought forward made £453. The directors recommended payment of dividends of 5 per cent. on the preference and ordinary shares. £200 was placed to depreciation fund and £50 to reserve, leaving £31 to be carried forward. The chairman (Mr. J. H. Blake) said the company was a progressive one. In 1912 the income was only £549. 10s., in 1913 £706. 8s. and in 1914 it amounted to £1,004. 18s. When the scheme was started he had no idea that the income from electric lighting would reach £1,000 in so short a time, and he thought the report was very satisfactory.

UNITED ELECTRIC TRAMWAYS OF MONTEVIDEO (LTD.)—At the annual meeting on Monday it was reported that the gross receipts for the tramway system for the year to Oct. 31, 1914 (the fiscal year of the Uruguayan Co.) were $1,698,885 (against $1,755,572), and operating expenses $1,033,942 (against $1,045,941), leaving net receipts $664,943 (£141,477) against $709,631 (£150,985). The passengers carried were 43,862,849 (against 44,622,690), and the car-miles run 7,390,283 (against 7,461,194), the percentage of operating expenses to gross receipts being 60·86 (against 59·58). The falling off in traffics was due principally to the financial stringency which prevailed throughout the whole of South America, accentuated in the latter months of the year by the European conflict and other causes. The equipment of the two sub-stations referred to in previous reports, has been completed, and both stations are in operation, although the Diesel engines have not yet been taken over from the contractors. Owing to the high price of oil fuel, it has been decided for the present to operate the sub-stations on Sundays and feast days only and in case of emergencies. The amount receivable from La Sociedad Comercial de Montevideo was £133,817. 18s. 4d. After providing for administration expenses and charging £48,850. 9s. 5d. for debenture interest, there was a credit balance of £77,034. 17s. 5d., making, with £12,641. 7s. 6d. brought forward, £89,676. 4s. 11d. After providing for redemption of debenture stock and share capital, setting aside £25,000 for renewals and contingencies, and paying interim dividends of 6 and 4 per cent. on the preference and ordinary shares respectively, the directors recommend payment of dividends in respect of the half-year to March 31 last of 6 per cent. per annum on the preference and of 4 per cent. per annum on the ordinary shares, leaving to be carried forward £12,972. 18s. 3d.

The chairman (Mr. G. A. Toucher, M.P.) said that local depression and the war had affected the year's results. Their traffic receipts showed a decline of £12,061, and their operating expenses were 60·86 per cent. (against 59·58 per cent.) of the gross receipts. For four consecutive years they had paid 7 per cent. on the ordinary shares, so that a reduction to 4 per cent. was disappointing but not surprising to those who knew the severity of the crisis through which South America was passing. In view of the big fall in revenue and the serious outlook, all expenditure of a capital nature had, as far as possible, been rigorously curtailed. The completion of the two sub-station buildings and the installation of the necessary plant practically accounted for the whole of the expenditure (£50,609) during the year. The results for the first six months of the current year were worse than in 1914. None of the adverse conditions had yet disappeared: financial depression continued, and weather conditions throughout the summer season had been bad. Expenses were increasing in an unprecedented degree: the price of coal had risen and freight had doubled. The traffic receipts for the half-year were £174,655, against £200,181, and net receipts were £68,311, against £88,095.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

FULLER'S WIRE & CABLE CO. (LTD.) (140,633).—Reg. June 11, capital £25,000 in £1 shares, to carry on the business of makers of telegraph, telephone and electric wires, cables and appliances, drawers, workers and weavers of wires, manufacturers of ropes, cords, cables and hawsers, manufacturers and workers of indiarubber, rubber goods, vulcanite and ebonite, electrical engineers, &c. Private company. First directors are G. Fuller, G. J. A. Fuller, L. Fuller and F. J. Gordon. Secretary (pro tem.): G. J. A. Fuller. Reg. office: Woodland Works, Wick-lane, Old Ford-road, E.

FREE WIRE LIGHT CO. (LTD.) (140,578).—Reg. June 7, capital £1,000 in £10 shares, to carry on the business of wiring houses of intending consumers of electric light. Private company. First directors are T. R. Reeves, J. N. A. Houblon and E. Reeves. Reg. office: Salisbury House, London Wall, E.C.

LIVER CHAIN WORKS (LTD.) (140,584).—Reg. June 7, capital £5,000, in £1 shares, to carry on the business of manufacturers of chains, metal buckles, dies, &c., by any process, particularly by patent or other bending and electrical welding machines, and to adopt an agreement with A. Nzerum. Private company. First directors are A. Naerum (permanent managing) and E. J. Holden. Reg. office: [illegible].

NORDISK ELECTRICAL POWER CO. (LTD.)—(140,530)—Reg. June 2, capital £10,000 in £10 shares, to develop water and other powers for the production of electric, hydraulic or other power, to transmit, distribute and supply same throughout the United Kingdom, Northern Europe and elsewhere. Private company. Reg. office: 18, Hatton Garden, E.C.

MORTGAGES AND CHARGES.

DURAM (LTD.) Particulars of £20,000 debentures, created March 23, 1915, have been filed, amount of present issue being £5,600. Property charged: Company's undertaking and property, present and future. No trustees.

KINGOLITE CO. (LTD.)—Charge as additional security dated May 14, 1915 (supplemental to debenture dated July 9, 1914, securing £400). Property charged: Certain royalties. Holder: E. D. Taylor.

NAVALTUM (LTD.)—Particulars of £5,600 debentures, created March 22, 1915, have been filed, amount of present issue being £5,000. Property charged: Company's undertaking and property, present and future. No trustees. Memorandum of satisfaction in full on May 22, 1915, of debentures dated May 8 and July 3, 1914, securing £900, has also been notified.

RECEIVERSHIP.

DURELL, WALKER & CO. (LTD.)—Notice of appointment of H. Dennis, Staple House, 51 and 52, Chancery-lane, W.C., as receiver and manager on June 9, 1915, under powers contained in debentures dated July 15, 1912, has been filed.

CITY NOTES.

MEMORANDA (June 17).—Bank rate 5 per cent. (since Aug. 8, 1914. Consols 66½xd. Consols Pay Day July 1. Stocks and Shares Ticket Days June 24 and July 13. Pay Days June 25 and July 14. Price of silver, 23⅞d.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—The share and transfer books will be closed from the 17th to 24th inst. inclusive, for preparing the dividend warrants on the 6 per cent. preference shares for the half-year ending 30th inst.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and registers of holders of the 5 per cent. first and the 4½ per cent. second debenture stocks will be closed from the 16th to the 30th inst. inclusive.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—The directors have declared an interim dividend of 2s. 6d. per share (less tax) on the ordinary shares for the past half-year.

REES ROTURBO MFG. CO. (LTD.)—The profit for 1914 was £1,570, and after meeting interest charges, the surplus of £2,539 brought forward has been reduced to £413.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The directors have declared a 10 months' dividend at the rate of 6 per cent. per annum (less tax) on the preference shares, thereby making the cumulative dividend paid up to April 30, 1914.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, June 16. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Secs.	Last Dividend	Name.	Price, Wed. June 16.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 3 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	10½	5 19 1	Feb, Aug
5	10%	Brompton & Kensington Ord.	8¾	5 19 1	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St.	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	90½	4 8 5	Jan. July
5	2/3	Do. 4½% Pref.	4¾	5 9 10	..
5	5%	Do. Ord.	4	6 5 0	Aug. Feb
10	9%	City of London Elec. Lt. Ord.	14	6 8 7	Feb, Aug
10	6%	Do. 6% Pref.	12¾	4 17 0	Mar, Jly
St.	6%	Do. 5% Deb. St.	110	4 10 11	Jan, Dec
10	7%	County of London Ord.	11	6 7 3	Mar, Sept
10	6%	Do. 6% Pref.	11½	5 6 8	Feb, Aug
St.	4½%	Do. 2nd Deb.	97	4 12 [illegible]	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	80	5 12 6	July
5	[illegible]	Kensington and Knightsbridge Ord.	7¾	6 4 2	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 9	Jan, July
5	3·0	London Elec. Supp. 6% Pref.	5½	5 19 3	..
St.	4%	Do. 4% Mort. Deben.	85½	4 11 11	Jan, July
[illegible]	[illegible]	Metropolitan E. Supp. Ord.	3¾	5 13 7	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	94½	4 15 3	Jan, July
[illegible]	[illegible]	Midland Elec. Corpn. 1st Mort. Deb. St.	[illegible]	[illegible]	Jan, July
[illegible]	[illegible]	Newcastle & Dist. E.L. 6% 2nd Dbs.	95½	6 1 0	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref.	15½	5 11 7	Apl, Oct
St.	4%	South London E.S. 1st Mort. Debs.	85	5 5 3	Jan, July.
St.	4½%	[illegible]	86	5 10 3	Apl, Oct
[illegible]	[illegible]	Waste Heat & Gas Elec. Gen. Stations.	8	7 12 9	..
[illegible]	[illegible]	Westminster E.S. Corp. Ord.	21	[illegible]	Mar, Sept
5	4½	[illegible]	4½	4 14 [illegible]	Jan, July.
		Electric Railways & Tramways.			
[illegible]	[illegible]	[illegible]	8½	5 11 [illegible]	Apl, Oct
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Apl, Oct
[illegible]	4%	Central London Guar. Assented Ord.	3½	[illegible]	..
St.	4%	[illegible]	[illegible]	[illegible]	..
[illegible]	[illegible]	[illegible]	[illegible]	5 11 [illegible]	May, Nov
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
1	5%	[illegible]	7½	7 11 11	Feb, Aug
1	4%	[illegible]	1¾	[illegible]	Jan, July
1	4%	[illegible]	[illegible]	[illegible]	Mar, Sept.
1	4%	[illegible]	[illegible]	[illegible]	Jan, Jly.
[illegible]	11%	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	7½	4 1 [illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	7¾	4 14 [illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
St.	4%	[illegible]	92	4 7 0	May, Nov

†Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	NAME.	Price, Wed., June 16.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*	£ s. d.		
5	4½	[illegible]	7¾	6 2 6	Feb, Aug
[illegible]	4	[illegible]	12½	4 12 6	Jan, July
[illegible]	4	[illegible]	8⅞	4 10 [illegible]	Jan, July
[illegible]	4	Do. 4% Debs. (1903-5)	[illegible]	4 11 7	Jan, July
[illegible]	4	Do. 4% Guar. Stock	[illegible]	[illegible]	Mar, Sept
10	[illegible]	[illegible]	1⅛	.. ..	..
1	[illegible]	[illegible]	1	.. ..	..
[illegible]	6%	Do. [illegible]	112	5 8 11	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 15	74½	8 1 11	Mar, Sept
[illegible]	4½	[illegible]	9¾	4 10 2	Jan, July
[illegible]	..	Yorkshire W. Riding Ord.	4	.. ..	March
[illegible]	[illegible]	[illegible]	4⅜	[illegible]	Jan, July
		Electric Manufacturing, &c.			
1	1/93	Babcock & Wilcox Ord.	2[illegible]	[illegible]	Apl, Oct
1	1/0	Brit. Aluminium Ord.	[illegible]	[illegible]	Mar
100	5%	Do. Prior Lien Debs.	[illegible]	[illegible]	Jan, July.
[illegible]	[illegible]	[illegible]	[illegible]	6 8 10	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	[illegible]	[illegible]	Aug, Feb
[illegible]	[illegible]	[illegible]	[illegible]	4 15 5	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	[illegible]	5 12 11	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	[illegible]	8 0 0	Apl, Oct
[illegible]	[illegible]	[illegible]	[illegible]	5 18 5	Apl, Oct
[illegible]	[illegible]	[illegible]	73	5 9 4	Jan, July
[illegible]	[illegible]	[illegible] Ord.	[illegible]	6 5 8	Jan, July
5	2/6	Do. 5% Pref.	[illegible]	4 17 7	Feb, Aug
1	15%	Castner Kellner	[illegible]	5 17 1	May, Nov
1	[illegible]	[illegible] Pref.	[illegible]	6 17 2	Sept
5	[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
1	[illegible]	[illegible]	[illegible]	9 12 0	May
1	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
St.	[illegible]	[illegible]	[illegible]	5 15 1	Jan, July
10	6%	General Electric 6% Pref.	[illegible]	5 18 11	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	14½	7 0 4	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	5 0 0	..
St.	[illegible]	[illegible]	98	4 11 10	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	[illegible]	5 12 9	Feb, Aug
10	5%	Do. Pref.	[illegible]	[illegible]	Apl, Oct
10	[illegible]	[illegible]	9[illegible]	4 1 [illegible]	Apl, Oct
[illegible]	[illegible]	[illegible]	37	[illegible]	Mar, July
10	[illegible]	[illegible]	95	4 4 3	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 3 1	May, Aug
[illegible]	[illegible]	[illegible]	[illegible]	4 17 [illegible]	May, Aug
St.	4	[illegible]	93	4 6 0	Jun, Dec
100	4½	[illegible]	100[illegible]	4 9 4	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	95[illegible]	4 14 7	May, Nov
		Telegraphs.			
[illegible]	[illegible]	[illegible]	[illegible]	5 [illegible] 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	10[illegible]	5 13 2	Feb, May, Aug, N
St.	30/0	Do. Def. Ord.	22[illegible]	6 12 7	Feb, May, Aug, N
St.	[illegible]	[illegible]	80	5 0 0	Ja, Ap, Jly, O
10	5%	Cuba Submarine Ord.	8[illegible]	5 13 6	May, Nov.
10	10/0	Do. 10% Pref.	15[illegible]	6 [illegible] 0	..
5	5/0	Direct Spanish 10% Pref.	7[illegible]	6 13 4	..
10	4%	Direct United States	[illegible]	6 4 3	Ja, Ap, Jly, O
St.	65/0	Eastern Tel. Co. Ord.	130[illegible]	5 7 [illegible]	Ja, My, Jly, O
St.	[illegible]	[illegible]	[illegible]	4 11 11	Ja, My, Jly, O
St.	[illegible]	[illegible]	92	4 7 [illegible]	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	90	4 [illegible] 11	Feb, Aug
10	7%	Do. Ord.	12[illegible]	5 9 10	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. with Coup. 7	31[illegible]	6 19 8	Ja, My, Jly
2	13%	[illegible]	54	6 0 4	May, Nov
[illegible]	[illegible]	[illegible]	[illegible]	10 [illegible]	April
1	[illegible]	[illegible]	[illegible]	July	
10	9d.	West India & Panama Ord.	[illegible]	8 13 11	May, Nov
[illegible]	[illegible]	[illegible]	[illegible]	7 3 4	May, Nov
[illegible]	[illegible]	[illegible]	[illegible]	5 4 2	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	[illegible]	4 10 [illegible]	Jun, Dec
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	126[illegible]	[illegible] [illegible]	Ja, Ap, Jn, O
[illegible]	[illegible]	[illegible]	[illegible]	6 [illegible]	Jan, July
1	[illegible]	[illegible]	[illegible]	6 12 [illegible]	Nov.
[illegible]	[illegible]	[illegible]	97[illegible]	4 [illegible] 4	May, Nov
[illegible]	[illegible]	[illegible]	2[illegible]	4 [illegible] 4	Apl, Oct
St.	4%	Do. Db. St.	[illegible]	4 12 [illegible]	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	86	5 2 3	Jan, July
[illegible]	[illegible]	United River Plate Ord.	[illegible]	[illegible] 13 4	Apl, Oct
[illegible]	[illegible]	[illegible]	4 [illegible]	[illegible] 3 3	Jan, July
St.	[illegible]	Do. Deb. Stk.	[illegible]	4 [illegible] 4	Jan, July
		Financial and Investment.			
10	6%	[illegible]	11[illegible]	5 [illegible] 10	Sp, Dc, Mr, Jn
[illegible]	[illegible]	[illegible]	1[illegible]	[illegible] 1	Sp, Dc, Mr, Jn
1	[illegible]	Mackay Companies' Common	[illegible]	6 5 0	Ja, Ap, Jly, O
[illegible]	4	[illegible]	[illegible]	5 14 3	Ja, Ap, Jly, O
100	6%	Submarine Cable Trust Certs.	125[illegible]	4 15 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	[illegible]	Anglo Argentine Trams. 5% Debs.	[illegible]	5 17 0	Jun, Dec
St.	[illegible]	[illegible]	[illegible]	5 3 9	Jan, July
St.	[illegible]	[illegible]	87	4 12 0	Jan, July
5	2/9	Do. 5½% 1st Pref.	[illegible]	6 2 3	Jan, July
5	2/9	[illegible]	[illegible]	7 6 8	Jan, July
100	[illegible]	Brazilian Traction Ord.	[illegible]	11 [illegible] 9	Feb, May, Aug, N
10	[illegible]	[illegible]	[illegible]	[illegible] 13 6	Ja, Ap, Jly, O
[illegible]	[illegible]	Brisbane Trams Ord.	[illegible]	5 7 5	May
[illegible]	[illegible]	[illegible]	[illegible]	5 0 8	May, Nov
St.	[illegible]	[illegible]	[illegible]	5 13 4	..
[illegible]	[illegible]	[illegible]	[illegible]	7 18 4	Mar, Sep
[illegible]	[illegible]	[illegible]	[illegible]	5 13 3	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	6 9 0	..
5	6%	Madras Elec. Trams 6% Cum. Pref.	[illegible]	7 4 11	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	.. ..	Feb, M, Aug, N
[illegible]	[illegible]	[illegible]	35[illegible]	.. ..	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	57	5 15 5	Feb, Aug
[illegible]	[illegible]	[illegible]	100[illegible]	[illegible] [illegible]	Jun, Dec
[illegible]	[illegible]	Toronto Railway Co. 4½% Bds	[illegible]	[illegible] [illegible]	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	[illegible]	14 [illegible]	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	4 16 7	Jun, Dec
[illegible]	[illegible]	[illegible]	[illegible]	14 [illegible]	..
[illegible]	[illegible]	[illegible]	[illegible]	6 15 10	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	5 0 8	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	7 12 2	Ja, Apl, Jly, O
St.	[illegible]	[illegible]	10[illegible]	4 17 7	June, Dec
[illegible]	[illegible]	[illegible]	10[illegible]	4 19 0	..
[illegible]	[illegible]	[illegible]	10[illegible]	4 16 10	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	4 15 3	Ja, Apl, Jly, O
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	5 1 8	[illegible]
..	5½%	Do. 5½% 2nd Mort. Deb.	[illegible]	[illegible] [illegible]	[illegible]

[illegible] Interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date June 16, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	14½d.	Antimony	£125 0 0
Solid Drawn Copper Tubes	14½d.	English Lead	£28 5 0
Brazed Copper Tubes	14½d.		
Brazed Brass Tubes	16d.	**Old Metals.**	per ton.
Brass Wire	14½d.	Clean Scrap Copper	£75 10 0
Copper Wire	14½d.	Brazlery Copper Scrap	£70 0 0
Rolled Brass	14½d.	Clean Scrap Brass	£56 0 0
Brass Sheets	15½d.	Old Lead	£21 0 0
		Old Zinc	£68 0 0
	per ton.	Hollow Pewter	£120 0 0
Copper Sheets	£110 0 0	Black Pewter	£85 0 0
Spelter	£115 0 0	Gun Metal	£65 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date June 15, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£60 0 0	Old Lead	£23 0 0
Clean Mixed Brass	£64 0 0	Tea Lead	£21 0 0
Clean Copper	£75 0 0	Old Zinc	£75 0 0
Brazlery Copper	£69 0 0	Hollow Pewter	£120 0 0
Gun Metal	£67 0 0	Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec.	No. of weeks.	Aggregate. Amount	Inc. or dec.
		£	£		£	£
Aberdeen Corporation	June 6	2,[illegible]	— [illegible]	[illegible]	..	..
Anglo-Argentine	.. 10	50,398	— 8,257	23	1,184,479	— 111,369
Ashton-under-Lyne	.. 12	475	+ 25	11	5,351	+ ..
Ayr Corporation	.. 12	365	— 37	4	1,357	— 168
Bath Electric Trams, Ltd						
Birkenhead Corporation	.. 13	1,412	[illegible]	11	14,206	— 338
† Birmingham Corporation	.. 12	13,202	[illegible]	11	136,941	+ 1,162
Blackburn Corporation	.. 12	1,295	[illegible]	11	14,359	— 1,744
Blackpool Corporation	.. 12	1,116	[illegible]	11	12,995	— 3,043
Blackpool and Fleetwood	.. 12	622	[illegible]	23	10,276	— 1,759
Bolton Corporation	.. 13	2,832	[illegible]	11	27,818	— 3,565
Bournemouth ... { Trams	.. 9	1,974	— 52	10	21,340	— 140
{ Buses	.. 9	31	[illegible]	10	203	+ 22
Bradford Corporation	.. 12	6,772	[illegible]	11	70,285	— 1,242
Brighton Corporation	.. 13	1,122	[illegible]	11	11,014	— 732
Bristol Trams { Trams	.. 11	4,772	[illegible]	23	104,996	— 1,525
{ Buses, &c.	.. 11	4,965	[illegible]	23	105,379	+ 21,724
Burnley E. Trams & Lig.	.. 12	R4,516	[illegible]	..	..	— R42,819
Burnley Corporation	.. 12	1,544	[illegible]	11	31,625	— 1,495
Burton Corporation	.. 13	295	[illegible]	11	3,019	— 226
Bury Corporation	.. 13	1,393	[illegible]	11	15,359	— 503
Calcutta Tramways Co.	.. 12	R63,343	[illegible]	23	R1,518,881	— R87,199
Cattewater Trams	..	..	..	..	..	..
Cardiff Corporation	.. 5	2,643	— [illegible]	5	25,269	— 2,551
Cork Electric Trams Co.	.. 10	555	[illegible]	23	10,945	— 144
Coventry Corporation	.. 13	977	[illegible]	11	10,246	+ 889
Croydon Corporation	.. 4	1,719	[illegible]	4	17,101	— 327
*Derby Corporation	.. 12	1,071	[illegible]	11	11,057	— 162
Dover Corporation	.. 12	308	[illegible]	10	3,122	+ 552
Dublin & Lucan Railway	.. 11	160	[illegible]	23	3,211	— [illegible]
Dublin United	.. 11	6,389	[illegible]	23	136,483	— [illegible]
Dundee Corporation	.. 9	1,384	[illegible]	48	4,757	— 62
East Ham Council	.. 12	1,376	[illegible]	10	13,879	— 2,760
Exeter Corporation	..	..	..	..	..	..
Glasgow Corporation	.. 12	2[illegible]	[illegible]	23	40,006	+ 3,018
Glossop Trams	.. 12	136	[illegible]	24	2,803	— 144
Gloucester Corpn.	.. 7	3[illegible]	[illegible]	14	3,308	— 151
Halifax Corpn. { Trams	.. 5	[illegible]	[illegible]	11	22,697	— 187
{ Buses	.. 5	4[illegible]	[illegible]	[illegible]	511	— 15
Hastings Elec. Trams Co.	.. 10	957	[illegible]	23	18,878	— 837
Huddersfield Corpn.	.. 12	2,768	[illegible]	11	28,720	+ 2,941
Hull Corporation	.. 12	3,406	[illegible]	10	32,424	— 1,128
Ilford District Council	.. 12	690	[illegible]	10	6,485	— 1,442
Ilkeston Corporation	.. 4	138	[illegible]	10	1,278	— 62
Ipswich Corporation	.. 12	[illegible]	[illegible]	10	5,147	— 106
Isle of Thanet Co.	.. 12	413	[illegible]	36	11,585	— 3,378
Kilmarnock Corporation	.. 5	169	[illegible]	3	498	— 80
Lanarkshire Trams Co.	.. 13	2,093	[illegible]	23	41,948	— 1,802
Lancashire United	.. 4	1,777	[illegible]	23	37,588	+ 212
Leeds Corporation	.. 12	9,381	[illegible]	11	94,351	+ 4,279
Leicester Corporation	.. 12	3,252	[illegible]	24	68,549	+ 1,004
Leith Corporation	.. 13	816	[illegible]	4	3,188	+ 132
Lincoln Corporation	.. 12	135	[illegible]	11	1,473	— 55
Liverpool Corporation	.. 12	13,928	[illegible]	23	300,919	— 3,195
Llandudno & Colwyn Bay R	.. 11	358	[illegible]	27	7,283	+ 862
London County Council	.. 2	23,586	—23,760	9	355,867	— 45,285
Lowestoft Corporation	..	..	..	..	..	..
Maidstone Corporation	.. 10	212	[illegible]	10	2,236	— 69
Manchester Corporation	.. 12	18,348	[illegible]	10	189,203	+ 538
Nelson Corporation	.. 12	197	[illegible]	10	2,045	— 314
Newcastle-on-Tyne Corpn.	.. 12	6 451	[illegible]	10	64,544	+ 9,098
Newport (Mon.) Corpn.	..	..	..	..	..	..
Northampton Corporation	.. 11	[illegible]	[illegible]	10	[illegible]	[illegible]
Nottingham Corporation	.. 10	3,768	[illegible]	10	36,853	[illegible]
Oldham Corporation	.. 13	2,323	[illegible]	12	26,746	— 690
Portsmouth Corporation	.. 5	2,548	[illegible]	10	24,266	..
Preston Corporation	..	..	..	..	..	..
R[illegible]	.. 12	1,706	[illegible]	10	18,447	[illegible]
Rotherham Corporation	.. 9	1,147	[illegible]	10	11,092	[illegible]
Salford Corporation	.. 14	5,437	[illegible]	11	56,347	— 473
†Sheffield Corporation	.. 13	8,824	[illegible]	11	97,965	— 6,626
Southampton Corpn.	.. 9	1,477	[illegible]	11	14,392	[illegible]
Southend Corporation	.. 9	749	[illegible]	10	8,325	— 1,822
South Shields	.. 8	[illegible]	[illegible]	11	[illegible]	— 40
St'lyb'dge, Hyde, &c., Jt. B.	.. 12	845	[illegible]	11	8,799	[illegible]
Sunderland Corporation	.. 13	1,559	[illegible]	11	15,426	— 484
Sunderland District	.. 9	543	[illegible]	10	17,465	— 1,175
Swindon Corporation	.. 9	206	[illegible]	11	1,968	[illegible]
Tynemouth Corporation	.. 5	610	[illegible]	10	12,047	[illegible]
Wallasey Corporation	.. 11	1,323	[illegible]	11	13,176	[illegible]
Walsall Corporation	.. 11	742	[illegible]	11	[illegible]	[illegible]
Warrington Corporation	.. 13	987	[illegible]	11	9,561	[illegible]
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	.. 13	3,205	[illegible]	10	[illegible]	[illegible]
Wigan Corporation	.. 13	1,479	[illegible]	11	15,548	— 450
Wolverhampton Corpn.	.. 9	1,076	[illegible]	11	[illegible]	— 166
Yorkshire W.R. Trams	.. 13	[illegible]	[illegible]	11	36,829	[illegible]

(a) These figures are with the corresponding period last year. * Partly electrical
† Including motor buses, &c. ; Minus 2 days. ‡ Minus 3 days. ‖ Plus 3 days.
¶ [illegible] ** Compared with one week more last year. †† 10 days.

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NOTES.

The British Manufacturer.

IN our present issue we give an interesting account of the equipment of the Regent Palace Hotel, London. This hotel is remarkable for the completeness of the arrangements that have been adopted for the comfort of visitors. In the equipment there is a considerable amount of electrical plant, for without the aid of electricity it would be impossible to carry out all the operations required in ventilating, heating and in many other ways. Hitherto these matters have been dealt with in a much more haphazard way, and to place them all in the control of one operator in a single control room is a new step in work of this kind. Unfortunately, we are not able to give an account of this interesting feature owing to the fact that its completion has been delayed owing to the war. When finished, this control room will contain 250 electrical instruments, by means of which the operator will be able to determine the conditions in all parts of the hotel, and will be able to regulate matters accordingly. Prior to an inspection of the building recently, we had the pleasure of attending a luncheon given to the press, when the chair was taken by Mr. A. H. BARKER, the consulting engineer for the heating and ventilating of the building. During the course of his remarks, Mr. BARKER made some reflections upon the lack of adaptability of the British manufacturer, and the story he told we give briefly in what follows.

WHEN considering the equipment of the control room Mr. BARKER found it would be necessary to have special electrical instruments, such as were not then on the market. Having decided what would meet his requirements, he asked certain British manufacturers whether they would be willing to make the required instruments. He found, however, great unwillingness to take on the work, although one firm said they would do so provided the number of instruments required was not less than 1,000. That being so, Mr. BARKER thought it desirable to go to Berlin, previously advising some of the German firms of his intentions and requirements. On his arrival at Berlin he found himself received with open arms by three German firms who, unlike the British firms, were only too anxious to obtain the business. Not only did they give every possible information, but they made up samples of what they proposed, and these were duly brought back to this country. Owing to the outbreak of war the German instruments were finally not obtainable, and the order was ultimately placed in this country, but at a price which was 50 per cent. in excess of that quoted in Berlin. Although vague statements are often made as to the lack of enterprise shown by our manufacturers, first-hand information is not often available, and it is instructive to hear of an actual instance. There may, of course, be some extenuating circumstances in this case, but unless some special point was made in regard to price, and this, we understand, was not so, we fail to see why the British manufacturer should be unwilling to take up this class of work before the war, and willing to take it up later on when in all probability his resources were mostly required for Government work. It is this lack of adaptability which in the past has put our German competitors to so great an advantage, and has enabled them to obtain and maintain a footing.

The Association of Consulting Engineers.

[illegible] very questionable taste on the Association of Consulting Engineers. Our contemporary should remember that for some years there has been an outcry against methods followed by certain consultants. What, then, is the remedy? Although the practices to which exception is taken cannot be stopped, it is at least open to those consulting engineers who feel they can do so to adhere to certain rules of professional conduct, and to bind themselves to act in a certain way. This the members of the Association of Consulting Engineers have done. Such action does not prevent other

engineers who wish to act as consultants from doing so, but it at least provides a body of men with which the public can deal and be sure that certain principles will be followed. It is, of course, easy to make innuendos, like those in which our contemporary indulges, but they serve no useful purpose, and it would be far better if the evil were recognised and the efforts made by the Association were supported. Our contemporary seems to think it strange, among other things, that the Institution of Electrical Engineers should take any notice of objections of the Association to certain points in the proposed Model General Conditions of Contract. It should surely be clear, however, that the consultant represents the purchaser, and it is the duty of the Institution to draw up conditions which are fair to all parties. If a body like the Association were not required it is difficult to understand why similar bodies have been formed in other countries. Actually, the Association has done useful work in the past, in a comparatively short existence, and we are sure that it will do very useful work in the future.

Linking-Up in London.

We are glad to see that a further move is being made to link up some of the municipal undertakings in London, the authorities concerned being Battersea, Fulham and Hammersmith. Details of the scheme have not yet been published, but the object appears to be the supply of electrical energy in bulk between the authorities concerned so as to obtain greater economy. The Hammersmith Electricity Committee are advised that if the scheme is adopted it will be possible to shut down at certain times two out of the three stations at present supplying the combined area. The importance of combination of this kind cannot well be exaggerated. It necessarily leads to the avoidance of so much spare plant, which must otherwise be put down in each station to ensure the continuity of supply, and apart from this, the efficiency of running at certain times of year, when the load is low at a station mainly dependent on a lighting load, may be considerable.

Royal Engineers (T.F.).—The following appointments have been made :

Tyne Electrical Engineers : Corporal C. A. C. Aitkins and Corporal E. H. Peabody to be second Lieutenants.

No. 2 Electric Lights Company, East Riding (Fortress) Engineers : Chas. M. Bostock (late lieutenant, Territorial Force Reserve) to be second lieutenant.

Soft Soda Glass Suitable for X-Ray Bulbs.—The Glass Research Committee of the Institute of Chemistry find that a glass such as that made from formula No. 10, recently published by them, and recommended for X-ray bulbs, does not give a green [illegible] glow if it is made from approximately pure materials. The slight glow given is blue. In [illegible] a green [illegible] appears to be preferred by users of X-ray tubes, it seemed desirable to determine the conditions for obtaining this effect. It has been [illegible] and such a glass as [illegible] is obtained by the addition of [illegible] respectively used to [illegible].

Civil List Pensions.—A list has been issued giving particulars of all pensions granted during the year ended March 31, 1915, and [illegible] the provisions of the Civil List Act, 1910. Fourteen pensions have been granted amounting in all to £1,060. Among those granted for scientific research work, &c., are the following :—

Mrs. Constance Emily Burch, in consideration of the value of the researches of her husband, the late Dr. George James Burch, F.R.S., in physics and physiology, and of her inadequate means of support, £60.

Mr. William Grenfell Wallace, £50 ; Miss Violet Wallace, £50 ; in consideration of the scientific work of their father, the late Dr. Alfred Russel Wallace, O.M., and of their inadequate means of support. In trust to two trustees.

Dr. Charlton Bastian, F.R.S., in consideration of his services to science, and of his straitened circumstances, £150.

Dr. Marshall Watts, in consideration of his scientific work, and of his straitened circumstances, £75.

Engineering Institutions Volunteer Training Corps.—It will be remembered that it was decided recently to form a volunteer training corps of engineers, and that members of the Institution of Electrical Engineers were circularised with this object in view. The corps is now formed. The objects of the corps are :—

1. To train men of military age and to make them useful Royal Engineer recruits if and when they are able to enlist.

2. To furnish Engineer units to assist in the completion of the Volunteer organisation.

3. To organise the Corps so that the maximum advantage may be taken of the specialised engineering skill of its members at the earliest possible moment.

Drill takes place through the kindness of Colonel Le Rossignol and the officers of the London Electrical Engineers Corps at the Drill Hall, 46, Regency-street, Westminster. Although the first drill only took place on the 2nd inst., already 130 members are enrolled. Membership is not restricted to members of the engineering institutions, and applications should be made to the Commandant, Lt.-Col. C. B. Clay, V.D., at Marconi House, Strand, London, W.C.

Demand for State Control of Coal Prices.—On Tuesday, at the final meeting of the conference of large coal consumers, shipowners, coalmasters and miners, with members of Parliament, the following resolutions were passed :—

1. That during the continuance of the war the maximum price of coal, for home consumption and export to our Allies, at the pit-head be fixed on the basis of the prices charged at the pit-head for substantial quantities of coal sold during the 12 months preceding the war, with an addition of 4s. 3d. per ton, or such other sum as may be prescribed, to cover the increased costs owing to the existence of the war.

2. That the rate of freight for coasting steamers employed in the coal trade be fixed on the basis of the rate charged for freight during the 12 months preceding the war, with an addition of such sum as will reasonably cover the increased cost owing to the existence of the war, and that the Government be urged to assign a further number of the interned steamers for the use of the coal trade.

3. That the Government be asked to regulate the price charged by the merchant to the consumer.

There was some opposition to the last resolution.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Dr. C. C. Garrard continues his article on "Apparatus for Protecting Electrical Machinery Against Abnormal Electrical Conditions" (p. 423).

We give an abstract of the Report of the Executive Committee of the National Physical Laboratory for the year 1914-15 (p. 422).

We also give the Report of the Incorporated Municipal Electrical Association (p. 425) and an account of the Annual General Meeting.

We publish a Paper by Prof. Alexander Artom on "The Dirigibility of Electric Waves" (p. 434).

Our Leading Article deals with the Electric Vehicle Position (p. 436).

We describe a 200 H.P. locomotive to be used on the New Zealand Government Railways. The [illegible] Transmission system (p. 438).

We give an account of the Engineering Plant of the Regent Palace Hotel, London (p. 431).

[illegible] Meetings and Reports. Meetings of the Birmingham District Power & Traction Co. and Globe Telegraph & Trust Co. are reported, and directors' reports [illegible] of the Aluminium Corpn., Greenwood & Batley, Imperial Tramways Co., Madras Electrical Supply Corpn., Manila Electric Railroad & Lighting Corpn., Peel Conner Telephone Works, Tubes Limited, Waygood Otis, L. J. and J. G. White & Co. (pp. 453-4).

OBITUARY.

E. Rathenau.—The death is announced of Herr Geheimer Baurat Emil Rathenau, managing director of the well-known Allgemeine Elektricitäts Gesellschaft, of Berlin. After serving a four years' apprenticeship at the Wilhelmshütte in the mechanical engineering shops, Herr Rathenau finished his training at the Hanover and Zurich Polytechnics. After leaving Zurich he entered Messrs. A. Borsig's locomotive factory at Berlin, and later he came to London, where he entered the firm of John Penn & Son as technical draughtsman. To gain further experience in machine design he subsequently took an appointment with Messrs. Easton, Amos & Sons, and later on joined the staff of the English & Continental Steam Engines Improvement Co. Herr Rathenau returned to Germany in 1865, and, with a friend, bought the mechanical engineering works of M. Webers in Berlin. In this he was very successful, especially during the 1866 and 1870-71 wars, when several contracts were placed with the firm for war material. In 1876 he visited the Philadelphia Exhibition, where he saw the first telephone, but on his return to Germany he was unsuccessful in securing a concession for telephony in Berlin. The Paris Exhibition of 1881, however, incited him to a more successful move, for, having seen Edison's incandescent lighting system, he acquired the German Edison patent rights from the Continental Edison Co., succeeded in interesting rich banking firms in the matter and founded a pioneer company. The latter company developed into the German Edison Co. for Applied Electricity, with a capital of five million marks, was formed in 1883, Herr Rathenau being the first director. Out of this company grew the world-famed Allgemeine Elektricitäts Gesellschaft, and also the Berlin Electricity Works, of both of which companies Herr Rathenau has been managing director from the commencement. In July, 1900, the Emperor conferred upon him the title of Geheimer Baurat. Various other honours and distinctions were conferred upon him, including that of officer of the French Legion of Honour, honorary Doctor of Engineering of the Berlin Technical High School, and honorary Doctor of Philosophy of Berlin University. Deceased was 76 years of age.

R. P. Hulton.—We regret to announce that Mr. Ralph P. Hulton, A.M.I.E.E., who was formerly North Country representative of Holophane (Ltd.), has succumbed to wounds received in the war operations at the Dardanelles. Immediately upon the outbreak of war, Mr. Hulton enlisted in the Engineer Section of the Royal Naval Division.

The "Manchester University Magazine" announces the death of Lieut. J. L. Moffet, B.Sc., A.M.I.E.E., of the 3rd Battalion Royal Scots Fusiliers, who was killed in action within five weeks of reaching the front.

PERSONAL.

Mr. R. J. Mitchell has resigned his position as commercial engineer to Edison Accumulators (Ltd.), which position he has held for the last three years, to take up a position as engineer to Mr. E. Sanger-Shepherd, 5, 6 and 7, Gray's Inn-passage, Holborn, the well-known worker in many scientific fields, including natural colour photography and telegraphic transmission of photographs.

Mr. A. J. Langley Moone, locomotive electrical engineer to the South Indian Railway, and for eight years assistant electrical engineer to the L. & S.W. Railway, has taken a commission in the Indian Army for active service.

Mr. Walter J. Cridge has been gazetted Second-Lieutenant in the Sherwood Foresters.

The engineer and manager of the Redditch Council electricity works (Mr. R. N. Mayne) recently obtained a commission in the Bedfordshire Regiment.

The Council, however, made urgent representations to the War Office that Mr. Mayne could not be spared as a large extension and reconstruction scheme, involving an outlay of £35,000, was in progress at the electricity works and that many manufacturers who were engaged upon important Government contracts, were dependent upon the undertaking for a supply of current for power. The War Office have, therefore, cancelled Mr. Mayne's army commission, but intimate that, in the event of the Council being able to replace Mr. Mayne, a further application for a commission will receive favourable consideration.

APPOINTMENTS VACANT AND FILLED.

An electrical engineer is required for South America to take charge (under chief engineer) of the erection and running of a 400 k.w. three-phase power and lighting plant. *See advertisement.*

An electrical engineer is wanted as manager of the electrical department of a well-established general engineering and contracting business in the Midlands. *See an advertisement.*

The West India & Panama Telegraph Co., Spencer House, South-place, London, E.C., advertise for a young electrician competent to test submarine cables and assist the chief electrician on board their cable repair steamer "Henry Holmes."

A junior shift engineer is required at the Accrington Corporation electricity works. Salary £2 per week. Applications to the acting engineer and manager, Mr. A. W. Clegg, A.M.I.E.E.

A junior lecturer and demonstrator is required in the engineering department of the Birmingham Municipal Technical School. Commencing salary £125. Applications by June 30. Particulars from the Secretary.

Leicestershire Education Committee require a principal of the Loughborough Technical Institute and Inspector of County Evening Schools. Salary £300, rising to £400 per annum. Applications to Director of Education, 33, Bowling Green-street, Leicester, by July 5.

A demonstrator is required in the physics department of the Birmingham Municipal Technical School. Commencing salary £125. Applications to the secretary, Mr. Geo. Mellor, Suffolk-street, Birmingham, by June 30.

Mr. A. J. Bansfield, of the Isle of Thanet Electric Tramways & Lighting Co., has been appointed assistant manager of the Chatham & District Light Railways Co.

Mr. R. H. Cridge has been appointed to the Control Gear Section of the British Westinghouse Co. at Trafford Park.

Mr. J. A. Parker has been appointed chief clerk of the Belfast electricity department.

INSTITUTIONS AND SOCIETIES.

Employment of Disabled Sailors and Soldiers.—The Council of the Institution of Electrical Engineers desire to call attention to the demand for employment from disabled sailors and soldiers. The number at present requiring employment is not very large, but it may increase considerably during the next few months.

Professional Classes War Relief Council.—The Professional Classes War Relief Council has issued a report of six months' work which shows at once not only the great need that existed for such an organisation, but the variety of means that have been employed. The applications during the six months ending May 6 numbered 2,000, and the number of cases dealt with or now on the books is 1,600. The expenditure is now at the rate of £430 per week, and unless a sum of £25,000 can be raised in the next few months the work cannot be continued. The offices of the Council are 13 and 14, Prince's-gate, London, S.W.

Electric Vehicle Committee.—A meeting of this Committee was held in London, under the chairmanship of Mr. Chattock, on the 11th inst. Mr. A. R. Fearnley, the general manager of the Sheffield Corporation tramways, has been co-opted a member of the committee as the representative of the Municipal Tramways Association. It was reported that the sales of No. 3 (June) issue of the "Electric Vehicle" had been very satisfactory, although the number had only been out a few days. It was decided to send in a request that evidence be heard by the Special Committee of the Local Government Board on Motor Traffic with regard to the effect of the use of electric vehicles. The secretary was instructed to give evidence if the application was acceded to. The secretary was also instructed to write to the representative electrical institutions in the colonies suggesting the advisability of adopting the Committee's standards in regard to electric vehicles.

ARRANGEMENTS FOR THE WEEK.

Friday, June 25th (to-day).

PHYSICAL SOCIETY.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington, London, S.W. Agenda: Papers on "A Theory of the Electrical Resistance of Metals," by the President, Sir J. J. Thomson, O.M., F.R.S.; and "On an Unbroken Alternating Current for Cable Telegraphy," by Lt.-Col. Squier.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer commanding, Lt.-Col. C. B. Clay, V.D.

The following orders have been issued for the week ending July 3:—Mondays, Wednesdays and Fridays, drills at 6.30 and 7.30 p.m. Technical instruction will be given by instructors of the London Electrical Engineers for one hour, and squad and platoon instruction for one hour.

NATIONAL PHYSICAL LABORATORY.

This year, owing to the exceptional circumstances, the annual inspection of the National Physical Laboratory has not been held. The report of the Executive Committee was adopted by the general board on the 15th inst. In what follows we give an abstract of those parts of the report which are of general and electrical interest.

The work of the laboratory, like everything else in this country, has been greatly affected by the war. Some 25 per cent. of the staff have joined the colours, and a reorganisation of the work has been required in practically all divisions. The Committee are indebted to those who have remained for the manner in which they have taken up unusual duties, and feel sure the general board will appreciate the way in which the work has been carried on, and the record of progress shown in the report.

In last year's report some account was given of the steps which had been taken in consequence of a resolution passed by the Board in 1913 to bring the financial position of the laboratory before the Government. Those steps were approved by the board at their meeting in 1914, when it was stated that a committee had been appointed, consisting of representatives of the Royal Society and of the technical societies represented on the board, to consider what form the action should take. As a result of the deliberations of this Committee it was arranged that a letter should be sent to the Prime Minister by the President of the Royal Society asking him to receive a deputation to lay before him reasons for relieving the Royal Society from the financial responsibility involved in their control of the laboratory and for placing the Committee in a position to carry out efficiently work urgently required, by granting increased support from public funds. A memorandum drawn up by the Executive Committee giving a statement of these reasons was presented to the Royal Society in May, 1914, and a letter approved by the President and Council was sent, along with the memorandum, to Mr. Asquith in July. The receipt of the letter was acknowledged, but the outbreak of the war has prevented further action.

The financial results of the year have been adversely affected by the war. Up to the end of June the receipts for work done were considerably in excess of those for the corresponding three months of last year; during July, August and September there was a heavy fall amounting to some £2,100, and the Committee approached the Treasury, placing before their Lordships an estimate of the probable position at the end of the year should this fall in receipts continue, and asking for some assurance of support. Since September, however, there has been a considerable recovery and the result for the year is, as the accounts show, less unsatisfactory than was feared.

In some divisions, notably in the department of metallurgical chemistry, there has been a marked falling off in the test work.

Reference was made in last year's report to various Government Committees on which the director was serving. Lord Parker's Committee on Research in Telegraphy and Telephony reported in June, 1914, in favour of establishing a National Research Laboratory in these subjects at the National Physical Laboratory under conditions specified in the report. It was proposed to appoint a National Telegraphic Research Committee, which should determine the details of the work of the laboratory. The staff of the telegraphic laboratory were to be appointed by the Executive Committee, on the nomination of the Research Committee, and were to work under the direction of the director of the National Physical Laboratory. Some communication passed in July between the Committee and the Secretary of the Treasury, but in consequence of the war no formal action has been taken by the Government.

The Committee on the Lighting of Factories and Workshops, of which the director is chairman, and Mr. Paterson secretary, have completed their first report. The appendices contain a vast amount of information on the subject of the inquiry, much of which is due to Mr. Paterson, Mr. Walsh and other members of the staff.

Dr. Harker has been appointed to represent the laboratory on the Refractories Committee of the Institution of Gas Engineers. The need for research on refractories for furnace work of all kinds is well known, and the Executive Committee hope the laboratory may be able to assist the Institution in their inquiries.

International work has naturally not made much progress. Mr. T. Smith was nominated to represent the laboratory at an International Conference on Photography to be held in 1915, but the meeting has been [illegible]

Further correspondence took place during the early part of the year with the directors of the Reichsanstalt and the Bureau of Standards as to the International Scale of Temperature, and a conference, at which it was hoped certain small points still in doubt might have been settled, was to have been held in Berlin last September. Meanwhile, the scale, as far as it has been agreed to, has been incorporated into the new edition of the test pamphlet of the heat division just issued.

[illegible] by Dr. Grebe and Dr. Schultze, of the Reichsanstalt, who spent some time in Teddington comparing certain electric and thermometric standards. Since the [illegible] a committee [illegible] of the sub-committee of the [illegible] Mr. A. [illegible] meetings [illegible] and [illegible] are pending. [illegible] of the American Institute of Electrical Engineers and it is probable that a scheme will be adopted there and in America will [illegible] in all essential particulars. Dr. Rosenhain visited Australia in the summer as a member of the British Association, and was able, the Committee are glad to learn, to be of great service to the Commonwealth Government on some urgent matters connected with the war.

The laboratory has, as usual, been consulted by various Government Departments, besides the Admiralty and War Office.

The report to the Board of Trade dealing with ships' lights has been mentioned in previous reports; more urgent matters have prevented its full consideration. Among interesting reports made to the board may be mentioned one on Leather Measuring Machines, in which the action of the machines used in the leather trade for measuring skins is very fully discussed.

One or two recent fires at sea, notably that on the "Volturno" in October, 1913, have been set down to the presence of barium peroxide in the cargo, and the board entrusted the laboratory with an investigation into the conditions under which barium peroxide might take fire; this has resulted in the issue of special instructions for the storage of the material on board ship. The importance of research into the manufacture of optical glass has been brought to the notice of the Board of Trade from various quarters, and the director has been invited to prepare for the consideration of the board a scheme of research at the laboratory.

The large impact testing machine erected by the help of the India Office and the Engineering Standards Committee, has been completed, and the international research on methods of impact testing is in progress.

In the Electrical Standards division Mr. F. E. Smith again calls attention to the great accuracy with which the fundamental electrical standards can be reproduced. It has not been possible to obtain the exact figures which result from the comparison made by Mr. F. E. Smith and Dr. Giebe between the absolute measurements of resistance at the National Physical Laboratory and the Reichsanstalt, but it is known that the agreement is very close. A comparison between five mercury resistance tubes made and calibrated at the N.P.L., and five constructed at Tokio, shows a mean difference of eight parts in one million, while Weston cells made at Petrograd were found to agree with the Laboratory Standards to within one part in 100,000. The comparisons of some standards of inductance made by Dr. Giebe and Mr. Campbell are equally satisfactory.

Mr. Campbell's valuable Paper on the measurement of large high-frequency currents must be mentioned; he and Mr. Dye have extended the range and added to the accuracy of their high-frequency measurements in a marked manner.

In the alternating-current measurements division much has been done to improve the accuracy of the measurements and to accelerate the work. The increased volume of the work makes it necessary to increase the speed wherever possible, and additional equipment has been provided with this object. The tests in the direct-current division have increased largely, in consequence of the war; the research work has dealt chiefly with the rise of temperature of underground cables, and, thanks to the cordial co-operation of the engineers in a number of large centres, Mr. Melsom, who has devoted much time and energy to the work, has obtained a series of interesting results which will in due time be communicated to the Institution of Electrical Engineers, at whose cost the research is being carried out.

Mr. Paterson has communicated to the Physical Society two most interesting photometric Papers. One of these deals with the methods by which the values of the high efficiency Electrical Standards have been determined, and the Committee take this opportunity of thanking the General Electric Co. for their generosity in presenting a very complete series of standard lamps made especially at the Osram Lamp Works. The other research has led to formulæ connecting the light emitted per watt with the temperature of the filament, for both carbon and tungsten lamps, and is of great interest.

In Dr. Kaye's absence the work of the radium division has fallen on Mr. Higgins, and 61 samples, having a total value of £32,000, have been tested; the figures show the importance of having a National Standard, and the Committee trust that their work has been of real value.

The following table is a summary of the number of tests carried out at the laboratory during the last three years:—

	1913	1914	1915
Electrical measurements	348	259	191
Electrotechnics	2,261	3,828	5,080
Photometry	700	1,142	410
Heat	33,634	28,136	24,017
Radium	—	7	72
Optics	9,902	7,846	10,579
Metrology	4,476	4,799	5,797
Taximeter testing	16,966	18,184	15,539
Engineering department	517	453	617
William Froude National Tank	17	67	61

During the year there has been a marked reduction in the income, which has allen from £43,713. 6s. 10d. to £39,653. 5s. 6d., or by £4,060. 1s. 4d. The fees from tests have dropped from £25,142. 18s. to £20,017. 8s. 5d. by £5,124. 9s. 7d. or some 20 per cent., while the receipts for special investigations have been £1,612. 8s. 7d., as against £2,533. 3s. 11d. Thus, under these two headings alone there has been a reduction of over £6,000. The Treasury grant for aeronautics included in the income of the year, on the other hand, has risen from £5,311. 8s. 10d. to £7,474. 10s. 8d involving, however, an equal increase in expenditure. With regard to the fall in receipts for special investigations, it should be noted that the expenditure under this head has also been greatly reduced.

The total expenditure has been reduced from £40,968. 6s. 11d. to £39,572. 11s. 10d., or by £1,395. 15s. 1d. Of the various items of ex-

penditure, salaries and wages have increased by £2,299. 19s. 1d., due in large measure to the additions to the aeronautics staff required by the 7 ft. air channel and rolling mill. Under practically all the other headings there has been a marked reduction effected. Thus in 1913-14, £2,439. 13s. 4d. was spent out of income on additions to and renewals of equipment; during the year under review the corresponding sum has been £856. 2s. 6d. Reductions such as this cannot be maintained without very seriously hampering the work. As already explained, the research work has been greatly reduced in consequence of the absence of many of the staff and the employment of others on war service. The Hon. Sir C. A. Parsons has recently placed a sum of £1.000 at the disposal of the Committee to be used at their discretion in additions to the equipments and the board will wish to thank him for his generosity, which will enable some marked deficiencies to be filled.

As a net result the accounts show a credit balance* of £80. 13s. 8d. The result is much more satisfactory than the Committee, in the earlier stages of the war, had dared to hope, and they trust it will be satisfactory to the general board. It has only been reached by the exercise of the greatest care and economy in expenditure, an economy which must, if continued for long, have disastrous results. Last year the credit balance was £2,744. 19s. 11d. Of this sum, £1,000 was employed in reducing the debt on the tank building fund, which now stands at £1,660. 14s. 4d. Including this year's balance the sum to the credit of the general fund now amounts to £2,347. 5s. 3d.

The statement of work proposed for the year 1915-16 is naturally shorter than usual. The following extracts show what is contemplated in certain branches of physics and engineering :—

Electricity.—The usual experiments will be carried out for the maintenance of the electrical standards.

In the immediate future it is hoped to carry out experiments with the new Schuster magnetometer. In addition to using the instrument to measure the horizontal component of the earth's magnetic field, it is proposed to measure the vertical component, and thus indirectly the inclination. Direct measurements of the magnetic inclination may also be made with a new form of inductor.

Many details of the method for a re-determination of the mechanical equivalent of heat have been worked out, and it is hoped it will be possible to proceed with the construction of the apparatus, and to make a few preliminary experiments. The determination involves the construction of some special platinum thermometers and a new bridge.

Other work projected includes the re-winding of the coils of the current balance, the construction of some low resistances and the re-design of wire resistance standards.

In connection with the wavemeter and high-frequency work, it is proposed to complete the series of current transformers so as to afford a good range of current measurement. It is hoped to finish the construction of the Poulsen arc lamp and to investigate methods of decrement measurement with continuous oscillations. Wattmeter methods may also be tried.

The constants of the standard wavemeter set at the laboratory were determined over a range of from 200 metres to 11,000 metres by the direct measurement of the frequency, using a photographic method. With a view to securing international agreement it is desirable to arrange for some inter-comparison of standard inductances and capacities, and probably to repeat some of the fundamental measurements on which the laboratory standard depends. Arrangements for this are under consideration.

It is proposed to continue the construction of a set of oil-cooled resistances for high-frequency work; also to construct several high resistances of very small but calculable self inductance, consisting of long thin wires supported at a definite distance from one another and immersed in oil.

It is proposed to continue the research on the power factors of condensers of various dielectrics, both solid and liquid, at different temperatures and frequencies.

For very high and low ranges it is proposed to construct inductometers of more permanent form, similar to the models described in the report for 1913. Two marble cylinders have been obtained, on which it is hoped to wind standard single-layer inductance coils.

After some further experiments with the new apparatus for permeability tests, it is hoped to publish a description of the methods used. The magnet steel tests for the Institution of Electrical Engineers will be continued.

Photometry.—The development of suitable sub-standards for use in the testing of gas-filled electric lamps is becoming an urgent matter. Experimental standards have already been made up for the laboratory by the Osram Lamp Works, and are being thoroughly tested before duplication into complete sets of standards. The cascade method adopted at the laboratory for the realisation of candle-power in white light will be eminently suited for extension to these sources of light of still higher efficiency. Four sets of gas-filled standard are required to bridge the colour interval between the present highest temperature standards operating at 1·5 watts per candle and those which are required in the testing of nitrogen-filled lamps, and their preparation and standardisation will be pushed forward during the year.

The experiments on the coefficient of reflection of the white cards used in photometry will be continued and extended to some other materials, a knowledge of whose characteristics in this respect will be of practical value.

* Against this should be set an expenditure of £164, which is being incurred for waterproofing the parapets of certain of the roof gutters.

Photometric measurements in favourable circumstances can be carried out to an accuracy of about one part in 1,000. On account of the rapid change of candle power of electric lamps with voltage, this change of one part in 1,000 will be caused by a change of one part in 5,000 in the voltage, and the ratio is still greater if adjustments are made on the basis of current. It is therefore necessary that instrumental errors in the electrical measurements should not exceed about one part in 10,000. This is an accuracy higher than is required in general commercial measurements, and it is difficult to attain with commercial apparatus. The requirements of precision photometry have led to the consideration of the design of a special potentiometer for such measurements, and drawings have been got out for one of comparatively low resistance, without a slide-wire, which will measure up to 3 volts by ten-thousandths of a volt. It is hoped that it will be found possible to put it in hand during the year.

If opportunity permits, it is hoped to repeat to a greater accuracy, and to extend the scope of, the experiments on the method of colour identity for the estimation of the temperature of glowing bodies.

Measurements are being made at the instigation of the British National Committee on Illumination, to determine the correct flame height of the Hefner lamp to give one British candle.

Electrotechnics.—Some investigations on micanite which are at present in hand will probably be concluded early in the year.

The new dividing resistances capable of being used up to 40,000 volts, now in process of construction at the laboratory, have to be completed. These are of the woven wire type and their use on high voltages requires investigation, particularly in regard to their capacity currents to earth. The testing of such resistances for change of accuracy under different conditions of loading, also requires investigation, which will, it is hoped, be undertaken.

A low voltage electrometer reading up to 10 volts is being fitted with a suitable suspension and mirror to enable it to be used to the high accuracy attained with the electrometers installed. This instrument and accessory apparatus require to be put into working order. The two 100 volt electrostatic voltmeters constructed at the laboratory have also to be improved as regards their contact P.D. before being taken into regular use.

If opportunity permits an investigation will be made into the production of high frequency currents for instrument testing by methods which may serve provisionally until a high-frequency generator set is available. Such a set is eminently desirable.

The work on buried cables will be continued, and will form the main research work for the year. Some further investigation, at present under consideration by the Research Committee of the Institution of Electrical Engineers, into the effect of temperature on the rubber insulation of cables, will be undertaken if that Committee desires.

Heat.—The work in this subject will refer, among other subjects, to temperature scales, heat insulation and heat losses from surfaces. If the necessary funds can be found to render possible the acquisition of the additional assistance and apparatus required, and suitable accommodation for the work, it is proposed to institute a systematic research into the behaviour of refractories at high temperatures, and in particular to study some of the problems which have arisen in connection with the materials used in the construction of gas retorts. Other work will be commenced with the specific heats of gases and metals, flash point apparatus and solar maximum thermometers.

(*To be continued.*)

APPARATUS FOR PROTECTING ELECTRICAL MACHINERY AGAINST ABNORMAL ELECTRICAL CONDITIONS.*

BY C. C. GARRARD.

(*Continued from p.* 353.)

Summary.—The author deals first with the conditions which give rise to abnormal electrical conditions of a transient type, such as those due to switching, arcs and sparks. Methods of suppressing arcs to earth are described. The author then passes on to pressure rises between the turns of electrical windings, and those due to causes exterior to the system, such as lightning. Various protective devices are described, such as water jet earthing resistances, the Moscicki and other condensers, Giles' valve and the more ordinary lightning arresters. In conclusion the question of earth plates is considered.

Arcing Grounds.—Some experiments on the pressure rises produced by arcing grounds were made by E. J. Berg (see "Trans." of Am. Inst. E.E., Vol. XXVII., 1908, p. 711) and yielded very illuminating results.

Fig. 1 represents a typical diagram of connections of one of Berg's tests. It will be seen that one end of the high pressure side of the step-down transformer is allowed to arc to earth through a spark gap in air. The current which flows through the arc, of course, is the capacity current of the system. Pressure rises were measured by means of needle gaps. The needle gap for the normal voltage of 33,000 volts was 2 in. It

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will be seen that due to the arcing ground there is a pressure rise across the whole transformer winding of more than 100 per cent. (4·1 in. needle gap). The most striking result, as we should expect, however, is the pressure rise across the end turns (2½ per cent. of the winding) which amounted to 15 times the normal pressure (0·43 in. needle gap). No abnormal voltage existed across the end turns on the ungrounded side of the transformers. Substantially similar rises were obtained with transformers connected three phase.

A rather remarkable result was obtained with air choke coils in series with the transformer and between it and the arcing ground. It was found that these did not diminish the pressure rises at the transformer. In fact resonance seemed to occur with the coils. This shows that choke coils alone are not sufficient protection against the pressure rises due to arcing grounds and contradicts Peck's conclusion (*see* "Journal"

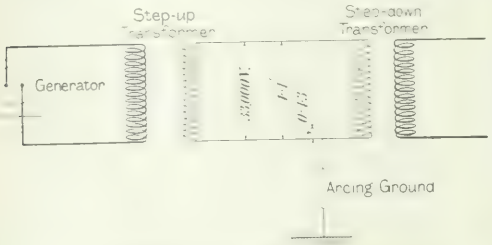
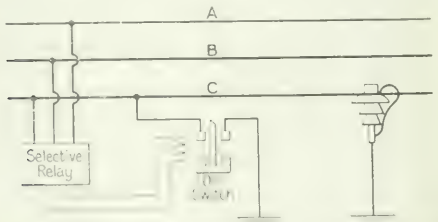


Fig. 4. Diagram of Berg's Tests on Arcing Grounds.

I.E.E., Vol. 40, 1908, p. 515) that choke coils in series with the apparatus to be protected guard against concentration of potential.

In the present author's opinion choke coils assist such protection as they retard the entrance of the dangerous voltage, but they must be combined with an additional safeguard such as a condenser.

Berg also found that resistance in the circuit of the arcing ground up to very large values (160,000 ohms) did not diminish the pressure rises, which shows that grounds over insulators and the like are just as destructive as direct grounds without resistance. Experiments on loaded transformers gave exactly similar results but it was found that with a permanent ground, instead of one through an arc, no abnormal voltage existed. It



Arcing Ground Suppressor.

will, therefore, be seen that should a line be accidently grounded [illegible] to be permanently grounded the faulty phase, the permanent ground being removed after the fault has been [illegible].

The Arcing Ground Suppressor.—In the preceding para- [illegible] system it is best to dead earth immediately the phase [illegible] which [illegible] In order to do this automatically [illegible] the Arcing Ground [illegible] Trans. A.I.E.E., Vol. XXX, 1911, p. 257) [illegible] to the primary circuit the arcing ground suppressor has another good feature in protecting the line insulators from damage. Should a "spill over," *i.e.*, arc over an insulator occur, the same is suppressed before the insulator has time to be damaged. The principle upon which the apparatus works is illustrated in Fig. 5. On phase C will be noticed an insulator having an arc playing across it. We are only concerned, of course, with systems having an insulated neutral or one grounded across a relatively high resistance. The effect of the insulator breaking down is to bring phase C to, or near,

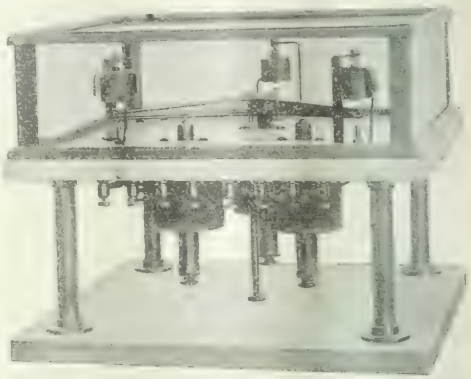


Fig. 6.—Three-phase Electromagnetic Selective Relay for Arcing Ground Suppressor.

earth potential. The selective relay picks out that phase which is thus brought near to earth potential, and through the intermediary of the trip coil and oil switch connects the earthed phase to earth for a fraction of a second, after which period it is automatically disconnected again. Of course, three earthing oil switches are used, one in each phase, but only one is shown in the figure. This disconnection of the earthed phase again is

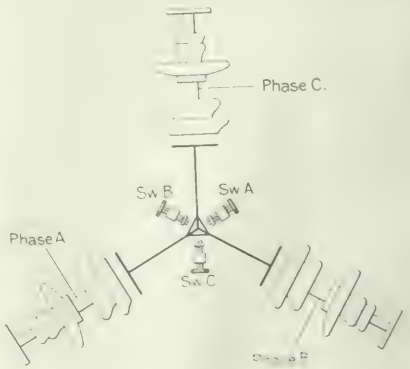


Fig. 7. Diagram of Electrostatic Selective Relay.

only arranged for on overhead lines as the whole object is to extinguish the arc across the insulator. In the event of the insulator being punctured the oil switch will close and earth the phase a second time. By means of a "second stroke interlock" the oil earthing switch now remains permanently closed. With cable systems on the other hand this second stroke interlock is left out and the earthing switch remains continuously closed after the first instead of after the second closing.

The following additional safety devices are provided :—

(*a*) Interlocks between the three earthing oil switches to prevent more than one closing at the same time.

(*b*) Interlock on the selective relay to make it impossible to energise two trip coils simultaneously.

(c) The oil switch first earths the phase through a damping resistance, then short-circuits same. This prevents any oscillations occurring.

The diagram of connections of the Arcing Ground Suppressor showing the various interlocks is given in Fig. 8.

Construction of Arc Suppressing Relay.—This is constructed upon exactly the same principle as the ordinary leakage detector. For high voltages it operates on the electrostatic principle. Reference to Fig. 7 will show that it consists of three condensers made up of porcelain insulators. These are connected to the lines, and if the voltages above earth of each line are equal, the central vane remains still. In the event, say, of phase C becoming earthed the pull on its condenser ceases whereas the pull on the other condensers increases. Consequently, contact is made at Sw. C, which causes the corresponding earthing switch to close.

For low voltages the arrangement works on the electromagnetic principle (see Fig. 6) and consists of three solenoids

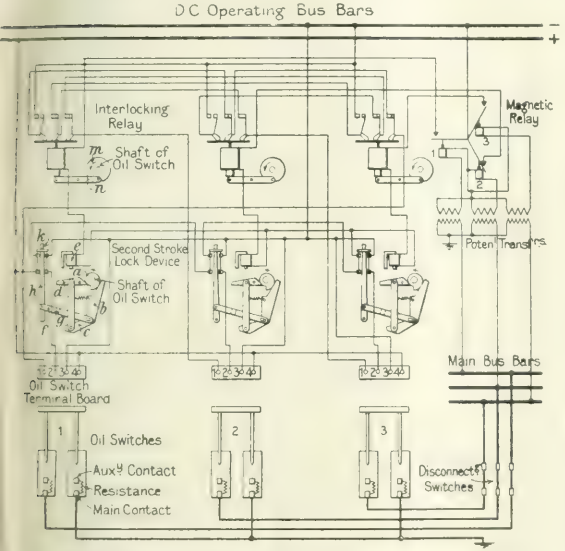


Fig. 8.—Diagram of Connections of Arcing Ground Suppressor.

connected in star fed by three potential transformers also connected in star, but the underlying principle is exactly the same.

Tests have been made on the efficacy of the suppressor in protecting line insulators by Burkholder and Marvin ("Trans." Am.I.E.E., Vol. XXX., 1911, p. 327) and others with good results. These show that one suppressor installed, say, on the bus bars is ample to cover all existing systems. It was found that the arcs across the insulators were extinguished without doing any damage whatever to them, the time taken to do this not exceeding one-half second from the time of starting. Under these circumstances neither the arc nor the operation of the grounding switch caused any disturbance on the lines nor interruption of service.

(To be continued.)

Underground 23,000 volt Transmission.—It is stated in "Electrical News" that the Toledo Railways & Light Co. recently put into successful operation a 23,000 volt, three-phase underground transmission system for supplying 12,000 kw. to the Willys-Overland automobile factory at Toledo

ANNUAL REPORT OF THE I.M.E.A.

Model General Conditions of Contract.—Upon considering the model general conditions of contract placed before the annual general meeting in June, 1913, and further considered at a subsequent extraordinary general meeting held in the following month, it was resolved that the Association of Municipal Corporations should be consulted, and that until the report of a joint committee, composed of members of that Association and of the I.M.E.A., had been laid before the general body of members, the Council were not to communicate with the B.E.A.M.A., or any other body on the question. The Council of the B.E.A.M.A., which had not been consulted by the A.M.C. regarding the proposed amendments, decided to adopt the model general conditions as issued by the Institution of Electrical Engineers for a period of one year in respect of municipal contracts in order to see how they worked. The B.E.A.M.A. asked for the views of the Council upon this proposal, and inquired if they would fall into line with it. Under the circumstances no reply could be given, and the matter is left as heretofore for each corporation to deal with the manufacturers direct. The A.M.C. has since been in negotiation with the B.E.A.M.A., but arrangements have not reached a report stage.

I.M.E.A. Bill.—The Council, having given further careful consideration to the matter, including the various observations made in reply to a circular letter, decided that no further action be taken with the suggestion for a joint private Bill, and that the Association revert to the pressing forward of a Bill promoted in the manner originally arranged. The following suggestions from members and from power companies for further clauses to be added to the Bill have received consideration by the Council :—

"Words to be inserted to make it clear that the powers of the Bill are to be in addition to, and not in substitution for, any powers already held by undertakers."

"Clause to authorise special systems of charging based upon electrical assessment."

"Compulsory way-leaves."

"Power to companies to supply electricity for lighting throughout their power supply areas."

The acting president, Mr. A. C. Cramb, had an interview with Mr. Rawlings, the president of the Electrical Contractors' Association, as a result of which the Council decided that no further concessions be made beyond those contained in the Bill as last printed. After careful consideration of the results of the I.M.E.A.'s Parliamentary propaganda in support of the Bill, Messrs. A. C. Cramb, Bailie Smith, A. H. Seabrook, S. E. Fedden and H. Faraday Proctor, were appointed as a sub-committee to meet the B.E.A.M.A. with a view of discussing this question with them. The Corporation of Glasgow has arranged terms upon which it will operate its publicity and sales departments. The Electrical Contractors' Association in Scotland have agreed to terms less advantageous to themselves than those to which the Electrical Contractors' Association take exception in the Bill.

Engineering Standards Committee.—The Council has voted a sum of 20 guineas from the funds of the Association as a donation from the I.M.E.A. to the Engineering Standards Committee which receives considerable subsidies from the other bodies represented thereon. The response to the appeal for subscriptions made by the Engineering Standards Committee has been very poor from municipal electrical undertakings. The Council feel that perhaps it is not realised how specially valuable the work done by the Standard Committee is to electrical engineering undertakings, how the standardisation of apparatus cheapens the cost of its manufacture, and reduces the time taken in the preparation of specifications by the engineers in charge of such undertakings. They wish, therefore, to make a special appeal to the committees who control municipal electrical supply undertakings, to give their generous support to the Standards Committee by making an annual subscription towards the fund.

Development Committee.—The following resolution was passed at the last annual general meeting :—

"That a special committee be formed of members of this Association, not necessarily members of Council, to deal with any matters that may tend to encourage the use of electricity from the public supply mains, and that this Association shall invite other associations and persons who can assist in furthering the object for which the committee is formed, to join such committee."

At the first Council meeting of the session a special committee was formed in accordance with the terms of the resolution, and was invited to prepare a scheme for the consideration of the Council. Mr. Vignoles was appointed hon. secretary of the committee, but had volunteered and been accepted for war service. At the request of the Council Mr. J. W. Beauchamp accepted the hon. secretaryship of the committee for the time being. Representatives of kindred associations and other persons likely to be of service were co-opted as members, and the work so far accomplished is set out on the Development Committee's report, which forms an addendum to the Council's report.

Lamp Patents and Ilford Case.—In regard to the Ilford case, it was represented to the Council that in view of the judge's opinion further technical evidence was necessary, and that it would be desirable to retain a leader with special knowledge of the Electric Lighting Acts. The Association and other interested bodies were asked for some contribution, towards the extra cost. The Council after due consideration asked the hon. secretary to draw up a statement as to the dangers of the gas companys' attack, and circulate it to the local authorities represented in the Association, asking them to contribute to the expenses of supporting a

test case, and inviting those members of the Association who would be prepared to give voluntary evidence to send in their names. Considerable financial support was promised in response.

Mr. Faraday Proctor presented a valuable report on the subject to the Council. Having carefully examined the tariffs of over 100 of the municipal undertakings, he was of opinion that there were only a few which might be subjected to attack on the grounds of the objections alleged in the Long Eaton and Ilford cases. Some of these cases were at the time receiving consideration with a view to amendment, and in other cases the engineers were prepared to recommend amendments if such were thought desirable. The ground would, therefore, appear to be clear at least as regards the tariffs put forward by the large number of members who replied to the letters of inquiry.

Yorkshire Electric Power Co.'s Bill.—With reference to the moral support given by the Council to the petitions against the Bill by certain municipalities, as set forth in the last report, a communication was subsequently received from the Association of Electric Power Companies in regard to the attitude of the I.M.E.A. in advising the local authorities in the Yorkshire Electric Power Co.'s area to oppose the Bill. It was suggested that the I.M.E.A. had not realised that the Yorkshire Electric Power Co. were only seeking to get lighting powers in the areas in which under their existing Acts they could already supply power. This materially altered the position, and steps were at once taken to make it clear that if the I.M.E.A. had been informed at the time as to the limits of the powers sought by the Yorkshire Electric Power Co. active opposition would probably not have been given.

The chief points raised by the Council were : (*a*) Whether any of the areas referred to in the first schedule in the 1915 Bill were included in the supply areas of any undertakers, municipal or otherwise. (*b*) The consideration of the question of those portions of the areas which bordered upon the existing supply areas of other undertakers.

Concerning (*a*) the Council were informed that the reply was in the negative, wherever powers had been held they had lapsed and been cancelled. Concerning (*b*) the Council were of the opinion that, inasmuch as it was desirable to avoid unnecessary duplication of electricity supply mains in any area, the proposals of the Bill were reasonable, provided that satisfactory protective clauses were inserted. The larger towns affected, such as Bradford, Doncaster, Dewsbury, Hull, Leeds, Middlesbrough, Rotherham, Sheffield and Wakefield were communicated with, and informed of the views of the I.M.E.A. on the matter. The Select Committe of the House of Lords, to whom the Bill was referred, after hearing evidence on behalf of the promoters and from the Board of Trade, announced that the Bill could not proceed as regards the clauses which the company considered of primary importance. The measure was thereupon withdrawn.

Lamp Specifications.—The Tungsten Lamp Association invited the Council to send representatives to form a Joint Committee to discuss the outlines of the specification proposed to be put forward by the Tungsten Lamp Association. As the Council were already represented on the Sectional Committee of the Engineering Standards Committee dealing with a similar subject, they did not see that any useful purpose would be served by meeting the Tungsten Lamp Association, bearing in mind the views which the I.M.E.A. representatives held on the matter.

Sir John F. C. Snell.—The Council records with satisfaction and pleasure the honours conferred upon Mr. J. F. C. Snell, a past president of this Association, his Majesty the King having bestowed knighthood upon him in recognition of his services to the electrical industry, and the Institution of Electrical Engineers having elected him as their president.

L.G.B. Loans.—The Council has had under consideration the action of the Local Government Board in refusing loans for extensions, &c., owing to the war. After most careful deliberation and consideration of the subject from all points of view, including that of the desirability of bringing the war to a successful conclusion at the earliest possible date, the Council felt that they could not recommend action being taken on general lines. It was thought that the case of each undertaking should be considered upon its merits. The question is now being dealt with by the Association of Municipal Corporations and the Institute of Municipal Engineers.

Coal Consumption.—In response to a circular letter sent to 195 towns represented in the Association (chairmen and engineers), 44 replies were received to the following effect : 20 had some difficulty in obtaining [illegible] for the present, 15 had no difficulty, [illegible] consideration, 9 have not yet replied.

The chief articles regarding which difficulty was experienced were in connection with the supply of lamps and carbons. The matter was [illegible] Development Committee for consideration.

Men Engaged in Electrical Work.—With the object of ensuring that members [illegible] should not be accepted for enlistment without special permission, the War Office had been approached, [illegible] the depletion of the staff [illegible] the carrying out of the works of electricity departments. The War Office agreed that those who were of [illegible] to the country [illegible] consideration to [illegible] exemption, but could not [illegible].

Joint Motor Committee.—The B.E.A.M.A. invited the Council to appoint [illegible] Joint Motor Committee. Messrs. A. C. [illegible] H. E. Fedden and J. W. Beauchamp were appointed to represent the I.M.E.A. The suggestion of the B.E.A.M.A. was that there should be a standard specification which should be adopted by the I.M.E.A., and that an arrangement should be made as to preferential discount to undertakings in their districts where such undertakings have the power to sell motors. The Joint Committee eventually recommended that the I.M.E.A. and B.E.A.M.A. should adopt a standard specification for direct-current motors, preferably that to be issued by the Engineering Standards Committee, and until this was issued, the B.E.A.M.A. motor specification.

Board of Industry.—Messrs. H. Faraday Proctor, S. F. Fedden, A. H. Seabrook, A. C. Cramb and Bailie Smith attended on behalf of the Council a joint meeting of representatives of the B.E.A.M.A. and the British Engineers' Association to consider the question of the protection of British interests. Proposals were made for the formation of a Government Department to be entitled the Board of Industry, or, alternatively, the appointment of a fully representative committee. The former course was adopted, and it was decided to invite the I.M.E.A. to appoint a representative on the Joint Committee, one of the main objects being to secure the principle that public money should be expended only on British manufactures. Mr. A. C. Cramb (acting president) was appointed to represent the Association. The following resolution was passed subsequently by the joint meeting, and the Associations represented were asked to adopt it :—

"Resolved, that this Association, fully recognising the necessity for the creation of a new Government Department whose sole function it shall be to safeguard and promote the industries and commerce of the British Empire, is prepared to co-operate with those other associations who, on the invitation of the British Engineers' Association, have signified their general approval of its proposals that a scheme for the purpose should be prepared and brought before the Government.

"It is further resolved that this association shall nominate representatives not exceeding two to act on a Joint Committee for this purpose and of inviting the co-operation of any further bodies or individuals whose services may be of use in the forwarding of this movement, and that Messrs. and be hereby nominated representatives of this association on the aforesaid Joint Committee."

Municipal Loans.—The Institution of Electrical Engineers submitted to the Council a copy of a report of the Municipal Loans Committee of the I.E.E., which with slight amendment had been adopted by that body. The I.E.E. Committee were preparing a memorandum for presentation to the Local Government Board on the matter. The Council, after due consideration, supported the recommendations made by the Institution of Electrical Engineers, in regard to the periods allowed for the repayment of loans :—

	Periods recommended. Years.
(*a*) Cables substantially constructed and laid	30
(*b*) Conduits substantially constructed	60
(*c*) Accumulators and batteries in cases where the sanctioning authority is satisfied that adequate provision has been made for the proper maintenance of the batteries	15
(*d*) Reinforced concrete	30

Hon. Treasurer's Report.—The income from subscriptions remains normal, and there is a considerable increase in the revenue from the "Proceedings" (sales and advertisements). The increase in the outgoings for printing is due chiefly to the size of the "Proceedings," which always vary in bulk. There is a surplus for the year of £62, against £65 last year. The total surplus of assets over liabilities is £848, and £100 has been invested in War Loan stock, bringing the invested funds to, say, £700, the present market value of which is £635. It will be noted that there are no bad debts, and that so far the war has had no detrimental effect on the Association from a financial point of view. The council's report would be incomplete without same reference to the time which its members devote to Committee work in addition to that involved in the council meetings. They would specially refer to the large amount of honorary secretarial and organisation work undertaken with great advantage to the Association and the Committees concerned by Mr. H. Faraday Proctor, the hon. secretary of the I.M.E.A., Mr. Frank Ayton, the hon. secretary of the Electric Vehicle Committee, and Mr. J. W. Beauchamp, the acting hon. secretary of the Development Committee.

Report of the Development Committee.

Meetings.—Meetings of the committee were held monthly up to April 16, 1915, when it was decided that, owing to the difficulties in carrying out this class of work, brought about by the war, and the increased demand upon the time of members, that the meetings should only take place approximately once in three months, the chairman having power to call a special meeting at a shorter interval if required.

Ways and Means.—So far, no special arrangements have been made for providing funds for carrying on the work of the committee, the out of pocket expenses in connection with the secretarial work having been defrayed by the funds of the I.M.E.A.

Division of Sub-committees.—It was decided that the actual work of the committee should, so far as possible, be broken up and given out to sub-committees of comparatively limited size and scope of operations, such sub-committees to be distributed geographically so far as convenient.

In the first instance the following sub-committees were constituted and put in motion :—

1. Publicity Sub-committee. (London District.)

I.M.E.A. Members.—A. H. Seabrook, A. C. Cramb (hon. secretary).

Co-opted Members.—D. N. Dunlop, C. Palmer, W. C. P. Tapper, L. G. Tate, F. W. Willcox.

2. Electrical Installations Sub-committee. (Bradford District.)

I.M.E.A. Member.—T. Roles (hon. secretary).

3. Domestic Appliances Sub-committee. (Birmingham District.)

I.M.E.A. Members.—R. A. Chattock, G. Wilkinson, S. T. Allen (hon. secretary).

Co-opted Members.—N. Hyde, C. M. Slaney, J. P. Wilmshurst.

Up to date, the principal work which the sub-committees have been engaged in has been as follows :—

1. *Publicity Sub-committee.—The preparation, in preliminary stages, of a scheme of co-operative advertising, printing and publicity work.* The sub-committee have interviewed advertising agents and printing firms, and obtained information with regard to the possibilities of producing publicity matter, and for bringing about an arrangement with a suitable firm for the production of such matter, under the guidance of the Publicity Committee, and for the payment towards the funds of the Development Committee of some proportion of the profits which might accrue in the sale of such matter to electricity undertakings. Mr. Dunlop, on behalf of the B.E.A.M.A., offered office accommodation, and the assistance of himself and his staff, to further theses objects, particularly in regard to detailed work of purchasing, distributing and collecting accounts in regard to the publicity matter. This offer has been accepted by the Development Committee, who hereby express their appreciation of the same, and hope that the future may enable them to avail themselves of it at least until such time as reasonable funds are forthcoming, and the development work of the I.M.E.A. can be put upon a proper financial basis. The Publicity Sub-committee have, after due deliberation, insisted upon the absolute necessity of providing regular funds and the establishment of at least a small paid staff, whose whole time could be devoted to this class of work, leaving the members only the task of guiding and making suggestions with regard to the class and suitability of the matter to be prepared ; in fact, the general direction of the publicity campaign. The sub-committee direct attention to the urgent need of the provisions relating to publicity work which are contained in the I.M.E.A. Bill, and feel that their operations must be heavily handicapped until fuller powers are granted to municipal electric supply undertakings. Communication has been opened up with the Publicity Committee of the London electric supply companies, with a view, if possible, to combining the efforts of all classes of electric supply undertakings in regard to publicity, to avoid wasteful overlapping, and bring about at the earliest moment an organised campaign for the development of public electricity service. Communications have also been received and considered from the Society for Electrical Development, New York, the manager of which (Mr. Wakeman) was good enough to offer assistance, and, so far as possible, means of co-operation between publicity undertakings on both sides of the water, and it is hoped that, under circumstances more favourable to this class of work than those at present obtaining, that the idea may be developed.

2. *Electrical Installations Sub-committee.*—In this case operations have been very much interfered with by the present abnormal conditions, but the secretary has reported upon the preliminary stages taken to bring together suitable men for procedure with this work as soon as possible. For the present the Electrical Installations Sub-committee will proceed so far as possible

(*a*) To examine, tabulate and describe the various methods of wiring in use, with advantages and disadvantages, with a view to bringing about any possible reductions in the cost of installation work compatible with safety.

(*b*) To obtain the assistance and opinions of practical men in touch with this class of work, and to promote discussion on the subject.

(*c*) To promote practical criticisms of accessories in common use in connection with installation work, with a view to collating information which would be valuable to manufacturers and users.

(*d*) To take an early opportunity of considering alternatives to the present design of plug contact for heating, cooking and other purposes, particularly in regard to the possibilities of superseding the ordinary pin

3. *Domestic Appliances Sub-committee.*—

proposition being to carry out various investigations with regard to hot and boiling plates, and to invite the advice and criticisms of manufacturers in connection with that subject. The sub-committee's work will

of the Electrical Installations Sub-committee would leave off. It is

analysis, might be produced in booklet form, and

Council, they could be sold, and would, presumably contain matter of use and interest to manufacturers and others. Also, any information obtained in this way would constitute valuable guidance for the Publicity Sub-committee. Later it is hoped to expand into the questions of hire and hire purchase, costs of maintenance of apparatus, and analysis of existing schemes.

Engineering Standards Committee.—"The Development Committee considered a letter published in the technical press from Mr. C. H. Wordingham to the secretary of the I.E.E., dealing with the question of establishing a central testing institution or proving house. The committee associated itself with the views expressed by Mr. Wordingham therein, but urged that the National Physical Laboratory and its existing organisation should be employed whenever possible, as further support would enable it to extend its field of operations and would have the advantage of assisting to develop a laboratory which is entirely independent of trade interests."

Standardisation of Apparatus.—This question has received the attention of the committee, who have kept in mind the desirability of assisting manufacturers to produce cheaper appliances, also the danger of crystalising design in regard to appliances which appear capable of considerable further development. It is proposed in this connection to work as far as possible in conjunction with the Engineering Standards Committee.

Report of the Electric Vehicle Committee.

Ten meetings of the committee have been held, all in London with the exception of that held in Birmingham in May. The committee elected the following as its officers for the year :—

Chairman, R. A. Chattock.
Hon. secretary, F. Ayton.
Hon. treasurer, J. Christie.
Chairman of the Technical Sub-committee, R. A. Chattock.
Acting hon-secretary of the Technical Sub-committee, J. Christie.
Chairman of Commercial Sub-committee, A. H. Seabrook.
Hon. editor of "The Electric Vehicle," A. H. Seabrook.

The secretary of the Association, Mr. McArthur Butler, attends the meetings officially on behalf of the Association, and the committee are indebted to him for much valuable assistance. The work of the committee during the period mentioned has covered the following :—

Charging Plug and Receptacle.—The method to employ in gripping the charging cable to the plug was decided upon, and a complete design and specification for the plug and receptacle was published in the March issue of "The Electric Vehicle." An application was submitted to the Engineering Standards Committee for the standardisation of this accessory, and the sub-committee of that body, which dealt with the matter, agreed to recommend the committee to standardise the dimensions of the contacts, as well as to supervise the manufacture of gauges for them. Two firms in this country are now supplying the fitting in accordance with this committee's specification.

Tariff for Electric Energy for Charging Vehicle Batteries.—The committee attach great importance to the adoption, as far as possible, of a uniform tariff throughout the country for this purpose. They have, in various communications addressed to electric supply undertakings, urged them to come into line upon a flat rate of 1d. per unit for "off peak" supply. The list contains the names of 105 undertakings that have adopted the committee's recommendation on this matter. The committee believe it is only a question of time before all progressive undertakings will adopt this tariff.

Financial Support.—When the committee got fully to work it was soon apparent that funds were necessary in order to make real progress. Up to that time what little expenditure had been necessary was borne by the parent Association. It was, therefore, decided to appeal to all electric supply undertakings for financial support, and the accounts show that the response has, on the whole, been satisfactory. The committee are under a special debt of gratitude to Alderman J. P. Smith, of Barrow, who started the list with a private donation of £5, and to the accumulator makers' section of the British Electrical and Allied Manufacturers' Association, who came forward with a handsome contribution of £50. In a few instances Corporations have announced that they will make the contribution an annual one, and the committee sincerely trust that all the donors mentioned in the accompanying list will give similar amounts during the present year. The important work which the committee is engaged upon cannot go forward without adequate financial support.

Standard Charging Voltage.—After considering the matter, the committee decided that it would be of advantage to adopt a definite range of charging voltage. They consequently fixed this range between 85 and 120, which corresponds with the voltage which will take care of the

Standard Number of Cells.—For the reason given above, the committee have fixed 44 as the standard number of cells per vehicle for lead plate batteries.

Rubber Tyres.—At the meeting of the Society of Motor Manufacturers and Traders, the Engineering Standards Committee decided to standardise certain rims for solid rubber tyres, and your committee decided to support the Association in this important matter by recommending that these rims, of the sizes given below, should be used for all commercial electric vehicles :—

Sizes referred to are as follows :—

670 mm.	741 mm.	850 mm.
720 mm.	771 mm.	881 mm.

Co-operation between the Committee and the Commercial Motor Users' Association.—[illegible] the committee, Mr. F. S. [illegible] the Commercial Motor Users' Association, it has been arranged that the Association will allow the committee a voice in all future arrangements which they make in regard to parades of motor vehicles in so far as such arrangements apply to electric vehicles. The Association has also very kindly offered to allocate to the use of this committee a section in the next edition of its "Night Shelter Handbook for Commercial Vehicles," in which the committee can set forth information as to charging stations about the country, tariffs, &c., and the Association has also offered to include a map upon which these charging stations may be indicated. The committee take this opportunity of recording their thanks to Mr. Shrapnell-Smith, and the Association he represents, for their kindly courtesy in these matters.

Affiliation with the Electric Vehicle Association of America.—The committee desire to again refer to the most useful results which have followed upon the continued affiliation with this important Association through the membership of their honorary secretary. The Association, both through its most energetic executive secretary, Mr. A. Jackson Marshall, and the chairmen of its various committees, has shown itself most anxious to help this committee whenever such help has been asked. The committee desire to place upon record their appreciation of the value of this co-operation, and their thanks for much useful information received.

Standard Charging Equipment and Methods of Charging.—The importance of this subject has been recognised by the committee, and for some time the technical sub-committee have been hard at work upon it. A very full report is in hand, which the committee hope to publish shortly.

In closing this report, the I.M.E.A. representatives on the committee take the opportunity of expressing their thanks to the co-opted members for the extremely valuable work which they have so willingly performed during the year under review. It is no exaggeration to say that the progress which has been made would have been impossible but for the assistance which these gentlemen have given.

ANNUAL GENERAL MEETING OF THE I.M.E.A.

The [illegible] meeting of the Incorporated Municipal Electrical [illegible] was held on the [illegible] of Electrical Engineers, London, on Friday last, Mr. A. C. Cramb, borough electrical engineer, Croydon, presiding.

Mr. R. A. Chattock (Birmingham) referred specially to the importance of the work of the Standards Committee, and to the immense value which it was proving to the members of the Association. It was possible to save an enormous amount of time in the preparation of specifications by reason of the work of the committee, and he urged all engineers in charge of municipal undertakings to put this forward as a justification for the appeal which the committee was making for funds with which to continue its efforts. He would appeal to them to use their influence with the committees to vote funds for this very laudable object.

Mr. H. Faraday Proctor (Bristol) commenting upon the matter of the Local Government Board and municipal loans, said that a deputation comprising Sir John Snell, Mr. C. P. Sparks and Sir John Wolfe Barry had waited upon the Treasury with a view to obtaining sanction for loans for municipal electrical developments, and although nothing yet had resulted from the efforts of this delegation, Mr. Proctor wished to assure the members of the Association that their interests were being looked after in every way, and also that the Treasury was in sympathy with the objects which they had in view.

Mr. Cramb said that the thanks of the Association were due to the Institution of Electrical Engineers for providing accommodation for the Association, not only for the meetings of its various committees, but also for the purposes of the annual convention. These facilities had been furnished without any charge.

Councillor H. R. Barge (Poplar) proposed and Mr. E. S. Rayner (Doncaster) seconded the adoption of the annual report.

Mr. S. E. Fedden (Sheffield), in moving the adoption of the report of the Development Committee, called attention to the fact that the active operations of this had been more or less held up by the war. So far as general publicity work was concerned, the country had been divided up into districts, and it was hoped as the result of this work a certain amount of advertising would be undertaken, although the cost of this would need [illegible] to keep alive the interest in the work of the Development Committee, and the [illegible]

Ald. J. P. Smith (Barrow-in-Furness) seconded the adoption of the [illegible] of the Electric Vehicle Committee Mr. R. A. Chattock referred to the work done, particularly in regard to standardising of plugs and charging machinery. [illegible] ons large towns, so that industrial [illegible] that the committee could rely upon carrying on the work under proper financial support.

Mr. S. J. Watson, in seconding, said he would like to emphasise the splendid work accomplished on behalf of the committee by Mr. Ayton, to whom they were under a great debt of obligation.

The following Council were elected :—

I.M.E.A. Council 1915-16.

President.—Mr. A. C. Cramb (Croydon).
Senior Vice-President.—Mr. F. M. Long (Norwich).
Junior Vice-President.—Mr. A. H. Seabrook (St. Marylebone).
Immediate Past Presidents.—Messrs. G. Wilkinson (Harrogate), R. A Chattock (Birmingham), H. Richardson (Dundee).
Hon. Solicitor.—Ald. G. Pearson (Bristol).
Hon. Secretary.—Mr. H. Faraday Proctor (Bristol).
Hon. Treasurer.—Mr. J. E. Edgcome (Kingston-upon-Thames).
Members of Council.—Engineers: Messrs. J. W. Beauchamp (West Ham), A. S. Blackman (Sunderland), S. E. Fedden (Sheffield), T. Roles (Bradford), W. A. Vignoles (Grimsby), W. Wyld (Hampstead), W. W. Lackie (Glasgow), S. L. Pearce (Manchester), S. E. Britton (Chester). *Committee Representatives*: Councillor Crowther (Sheffield), Ald. Ellaway (Birmingham), Ald. J. P. Smith (Barrow-in-Furness), Bailie W. B. Smith (Glasgow), Councillor H. R. Barge (Poplar), Ald. Sir J. Beecham (St. Helens).

In regard to the place of meeting for 1916, owing to the war, it was decided to leave this matter in the hands of the President and Council. Mr. Faraday Proctor thought it should not be held in London, which seemed very unsuitable, as members got so scattered.

Mr. Faraday Proctor then read a letter from Mr. Edgcome on the question of State insurance against damage by fire or explosion due to hostile aircraft, in which the writer expressed the opinion that such damage should be a charge on the country as a whole. It should not be necessary for individuals to insure, particularly as heavy premiums were asked in districts where the risk was considered to be greatest. Mr. Proctor said this letter had been considered by the Council, who were in sympathy with Mr. Edgcome's views, and the following resolutions were submitted to the meeting :—

"That this meeting is of opinion that the Government should hold themselves financially responsible for all damage to real and personal property situated in the British Isles directly attributable to the present war."

"That a copy of this resolution be transmitted to the Premier."

Mr. F. Ayton (Ipswich), in seconding, said his town was greatly interested in this question. He felt that the rates of insurance on the East Coast were much too heavy, and that the risk should be distributed all over the country.

Councillor Crowther (Sheffield) supported the resolutions. Some parts of the country were in more danger from air invasions than others, and perhaps ought to take their own risks, but they had to bear in mind that these particular districts were engaged in work of national benefit. Such places as Birmingham, Sheffield and other towns were producing munitions of war to be used for the national good, and, as a matter of justice any danger they might be bringing upon themselves in so doing should be a national charge.

Ald. Smith (Liverpool) thought the country's burden was already heavy enough without adding to it. Men who were making munitions were also making profits, and the proper course was not to take such a sweeping resolution, which might under great activity by the enemy cause huge claims. It would be more convenient if those desiring to be insured were insured by the Government at a nominal or reasonable rate. The Government certainly ought to take the matter in hand, but only on a definite insurance basis for a definite amount subject to a definite premium.

Councillor Barge said he noticed that the other day the Prime Minister, in reply to a question, stated that the Government were taking responsibility for meeting loss sustained. He did not agree with the last speaker that they should differentiate as between different parts of the country. They were united as a nation, and as a nation ought to meet the loss sustained by individuals.

The resolutions having been carried,

Bailie Smith (Glasgow), on the subject of coal supplies, said he represented the Association in this matter as a member of the deputation formed at a meeting held there a few weeks ago. They had had an interview with the Government committee controlling the export of coal, which had the whole matter at its fingers' ends, and the Association could trust the Government to keep a tight grip of the question of allowing coal to go out of the country to questionable neutrals. Last week the members of the deputation, had met 200 M.P.'s. A good impression was made, and some of them had been called up again on Tuesday to attend under the same conditions. A committee of 12 was formed, 11 M.P.'s and the head of their own deputation, Sir Herbert Wood[illegible]. That committee had since met, and it was hoped that they would report in a week to the Government and give some recommendations as to action. Unanimity was expressed on two points, the necessity of getting the mines to work at least full time, and the necessity to control prices. It was admitted that there was avoidable absenteeism on the part of the miners, who were not working full time. [illegible] could be made, but it was put to the meeting that miners must be permitted to work at least full time, so that there should be enough coal to supply our own demands and those of our Allies. In regard to the second point, Sir A. Markham, who was [illegible] colliery owner, told the M.P.'s that a fictitious and unreasonable price was being charged by colliery owners, and recommended the Government to form some organisation that would control and fix the price for each district based on the price of coal a year ago plus the extra cost, and not to allow any speculative or fictitious

prices to be charged. He (Bailie Smith) emphasised the importance of members using all the influence they could with their local M.P.'s to support the committee.

Councillor DYMOND (Hereford) proposed a vote of thanks to the acting president, Mr. Cramb, who had performed his duties in a manner which commended itself to all, in being audible, businesslike and brief. Unfortunately, they only met Mr. Cramb in a sternly business way this year, but, having been elected president for the ensuing year, he hoped the Convention then would not be confined to business, but would give the President an opportunity to shine on the social side in the same way as he had this time shone on the business side.

Ald. BARGE proposed a vote of thanks to the hon. officers, specially coupling the name of Mr. Faraday Proctor, the hon. secretary. During the past year the officers must have had much extra and much unforeseen work to do, and they had proved themselves most efficient.

A vote of thanks to the President and Council of the Institution of Electrical Engineers for allowing the meetings to be held at the Institution brought the proceedings to a close.

CONTROL APPARATUS FOR STEEL MILL AUXILIARY ROLLS.

The manufacture of steel being essentially a series of processes, immunity from defects in design of the machinery used for any stage in the process, however relatively insignificant its function, is of vital importance. In no branch of the industry have greater improvements been made during recent years to produce absolute reliability, simplicity and greater output than in the electrical equipments for controlling the reversible motors driving the live rolls.

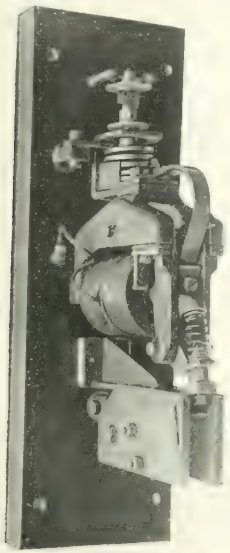


FIG. 1.—B.T.-H. CONTACTOR WITH SHUNT OPERATING COIL FITTED WITH MECHANICALLY INTERLOCKED ACCELERATING RELAY.

Control apparatus for this service is subjected to the most severe conditions to which electrical apparatus has been applied for commercial purposes, as the motors driving the rolls have to be started, checked, started again or reversed as often as 20 to 30 times a minute throughout a day of 20 hours. The controlling device originally used was the well-known hand operated dial type adopted for other industries, consisting of contacts for reversing the armature connections, and introducing or cutting out resistance in series with the motor armature for starting and reversing the main armature current passing through these contacts. The earliest forms, as for other industries, consisted of fixed contacts mounted in one plane on slate or other insulating material, over which were moved contacts mounted on or geared to the operating lever. These dial type controllers were at one time superseded by the well known drum type controller as used for tramcars. The latter could be more conveniently applied to this form of controller which has the additional advantage that the wear caused by arcing on the moving contacts is less, due to the fact that a different contact is used for each division of resistance, whereas in the dial type the same moving contact is subjected to the arcing of each resistance step.

A drum type of controller, however, becomes very massive when sufficient control points are used to limit the current which flows on the first notch to a low value, and the moving parts become so heavy as to cause fatigue to the operator. For this reason the dial type, which in its later forms was a sound mechanical structure, was in many cases preferred to the drum type.

The usual practice, adopted when starting a motor, of delaying movement of controller handle from step to step until the motor has accelerated and the current decreased to approximately its steady value, cannot be observed in this service, where the operator's whole

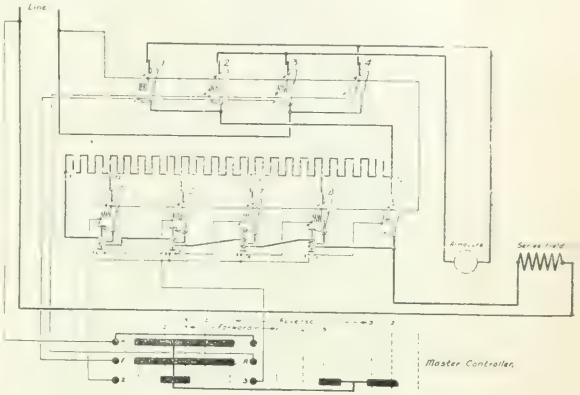


FIG. 2.—CONNECTIONS OF B.T.-H. CONTROL PANEL (A.C.) FOR USE WITH REVERSIBLE SERIES MOTOR DRIVING LIVE ROLLS.

attention must be applied to the billet being rolled, and not to the protection of the motor or gears. Some form of automatic protection is, therefore, necessary, and this must be applied so as not to delay notching an instant after the current has decreased to the required limit for cutting out the next step of resistance. For this reason dashpot control is not suitable.

These considerations lead to the conclusion that the best solution of the problem is obtained by the use of a manually-operated master controller and electrically-operated contactor switches, the contactors closing partly under the influence of the master controller and partly of the main current. As the cycle of operations is varying all the time it is impossible to apply a device for producing entirely automatically the required results, and the human element must necessarily be introduced.

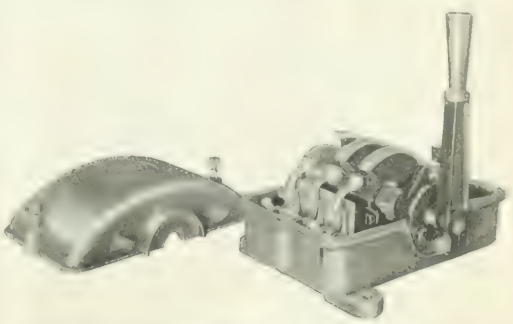


FIG. 3.—B.T.-H. MASTER CONTROLLER WITH COVER REMOVED.

This form of controlling device is now being generally adopted for the control of auxiliary rolls. Such a system to be satisfactory for use in a steel works must be free from the mass of small wiring and auxiliary contacts usually associated with the earliest forms of automatic devices. A contactor having the necessary rugged characteristics and simplicity of construction for the service, is found in the type universally adopted for railway service, which has solid main contacts pressed together by strong spiral springs. Fig. 1 shows the type in question for direct current circuits which has very

few parts, all parts being easily accessible for inspection, cleaning and renewals.

The method of making the current limit relay part of the contactor, adopted by the British Thomson-Houston Co., of Rugby, who were the first to introduce contactor systems for the control of live roller gear in this country, enables a very simple wiring system to be adopted, as shown in Fig. 2, which is a typical diagram for live roll service. Referring to the diagram, contactors 1 and 2 are mechanically interlocked, so that they cannot be closed together; so also are contactors 3 and 4. Each current limit relay consists of a main coil and iron plunger, the plunger carrying a contact disc which bridges two contact posts when in its lower position. The plunger is held mechanically in its upper position by the moving arm of the contactor when the contactor is open, as shown in the photograph. When the contactor closes the plunger is mechanically released, and is only held in the upper position by the magnetic effect of the main current. When the main current has decreased to a predetermined

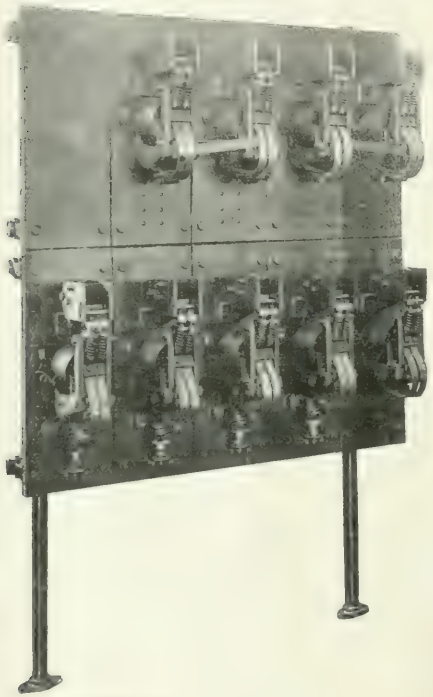


Fig. 4.—B.T.-H. Contactor Panel.

value due to the speeding up of the armature, the plunger falls to its lowest position, thus closing the operating coil circuit of the next resistance contactor, which closes, causing the main current to increase and accelerate the motor. This is repeated for each resistance step.

The type of master controller as used by the B.T.-H. Co. is as shown in Fig. 3. This has three control points—both forward and reverse. The first point closes the armature circuit through a very high resistance. This serves as a check point when the controller handle is thrown from forward to reverse. The second point corresponds to slow running of the motor, and is used for turning the [illegible]. When the controller is on the third step the rest of the resistance contactors notch up automatically under the influence of the current limit relays.

The great advantages obtained with the contactor equipments [illegible] controller equipments have been as follows: The [illegible] the energy [illegible] and power, and the consequent [illegible] reduced, due to the fact that the current [illegible] just being subjected to excessive stresses. The [illegible] a quick make and break action and being [illegible] operation [illegible] are more suitable for controlling heavy motors [illegible] ordinary [illegible] and [illegible] better able to deal with heavy currents than the hand-operated [illegible] they are not subjected to such heavy currents, due to the fact that the current is controlled within limits by the relays. The quantity of steel rolled in a given time is increased, as the operator can move the controller handle as rapidly as he likes without fear of breaking pinions or shafts, the motor being automatically accelerated or reversed in the shortest safe time. Another important feature is that these small master controllers can be used by the operator without fatigue.

Fig. 4 shows a typical contactor panel for alternating-current circuits as made by the B.T.-H. Co.

Fig. 5 shows a control equipment for direct current circuits for which another form of current limit relay is used, the control system being otherwise the same as described above. The relays in this case are small series-contactors, the main contacts of which are in the control circuit, the operating coils being in the main circuit. These series-contactor relays, which are shown in Fig. 6, are a B.T.-H. Co. patent. They have the property that they can be adjusted so that the contacts will remain in the open position if a current of more than a

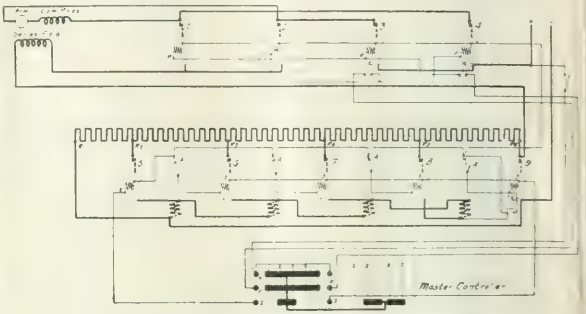


Fig. 5.—Connections of B.T.-H. Control Panel (D.C.) for use with Reversible Series Motors Driving Live Rolls.

desired value be switched through the operating coil, and will close automatically when the current has decreased to a desired value.

In Fig. 5 the main contactors which are operated by shunt-wound coils are marked 1—9 inclusive. The contacts of the relays are marked A, the main coils of the relays being shown immediately below the contacts. A main contactor in closing to short-circuit one of the divisions of the starting resistance completes a circuit

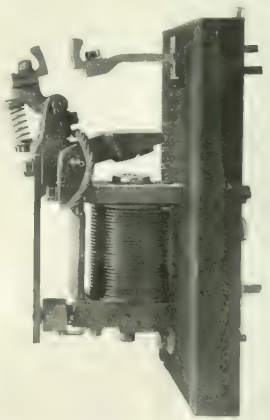


Fig. 6.—B.T.-H. Series Contactor.

through the operating coil of the relay controlling the contactor next to close in the sequence. The instantaneous increase in the line current caused by short-circuiting a division of the starting resistance causes the relay contacts to remain open until the motor has accelerated and the line current has decreased to a safe value. The relay then closes, completing the circuit to the operating coil of a main contactor which then closes. The main contactor in closing energises the coil of the next relay, and so on. We understand that the control system shown in Fig. 5 is being successfully used for rolling mill service.

ENGINEERING PLANT AT THE REGENT PALACE HOTEL

The Regent Palace Hotel, London, is said to be the largest hotel in Europe; and in accommodating some 1,500 resident visitors, in addition to a large restaurant business, it would certainly appear to have considerable justification for the claim. The engineering plant also presents several unique features in addition to the large scale on which it is designed. Few outside those interested in hotel equipment realise the extensive nature and completeness of the electrical heating and ventilating systems in an establishment of this kind. The Regent Palace Hotel has been aptly compared with a battleship in the efficiency and up-to-dateness of the engineering plant. In effect it is largely a model upon which new and equally immense buildings to be erected in the future will be designed.

The heating, ventilating and general engineering plant was designed by and installed under the direction of Mr. A. H. Barker, B.A., B.Sc., Wh.Sc., consulting engineer and professor in heating and ventilating engineering at the London University. The electrical equipment, lighting and power, wiring, &c., was carried out by the company's own staff, under the direction of the chief electrical engineer, Mr. Cushion. To the directors of the Strand Hotel (Ltd.), and these two gentlemen we are indebted for particulars of the plant, and an opportunity of inspecting same.

The heating, ventilating and hot water supply work was executed by Messrs. J. Jeffreys & Co. (Ltd.) There are in all some 300 miles of pipes in the building and 15 miles of air ducts. The warming is effected partly by hot water radiators, partly by vacuum steam, and partly by electric fires. The whole of the reception rooms on the basement, mezzanine and ground floor are supplied with low-pressure hot-water radiators from duplicate steam heaters fixed in the sub-basement. The circulation is by natural gravity accelerated when necessary by electrically-driven pumps. The arrangement is such that the temperature of the water circulating to each of the principal reception rooms is under independent control. The 1,028 bedrooms are warmed by electric fires, and the bedroom corridors by radiators on the vacuum-steam principle. Each corridor is under separate control, and the whole service is operated from the sub-basement. The general arrangement is shown in Fig. 1.

The ventilation of the principal reception rooms is on what is known as the "balanced system." Fresh cooled air is supplied by two large general fans. Each principal room has its own independent extract fan. Fresh air is thus forced in while vitiated air is simultaneously withdrawn from the room in any desired quantity. This desirable but elaborate system is adopted to avoid the production of draughts. For ventilation of the main reception rooms fresh air is admitted into a large settling chamber. In it all the heavier dust and other impurities are allowed to settle. It then next passes through one of the largest air washers in the world, where it is thoroughly cleansed of dust and other impurities, cooled and humidified. In the hot days of summer provision is made for cooling the air through a considerable range by refrigerator coils, water, or ice, as required. In cold weather it is suitably tempered by passing over a battery of warm pipes. From the air washer it is led through two centrifugal fans, and driven through underground ducts to all parts of the building. The ducts are so arranged that either fan can be employed for the supply to the whole building, thus minimising the risk of heated air. There are two ducts for each room, one for warm and the other for cold air. Warmed or cooled air can be admitted in any proportion to any of the principal rooms independently of one another, so that one room can be supplied with cold air and an adjacent one simultaneously with warm air.



FIG. 2.—VIEW OF VENTILATING TRUNK, SHOWING DAMPERS.

The kitchen is of unusual height and size, and fitted with probably as fine a cooking plant as is to be found anywhere in the world. Steam, gas, electricity and coal fuel are all employed. The whole of the ceiling is false, with a ventilating space over the entire area. It is perforated by innumerable holes cast in removable panels, so that the entire ceiling can be periodically taken down for cleaning.

From this false ceiling-space the air is drawn along a large duct to a fan, similar to those employed in the ventilation of a mine, fixed on the mezzanine floor. This fan is of sufficient power to change the whole of the air in the kitchen and surrounding rooms every 1½ minutes. The air is delivered into a large duct which conducts it to the extreme top of the building. The smell of cooking is thus entirely avoided.

A special feature is a large room for airing all the linen used in the hotel. This is fed by a continuous stream of warm fresh air supplied by a fan, driven by a 5 h.p. motor and steam heater, so that all the linen required throughout the building is thoroughly aired before being used. Each bedroom is separately ventilated by a trunk carrying vitiated air to the top of the building. Fresh air is introduced at the will of the occupant either from the warmed corridor or from the adjacent areas. The lavatories, baths and w.c.'s throughout the building are similarly ventilated by extract fans, which withdraw the air to the roof.

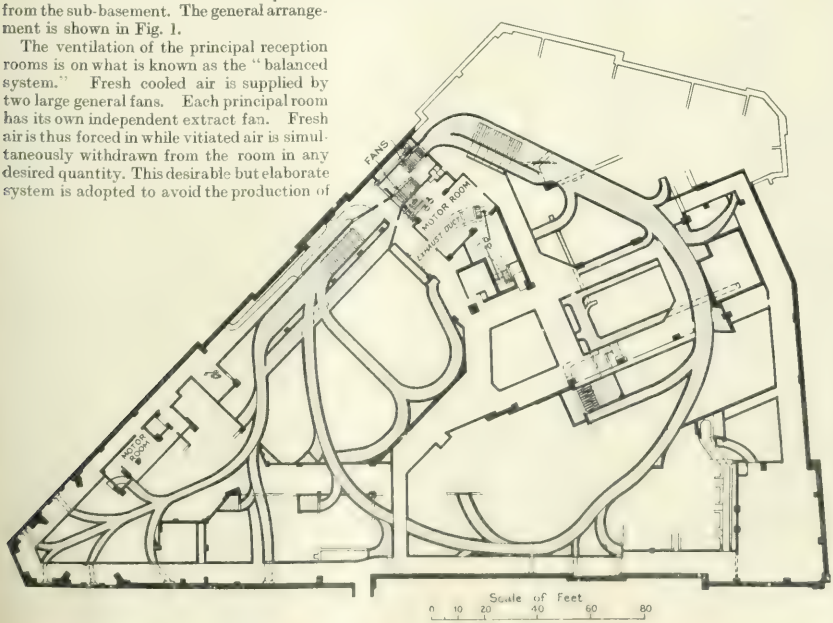


FIG. 1. PLAN OF VENTILATING TRUNK IN BASEMENT.

As every bedroom has its own hot water supply tap, and as there is more than liberal bath accommodation, the provision of hot water was one of the most difficult problems in the entire installation. The supply to the hotel, and to every bedroom in it, is furnished by three very large "calorifiers," or steam heaters, fixed in the sub-basement heater room, adjacent to the main boilers. The temperature of the water is automatically controlled by electrical valves. There are also two large storage cylinders fixed on the roof, holding 20,000 gallons of hot water. The hot water is circulated to the taps by



Fig. 3.—The Air Washer.

natural gravity, accelerated, when necessary, by a pump. It is thus led to every bedroom and to the innumerable sinks, lavatories and baths fixed in every part of the building.

Control.—The method by which the whole of this huge plant is brought under the control of a single man is one of the features of the plant. In the heart of the building is situated the "control room," or engineer's office. Here are fixed electrical instruments enabling the engineer in charge to determine, without leaving his seat, what is the temperature at any one of about 250 points in all parts of the building. Any five of these points can be simultaneously connected at will to a multiplex self-recording instrument enabling a simultaneous permanent record of temperature changes at all these

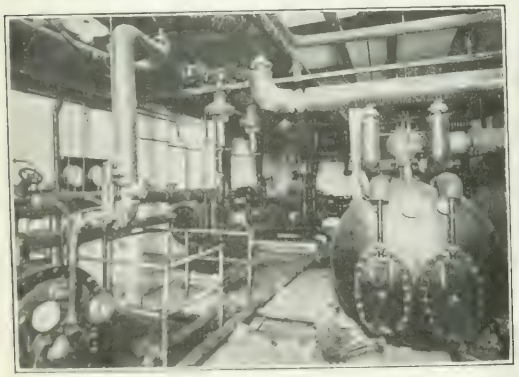


Fig. 4.—The Calorifiers.

can be effected without a workman being seen. All this immense mass of pipes is fixed in the sub-basement and in concealed vertical ducts and under floors. The visitor does not see any one of the 300 miles of pipe which minister to his comfort and convenience

The pneumatic despatch service consists of two sizes of tubing—2¼ in. outside diameter and 1½ in. In the installation there are over 4,000 ft. of tubing, 1,000 connecting sleeves, and 175 bends. The carriers are drawn through the tube by suction, which is maintained by means of a blower driven by a 6 h.p. motor.

Some idea of the extensiveness of the lighting and power installation may be gauged by reference to a few figures. There are 1,028

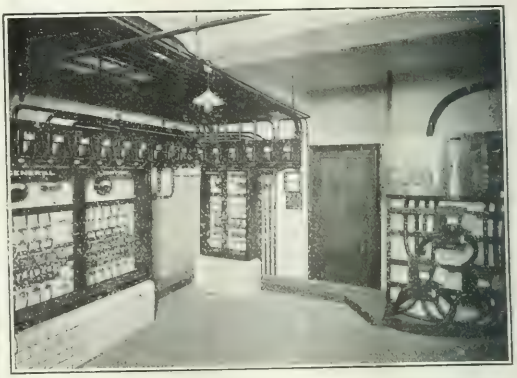


Fig. 5.—Switch Room No. 1.

bedrooms, any one of which is arranged to be provided with a 1½ kw. Belling fire. The total amount of cable used is over 180 miles run in upwards of 300,000 ft. of screwed conduit. There are also a large number of electric motors for driving fans, &c., in addition to those required for the 32 lifts in the building.

The whole of the current is supplied at 220 volts by the St. James's and Pall Mall Supply Co. (Ltd.), in Carnaby-street close by the hotel. Two 0·8 sq. in. cables are run directly and independently into the building from the Carnaby-street sub-station for the heating circuit, and the other main cables are proportionately large. They are taken into two separate switchrooms through the company's main switch fuse and a circuit breaker. Three systems are provided, for general



Fig. 6.—Switch Room No. 2.

lighting, "police" or "council" lighting, and for the general power service. Each has a capacity of 300 amperes, making the total capacity, apart from the special service to the electric fires, of 1,800 amperes. It may be mentioned that the "police" or "council" service is a separate service required by the regulations in all public buildings of this kind.

The main service is taken into three main distribution boards; from these are taken cables which serve each floor independently. Every floor is also separately metered and protected by enclosed

cartridge fuses of G.E.C. make. The distribution board controlling the heating circuits is in a separate chamber in the sub-basement, and consists of 60 separate D.P. fuses and switches and is over 30 ft. long. From this board are taken 56 pairs of 19/16 cables to the various floors, and on each floor there are six sub-distribution boards. The sizes of the cables and feeders are designed to allow the whole of the heaters to be turned on at one time.

The most important section of the power is that required for driving the ventilating fans and lifts, which systems are described above. The electric motor nevertheless plays an important part in the kitchen equipment, &c.: for example, there is a 4 H.P. motor



Fig. 7. Distribution Board.

driving a "Hall" refrigerator, an ice-making machine, an almond crusher and a "whisk." The latter is provided with an ingenious form of friction drive, which enables the speed to be adjusted within very narrow limits. In the French bakery there is a 2 H.P. motor-driven bacon cutter and a mincing machine. The refrigerating plant for the cold storage rooms is driven by an 18 H.P. motor with a brine circulating pump driven by a $2\frac{3}{4}$ H.P. motor. There are also a large number of buffing machines for boot cleaning, driven electrically. The vacuum cleaning plant, which feeds four points on each floor, is operated by an 8 H.P. motor.

For the lighting of the building some 6,000 Osram lamps have been installed, and the wiring has been laid out in two systems to



Fig. 8. Motors of Service Lifts.

comply with the L.C.C. regulations. The required number of lamps in all the public portions of the hotel are supplied from what is known as the "counsel main," which feeds two principal distribution boards. There are also two general lighting boards, from which a supply is given to the rest of the lamps in the building. Convenient control for all the bedroom lights is provided—a fact which will add materially to the comfort of hotel guests. Each room is provided with two lamps, either of which is controlled from a three point switch at the bedside. A certain number of cross and corner corridor lights are supplied from the alternate one of the two distinct systems into which the lighting supply is divided. In this simple manner the important lights in corridors are rendered independent of the same general circuit which supplies bedrooms immediately adjoining those corridors. These special corridor lights are controlled by master switches at central points. The general scheme of illumination is on the semi-direct system, and for this purpose a variety of designs of fittings by the Bromsgrove Guild have been installed. In the dome of the Rotunda Court a novel plan has been adopted of introducing opal bulls-eyes into the risers which support the glazing of the dome. Behind each opal is a 30-watt lamp. Around the dome cornice is a ring of lamps, which are concealed from view at the floor level, but which throw a considerable volume of light upwards into the dome.

Wiring.—The whole of the wiring is carried out in screwed steel "Geekoduct" conduit, with brass unions, which are designed to secure lasting mechanical and electrical continuity throughout the system. Throughout the whole scheme a special water-tight junction box has been used at frequent intervals. This, together with the conduit layout, permits of the withdrawal of any length of wire or cable without any disturbance of the permanent structure, decorations of the building, the plaster or cement in which the conduit is buried.

There are five electric passenger lifts, each constructed to carry a load of 15 cwt. at a speed of 300 ft. per minute, the height of travel varying from 85 ft. to 122 ft. 3 in.—this lift travelling from the basement to the roof. The cages are fitted with Waygood-Otis safety apparatus, designed to arrest the descent of the cage in case of failure of the suspension ropes. The winding machines are of the firm's

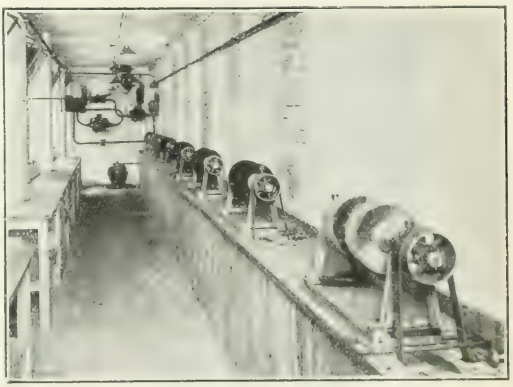


Fig. 9.—Electric Boot Cleaners.

latest pattern, with powerful motors coupled to machine-cut worm and wheel winding gear of highest efficiency, and designed for smooth running. Each lift is controlled by a pilot switch in the cage, operated by a removable handle actuating the main controller, which is specially designed to secure smooth and gradual starting and stopping, this, of course, being an essential feature in electric lifts running at high speeds.

In connection with the passenger lifts, a signalling arrangement is employed, which is the latest device for this purpose. In each cage is fitted a flashlight annunciator signal fixture. When a passenger wishes to call a lift he pushes the button on the enclosure and this illuminates in each cage a miniature lamp representing that particular floor, and also operates a small buzzer to call the attention of the operator to the signal. The first cage arriving at the floor from which the signal is given will stop and pick up the passenger, and upon leaving the floor will automatically extinguish the signal lamps in all cages. The indicator in each cage shows to the operator the direction in which the passenger wishes to travel as well as the floor on which he is standing.

There is also an electric luggage lift carrying a load of 15 cwt. at a speed of 300 ft. per minute, and two electric goods lifts of the same duty which travel from the basement to the ninth floor. In all there are 32 lifts, including service and restaurant lifts.

Mr. A. H. Barker, the consulting engineer for heating and ventilating, took the chair at the luncheon given to the technical press on the 14th inst., and among those present were Prof. Coker and Prof. Simpson. Mr. Barker explained that many conflicting conditions

had to be taken into account. In working out a scheme for a building of this kind extreme flexibility was essential. Not only was it necessary to control the temperature but also to control the flow of air in any one room, which control was obtained by maintaining any desired air pressure in any part of the hotel. For example, it was necessary to have a higher pressure in the grill room than in the adjacent kitchen. Both volume and pressure ought, therefore, to be taken into account. Further, it was necessary to control the humidity, and to ensure complete freedom from breakdown. The air was absolutely clean owing to the treatment that it received, dust counters failing to reveal the presence of any dust, and all parts of the air flues could be easily reached for cleaning by hand. The air for the boilers is pre-heated by passing through a duct in the main flue and thereby about 40 tons of coal is saved per annum out of 1,250.

NEW RESEARCHES ON THE DIRIGIBILITY OF ELECTRIC WAVES.*

BY PROF. ALEXANDER ARTOM.

From the very beginning of wireless telegraphy I set myself the task of studying some problems the resolution of which might the better assure the continuity and independence of functioning of wireless stations. I interested myself chiefly in the manner of directing electric waves, this being, in my view, one of the most important properties for enabling radiotelegraphic communications between various stations to be accomplished without reciprocal disturbance. I proposed various methods for obtaining the dirigibility of electric waves, methods on which I experimented, with results in perfect accordance with my previous theoretical conceptions, with the help of the Italian Royal Navy, as I have explained in previous notes.†

In the note of June 17, 1906, I emphasised the great importance, from the view of the dirigibility of electric waves, of the form of aerials, of their relative position and of their situation with respect to the earth.

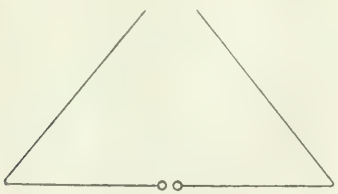


FIG. 1.

The object of the present note is to describe some simple but important forms of dirigible radiotelegraphic aerials which I have devised and experimented on between stations placed so far apart as hundreds of kilometres.

The shapes of the radiotelegraphic aerials which I have devised are in general composed of two or more inclined conductors, symmetrically placed in regard to a vertical plane, or of oscillating circuits of suitable shape.

1. A simple form of radiotelegraphic aerial is that of Fig. 1, consisting of an isosceles triangle open at the summit. This I thought of as far back as 1898 and employed in 1902. When the two branches of the aerial are fed by currents of opposite phase the diagram of dirigibility of the electric waves radiated is that shown in Fig. 2. This [illegible] aerial, indicated by me in previous notes, and based on the employment of two electric oscillations with displaced phase. The theory of my method has been later confirmed by Eccles, by Garbasso and others. The curves of dirigibility were later also determined by measuring the intensity of the radiation in the different directions by a Duddell thermo-galvanometer.

These curves, as we see in Fig. 2, have the shape of two ellipses with common tangent, the greater axis lying in the plane of the triangular aerial, and of which the base of the triangle coincides with the common axis of the two ellipses. In other words, the radiation extends all along the direction of the plane of the radiotelegraphic aerial, on the right as well as on the left. In the direction perpendicular to the plane of the aerial the radiation is practically nil. [illegible] direction of the plane of the aerial and in those near it radiotelegrams can be sent to a distance of 400 or more kilometres with the cost of energy inferior to that employed in ordinary radiotelegraphic stations, while in the direction perpendicular to the plane of the aerial and in that comprised in a fairly wide sector, the radiation is practically nil, even at a distance of 1 km. The same triangular aerial used as a receiving aerial (Fig. 3) has identical properties with regard to the reception of wireless telegrams.

Such an aerial receives in perfect condition the radiotelegrams from radiotelegraphic stations situated in the direction of the aerial and in those adjacent to it. This happens because the electric waves which come from those directions strike the aerials in successive

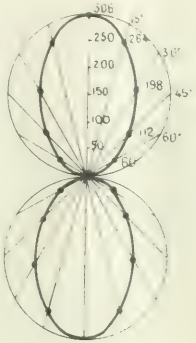


FIG. 2.

instants of time and generate currents differing in phase, which either directly or by induction are transmitted to the apparatus detecting the electric waves: this can be of the crystal, or any other, type. The electric oscillations coming from the radiotelegraphic stations situated near the plane of symmetry, perpendicular to the plane of the aerial, strike the two branches of the aerial sensibly at the same instant, and provoke in the receiving apparatus differential effects—that is to say, opposing currents—and in this case sensibly equal and of the same phase. In other words, the radiotelegraphic stations, situated in the positions above indicated, have no influence on the receiving apparatus.

This fact is of considerable practical importance, because, thanks to this property, radiotelegraphic services can be made independent of disturbances from stations with which there is no desire to communicate.

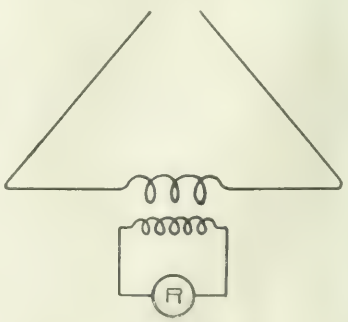


FIG. 3.

2. A very important property of this shape of dirigible radiotelegraphic aerial is the one I described in January, 1907, and realised with complete success shortly afterwards at the stations of the Italian Royal Marine on the coast of the Adriatic.

Let us imagine as revolving round the vertical axis of symmetry, one of the two rectangular triangles in which the isosceles triangle can be divided by tracing the altitude of the triangle. We thus have an aerial (Fig. 4) consisting of the hypotenuse and of a cathetus of two rectangular triangles, the planes of which form a dihedral angle.

By varying the value of the dihedral angle we can construct a diagram (Fig. 5) of the distribution of radiated energy, such as to satisfy all the exigencies of practice. Thus, for example, by dimin-

* From the Proceedings of the R. Accademia Lincei, 1915.

† R. Accademia dei Lincei, March 18, 1906; February 5, 1905, and June 17, 1906.

ishing the value of the dihedral angle between the two branches of the aerial the curve of direction will be either restricted or elongated. In other words, it is possible, as experiments have proved, for radiotelegrams to arrive exclusively from determined regions, avoiding all possibility of being intercepted by apparatus situated outside the selected zones.

It is important to remember at this point what I pointed out as far back as 1904—namely, that the directive properties of these aerials can be made even more perfect by making several couples of such aerials work together, taking into account the phases of the oscillatory currents. They can then be placed either on the same plane or in parallel planes, or making an angle, so that the results of their separate working unite in the required directions.

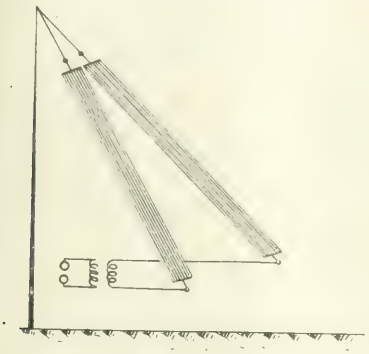


FIG. 4.

3. I have also experimented with another dirigible radiotelegraphic aerial with good results, so as to secure the continuity and independence of operation of radiotelegraphic apparatus from the injurious effects of atmospheric electricity and those due to electric oscillations radiated from stations with which there is no desire to communicate. Such a radiotelegraphic aerial is represented in Fig. 6. In this aerial the upper extremities of the triangle of Fig. 1 are but bent back and put into communication with the earth by means of two conductors. The receiving apparatus is connected by means of an inductively coupled circuit to the central part of the horizontal conductor.

Like the aerial of Fig. 3, it makes the receiving apparatus sensitive to the waves which arrive from the stations situated near the plane of the aerial, and it excludes the waves coming from the stations situated outside the plane of the aerial.

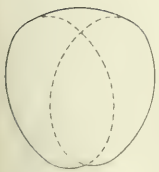


FIG. 5.

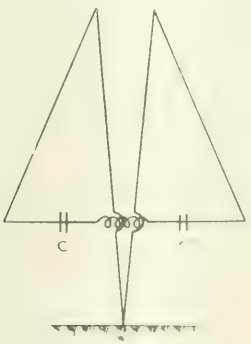


FIG. 6.

In this case, the aerial, instead of being partially closed, constitutes a circuit that is wholly metallic, interrupted only by condensers. Its action as a receiving aerial is due to the E.M.F. generated by the variations of the magnetic flux which crosses the surface closed in by the aerial. An aerial of this form lends itself well, as experiments of several years have proved, to the elimination to a marked extent of the harmful effects of atmospheric electricity on the receiver. It is also singularly well adapted for obtaining directivity with electric waves of great length, without having to increase the dimensions of the aerial to an excessive extent.

In my dirigible radiotelegraphic stations, when wishing to transmit or receive wireless telegrams from different directions in azimuth, several dirigible aerials are placed round a single mast by which they are supported. In general terms the dirigible radiotelegraphic stations which I have devised assume the appearance of a large cone with its vertex of the summit, and the generating lines consist of inclined wires of various aerials which serve to operate in various directions.

The directive and selective properties of the dirigible aerials thus placed can be utilised by using the aforesaid aerials independently of one another. The extremities of each aerial are taken to suitable commutators which connect them as desired either to the generating circuits or to receiving circuits. In the dirigible stations above described the different aerials can be united, on the other hand, in such a way as to utilise the effects either of combination or of interference of the waves radiated or received. In both these methods of utilising the directive and selective properties of these aerials we can determine with precision the position in which is to be found the radiotelegraphic station transmitting the radiotelegram.

THE BRIQUETTING OF METAL WASTE.*

BY E. L. HIRSCH.

In order to utilise most efficiently small metal waste, such as turnings, filings, &c., the Rónay process has been worked out, according to which the waste is formed into briquettes solely by the application of high pressure, *i.e.*, without the use of any binding material. The amount of compression to which it is subjected is substantially as follows: 11·5 kilos of bronze turnings in a loose condition take up a space of 12 litres, and when shaken together 9 litres. When compressed into a briquette, however, they only occupy a space of 1·89 litres, *i.e.*, their volume is about one-sixth of what it was originally. The main advantage of such briquetting is that, by reason of the smaller surface exposed to the air when the metal is heated to melt it down, the loss by oxidation is generally reduced to one-half, in some cases it is reduced considerably more, *e.g.*, in one test the loss by oxidation with loose brass waste was 19·2 per cent., but with briquetted waste only 5·4 per cent. Another advantage is the reduction which is obtained in the time required for melting. Thus for charges of 200 kilos of an alloy melted in the same furnace, the solid metal charge took 1 hour 10 min. to melt, and the briquette 50 min. The average shortening of the time of melting is 30 per cent. A further advantage of the briquetting is a considerable improvement in the quality of the metal, *i.e.*, density and freedom from blow holes and pores.

The tensile strength of bars made from metal produced from briquetted waste was also found to be about 15 per cent. higher than bars made from metal produced from loose waste, the extension being increased 20 per cent. The average analysis of the waste being as follows:—

Copper	81·68 to 81·10
Tin	6·44 „ 6·40
Zinc	7·2 „ 7·56
Lead	4·65 „ 4·82
Iron	0·11 „ 0·15
Aluminium and bismuth	Traces

The following results were obtained in tests of waste from drawn brass rod:

	Loose waste.	Briquettes.
Percentage loss by oxidation	13·0	4·7
	9·5	4·3
Mean value	11·5	4·5
Time required for melting in minutes	85·0	44·0

The melts were made in ordinary shaft furnaces with natural draught, and heated by coke, the brass used containing about 10 per cent. of zinc.

The results obtained with aluminium waste were as follows:—

	Loose waste.	Briquettes.
Percentage loss by oxidation	13·8	8·1
Time required for melting in minutes	40·0	31·0

Another advantage is that the loss of metal by dropping, which amounts to about 2 per cent. with loose waste, is avoided. A further advantage is that very uniform alloys can be produced with a single melt, that is to say, without having to remelt the first metal obtained in order to render it of uniform composition.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Vol. XXXV, pp. 1092–1094.

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THE ELECTRIC VEHICLE POSITION.

In looking at the development of the electric vehicle at the present time there are two distinct points of view to be taken into account. The first is that of the user, the second that of the station engineer. The point of view of the user has very naturally been regarded hitherto as the most important, it being essential to convince a certain number of users that the electric vehicle is commercially practicable before any serious progress can be made. The new movement has been particularly difficult owing to the fact that it has been necessary to live down the prejudices caused by failures of many years ago. We have, in fact, been paying the penalty for early attempts.

The present movement began to take active shape with the appointment of the Electric Vehicle Committee by the Incorporated Municipal Electrical Association two years ago. Since then much progress has been made. An initial difficulty in a matter of this kind is the provision of definite costs to which reference can be made without any question. These are now becoming rapidly available. From the interesting report on the subject by Mr. F. Ayton to the Incorporated Municipal Electrical Association it now appears that an electric vehicle of the type of the light delivery van, or its equivalent, requires about 0·5 unit per mile, including battery losses ; thus, with energy at 1d. per unit, this amounts to about ½d. per mile. Messrs. Liberty have obtained the figure of 0·4d., as against 1½d. per mile for petrol. Mr. A. C. Cramb gives, as the result of his experience in Croydon, a total of 5·785d. per mile, including depreciation and other charges, and assuming a mileage of 5,000 miles per annum. There is a great deal of other valuable information in this report.

Turning to the other point of view, we find that the electrical engineer is not always as sympathetic as he should be towards innovations. Certainly it should not be more difficult to convert the engineer than the layman, but such is often the case. For example, the Electric Vehicle Committee have had no little difficulty to obtain a reasonable tariff for the charging of electric vehicles in all cases, and

we understand that some stations have gone so far as to demand a minimum of 5s. per charge, which is just the way to stop progress. We are given to speaking of the inertia of Government departments, but we fear that inertia is often to be found among engineers in matters of this kind, and that much harm may be done thereby. It is essential that the station engineer should look well into the future, and see if it is not desirable for him to cultivate a load which may be worth having a few years hence. There is also something very fitting in the employment of some form of electric vehicle by electricity stations. Further, the station engineer should bear in mind that he can do something towards the much desired lowering of first cost. If every station in this country were to purchase a vehicle this would have a material effect in obtaining this desirable end, because the lowering of prices can only be obtained by manufacturing vehicles on a larger scale.

In putting forward the advantages of the electric vehicle it is well to bear in mind the direction in which progress is best made. It is better not, in our enthusiasm, to regard the electric vehicle as being an all-round competitor of the petrol car; both types have their spheres of usefulness. The direction in which the electric is particularly useful at the present time is for comparatively low speeds, short haulages and commercial vehicles. It will be much the best for us to concentrate our efforts on those lines along which the electric vehicle can be developed most easily. Moreover, for this development to go forward, it is essential that the electrical engineer should himself realise that he has a good thing in it.

REVIEWS.

Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Electric Light Fitting. By S. C. BATSTONE. Pp. xvi. + 317. (London: Whittaker & Co.) 5s. net.

Mr. Batstone has been much more successful than most authors of books on electrical installation work. He has managed to deal with most phases of his subject, and at the same time has not strayed away into the many side paths of electrical work which often involve so much description that has no real concern with lighting work. He has dealt with the subject, too, in a clear fashion, giving each section a fair proportion of attention and not over-elaborating greatly any one of them. If anything, too much space is given to a series of illustrations of ordinary electrical fittings such as switches, tubing boxes of many kinds, casings and so forth, but even this is almost forgivable on account of these illustrations being specially prepared, and not, as usual, reprints from various makers' catalogues. The risk of this system of excessive illustration is that the reader is apt to think that all types have been shown.

Whilst on the subject of illustrations, mention might be made of Mr. Batstone's "ornamental" fittings. In a future edition his own illustrations in this section might with advantage be abandoned in favour of a few from a first-class maker's catalogue.

A more serious item is the omission of all but the very briefest reference to the various systems of wiring other than tubing, casing and cleated work. Henley's wiring systems, twin or concentric, and Stannos wiring, are described very briefly, whilst C.T.S. wiring is not even mentioned. This is a decided defect, as these systems and others are certainly of more importance than Mr. Batstone would imply by his treatment of them.

Another omission that the practical man will notice is the failure to deal with the question of alternative systems of wiring up between a series of lights and switches. This is certainly a difficult subject to treat in a book, but to print a few isometric sketches of one such series, showing alternative routes for the wires with the advantages of each explained in the text, should not form an insoluble problem, whilst even to point out the importance of the matter would be great progress. The diagrams of wiring work that are given are very clear and, apart from this omission, are very valuable.

The chapter dealing with private plants suffers somewhat by comparison with other sections. It contains much valuable information, but has several defects. For example, all the diagrams show the battery cells arranged in double tier (which should never be done unless unavoidable); the size of plant worked out on pp. 306 and 307 is decidedly larger than necessary; and the scale for the engine room plans is not given.

On the whole, however, the book is certainly one to be recommended, though the 40 pages of I.E.E. wiring rules scarcely need reprinting. E. H. F.

The Spectroscopy of the Extreme Ultra-Violet. By THEODORE LYMAN, Ph.D. (London: Longmans, Green & Co., 1914.) Pp. 135. 5s. net.

This book forms one of the valuable monographs on physics edited by Sir J. J. Thomson and Dr. Horton. The ordinary ultra-violet spectrum lies between the wave-lengths λ4,000 and λ2,000. The first and shorter part of Prof. Lyman's monograph deals with this region, whilst the second and more important portion treats of the "Schumann" region—*i.e.*, wave-lengths shorter than λ2,000. As is well-known, Victor Schumann was the first to carry out extensive and important investigations in this part of the spectrum. His success was due to the substitution of fluorite for quartz, the construction of a special "vacuum" apparatus, and the employment of photographic plates made with emulsion almost free from gelatine. Prof. Lyman's success in the investigation of the Schumann region has been largely due to the substitution of a very good concave grating ruled on speculum metal for the fluorite prism apparatus employed by Schumann. This has necessitated the construction of a new form of vacuum spectrograph. The present work contains a detailed description of this special apparatus. It may be remarked also that in the first part a short account is given of the various methods of photometry in the ultra-violet. After dealing with the question of apparatus the author gives an excellent account of the absorption and emission spectra of solids and gases in the extreme ultra-violet.

The Schumann region is of particular importance on account of the intensity of the photo-chemical, photo-electric and photo-abiotic effects produced by these short waves, and in the concluding chapter a short account of present knowledge on these very interesting and important subjects is given. The bactericidal action of the "Schumann light" is very remarkable. All motion is instantly stopped, and the bodies of the organisms break down and become miscible with water. This fact leads Prof. Lyman to the interesting conclusion that interplanetary space must be germ free, since the jets of burning hydrogen issuing from the sun must give rise to streams of Schumann radiation. If this is really powerful enough to protect the planetary system from invasion by living organisms, then the doctrine of Panspermia must fall to the ground as a plausible explanation of the origin of life on our own planet, even though such great authorities as Kelvin and Arrhenius have upheld it.

The monograph concludes with tables of "Schumann" spectra, a bibliography of the whole subject, a list of Schumann's Papers, and an account of the proper method of constructing and developing photographic plates suitable for work in the extreme ultra-violet. Prof. Lyman points out the importance of bridging the gap between the extreme Schumann region at about λ900 and the X ray region occurring at about λ1 and refers to the work of Dember who has employed for this purpose the current set up by a photo-electric effect.

We congratulate Prof. Lyman on the important and valuable work which he has carried out at Harvard University, and on the excellent monograph which he has produced. F. G. D.

THE THOMAS TRANSMISSION AS APPLIED TO A 200 H.P. LOCO-COACH.

In order to meet certain phases of railway working there has been some development during the last few years of what is sometimes called the auto railway car. This form of car, which carries its own supply of power, is used where the traffic is comparatively slight, and where nevertheless it is desired to maintain a reasonably frequent service. For work of this kind steam has certain disadvantages. The internal-combustion engine is ideal from certain points of view, but it is lacking in flexibility. Accumulator cars have been used for this purpose, more particularly on the German railways, but they require attention according to a definite routine and their radius of action is limited. On the other hand, the petrol-electric system gives the advantages of the internal-combustion system as well as the flexibility of the electric drive. It is not unlikely, therefore, that a good deal of progress will be made in the near future along this particular direction. One advantage of this combined system is that it is possible to provide with the same axle weight, which is often limited, more power with an internal-combustion locomotive than with the ordinary steam locomotive.

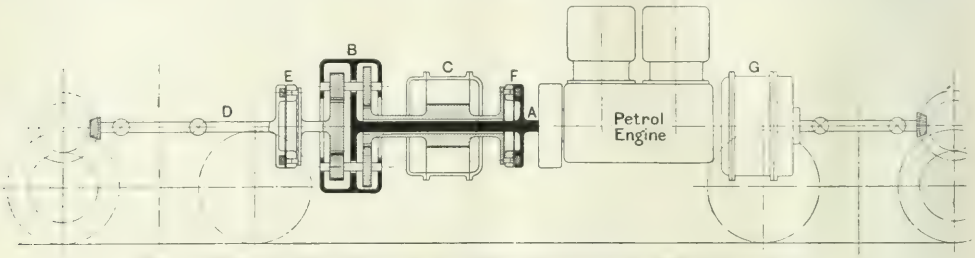


FIG. 1.—DIAGRAM OF ARRANGEMENTS OF THE THOMAS TRANSMISSION ON 200 H.P. LOCO-COACH.

The latest example of the petrol-electric vehicle is one made by the Thomas Transmission (Ltd.), for the New Zealand Government railways. The chassis of this electric was on view last week at Birmingham and in what follows we give some account of this latest development.

We understand the vehicle is to be used chiefly for suburban work, as the residents object to the smoke and noise of the steam locomotive. The conditions of service as specified are exceptionally severe. The coach is required to carry passengers and haul a 25 ton trailer up a grade of 1 in 40 at 15 miles per hour, the gross load being about 60 tons. The maximum speed on the level will be just over 40 miles per hour, and it is estimated that the vehicle will haul a gross load of 85 tons up the 1 in 40 grade at about 10 miles per hour. The coach alone will take the specified grade at a speed of 28 miles per hour.

The vehicle shown at Birmingham is not fitted with the body, as this is to be manufactured and fitted at the works of the New Zealand Government Railways in Wellington. It is believed that the seating capacity of the vehicle will be for about 50 passengers. In ordinary service it is understood that the vehicle will haul two 25-ton trailers each carrying its full complement of passengers. It is probable that the total number of passengers will be of the order of 150.

The question of fuel economy is a matter of very great interest. In the case of this first coach petrol fuel is to be used, but in future cases it is very probable that some cheaper form of fuel will be adopted. It is important to note that in a vehicle of this type the engine is only actually running and using fuel when it is doing useful work, so that there is not the enormous waste of fuel which is met with in all steam locomotives. It is estimated that the fuel consumption will be at the rate of 20 ton-miles per gallon of petrol on [illegible] and there is no reason why this should not be improved upon in actual service.

[illegible] on top speed all the power [illegible] and in starting and climbing [illegible] mechanically and part [illegible] the power of the petrol and the [illegible] the great flexibility and [illegible]

In order to make the [illegible] as would have [illegible] Fig. 1 shows diagrammatically. The system has already been described fully in our columns.* The engine driving shaft A is permanently connected to the casing B of the planetary gearing. This casing carries a set of planet wheels on two spindles which are supported in roller bearings in the sides of the casing. Each spindle has rigidly fixed to it two planet wheels of different diameters, and these in turn mesh with two sun wheels. The larger sun wheel drives the outside axle of one bogie through the free-wheeling magnetic clutch E and the driving shaft D. The final drive to the axle is by means of a bevel and spur reduction. The smaller sun wheel is connected direct to the armature of the first electrical machine C, and a second magnetic clutch F is provided for locking the planetary gearing.

The second electrical machine G is located on the opposite side of the engine, and drives the outside axle of the second bogie by means of a cardan shaft and a bevel and spur reduction, as in the case of the first bogie.

In order to start the engine, the clutch E is disengaged and the clutch F engaged. This locks the gearing, and the first electrical machine C is thus locked solid with the engine, so that when the battery provided for the purpose is connected across the series machine C the engine is caused to rotate and starts up.

In order to understand the action of the gearing, let it be assumed that both clutches are disengaged. When the engine drives the casing B a differential action is set up between the large sun wheel and the small sun wheel. The large sun wheel tends to rotate forwards in the same direction as the engine and the small sun wheel tends to rotate backwards in the opposite direction to the engine. If the clutch E is engaged, then the large sun wheel will be held stationary as it is connected direct to the load, and as the small sun wheel is free, it will rotate backwards at about the same speed as the engine rotates forwards. If current is taken from the machine C the motion of the small sun wheel will be retarded, so that the large sun wheel, *i.e.*, the load, must begin to move. By manipulation of the

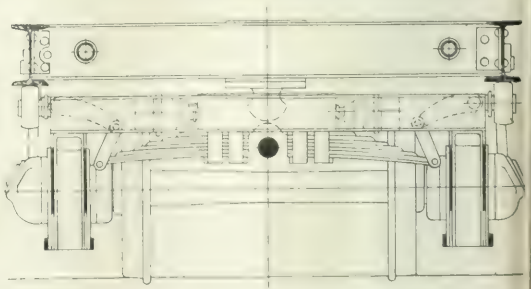


FIG. 2.—SECTION SHOWING BOGIE SUSPENSION.

field of the machine C this action can be continued until the small sun wheel is practically brought to rest, and the large sun wheel caused to rotate at about half engine speed.

During this initial period the current from the machine C is transmitted to the second machine G, which, acting as a motor, drives the second bogie electrically. It is clear, therefore, that there is a mechanical drive to the first bogie and an electrical drive to the second bogie.

The next operation is gradually to increase the speed of the large sun wheel until it reaches the engine speed, so that the gearing can

* THE ELECTRICIAN, Vol. LXVII., pp. 132 and 386. Also Vol. LXXIII., p. 826.

be locked solid by means of the clutch F, and a direct drive obtained for top speed.

This speeding up of the large sun wheel from half speed to top speed is obtained by changing the functions of the two electrical machines, and causing G to act as a generator and supply current to C as a motor, driving the latter in the same direction as the engine. This operation is a gradual one, and is carried out by manipulation of the field of the machine G. When the sun wheels and the casing rod. The chief advantage of this particular construction lies in the decreased length of the engine.

A departure from the usual "V" construction has been made in so far that all the valves are located on the outside of the "V." This has the advantage of greater accessibility. Special care has been taken to provide ample water space round the cylinder heads and valves. Two separate magnetos are provided, one for each set of cylinders.

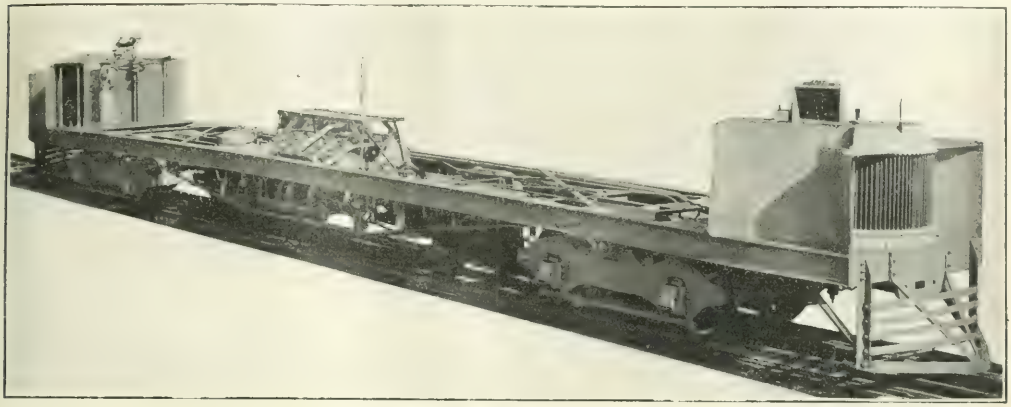


Fig. 3.—200 h.p. Petrol Loco-Coach Chassis.

have reached a common speed, the magnetic clutch F is engaged, so that the electrical transmission is cut out altogether and a direct drive obtained from the engine to the first bogie.

When the vehicle is travelling on top speed, the two electrical machines C and G are inoperative and can be used for any useful purpose. It is convenient to use them at this stage for charging the battery, which is used for starting up the engine and lighting the vehicle. It must be pointed out that this battery is never used at any time for assisting in the propulsion of the vehicle.

Two silencers are provided, one for each row of cylinders, and these are located on opposite sides of the engine on a level with the bottom of the crank case between the engine and the coach frame.

For railway work it is imperative that the vehicle should travel equally well in either direction, and for this reason the engine must be reversible. The reverse gear may appear complicated, but it is perfectly simple in its action, and the engine can be stopped and restarted in the opposite direction in a few seconds.

In order to decrease the height of the engine, the cylinders are

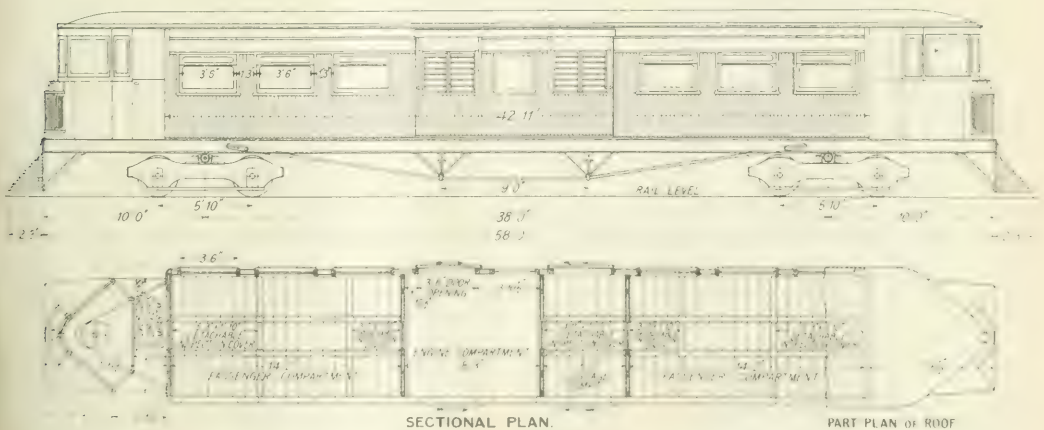


Fig. 4.—Sectional Plan and Elevation of Loco Coach.

The particular coach just completed for the New Zealand Government Railways is fitted with a 200 h.p. engine, manufactured by Messrs. J. Taylor & Sons (Ltd.), of London.

The eight-cylinder engine is of the "V" type, 7 in. bore by 8 in. stroke. The normal speed is 900 revs. per min., and the maximum speed 1,500 revs. per min. Opposite cylinders are on the same crank, so that one of each pair is provided with a forked connecting rod which has bearings on the outsides of the main [illegible] of the single

recessed into the crank case, this construction having the advantage of increased strength and stiffness. The camshafts are fitted with small flywheels to provide against back lash.

Water-cooling radiators are located at each end of the vehicle, and provision is made to allow ample draught of air through both radiators irrespective of the direction of motion of the vehicle. In addition to the water-cooling radiators, oil-cooling radiators are provided, one for the cooling of the lubricating oil for the engine and one

for cooling the oil which lubricates the planetary gearing. Circulation of the water is effected by means of two centrifugal pumps, and the lubricating oil by means of ordinary gear pumps. These pumps are all driven from the engine. Owing to the special method of reversing this engine, the only member that reverses its direction of rotation is the crankshaft, thereby allowing the pumps with the magnetos and camshafts to rotate always in the one direction.

The two electrical machines are totally enclosed and only weigh about 15 cwt. each.

Special attention has been given to the planetary gears, these gears being all cut double helical so as to ensure high efficiency and quiet running. Forced lubrication is provided for these gears, the oil being kept cool by means of an oil radiator. The chief novelty in connection with the transmission is the adoption of magnetic clutches. These are exceedingly simple to control and are most suitable for the large power being dealt with. The first electrical machine forms one complete unit with the planetary gearing and the two magnetic clutches. The second electrical machine is mounted independently of the prime mover and transmission unit referred to, as it drives the outside axle of the second bogie purely electrically. Tubular carden shafts are provided for the drives to the two bogies and universal joints are so interposed that perfect uniform angular velocity of the driven wheels is assured. The final drive to the axles is by means of bevel and spur reductions.

The suspension of the bogies is of somewhat novel design, as seen in Fig. 2; it aims at the elimination of rolling and tends to give easier riding of the vehicle than can be obtained with the usual design.

The control of the loco-coach is exceedingly simple and can be effected from either end of the vehicle. The main controller provides for 12 forward speeds, including direct drive on top. The reverse for continuous working is obtained by reversing the direction of rotation of the engine. Two reverse notches are provided in the controller for reversing for short distances when shunting, &c., the power being transmitted purely electrically. This is effected by coupling up No. 1 machine direct to the engine and transmitting the power electrically therefrom to the No. 2 machine, which is permanently coupled to one of the driving axles.

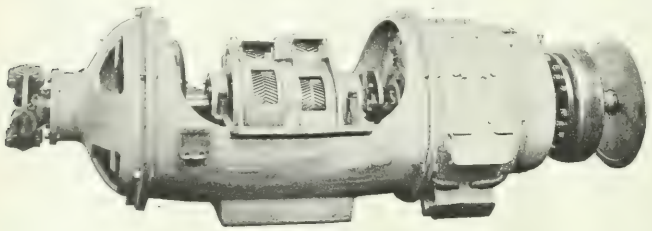


Fig. 5.—Transmission Unit.

In addition to the main controller an auxiliary switch is provided, which is used to control the car in very much the same way as the clutch pedal on an ordinary touring car.

It will be seen from the diagram that there are two magnetic clutches, first, the free-wheeling clutch, which is engaged for all running speeds, and second, the top-speed clutch, which is engaged only for the direct drive, starting the engine and emergency reverse. Both these clutches can be disengaged by putting this auxiliary switch in the "off" position. It will thus be seen that if at any time the driver wishes to bring the vehicle to rest, it is not necessary to move the main controller, the act of freeing the engine being obtained by moving only the auxiliary switch lever.

Westinghouse brake equipment is provided, the compressor being direct coupled to the crankshaft of the engine. In addition, hand brakes are provided for emergency use.

The weight of the complete vehicle exclusive of body is approximately 18 tons, of which the engine transmission and radiators weigh about 7 tons.

Fig. 5 shows one of the transmission units. The chassis is seen in Fig. 3 and a drawing of the complete coach is given in Fig. 4.

Commonwealth Edison Company. Data on the equipment [illegible] Commonwealth Edison Company, Chicago, show that at the beginning of the present year the company had in service [illegible] of apparatus. Two sales are detailed. The normal rate of increase is from 1,000,000 to 1,500,000 duct-[illegible] per year.

THE POINT FIVE ASSOCIATION.

A dinner of the Point Five Association was held on Thursday evening last under the chairmanship of Mr. S. E. Fedden, at Tricity House, London. The attendance was smaller than was anticipated, having regard to the fact that the dinner was held on one of the days of the Convention of the I.M.E.A., but what was lacking in numbers was made up in the animated character of the discussion. Mr. Fedden, in giving a short address of a rather informal character, referred first of all to matters connected with the war. He remarked that among other articles which were badly required for military purposes he would like to mention razors, which were being produced in large quantities in Sheffield, but not in a sufficient quantity to meet the needs. He therefore asked that any members having old razors which they no longer required would forward them to the Master Cutler of Sheffield, who would be delighted to have them to fill up the gap. With regard to the progress of the undertaking in Sheffield, he found that they had sufficient applications up to June to give them as large a winter load as they could carry. There had also been a large increase in output, which during the past six months had amounted to 29,000,000 units as compared with 14,000,000 units of the previous year. The chief difficulty he was experiencing was that of delivery of plant and coal. The increase in the price of coal so far amounted to 7s. on 11s. 6d. in the renewal of their contract. They were faced with large extra expenses, amounting to £23,000 for the coming year on three of four main items. With regard to electric cooking plant, Mr. Fedden made a few criticisms. He felt that the 3 kw. stoves which were coming into use were too heavy, and that they were losing the desirable feature of portability. Again, coffee-making urns would be more useful if they were made with more than one heat so that they could be used for a small as well as the full quantity of coffee. Further, he had experienced trouble with flexible cord for electric flat irons, and he felt that electric hot-plates were frequently made so as to take too long in heating up.

As the number present was comparatively small, Mr. Fedden proceeded to call for remarks from each in turn, members and guests alike. In the discussion that ensued the remarks had reference chiefly to the I.M.E.A. discussion that had been held that morning on the Point Five tariff on the one hand and to certain aspects of electric cooking on the other.

It was very evident by the remarks of several speakers that in their opinion proper advantage had not been taken of the I.M.E.A. discussion. This had degenerated largely into a matter of details, such as how to fix the primary charge, rather than emphasising the great importance of the general principle of the Point Five tariff. The chairman of one Electricity Committee was particularly emphatic on the way in which an excellent opportunity had been missed, and more than one speaker seemed to feel that every member of the Point Fives should have made a point of supporting the tariff in the I.M.E.A. discussion. Mr. J. H. Bowden, on the other hand, said that the authors had themselves to blame for the character of the discussion, as they had taken so much trouble to rub in the desirability of the rateable value system. Councillor H. R. Barge (chairman of the Poplar Committee) spoke with enthusiasm of the Point Five tariff, saying that he would undertake to do more work in a day on that tariff than another man would do in a week with the maximum demand. Councillor Crowther expressed the view that the electrical engineer did not have proper faith in the electical industry, or he would push it as he should.

In regard to purely station matters Councillor Davis (chairman of the Ilford Electricity Committee) remarked that some engineers may have thought that the Ilford Council had climbed down somewhat seriously over the recent action by the local gas company. Their reason for not proceeding with the fight was simply due to the fact that it would be much cheaper for them to obtain the necessary powers than to fight a case which might have to go to the House of Lords. Many of the speakers gave particulars of the progress of their undertakings. Mr. Bowden advised members not to increase their prices if they could possibly avoid it. There had been a considerable advance in the cost at Poplar, but, nevertheless, they had been able to reduce the price instead of advancing it. Mr. W. B. Woodhouse expressed the view that there was little doubt that we were in for a coal famine and that coal would be higher in price in the future than in the past. Colliery owners at the present time were

faced with losses on existing contracts, more particularly on account of the war bonus which had come into operation. They, therefore, found it absolutely necessary to advance their prices. All this would be greatly in favour of public electricity supply. Mr. S. T. ALLEN said he had purchased 25,000 tons of coke dust to add to his small coal in order to get over some of the difficulty. As to tariffs he made use of both the rateable value and the kilowatt basis, as at Poplar, so that he obtained all the advantages.

A good deal of discussion turned upon the value of the radiant type of hotplate. Mr. Shaw thought that there was no need for such a plate, but most of the speakers held the view that the radiant type had come to stay. This view was taken by Mr. Cooke, Mr. Britton, Mr. Hoadley, Mr. Bowden and Mr. Allen. The last-named had found it most satisfactory and also cheaper to work.

CORRESPONDENCE.

THE IRONMONGER AND ELECTRICAL APPARATUS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with considerable interest your very able article *re* the ironmonger and the sale of electrical apparatus. I heartily endorse your remarks. Many of the large ironmongery establishments over the country run electrical departments, and we, as a federation, have always had most pleasant relationships with the Electrical Contractors' Association, and I have worked on many occasions with their secretary, Mr. Leonard G. Tate.

The occasion that prompted your article was the holding of our exhibition in Manchester last week. "Cooking by electricity" has come to stay, and one of the principal attractions at our exhibition was no doubt the electrical stove and grill exhibited by the Falkirk Iron Co. (Ltd.). Some other firms exhibited electrical appliances, but, as far as the body of manufacturers who make electrical apparatus were concerned, the exhibition was practically without them. This was occasioned through the selfish policy adopted by the British Electrical and Allied Manufacturers' Association. The decision of their council—that they did not wish their members to exhibit—practically amounted to a boycott, and this prevented many sales that would have taken place in an exhibition that has been highly popular and successful between the manufacturer of electrical apparatus and the ironmonger who runs an electrical department.

When the B.E.A.M.A. held their exhibitions in London and Manchester ironmongers from all parts of the country attended, and placed orders with the exhibitors, and my council would have been the last to have acted in so selfish a manner as to request its members to refrain from taking any part in their exhibitions.

Your article deals with the matter of the sale of electrical apparatus in a broad and enlightened way, and that is the spirit which should animate the members of all trade organisations, whose objects are the betterment of the various industries they represent. I am thankful to say that our relationships with other trade societies are of the most cordial nature, and we have worked together for the general good of all.

Please accept my thanks for the capital account that you have also given of our exhibition, and the space that you have devoted to the various exhibits.—I am, &c.,

R. H. SMITH, F.R.G.S., F.C.S.,
General Secretary,
Ironmongers' Federated Association (Incorporated).

Sheffield, June 18.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his article under the above title in your issue of June 11th Prof. Blondel has revived the discussion of the best general method of stating the laws of induction. The best general method must evidently be that which meets every known case, and I should like to show that this end is obtained if the law is enunciated thus: *An E.M.F. is generated in a closed circuit when the number of magnetic lines, which cross the latter, is changed.*

The addition suggested by Prof. Blondel does not appear to be necessary, since this variation in the flux may be produced in any way whatever; either (1) by varying the flux passing through a fixed coil, or (2) by rotating the coil about an axis perpendicular to the flux, the flux being constant, or (3) by moving the coil in a plane perpendicular to the constant flux (or by moving the constant flux in a plane perpendicular to the fixed coil), or (4) by moving one side of the coil through the constant flux. Algebraically expressed, the above enunciation of the law reads

$$e = -N\frac{d\varphi}{dt}.$$

Taking the first case, which is that of the single-phase transformer, suppose the flux varies sinusoidally, so that $\varphi = \Phi \sin \omega t$. Then

$$e = -N\frac{d\Phi \sin \omega t}{dt} = -N\Phi\omega \cos \omega t.$$

This result is well known.

In the second case, if the coil rotate at an angular velocity ω in a constant flux Φ, the flux passing through the coil varies sinusoidally and equals $\Phi \sin \omega t$, when the time is reckoned from when the two sides of the coil lie in the same direction as the flux, *i.e.*, when the flux through the coil is zero.

The result is then the same as in the first case.

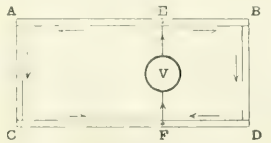


FIG. 1.

The third case is that of the ordinary direct-current machine or alternator. This is also well known, and gives the same result as the previous two.

The fourth case is that of the homopolar dynamo, although it has been stated that the law will not hold for this machine. Consider a machine of this kind with only one bar. In Fig. 1, imagine AB and CD to be the rings on either end of the machine developed out flat. Let AC and BD be the bar joining them and EF the brushes rubbing on the rings and connected through the voltmeter. The constant flux has a direction perpendicular to the plane of the paper all over the surface ABDC. As EF moves along from AC to BD, the flux passing through the coil AEFC increases, and that through

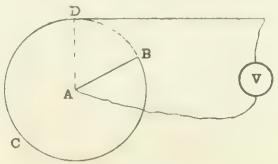


FIG. 2.

BEFD decreases. Hence an E.M.F. is induced which produces currents flowing in opposite directions in the two coils, as shown by the arrows.

If the armature rotate at a constant angular velocity ω, the flux passing through coil AEFC at any time t is

$$\varphi = \Phi\frac{\omega t}{2\pi}.$$

Hence the E.M.F. is

$$e = -\frac{d\varphi}{dt} = -\Phi\frac{\omega}{2\pi}.$$

This agrees with the well known formula

$$e = B$$

$$\Phi$$

since B 2π and $= \omega$.

Another example of this case is that obtained accidentally in Prof. Blondel's experiments. These experiments appear to be based on a fallacy, although I am inclined to think the translation is not all it should be. The flux passing through the N turns is Φ, and not $N\Phi$, the flux being constant whatever the number of turns. Hence the equation is not $e = -\frac{d(N\varphi)}{dt}$,

but $e = -N\frac{d\varphi}{dt}$, so that if the flux is constant, the E.M.F. is zero whatever the number of turns. The method adopted, however, of fixing the end of the coil to a slip-ring at the centre of the drum, introduces a different condition.

Let Fig. 2 represent one turn on the drum, one end of which is fixed to the slip-ring at the centre and the other end is being wound off to the second drum. This, in conjunction with the [illegible] conductors, constitutes a coil. The flux, however, only passes through part of this, viz., the sector ABCD in the position shown. It is clear that as the drum revolves, AB finally coincides with AD, when no flux whatever passes through the coil. If the drum rotates with a constant angular velocity ω, then the flux passing through the coil at any time t is

$$\varphi = \Phi\frac{2\pi - \omega t}{2\pi},$$

and therefore the E.M.F. induced is

$$e = \Phi\frac{\omega}{2\pi}.$$

Since, however, as was shown above, no E.M.F. is induced in a complete turn, any number of complete turns may be inserted between the beginning A and end D of the coil in Fig. 2, without affecting the result. Hence Fig. 2 represents simply the apparatus used by Prof. Blondel.

Taking the figures given by Prof. Blondel, we have B=800 gauss, radius of drum =10 cm., and speed =10 revs. per second. Hence

$$\Phi = 800 \times \pi \times 10^2 = 2{\cdot}51 \times 10^5 \text{ Maxwell.}$$

$$\omega = 10 \times 2\pi = 20\pi \text{ radians per second.}$$

Therefore $e = \frac{2{\cdot}51 \times 10^5 \times 20\pi}{2\pi} = 2{\cdot}51 \times 10^6$ C.G.S. units $= 0{\cdot}0251$ volt.

This agrees with the figure 0·0022 obtained on test.

The conception of the E.M.F. being induced by the conductor cutting the lines is, however, a very useful one, but since it fails completely in the case of the single-phase transformer, it cannot be considered general. Moreover, it has to be very carefully used when dealing with short-pitch coils.—I am, &c.,

Birmingham, June 17. ROBT. G. JAKEMAN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It would seem that Prof. David Robertson in his letter [illegible] conclusion that is somewhat too sweeping from the experiments of Prof. Blondel on the E.M.F. of induction, an account of which was given on p. 734.

Briefly, $eN\,d\varphi$, not $N\,d\varphi/dt$, is the more universal form for the E.M.F. To write $N\,d\varphi/dt$ is to suppose a motion of conductor in a certain way, such as Prof. Blondel's rotating arm and also continuous and tortuous motion generally, but it is obviously inapplicable to radial motion and transformer.

For a satisfactory motion of a conductor placed across and moving along two parallel rails in a magnetic field one must write the more fundamental form $e = vBN$, or $N\,dN/dt$ in a case of [illegible]

But if the rails be curved and the moving conductor of similar curvature, one can write either dN/dt or $N\,d\varphi/dt$, for now we have rotation. And if the parallel rails be curved to form concentric circles with the slides rotating, the form $N\,d\varphi/dt$ becomes convenient. And further, if the interior rail be shrunk to a point at the centre of the outer circular rail and the slider become a rotating arm (which is one of Prof. Blondel's cases) one naturally uses $N\,d\varphi/dt$. And, finally, the rotating disc with brush contact fixed in space may replace the rotating arm and movable contact. In this case also the convenient form is $N\,d\varphi/dt$. But in all these cases there is surely no argument in favour of writing $N\,d\varphi/dt$ for dN/dt, except that of convenience.—I am, &c.,

Porthcurnow, Cornwall, June 21. BENJAMIN DAVIES.

"THE GYROSCOPIC COMPASS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: So important is this matter of the gyro-compass that I have no hesitation in asking you to allow me space for more than a mere reply to Mr. Longland's letter of June 11th.

Sir Percy Scott very emphatically stated long before the war that the submarine was a thing whose importance to a navy could hardly be overestimated. The past 10 months seem to have borne out this statement and to have shown that to the under-dog (and, fortunately, Germany, at sea, is the under-dog in every sense of the word), especially to one whose ways are those of a low-bred mongrel, the submarine gives a most incongruous advantage.

In a recent Paper before the American Institute of Electrical Engineers (see Ford. "The Gyroscope." "Proceedings" Am. I.E.E., June 23, 1914) it is stated that: "In submarines the gyro-compass enables an accurate course to be laid when running submerged, so that after obtaining the bearing of the target from a great distance the submarine may approach, submerged, to within a short distance and fire its torpedo accurately." This is accomplished by aid of the Sperry gyro-compass, an instrument of the pendulum type, having, of course, the usual errors of latitude, acceleration and velocity. The Germans with their Anschütz can do equally well.

Think then, of the enormous advantage we might obtain over the Germans if we were in possession of a compass free from the usual errors. In submarine work the Germans would be outranged and outclassed.

The Sea-Star compass, about which the only available information is contained in Mr. E. K. Scott's Paper, read before the Institute of Marine Engineers on October 5, 1914, is the invention of Capt. V. H. Rozic, a Serbian. Nothing could be more pleasing or appropriate than that the invention of a Serbian, developed by British designers, should be successful in destroying the enemy in his own under-world.

It is, therefore, with disappointment that I have to say that, so far as I am able to gather from the information available, the Sea-Star cannot be free from the errors of latitude, acceleration and velocity common to the other types. I state this merely as my opinion arrived at by the sort of common-sense considerations outlined in my Paper published in your issue of May 14th. I may be mistaken, and should be most happy to discover that I am mistaken.

Mr. Longland firmly believes that on the point of latitude error I am mistaken, and has endeavoured to prove to me that the Sea-Star is free from such error. In what he has said I fail to find any proof; still worse, I fail to even guess what may be his line of thought, unless I may assume that the compass which *he* calls the Sea Star is not the same as that described in Mr. Scott's Paper. The gyro-compass there described is so arranged that, in principle, the least tendency to turn about the horizontal diametral axis causes the meridian motor to prevent such turning. I need only refer to Fig. 25 in the Paper, in which the contact roller and segments are shown. In the normal position the roller is so nearly in contact with both segments, that the smallest imaginable movement to left or right will cause current to be made. With such an arrangement I repeat that it is nonsense to say the gyroscope has freedom about the horizontal diametral axis. Also it

appears to me that the sensitive fork arrangement suggested in my letter of May 28th is the same in principle as the Sea-Star shown in Mr. Scott's sketches.

Mr. Longland must surely have in mind an arrangement which differs from that of Mr. Scott's Paper in that it demands considerable freedom of movement of the contact roller *between the two segments*. I suppose that, in any case, the endeavour would be—though the Paper makes no definite statement upon the point—to make motion about the vertical axis, due to the meridian motor, as nearly dead-beat as possible, so that, in principle, freedom of movement *over the segments* would be prevented, free movement about the horizontal diametral axis occurring only whilst the contact roller lay between the segments. Possibly, however, Mr. Longland's idea of the Sea-Star demands that the motion due to the meridian motor shall not be dead-beat.

Mr. Scott's Paper deals with the compass only too briefly, and makes claims which he himself would now withdraw—the claim, for instance, of freedom from acceleration error. He states that "three freedoms are provided," though this seems to be contradicted by his description and sketches. Mr. Longland says that his own description "is not that of a gyroscope having three degrees of freedom."

What I have just said surely shows that the nature of the compass under discussion has not been clearly defined. The statements I made referred to my own understanding of Mr. Scott's description. Mr. Longland's understanding of that description seems to be different from mine. This, I trust, disposes of the suggestion that I was accusing Mr. Longland either of ignorance of the subject or of an attempt to mislead, than which nothing indeed could have been further from my mind.

Unfortunately, any difference in principle between Mr. Longland's and Mr. Scott's Sea-Star, consisting either in freedom between contacts or in non-deadbeatness or both, seems to me to do nothing towards improving matters; all the errors named will still be present, and in the one case there will be in addition an entirely indefinite error due to the unavoidably indefinite frictional forces set up by the means of suspension of the compass whilst, in the interval between contacts, it has three degrees of freedom. Perhaps Mr. Longland holds that, in this interval the apparatus has not three degrees of freedom, maintaining that the meridian motor has friction, or locks the vertical axis. But in such a case, movement about the vertical axis being constrained by the earth, everyone knows that the gyro axle would move out of the horizontal, even though it should happen to be in the meridian (except at the equator). Thus the meridian motor would come into action so as to take the compass *off* the meridian. Again, if Mr. Longland demands that the action of the meridian motor shall be not deadbeat it follows that for considerable periods of time the roller will be upon its contacts and the meridian motor will be in action. But when this is the case, motion about the vertical axis is constrained not alone by the motor but also by the earth, and, once more, the compass will tend to remain out of the horizontal even though it should happen to be in the meridian. To avoid such error the axis with reference to which the motor acts should be not vertical but perpendicular to the earth's axis of spin. To set the axis thus would demand a knowledge of the latitude.

Mr. Longland defines the word "meridian," but seems to miss my point, which was that he had not attempted to prove that the meridian rather than some other direction was the normal goal for the compass.

It puzzles me to know what can have been the object of Mr. Longland's "confession of knowledge." The important thing is not *what* one knows, but *how* one knows. How does Mr. Longland know that "every time the gyrostat axle leaves the meridian, contact is made in such a way that the axle swings into the meridian again"? I have tried to show why I think this cannot be right. In what point have I erred, or has my treatment been incomplete? Mr. Longland says I am wrong when I write, "The torque due to the meridian motor is first to left and then to right, an alternating torque whose average value is nil." He says, "Taken separately the two parts of the sentence are correct, but taken together they are incorrect." I do not know what Mr. Longland means. Apparently, however, the point is that the action of the meridian motor is in some way affected by latitude. How is it affected? But first let us know definitely the construction of the compass under consideration.

If the Sea-Star, as described by Mr. Scott, were good I feel sure the Germans would already be using it. If, assuming it is at fault, anyone knows of means of perfecting it, such means should be kept secret from all except our own Government.

I should greatly regret to think that anyone had been deterred, by any words of mine, from putting forward a good thing, for I am well aware that my own knowledge of the mathematics of the gyroscope is very small.—I am, &c.,

London, June 14. F. M. Denton.

THE HEAVISIDE LAYER.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read the interesting article by Dr. Fleming in The Electrician of the 11th inst., and note that he seems to consider that the ionised layer necessary is due to particles shot out of the sun. As a *possibility* I would accept his explanation, but nothing more than that. Finally, why all experimental work on wireless telegraphy should cease because we happen to be at war with Germany almost passes one's comprehension. One would imagine that this is the *very time* to push experimental work of this kind for all it is worth.—I am, &c.,

Mill Hill, June 22. W. H. F. Murdoch.

[We regret that we are compelled to hold over some correspondence.—Ed. *E.*]

"A BOARD OF EXPERIMENT"

Under this heading several further communications have appeared in "The Times" and the "Morning Post" during the past week, and in what follows we give the substance of some of these letters:—

Prof. Andrew Gray, writing from Glasgow University, points out the difficulties which must attend "the mobilisation of all the inventive force and energy of the country," and expresses a doubt whether the writers of the various letters to "The Times" know from practical experience how many serious obstacles there are at present in the way of bringing this energy to bear. He points out how difficult it is for the inventor, even supposing he has the necessary funds at command, to obtain access to an engineering establishment or to a workshop of any kind equipped with machine tools. The reply received by the inventor at the present time is that he must wait until the war is over before those who are in a position to afford him the necessary facilities of manufacture can entertain his proposals. Prof. Gray is of opinion that something like a new department would have to be created.

Sir H. Trumain Wood has also contributed to the subject.

Mr. Charles Bright, discussing Prof. Gray's letter, suggests "the immediate establishment of an effective clearing house to which all offers for State service of any kind should be made, those in charge of such clearing house having a position and knowledge to which [illegible] could be most usefully directed—if at all."

It will be remembered that this correspondence in "The Times" originated with a letter from Mr. H. G. Wells, who to Tuesday's issue of our contemporary contributed a further letter on the subject, reviewing the correspondence that has followed in our contemporary. It will be seen that he practically endorses Mr. Charles Bright's suggestion. Mr. Wells points out that "the present crowd of [illegible] a committee or committees of distinguished men," and he expresses a doubt whether the result would be the most suitable instrument for rapidly taking up, examining, testing and rejecting or developing new ideas. Promptitude and a single purpose are what is needed (says Mr. Wells) in a case of this kind, and for this purpose "a more concentrated direction possibly even a single person" appointed by a proper organisation, would be far better. [illegible] Mr. Balfour and [illegible] Mr. Lloyd George. Mr. Wells illustrates his argument as follows:—

"Essentially I see it as a small department, collateral rather than

subordinate to the War Office and Admiralty. . . . The business of the bureau will be essentially to stand between these great administrative departments and the flood of crude and imperfect suggestions that beats upon them so distractingly and unavailingly; it will examine, test and develop these, and present such as are found suitable in a finished form ready for use to the fighting department. . . . The bureau would, I think, do its work best if it were a responsible official bureau, because then it would have comparatively free access to official information: it would know more exactly what was being done and what needed to be done. Its directorate could be under military discipline as regards imparting and discussing its secrets. That, however, is the ideal state of affairs. It would be quite possible for it to do a very considerable amount of useful and helpful work as a semi-official or even a merely sanctioned volunteer body, and that is the form in which I am making this present suggestion.

"The organisation of this bureau would consist first of an index (with a suitable system of cross references) of all the men and women with special scientific and technical knowledge and ability available, who could be called upon for advice, help and work upon the problems which would be its essential business. This index could be compiled very rapidly with the help and advice of the proprietors and editor of "Nature" and of the various leading technical journals, supplemented by the secretaries of our numerous scientific and technical societies. If the people on this list could be more or less officially embodied as a scientific force, as a corps or service, so much the better. Secondly, the bureau would maintain a list of laboratories, institutions and places free for experimental work. Under the education department alone at the present time there must be very considerable resources for investigation and experiment which are not being utilised for our national needs, and there are also numerous private laboratories. Thirdly, the bureau would need funds. These funds would be under the control of a small special committee which would sanction the directorate's appropriations. This much would constitute the working body of the bureau; its head and intelligence would be the director's office, or rather the directorial cranium into which would come from the one hand a confused tumult of proposals and inventions from outside, and from the War Office and Admiralty an occasional inquiry or demand arising out of the experience and necessities of the war. Its business would be to convey the digested residuum of the former to the fighting departments, and, under suitable precautions, to see to the requisitions of the latter. The bureau, acting through the director's office, would be essentially a clearing house of ideas. It would weed out the absurd and impossible—probably 99 per cent. of the matter sent in—it would sort out and set aside for development the under-developed but intelligent suggestions; from its index it would develop a galaxy of capable and willing consultants to whom these suggestions, or questions arising out of these suggestions, would be submitted and promptly attended to, and it would in suitable cases provide funds and, either immediately or mediately, direct trials and experiments. The beginnings of such a bureau might be made to-day; it might be at work within a week; it might be producing effects at the front within a month or six weeks of the present date."

In "The Times" of yesterday (Thursday) Prof. Patrick Geddes writes in cordial approval of Mr. Wells's proposed bureau.

Mr. TENNANT, in replying to a question in the House of Commons last Wednesday, stated that practically all the laboratories in the country had been placed at the disposal of the War Office. There was a large chemical staff of highly qualified men. The War Office had received great benefit from advice given by the Royal Society, the National Physical Laboratory, the universities and other bodies, and he desired to express the thanks of the Army Council for the assistance that had been given.

EDUCATIONAL NOTES.

University of Manchester. In the Faculty of Science complete courses of study (extending over three years) are arranged for the University Degrees in civil, mechanical and electrical engineering. Good facilities are provided for laboratory and research work: the civil and mechanical engineering laboratories have recently been equipped with new plant and apparatus, and the electrical engineering laboratories are in course of building. Particulars of courses can be obtained from the Registrar. The new session commences on Oct. 7.

Particulars of the lecture and laboratory courses in physics, preparatory to both the ordinary and honours degrees, will be forwarded on application to the Registrar. Prof. Sir E. Rutherford will meet [illegible] on Thursday, Oct. 7, at 10.30 a.m.

Manchester Municipal School of Technology.—The 1915 session [illegible] Complete courses of instruction [illegible] mechanical and electrical engineering, electrical and textile industries, architecture, &c. Prospectuses, [illegible] of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

NEW BOOKS AND NEW EDITIONS.

[Copies of the new books mentioned below can be obtained *post free* from THE ELECTRICIAN Office on payment of the prices indicated in parentheses. Where an asterisk is added * one extra 2d. days will elapse before books are supplied. It is only necessary to specify the number when sending remittance.]

492. "Design of Steam Boilers and Pressure Vessels." By Haven and Swett. 12s. 6d. net.

493. "Heat: Treatment of Steel." 10s. 6d. net (10s. 9d.)

494. "Electrical Instruments in Theory and Practice." By Murdoch and Oschwald. 10s. 6d. net (10s. 9d.)

495. "Textbook of Elementary Chemistry." By Perkin and Jaggers. 3s. net (3s. 3d.)

496. "Railroad Finance and Organisation." By W. Z. Ripley. 14s. net.

497 "Text Book of General Physics for College Students." By J. A. Culler. 7s. 6d. net (7s. 9d.).

498. "Atmospheric Electricity: Potential Gradient at Kew from 1892-1912." By C. Chree. 2s. net (2s. 3d.).

499. "Transmission of Electric Waves Over the Surface of the Earth." By A. E. H. Love. 1s. 6d. net. (1s. 9d.).

500. "First Principles of Production: A Study of First Principles in the Relation of Science to Industry." By J. H. Taylor Peddie. 5s. net (5s. 3d.).

501. "Design of Steam Boilers and Pressure Vessels." By Henva and Swett. 12s. 6d. net.

502. "Electrical Instruments in Theory and Practice." By Murdoch and Oschwald. 10s. 6d. net.

503. "Single Phase Electric Railways." By E. Austin. 21s. net.

504. "Railroad Accounting." By W. E. Hooper. 7s. 6d. net. (7s. 9d.)

505. "Practical Physical Chemistry." By J. B. Firth. 2s. 6d. net (2s. 9d.).

506. "Advanced Theory of Electricity in Magnetism." By Franklin and Macnutt. 8s. 6d. net (8s. 10d.).

507. "Elementary Experimental Statics." By I. P. Hart. 2s. 6d. net (2s. 9d.).

508. "Steam Boilers and Combustion." By J. Batey. 4s. net (4s. 4d.).

509. "Elementary Chemical Microscopy." By E. M. Chamot. 12s. 6d. net.

510. "Constant Voltage Transmission." By H. B. Dwight. 5s. 6d. net (5s. 10d.).

511. "Structural Engineering." By J. E. Kirkham. 25s. net.

512. "Materials of Construction." By A. P. Mills. 19s. net.

513. "Spiral and Worm Gearing." 10s. 6d. (10s. 9d.).

514. "Single-phase Electric Railways." By E. Austin. 21s. net.

515. "The Mechanics of Electricity." By F. J. B. Cordeiro. 5s. 6d. net (5s. 10d.)

516. "Continuous Current Electrical Engineering." By W. T. Maccall. 10s. 6d. net.

517. "Simple Methods of Radiographic Localisation." By T. Rankine 1s. net (1s. 2d.)

518. "Thermo-magnetic Study of the Eutectoid Transition Point of Carbon Steels." By Smith and Guild. 2s. net (2s. 2d.)

519. "Electricity for the Farm." By F. I. Anderson. 5s. 6d. net (5s. 9d.)

520. "X-Rays: How to Produce and Interpret Them." By H. Mowat. 8s. 6d. net (8s. 9d.)

521. "Romance of Electricity." By V. E. Johnson. 3s. 6d. (3s. 8d.)

522. "Romance of Modern Inventions." By V. E. Johnson. 3s. 6d. (3s. 8d.)

523. "Romance of Engineering." By G. D. Knox. 3s. 6d. (3s. 8d.).

524. Science and Technology, Examinations in (Board of Education). 9d. (11d.)

525. Logarithms for Business Purposes. By T. J. Millar. 1s. net (1s. 2d.)

526. Patents, Designs and Trade Marks Report, 1914. 2½d. (4d.)

527. Post Office Telegraphs and Telephones Account for 1913-14. 3d. (4d.)

528. "Inskip's Tables, Squares and Logarithms." 15s. net.

529. Board of Trade Report on Bills of Prov. Orders, Session 1915, relating to Railways, Tramways, Rail-less Electric Traction, Electricity Supply, Gas and Water Canals, Harbours, &c. 3½d. (5d.)

530. Handbook of London Trades (Gas and Electricity Supply Trades). 2d. (3d.)

531. "Mechanical Drawing." By J. Husband. 3s. net (3s. 4d.)

532. "A Treatise on Hand Lettering for Engineers." By W. J. Lincham. 7s. 6d. net (7s. 9d.).

533. "Surface Tension and Surface Energy and their Influence on Chemical Phenomena." By Willows and Hatschek. 2s. 6d. net (2s. 9d.)

534. "Mechanical Engineers' Pocket Book of Tables, Formulæ, Rules and Data." By D. K. Clark. 16th edition. 4s. 6d. net (4s. 10d.).

535. "A School Arithmetic, including Logarithms and Mensuration." By A. C. Jones. Parts I. to III., 1s. 6d. (1s. 9d.) each.

536. "Micrometers, Slide Gauges and Calipers." By A. W. Marshall. 6d. net (8d.)

537. "Telegraph Engineering: A Manual for Practising Telegraph Engineers and Engineering Students." By E. Hausmann, E.E., D.Sc. 14s. net.

538. "Theory of Measurements: A Manual for Physics Students." By J. S. Stevens. 6s. net.

539. Hawkins' Electrical Guides. In 10 Vols. Each 4s. 6d. (4s. 9d.). (Vols. IX. and X. in preparation.)

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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MR. WORDINGHAM'S "OPTIMISM."

The mechanism with which Nature has provided mankind for the purpose of the interchange of ideas is so complex that it needs to be used with the utmost care. As between one individual and another its functions may be exercised freely, but as between one individual and many others, as in the act of public speaking, they should be employed with some caution. In other words, it is highly desirable to avoid giving utterance in public to what "Punch" has so aptly illustrated and emphasised for many years as the "things best left unsaid." This advice applies particularly to engineering matters. We should not dream of accusing Mr. Wordingham of not reading "Punch," but from his very latest utterance we should imagine that he does not look to this national organ of wit and humour to guide a period

We could be more in error in [illegible] Mr. Wordingham as an electrical engineer, and although he no longer adorns the ranks of municipal servants, the esteem in which he is held by the I.M.E.A. is reflected in the position of honorary member of that body, of which, by the way, he was in the early days one of its most progressive presidents. By virtue of this fact, and his services on the Engineering Standards Committee, Mr. Wordingham attends the annual convention of the I.M.E.A. and frequently contributes to the discussions.

As to what should be said and what should be left unsaid is, of course, a matter of personal opinion. As individuals we may feel that his brother engineers are following a policy which is altogether wrong. Is he, then, to say nothing? Obviously not. There is such a thing as the unreasoning trend of fashion, and this is found, we regret to say, in engineering as in less serious walks of life. If the engineer is to follow the crowd, then serious criticism comes to an end, and solid progress must suffer, for it is an undoubted fact that progress flourishes best under the stimulus of criticism.

To come to the point of our grumble, Mr. Wordingham threw cold water on the electric vehicle movement because many years ago accumulator tramways proved a failure. This reasoning, however, is very far from being sound. Such an argument ignores entirely the progress that has been made during the interval. Time after time, innovations have met with failure at the start and with success at the finish. Take, for example, the petrol omnibus, which was initially a hopeless failure. It may, no doubt, be more difficult to realise that progress has been made in electric accumulators to the extent which has been the case, because this progress has been more in detail than in fundamentals. That, however, is no reason for ignoring it. At the present time we have not merely got cells which are very much stronger than they were years ago, but also new types of cells. Moreover, we have gone very much further than in years gone by, for results of cost are obtainable, not merely in America but in this country. All this must surely be taken into account, and, therefore, we would ask Mr. Wordingham not to cause discouragement in a field full of promise by merely taking account of ancient failures.

Snow Sweeping in New York. For the purposes of sweeping snow from New York streets a new form of sweeper, with a 14 ft. rotary broom, which is mounted on a special tram chassis, has been introduced, and was described in a recent number of the "Electric Railway Journal." The sweeper can consist of two cabs mounted on standard trucks and connected by a platform, the lower part of which is from 14 to 18 ins. above the ground. Under the central portion and longitudinally is mounted a rotary broom, which can be swung out on either side to a distance of 12 ft. from the rail. When in transit the broom can be swung round with its axis parallel to the axis of the car. The broom is swung round through worm gearing by means of a 5 h.p. motor, and is rotated by a 35 h.p. motor mounted on the axle of the broom at the inner end. The action of the broom is controlled by a man stationed in the front end cab, who can swing the broom in and out to pass vehicles and can vary the broom speed and pressure on the road as desired. Another man is stationed in the rear to drive the sweeper, and a mechanic is also always carried on board. The broom can also be carried to the opposite end of the bridge as required.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week June 14, 1915, to June 19, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]

HULL.—[illegible] Electrodes, 37 pkgs.; elec. machinery, 24 pkgs.

LONDON.—*U.S.A.:* Elec. machinery, £363; elec. lamps, £877; elec. carbons, £85; telephone materials, £224; unenumerated, £125. *Switzerland:* Elec. carbons, £300; unenumerated, £23. *Spain:* Lamp parts, £75. *Norway:* Telegraph poles, 3,932 pkgs. *Holland:* Elec. lamps, £820—154 pkgs.; elec. machinery, £446; lamp parts, £6; unenumerated, £81. *Sweden:* Elec. machinery, £552; telephone apparatus, 83 pkgs.; elec. lamps, £235; lamp parts, £152. *France:* Elec. carbons, £857; lamp parts, £730; elec. lamps, £55; unenumerated, £200. *Italy:* Elec. wire and cable, £1,190; elec. machinery, £1,931. *Canada:* Wire and cable, £2,250; unenumerated, £140.

SOUTHAMPTON.—*France:* Unenumerated, 43 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £39. *Melbourne:* Elec. machinery, £2,360; wire and cable, £2,500; elec. glow lamps, £170; unenumerated, £593. *Sydney:* Elec. machinery, £177; wire and cable, £10; telegraph material, £55; unenumerated, £1,252. *Wellington:* Wire and cable, £400; unenumerated, £83. *Brisbane:* Elec. machinery, £231; unenumerated, £73. *Dunedin:* Unenumerated, £74. *Christchurch:* Elec. machinery, £123; unenumerated, £156. *Perth:* Wire and cable, £39; unenumerated, £478. *Hobart:* Unenumerated, £70. *Lyttelton:* Elec. machinery, £38; unenumerated, £259. *Fremantle:* Elec. machinery, £15; unenumerated, £74.

AFRICA.—*Durban:* Machinery, £2,277; wire and cable, £2,535; unenumerated, £2,077. *Port Elizabeth:* Wire and cable, £80; unenumerated, £539. *Cape Town:* Elec. machinery, £125; unenumerated, £246. *East London:* Wire and cable, £5; unenumerated, £43. *Zanzibar:* Unenumerated, £95. *Delagoa:* Elec. machinery, £42. *Kilindini:* Elec. machinery, £118; unenumerated, £195.

EGYPT.—*Port Sudan:* Elec. machinery, £21. *Alexandria:* Elec. machinery, £37.

RUSSIA.—*Petrograd:* Wire and cable, £1,035; unenumerated, £178.

SPAIN.—*Seville:* Unenumerated, £70. *Santander:* Elec. machinery, £37. *Cartagena* Unenumerated, £29.

PORTUGAL.—*Oporto:* Unenumerated, £67.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £1,130; elec. machinery, £215; unenumerated, £802. *Montevideo:* Wire and cable, £50; unenumerated, £20. *Pernambuco:* Unenumerated, £359. *Rio de Janerio:* Unenumerated, £79. *Rosario:* Wire and cable, £260; unenumerated, £11. *Santos:* Unenumerated, £259. *Santa Fe:* Elec. machinery, £325.

HOLLAND.—*Amsterdam:* Wire and cable, £3,190; wireless telegraph material, £330; unenumerated, £107. *Rotterdam:* Wire and cable, £74; unenumerated, £81.

U.S.A.—*New York:* Unenumerated, £91.

JAPAN.—*Yokohama:* Unenumerated, £959.

CHINA.—*Hongkong:* Unenumerated, £11. *Shanghai:* Unenumerated, £138.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £163; elec. machinery, £2,053; unenumerated, £881. *Calcutta:* Wire and cable, £296; unenumerated, £72. *Colombo:* Wire and cable, £288; elec. machinery, £38; unenumerated, £46. *Madras:* Elec. machinery, £56; wire and cable, £134; unenumerated, £205. *Singapore:* Unenumerated, £72. *Penang:* Telegraph material, £16. *Port Swettenham:* Unenumerated, £39.

JAVA.—*Sourahaea:* Wire and cable, £553; unenumerated, £41.

CANADA.—*Toronto:* Unenumerated, £24. *Montreal:* Unenumerated, £25. *St. John N.B.:* Unenumerated, £24.

FRANCE.—*Boulogne:* Unenumerated, £26. *Paris:* Elec. machinery, £767; unenumerated, £28. *Dunkirk:* Unenumerated, £149. *Havre:* Elec. machinery, £130. *Calais:* Wire and cable, £2,070. *Nantes:* Unenumerated, £500. *Dieppe:* Elec. machinery, £40; unenumerated, £77.

GREECE.—*Piræus:* Elec. machinery, £96; unenumerated, £236. *Salonica:* Unenumerated, £375.

MALTA: Unenumerated, £25.

[illegible]

FOREIGN GOODS (duty paid and free).

Durban: Unenumerated, £56. *Amsterdam:* Unenumerated, £252. *Bankok:* Unenumerated, £29. *Barcelona:* Unenumerated, £55. *Bombay:* Unenumerated, £92. *East London:* Unenumerated, £215. *Melbourne:* Unenumerated, £17. *Paris:* Unenumerated, £18.

FOREIGN FREE GOODS, entered in transition through Bills of Lading.

Alexandria: Unenumerated, £126.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Osram Lamp Works (Ltd.) v. Pope's Electric Lamp Co. (Ltd.)

On Tuesday Mr. Justice Joyce commenced the hearing of this action [illegible] to restrain defendants from an alleged infringement of [illegible] letters patent 23,899 of 1904, for damages and for the delivery up of articles or things made in infringement of the said letters patent. Defendants denied infringement, and alleged that there was no subject matter for plaintiffs' patent and a lack of novelty.

[illegible] Mr. H. A. Colefax, K.C., Mr. J. Hunter Gray [illegible] (instructed by Messrs. Bristows, Cooke and Carpmael) appeared for the plaintiffs, Mr. T. Terrell, K.C., Mr. T. R. Hughes, K.C., and Mr. [illegible] (instructed by Messrs. Ravenscroft, Wood [illegible].

Mr. WALTER, in opening for plaintiffs, said that the action related to incandescent electric lamps, and more particularly to the filament in such lamps. After describing the process of manufacturing the lamp bulbs, he outlined the [illegible] of [illegible] electric lamp filaments. At first platinum was [illegible] were used, but they were a dismal failure, and carbon was next tried. A carbon lamp consumed about 4 watts of electricity per candle-power per hour. With the modern invention with which the case was concerned the consumption was brought down to 1 watt per candle-power per hour. Many people, therefore, set themselves to find something other than carbon which could be used in electric lamps, and amongst these was Dr. Welsbach, who invented the incandescent gas lamp, and at one time it seemed that his Osmium lamp would afford a solution of the problem. Dr. Welsbach discovered that if osmium and carbon were mixed, and a filament of the compound heated in an atmosphere of steam and hydrogen, the steam would combine with the carbon, and although osmium was greedy in its combination with oxygen, the presence of the hydrogen would prevent the oxygen acting upon the osmium. Greater heat was afterwards applied to consolidate the osmium. There were alternative processes described in Welsbach's specification, and the inventor also claimed that filaments could be made of rodium and ruthenium, metals of the platinum type, with the exception of the; alloys of osmium. The latter could not stand so high a temperature as would enable them to compete with osmium. The next step in order of date was the use of a metal called tantalum. That was a metal which could be drawn as wire, and was to-day in use. Later there was a suggestion by Siemens & Halske that molybdenum, thorium, titanium, tungsten and zirconium could be used as drawn wires. That was mainly important because of the mention of tungsten. By amendment in 1913 all but tungsten were cut out; but the specification related to drawn wire, and nobody could do the processes described until many years after that specification was published. The next specification was by Gülcher, who re-suggested the use of iridium, which had been suggested by Welsbach; but he did it, not by means of any protective gas, but in the open air. Just and Hannaman, who were the patentees of plaintiffs' patent, then published a specification which related to a suggested process of manufacturing tungsten filaments by taking certain oxychlorides and forming tunsten filaments by depositing on carbon tungsten or oxychlorides. There were also a specification by Bottome for compound carbon and tungsten, and two specifications by Lodyguine, which suggested the deposit on a core of platinum of tungsten and certain oxychlorides. That was the state of the art when Just and Hannaman made the invention described in the 1904 specification 23,899. That was a patent for manufacturing a tungsten filament, and these patentees discovered that tungsten, though not of the platinum group, if taken in metal form or in the form of its oxides or sulphides, mixed with an agglutinant and formed into a thread, and carbonised so as to form a filament of tungsten and carbon, could be protected by an atmosphere of hydrogen in the further process of burning out the carbon. Dr. Welsbach had discovered that that was the case with osmium and the metals of the platinum group. Those inventors discovered that it was also the case with tungsten, and that you could burn out the carbon by means of oxygen in steam without injury to the metal, which would be protected by the hydrogen. In a previous action by the Osram Company against the "Z" Electric Lamp Mfg. Co., that patent had been considered by Mr. Justice Warrington. In that action practically every one of the objections taken to plaintiffs' patent in that action were taken and overruled. It was suggested in the action against the "Z" Company, and it was now again suggested, that there was no subject matter in discovering that tungsten could be protected by hydrogen from the action of oxygen. Mr. Justice Warrington held that there was invention in it, and that there was nothing in chemistry which would have taught a person that because osmium and the metals of the platinum group would be so protected that the metal tungsten could also be protected by hydrogen. As Sir James Dewar once said, "There is no prevision in chemistry," and, in fact, titanium, zirconium and thorium did not react in that way. According to defendants' case, Welsbach, when he made his invention, though he was in fact treating osmium and the metals of the platinum group, must have known that tungsten, a metal otherwise possessing desirable qualities, would be susceptible to the same treatment. But until that specification no one ever suggested that that was the fact. That specification formed the basis for the manufacture of tungsten filaments in this country, and tungsten had substantially replaced carbon filaments for commercial lighting. There had been a subsequent development, and means had now been found for the working of tungsten, but that patent had not yet been before the Courts. Defendants operated by two methods; they used a carbonaceous binding material, and they took as their raw material a mixture of finely divided tungsten and a small quantity of one of the oxides of tungsten. Those were the metals referred to in the specification. They mixed that metal with an organic binding material and they made threads by a process of squirting, thus they obtained a thread of tungsten material bound together with carbon. Those filaments were dried so as to have some sort of form and then there were two alternatives in the first process. They had furnaces of iridium, down the walls of which an electric current flowed so as to heat it at the top to a temperature of about 950°C. Lower down the temperature was lower, and the bottom was cooled by a water jacket. The furnace was connected at the top by a pipe to a source of hydrogen; that was to say, hydrogen was forced into the interior of the furnace and hydrogen was also brought round the furnace to prevent the possibility of anything but hydrogen getting inside. The filaments which had been squirted and dried were put upon a holder from which they hung and passed very gradually from the bottom of the furnace into gradually increasing heat. When they got to the top they remained there a certain time and then passed down again into the cooled part, from which they could be taken out. They were, therefore, in an atmosphere of hydrogen being first carbonised in the lower and cooler portions of the furnace. When they got to the higher portions, what happened was that the hydrogen acted on the oxygen of the tungsten oxide, steam

was formed, and the oxygen in the steam burned out the carbon precisely as indicated in the specification. That same process appeared to be carried out partly, not in an iridium furnace but in a porcelain furnace which was heated electrically to a temperature of 950°C. The chemistry of the operation which took place in the porcelain furnace was precisely the same as in the other. By which ever method was adopted the makers had now got rid of some of their oxygen, and they wanted to get out more carbon, and they wanted to make more steam. After the cooled filaments were removed from the furnace they were, therefore, heated in an oven exposed to the air to a temperature of about 220 deg. By that means, as every chemist would know, some tungsten was oxidised and a little more oxide of tungsten. Then the filaments were passed into another iridium furnace with which hydrogen was entering at the top. At the top of that furnace the maximum heat was 1,850°C. As in the previous case the furnace was cooled at the bottom and the filaments were gradually raised through the increasing heat, and in the same way vapour was formed. The operation was, therefore, also carried out in an atmosphere of steam and hydrogen and the carbon was oxidised while the tungsten was protected. Electricity played no part in the process other than heating, and it was much the same as if current had been run through the filaments themselves in a prepared atmosphere in the manner described in Just and Hannaman's specification.

His LORDSHIP: The question is whether the process by which they make their lamps is an infringement of your process.

Mr. WALTER: Whether the filaments are made in substantially the manner described and whether the process of treatment is the same. Proceeding, Counsel said the second of the two processes to which he had referred was carried out by means of a quartz or silica tube about 2 ft. 6 in. long and about 2 in. in diameter. These were sealed at one end and were filled at the other end with a cover by which they could be connected with an exhaust pump. The filaments were put on to a holder and put inside the tube. The vessel was then closed up and the air pump put to work, and the quartz tube was put into an electrical furnace heated up to 950°C., the exhaust pump working continuously. Hydrogen with steam of carbonic oxide were the gases that came out of the tube, so that process was essentially the same as the others. The tube was taken out of the furnace in due course and allowed to cool. When cool it was put into an exposed oven heated up to 220 deg. More tungsten oxide having been formed in that way the filament was again put into the quartz tube and the dose was repeated in a final furnace heated up to 1,850 deg. Thus the one method of treating the filaments was carried out in a vacuum, the other in a stream of hydrogen, but in both the atmosphere was that described in the plaintiffs' specification.

Dr. F. W. PASSMORE, consulting chemist, then gave evidence in support of plaintiffs' case.

The hearing had not concluded when we went to press.

Tramcar Conductor Licences.

At Kingston-on-Thames recently Albert C. Godwin was summoned for acting as the conductor of a tramcar without having been licensed, and Mr. Arthur L. Barber, secretary of the London United Tramways (Ltd.), was summoned for suffering him to act in that capacity without a licence.

Evidence was given that defendant Godwin acted as a conductor on Whit Monday, but when asked for his licence he said he had applied to Scotland Yard and was waiting for it.

For the company it was said Godwin was only a week-end conductor, and was employed to make up the shortage caused by employés who had joined H.M. Forces. About 35 per cent. of the employés had left owing to the war and the company had experienced the greatest difficulty in making up the shortage. Scotland Yard would not allow women to act as conductors. It was urged that the employment of Godwin was unavoidable, and the Bench took this view, and dismissed both summonses.

Geo. Brown v. Lambeth Borough Council.

At the Lambeth (London) County Court on Friday, Judge Parry delivered a considered judgment in this action by plaintiff, a taxi-cab proprietor, for the recovery of damages for injury to a cab. The case was reported in our issue for May 21 (p. 253).

In giving judgment, his HONOUR said that plaintiff, while driving a taxi-cab at 11 p.m. on Jan. 6 last came into collision with a refuge in the middle of the road, knocking down one of its cast-iron guards and damaging an arc lamp standard. Plaintiff alleged that the occurrence was due to defendants' negligence in not lighting the refuge. Usually the refuge was lighted by an arc lamp, which on the date (under police regulations) had been considerably darkened. At the moment of the accident plaintiff said that the arc lamp was not alight. He was the only witness to this, but he saw no reason to disbelieve him. He thought plaintiff was going at a far greater speed than 8 miles an hour, but he did not think he was going at an unreasonable speed. The arc lamp was lighted and controlled by the local electric lighting company, acting for defendants. The company's servants found the arc lamp alight at 5:30 on the afternoon of Jan. 6, and again at 11 o'clock on the morning of Jan. 7. Evidence was given as to the type of lamp and the mechanism by which it was lighted and extinguished, but no effort was made to show that it was of inferior construction or in any way faulty. After the accident a police officer came up and noticed that the light was out, but his evidence was consistent with defendants' contention that the collision extinguished the lamp. There was no evidence to show how the lamp came to be extinguished or how long it had been extinguished, nor was there any evidence of negligence on behalf of the servants of defendants of the electric lighting company in superintendence, management or control of the lamp. The general lighting of the place was adequate and reasonable, having regard to the police requirements. The fact that the arc lamp was not alight undoubtedly contributed to the accident, as did the speed at which plaintiff was driving; so too, did the general darkening of the surrounding lamps under the Order in Council. He found that the lamp was out at the moment of the accident, that the lamp being out was not due to any negligence of defendants or their servants, and there was no evidence to show how it came about that the lamp was temporarily extinguished. The action here was founded on negligence. There was no evidence of any negligence, and therefore he gave judgment for defendants, with costs.

Mr. LEVER (for plaintiff) gave notice of appeal, and Judge Parry said he should be very pleased to hear that the appeal was successful.

Alien Enemy Patent.

At the Patent Office on Monday the Comptroller of Patents (Mr. W. Temple Franks, C.B.), and Sir C. N. Dalton heard an application by Messrs. Calder, Dixon & Co., of Middlesbrough, for a licence to use a German patent for treating timber by the Ruping process. Some weeks ago a similar application was made by Messrs. Hall Bros., of Newcastle. It was now stated that the Board of Trade had intimated their readiness to grant a licence to Messrs. Hall in respect of Post Office work only, the process being useful in the preparation of telegraph poles.

In support of the present application, it was urged by Mr. A. M. Christie, of Calder, Dixon & Co., that, in addition to the Government demand for telegraph poles, there was a demand for the Rupinised timber in the collieries and the ironstone mines of Northumberland and Durham.

The application was opposed by Mr. R. Gregory, on behalf of a number of firms, including Messrs. R. Wade, Sons & Co., Burt Bros. & Haywood, Messrs. Armstrong & Addison and Hall Bros. Before the war, it was stated that Messrs. Wade & Sons received from the German owners of the patent a general licence, and sub-licences were granted to a number of other English firms. Mr. Gregory submitted that it would be unfair that after those licensees had introduced the process into the country the applicants should take advantage of exceptional legislation in war time to capture the trade. If there was evidence of a demand he should not oppose a licence for all Government purposes.

The Comptroller-General of Patents (Mr. Temple Franks) observed that if the war were really going to last threee years timber might be required in the construction of railways, and there would be no harm in granting a licence for all Government purposes.

Mr. GREGORY asked the Comptroller to defer a decision on that matter for the present, seeing that there were so many interests involved.

The application will be reported upon in due course.

Fraudulent Consumption of Electricity.

At Tunbridge Wells Police Court on Monday, Harry Arthur Stonham was summoned for fraudently consuming electricity of the value of 1d., the property of the Corporation, between May 29 and June 12.

The Town Clerk (Mr. W. C. CRIPPS), who prosecuted, said that the Corporation charged 1d. per unit for electrical energy supplied for power and 4½d. per unit for lighting. The charge against defendant was that he had certain lamps connected to the power circuit, thereby getting lighting energy at the power rate.

Mr. CHAS. JOHN RANGER, a Corporation collector, who said defendant was a wiring contractor, gave evidence as to the quantity of electricity supplied to defendant.

Mr. JOHN W. B. RADFORD, mains engineer of the Corporation electricity department, stated that on May 29 he inspected defendant's electrical installation. There were two meters on the premises, one for lighting and one for power, and each was connected with its own circuit. Some of the lamps used for lighting were connected with the power circuit, viz., one 60-watt lamp in the office, one plug supplying three lamps in the workshop, three 55-watt lamps in the billiards room, one 30-watt lamp in the fitting and show room and a five-way plug lighting the fittings in the show room. Witness cut off the lighting current so that no current could pass through the lighting meter. The nine lamps mentioned, however, remained lighted. There were six lamps on the lighting circuit.

Mr. JOHN E. POWNALL, assistant electrical engineer, who visited defendant's premises on May 29, gave similar evidence. On June 12 he again visited the place with Mr. R. N. Torpy, borough electrical engineer.

Mr. REG. NORMAN TORPY, borough electrical engineer, said he visited the premises on June 12 with Mr. Pownall and corroborated the evidence given by that witness. The plug to the lamp in the office was not connected with a plug outside the office door.

Mr. R. VAUGHAN GOWER (for defendant) submitted that no case had been made out, inasmuch as there was no legal obligation upon a consumer to use the electricity which was supplied to him for a specific purpose. He obtained the current legally, and if he used it in contravention of his agreement with the Corporation that body had their civil remedy.

Mr. CRIPPS contended that sec. 23 of the Electric Lighting Act, 1882, made it clear that in the circumstances the current was fraudulently consumed. The current was supplied through two meters for two purposes.

The Justices disallowed the objection, and defendant pleaded not guilty.

Mr. GOWER said Mr. Stonham was a man who had taken a prominent part in the civil and religious life of the town. He admitted that the lamp in the office was temporarily connected to the power circuit, but it would not have used more than 16 or 17 units, whereas Mr. Stonham was en-

ticket to run up to 22 weeks at the maximum hiring charge. The [illegible]

DEFENDANT said he had a [illegible] to the street, fixed direct to the power and lighting circuits and marked "heat" and "light" to avoid mistake. On Nov. 29 [illegible] he took the glass globe to the billiards room, and on their leaving the room the plug fell out. Witness replaced it in the dark into the first hole he could feel. With regard to the lamp in the office, it fell down last December, and he told the boy to put it up and connect it to the nearest point. The boy connected it to the power, and witness had not had time to alter it. The three lamps in the workrooms were [illegible] lamps and shown appliances, and he had never known them used for lighting. The power connection to the billiards room had been made when he had a big scheme of illumination for cricket week, when he was compelled to use extra current, but current had not been used for lighting since; he could not explain why the billiards room lamps were connected to the power circuit when the inspector called.

After evidence of good character, the Chairman said the Bench considered the case proved, and defendant would be fined £3.

Re Buenos Aires Port & City Tramways Co. (Ltd.)—Last week Mr. Justice Eve appointed a receiver, with power to act at once.

PARLIAMENTARY INTELLIGENCE.

PLYMOUTH CORPORATION BILL.

In the House of Lords on the 16th inst. the Plymouth Corporation Bill came on for third reading.

The Earl of Donoughmore said the Bill contained two clauses not in accordance with the model bill. One clause related to gas fittings and the other dealt with electric fittings. He had received letters from several of their lordships intimating that they desired to move the rejection of the Bill on second reading on that account. He, however, appealed to them to allow the Bill to go to Committee, and they were good enough to consent. The Committee passed both clauses, but subsequently negotiations took place between all the parties, and the result had been a settlement on the following lines: The promoters agreed to withdraw the electric fittings clause and substitute for it the model clause. The gas fittings clause was not in the model form, and the Corporation would be allowed to trade in gas fittings on the same lines as the old Devonport Corporation had been allowed to trade. On the faith of a clause in the old Devonport Corporation Bill, the old Devonport Corporation had spent £70,000 in building up their business under a Parliamentary title, and he thought it would be unreasonable if the expenditure made on capital account on a Parliamentary title should be wasted through any action of their lordships. For that reason he recommended that that compromise of both parties should be ratified.

The Bill was then read a third time without opposition.

SPENNYMOOR & TUDHOE GAS BILL.

[illegible] of the House of Commons Unopposed Bill Committee considered this Bill last week.

Mr. CRIPPS, Parliamentary agent, stated that there had been a considerable development in the company's district, and it had become necessary to ask Parliament to sanction the raising of additional capital, &c. The first point arose on clause 33, which enabled the company to let on hire dynamos, stoves, &c. The Board of Trade objected to the inclusion of dynamos, on the ground (he supposed) that the hiring of dynamos should be left in the hands of electrical undertakers. That [illegible] A gas company could get more custom if they could go to a man and say they would give him the whole of the plant he required for his electricity supply scheme. The dynamo [illegible] gas engine, and would be part of a combined plant.

[illegible]

London Electric Railways Facilities Bill.—The promoters have [illegible] amendments to secure that the Act shall [illegible]

Rotherham Corporation Bill.—[illegible]

Provisional Orders.—[illegible]

Belmont, Delame, and Thurnscoe was considered on report and ordered for third reading.

The Bill to confirm the Clifden and Enniscorthy provisional orders has been read a second time in the House of Lords.

BANKRUPTCIES, LIQUIDATIONS, &c.

Trevor Dacsbury, engineer, electricity department, Sutton Coldfield, has been adjudicated bankrupt. The first meeting of creditors will take place at 191, Corporation-street, Birmingham, on June 30, and the public examination at the Court House, Corporation-street, Birmingham, on July 22.

A meeting of creditors of Pintsch's Electric Mfg. Co. (Ltd.) will take place at Friar's House, New Broad-street, London, E.C., on June 29.

ELECTRICITY SUPPLY.

EXTENSIONS.

London County Council. On Tuesday, on the recommendation of the Finance Committee, sanction was given to Hackney Council to borrow £3,031, repayable within 12 years on the annuity system, in respect of the amount spent up to March 31 last, for house services. Sanction was also given to the Stepney Council to borrow £16,278 for its electricity undertaking. In both cases the sanction of the Treasury has been obtained.

Marylebone (London). The Council recently decided to apply to the L.C.C. to authorise a loan of £5,450 for the electricity undertaking.

Reigate. An inquiry was held here on Monday into the application of the Council for permission to borrow £1,000 for the electricity undertaking.

Rochdale.—Application has been made to the L. G. Board for permission to borrow £4,400 for electric supply mains.

Salford.—Last week the Corporation decided to purchase an additional 5,000-kw. turbo-alternator for the Frederick-road generating station at an estimated cost of £16,200 in order to meet existing and future requirements for electrical energy, and particularly the pressing needs of many large firms who need power to carry out war contracts.

In the report of the Electricity Committee it was stated that similar plant was ordered from a Rugby firm in October last, but could not be delivered for many months owing to the calls made on the firm by the War Office. The present purchase was recommended on grounds of economy and efficiency and in view of the importance of the supply of power to manufacturers and others engaged in Government work.

The Chairman of the Committee (Councillor G. Billington) explained that it was a matter of extreme urgency, because unless the plant were obtained, the Committee could not guarantee a sufficient supply of current to their customers next winter without going to a local power company. In Salford there were close on 50 large manufacturing firms working almost wholly on Government contracts, and recently an urgent request for a very large supply of current had been made by one of them. The type of plant proposed had already proved itself a success, as a similar set in the Frederick-road station had not been shut down for a single day since it was installed and had saved the Committee over £1,000 a month to coal alone.

The Council then resolved itself into a General Purposes Committee to consider the purchase of other electrical plant at £4,277, and at a special meeting on Thursday the Council authorised an application to the L.G. Board for sanction to borrow the £4,277 required for the purchase, &c.

Stepney (London). [illegible] given its consent to the borrowing of £15,000 by the Council for extensions of the electric supply system.

Torquay. The L.G. Board have given instructions that the work of the extension of the Corbett-road electricity works is to be stopped.

The scheme involved the expenditure of £16,000 for new machinery and alteration of existing buildings, &c. Of the amount £12,000 was for machinery, and orders had been given and much of the plant completed, but arrangements have now been made which will be satisfactory to the contractors and the Corporation alike.

Willesden. The Electricity Committee proposes to extend the mains in order to supply the Private Palaces at Stonebridge, provided the owners agree to advance £250 towards the cost, such sum to be repaid by means of deductions from the accounts for current at the [illegible] per unit consumed.

GENERAL.

Battersea (London).—A special meeting of the Council is to be held to deal with the suggestion of the Electricity Committee that it is desirable that the resolution passed by the Council in September last (with reference to officers and employees joining H.M. Forces) should be modified so as to provide that it shall not apply, in future, to any officer or employee in the Electricity Department who is not, already on war work, unless the permission of the Electrical Engineer is obtained before enlistment.

Chester.—On Wednesday the Council adopted a recommendation of the Electricity Committee to raise the crest of the weir by 12 in., subject to the consent of the Board of Trade.

Hucknall.—As the Sherwood Colliery Co. propose to extend the electric generating plant at their Hucknall pits, the company offer to supply the Council with electricity in bulk for public or private purposes. It was not, however, proposed to carry out the scheme until after the termination of the war. The members viewed the proposal favourably, and it is probable that an arrangement will be made with the company.

Mansfield.—Owing to the increased cost of coal the charge for electric current has been increased by 10 per cent.

Marylebone (London).—The General Purposes Committee, reporting on a recommendation of the Electric Supply Committee as to the granting of a special war allowance to employees in order to meet the increased cost of living, state that they think that it is not expedient that any war allowance should be granted to employees to meet circumstances occasioned by the war without extra services having been rendered.

Middlesbrough.—At the last meeting of the Corporation the chairman of the Electricity Committee (Councillor Calvert) announced that progress had been made with the negotiations for the supply of electric current to certain firms engaged upon the manufacture of munitions of war.

He also stated that at one works it was proposed to install an electric furnace. That was quite a new thing in the district, and while it was being put down solely for the manufacture of war munitions, it was not at all improbable that it would remain in operation after the war and be a continued source of revenue.

A petition was received from 12 ratepayers asking for the extension of the electric supply mains to North Ormesby, but the Committee were unable to accede to the request, the Chairman pointing out that they had applied to the L.G. Board for power to borrow the money to lay the mains, but had been refused.

Oldham.—The Electricity Committee have decided to increase the price of electric current by a ½d. per unit for lighting and by 5 per cent. for power, cooking and heating. The committee state that the high price of coal has already cost the department about £5,000.

Poplar (London).—The Finance Committee have adopted the proposals of the Electricity Committee for the extension of the supplies [illegible] by undertaking for the next 12 months.

By the adoption of the proposal, the balance to credit of the Electricity Net surplus for the year, £14,770, less allowance in respect of loan charges, £4,823; superannuation and pension funds, £1,332; general fund, £3,500; and grant to staff, £1,000, leaving £4,073. From this has to be deducted the value of machinery destroyed during the year, less repayments on account of same and residual value of plant (£1,565), and amount to be written off after disposal of batteries of North and South sub-stations (£1,605), leaving £902 to be carried forward and earmarked against the disposal of No. 4 generating set, which will have to be dealt with during the current year.

Radcliffe (Lancs.).—The price of electric current for lighting has been increased by 10 per cent., and for power by 10 per cent.

Southport.—The Corporation have decided to make arrangements for the reading of electricity, gas and water meters by the same body of inspectors.

At the recent meeting of the Corporation a joint report of the Gas and Electricity Committees, which was opposed by members on the ground that some arrangement could not be made whereby the same inspectors could inspect the gas and electricity meters, contained the following: "We have made arrangements for having the gas and electricity meters read by the same inspectors, that they had proposed, and the inspectors will, for a period, read and record the Borough Electricity Department meters and gas meters to compare the readings and the duties of the present inspectors, and they also recommended that the matter be referred to the Water Board regarding the increased cost of having the gas meters read by the same inspectors as the gas and electricity meters."

Swansea.—The annual report of the Electricity Department has recently been issued, and shows a net profit of £7,156, against £5,813 in 1913/14.

The Borough Electrical Engineer (Mr. J. W. Tuely) commences by alluding to the commencement of the new supply of electric current, and also the development of the use of electric power for [illegible] there appears to be a good field in Swansea, for private and commercial purposes.

Taunton.—There will be a deficit of about £500 on the past year's working of the electricity undertaking, and in view of the increased cost of coal, &c., the charge for electric current for lighting will be increased by 10 per cent. from July 1.

Wednesbury.—The Council have notified that, owing to the increased cost of Mond gas, the price of electric current will be advanced by 7½ per cent. from 1st prox. Some time ago the charge for current was increased by 15 per cent.

TRACTION NOTES.

Bristol.—The Tramways Option Committee has opened negotiations with the Bristol Tramways & Carriage Co. in regard to the Corporation's option to purchase the company's tramway undertaking.

The company has been asked to state, in the event of the Corporation not deciding to purchase the undertaking, what increased facilities for cheap travelling it is prepared to give and what wayleave rental &c., it would be prepared to pay.

Darwen.—Some new tramcars have recently been put into service upon by the tramways department, and have given every satisfaction. The bodies were made by the United Electric Car Co., and the motors by Messrs. Dick, Kerr & Co., of Preston.

East Ham.—The Board of Trade has agreed to allow increased speed rates on various sections of the tramways.

Greenock.—At the last meeting of the Corporation it was stated that it had been agreed to allow tramway car trailers early in the morning, at meal hours and in the evening while men were coming from their work.

In regard to the renewal of the main thoroughfare from West Burn to Rue End street the Tramways Company has agreed to pay about £2,300, and the cost to the Corporation will be about £5,000 to have the thoroughfare paved. The outlay would be too great to take out of revenue in one year, and a scheme will be submitted to the company to enable them to carry on the work without hindrance from the Scottish office.

Women Conductors.—Cardiff, Hull, Portsmouth and Sheffield Corporations have decided, owing to the shortage of male labour, to engage women tramcar conductors.

The men employed by the South Staffordshire Tramway Co., the Birmingham & District Power & Traction Co. and the Birmingham & Midland Motor Omnibus Co. refused to work if women were engaged, and the companies recently applied to the Birmingham Watch Committee to license youths between 17 and 21 years of age. The Watch Committee did not think the companies should be allowed to engage youths over 18, and instructed the chief constable to issue licences only to youths between school age up to 18 years.

LIGHTING, POWER & HEATING NOTES.

Arbroath.—The Council have agreed to allow the present contract with the local electric lighting company to run out, and no contract for electric or gas lighting will be made until the present lighting restrictions are withdrawn.

Broadstairs.—The Council are considering the question of adopting electric light in the remaining streets of the district.

Dock Elevators.—The Mersey Docks & Harbour Board have decided to provide two modern belt electric discharging elevators at the east block of the Waterloo grain warehouses, at a cost of £8,750. The new elevators will increase the handling capacity from 70 to 100 tons per hour and will effect a saving of £1,000 a year.

Dublin.—On Monday the Corporation adopted a recommendation of the Electric Lighting Committee to increase by a ½d. per unit electric current for lighting, and by ¼d. per unit for power.

East Ham.—Instructions have been given for the whole of the lighting of the side streets to be suspended for the present, and for all lights on the main roads to be extinguished by midnight. The Town Clerk has been directed to communicate with West Ham, Ilford, Barking and Wanstead Councils and to ask them to take similar action.

Electricity in Mining.—The report of the Ebbw Vale Steel, Iron & Coal Co. for the year ended March 31 states that the re-construction of No. 5 pit, Ebbw Vale, has been amply justified, the output having increased and expenses having diminished.

Kensington (London).—The Borough Engineer has reported that the [illegible] for [illegible] have been completed and 11,214 the latter are to be disposed of.

Portstewart (Ireland).—The Town Commissioners have decided to proceed with the electric lighting of the town, and a loan of £6,[illegible] in the Y to meet the expenses has been sanctioned for this year's estimates.

EMPIRE NOTES.

Australasia. The "Australian Mining Standard" says Shepparton (Victoria) Urban Waterworks Trust has decided to employ an engineer to report on the scheme to adopt electric pumps for pumping the town water.

Northcote (Victoria) Council has withdrawn its opposition to the proposed electric tramway from the terminus of the cable tramway in Fitzroy, across the Merri Creek over a new bridge along St. George's-road, Northcote, to Preston boundary at Dundas-street, and then branch east and west through Preston. The cost of the line will be borne by Fitzroy Council (£27,000), Preston Council (£23,000) and Northcote Council (£15,000).

It is stated that owing to the stringency of the State exchequer, the construction of the electric tramways planned by the Tramways Trust for Port Adelaide is at a standstill. About 3½ miles of the most costly portion of the system have been completed by the contractors (Messrs. Burt & Timms), leaving nearly 6 miles, which will probably cost £30,000. The failure of Port Adelaide Council to undertake the reclamation of waste lands at Glanville is also said to be delaying the scheme.

"Tenders" (Melbourne and Sydney) says Mt. Gambier (S. Australia) Council has decided to apply for an Order in Council and to appoint a supervising engineer in connection with an electricity supply scheme to be carried out by a company floated by Bridges Ltd.

Electricity in Indian Collieries.—It is announced that the Indian Government is contemplating the introduction of rules for the more systematic inspection of electrical installations in the various mines in the country.

FOREIGN NOTES.

Greece.—A consular report from Piræus for 1914 says imports of electrotechnical appliances, electric conduction apparatus in boxes, motors, dynamos, switch and contact devices, mounted fuses, &c., electric fittings and lamps, h.t. cable and transmission lines, and electrolytic copper from Austria-Hungary were valued at more than twice the amount of goods of the same class received from the United Kingdom.

Russia.—It is announced that the Council of Ministers has decided that the management of the Petrograd Electric Light Co., which was founded in 1886 and worked with German capital, shall be taken over by the Government. A similar decision has been taken with regard to the Electro Peredatcha Co., of Moscow.

MISCELLANEOUS NOTES.

Arc Lamps for Sale.—The Council of the Royal Borough of Kensington invite tenders for the purchase and removal from their depot, Warwick-road, London, W., of 112 arc lamps. Quotations must be delivered at the offices of the Town Clerk, Town Hall, Kensington, by noon July 12. *See also our advertisement.*

Miners' Safety Lamps approved by the Home Secretary.—On June 15 the Home Secretary made an order approving for use in all mines to which the Coal Mines Act, 1911, applies, Messrs. Patterson & Co.'s flame lamp type B8, the Rutter miners' electric safety lamp and the Oldham emergency electric lamp type No. 2 (bull's-eye).

Technical Students and the War.—At the meeting of the Manchester Education Committee on Monday the chairman (Sir Thos. Shann) announced that Messrs. Alfred Herbert (Ltd.), of Coventry, had lent to the School of Technology a No. 3 combination turret lathe, which had just been completed under the firm's latest designs.

He said that the price of the machine, with the accompanying tools, was £878. 9s. The School of Technology, by placing at the disposal of the War Office the expert knowledge of its professors and lecturers, had been rendering valuable service in the production of war material. An opportunity had arisen for assisting the local Munitions Committee, and permission had been given for that committee to have its headquarters at the school. In addition, the school had undertaken the work of registering the names of persons who were willing to offer their services in producing war material. In order to assist such persons to obtain some workshop training before they entered the works, the School of Technology had arranged a number of special classes. The committee accepted the gift and tendered its thanks to Messrs. Herbert for their valuable gift.

The principal of the Municipal School of Technology (Mr. MAXWELL GARNETT) said that the men who had gone to help the War Office and Admiralty was by far the most valuable gift the school could give. 967 of their men had either received commissions or had enlisted, and a great number of them were men who would have been attending the school had they not been fighting instead. Of 187 university students 104 had received commissions, and 83 had enlisted in the ranks. Of the 967, 13 had already been killed. Perhaps the most important department in which the school was helping was in that of research. Prof. Miles Walker, head of the electrical engineering department, had designed all the motors that were being put into submarines at the present time. He thought that was "a very great feather in the cap of the School of Technology." Then Prof. Field (of the mechanical engineering department) had done some valuable work in connection with the wireless installation of aeroplanes; and Prof. Knecht (of the department of chemistry) had done valuable work in regard to explosives. Prof. Fox (of the textile industries department) had engaged in research tests on textile fabrics for aeroplanes and airships. Mr. Gamble, representing the photographic and printing crafts, and now a lieutenant in the Royal Naval Volunteer Reserve, was organising the photographic work for one of the Government services. The number of tests had increased very much this year. Nearly every month the sum received for tests showed an advance of between 50 and 100 per cent. There were other indications that the school's testing work would go on increasing.

Trading with the Enemy.—The Board of Trade have recently issued a further notice to manufacturers and exporters, emphasising the need for scrupulous care in the transaction of foreign business.

It is pointed out that the Government's reprisals policy is directed to suppress all enemy trade, whether import or export. The main difficulty in making this policy thoroughly effective arises from the fact that some traders in some neutral countries are making themselves agents for the supply of goods to enemy countries. British firms engaged in foreign trade, therefore, must have regard to these circumstances and survey with great caution every opening for business which is offered them by neutral importers or exporters. Especial care should be taken in opening new accounts in neutral countries, and in relation to any orders or inquiries of an abnormal character. In case of doubt as to the bona fides of particular consignees business should be suspended pending reference to the Board of Trade. It is inadvisable that any new accounts should be opened by any British trader in neutral countries during the war without the fullest inquiries as to the character of the business.

TENDERS INVITED.

Motor Converter and Transformer.

[illegible] Corporation invite tenders for the supply and [illegible] of One 1,000 k.w. Motor Converter and Transformer. Copies of specification, forms of tender, &c., from the engineer, Mr. F. A. [illegible], Dewar place, Edinburgh. Specification, [illegible] and drawing can be seen at, but not obtained from, the office of the engineer, Sir A. B. W. Kennedy, [illegible], Westminster, London, S.W. Tenders, addressed to the town clerk, Sir Thomas Hunter, W.S., City [illegible], to be delivered by [illegible] Monday, July 12. *See also our*

Electricity Meters.

[illegible] for the supply of [illegible] Meters [illegible] Copies of [illegible] from the City Council, Messrs. [illegible] & Co., Ltd., Bridge Square, [illegible], to whom tenders must be sent by noon July 26. *See an advertisement.*

Wiring and Fittings.

The WALSALL and WEST BROMWICH Unions Joint Committee require tenders by 4 p.m. July 5 for the Electric Lighting of new buildings in Great Barr Park. Specifications from the Clerk to the Committee, 22, Lombard-street, West Bromwich.

The METROPOLITAN ASYLUMS BOARD require tenders by 2:30 p.m. June 30 for the Electric Lighting of blocks 3 and 11 and isolation blocks 19 and 20 at the Grove Fever Hospital, Tooting Graveney, London, S.W. Specifications from the Board's offices, Embankment, E.C.

WALSALL and WEST BROMWICH Unions' Joint Committee require tenders by 4 p.m. July 5 for Electric Lighting, Heating, &c., in new buildings in Great Barr Park. Specifications, &c., from the Clerk, 22, Lombard-street, West Bromwich.

Tenders are required for Electric Lighting at BATLEY CARR Church. Specifications from Dr. Ward, Highbury, Batley Carr, to whom tenders by July 1.

MANCHESTER Sanitary Committee require tenders by 9 a.m. June 28 for additional Electric Lighting Plant, &c., for Baguley Sanatorium. Specifications from the City Architect.

Electrical and General Stores.

SALFORD Corporation want tenders by noon June 28 for supply of Cables, Cable Accessories, Conduits, Pipes, Troughing, m.d. Indicators, Carbon Brushes, Tools, Oils, &c. Specifications from the Electrical Engineer, Frederick-road, Pendleton.

Tenders are wanted by June 29 for 12 months' supply of Electrical Appliances, Rubber Goods, Packing, Oils, &c., to Devon County Asylum, EXMINSTER. Forms of tender from the Clerk.

TOXTETH PARK Guardians require tenders by June 26 for three months' supply of Electrical Supplies, Ironmongery, Oils and Colours, &c. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

Turbo-Alternators, Motor Generators, Transformers, Boilers, &c.

HALIFAX Tramways and Electricity Committee require tenders by noon July 1 for 5,000 kw. Turbo-alternator, with Condenser, two Natural Draft Chimney-type Cooling Towers, and Water-tube Boiler, Superheater and Mechanical Stokers. Forms of tender from the Borough Electrical Engineer.

ERITH Urban Council require tenders by noon July 5 for supply and erection of Water-tube Boiler, with Superheater, Economiser, Automatic Stoker, &c., 2,000 kw. Turbo-alternator, Condensing Plant, and Switchgear. Specifications from the Engineer and Manager of the Electricity Department.

SYDNEY (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

The NEW SOUTH WALES GOVERNMENT RAILWAYS AND TRAMWAYS DEPARTMENT require tenders by noon July 21 for supply of a 250 k.v.a. Direct-coupled Turbo-generator. Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Tenders are invited for the supply and delivery in MELBOURNE of one 1,000-kw. direct-current Generator with Field Regulator and accessories, one Liquid Starter with accessories, together with one spare set of Carbon Brushes and one spare Field Coil for generator. Tender forms &c., from the agents for City Council (Messrs. McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-bldgs., London E.C. Tenders to Chairman of Electric Supply Committee, Town Hall, Melbourne, by 10 a.m. Aug. 11.

Tenders are required by noon July 14 for the supply of two Three-phase Oil-cooled Transformers (75 kva. each) for the NEW SOUTH WALES GOVERNMENT RAILWAYS DEPT. Specification (No. 464) from the Electrical Engineer, 61, Hunter-street, Sydney.

Telephone and Telegraph Material, Wire, Instruments, &c.

The Deputy Postmaster-General, Perth (W.A.) will receive tenders until 3 p.m. July 7 for 31,000 Porcelain (or Stoneware) Insulators (schedule 432 W.A.) for the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department. Sample may be seen at the offices of the High Commissioner for the Commonwealth, 72, Victoria Street, London, S.W.

The Deputy Postmaster-General, Perth (W. Australia) requires tenders by 3 p.m. July 21 for 40 Trembling Bells, 3 lb. Gran. Carbon, 1,000 Earth Clips, 33,000 Fuses in tubes and 6 Galvanometers (Schedule 423 W.A.) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification, &c., from the Deputy Postmaster-General.

The Deputy Postmaster-General, Adelaide, will receive tenders until 2 p.m. July 14 for the supply of Galvanised Iron Wire to the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department. Specifications, &c., may be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Sydney (N.S.W.), will receive tenders until 2:30 p.m. July 1 for 100 tons of g.i. Wire for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General.

Telephone Exchanges.

The DIRECTOR-GENERAL OF TELEGRAPHS, MADRID, requires tenders by noon on the dates mentioned for the construction and working for 20 years of a Central Telephone Exchange at each of the following towns: Haro, Province of Logroño (June 26); Tudela, Province of Pamplona (June 27); Baza, Province of Granada (June 28); and Vinaroz, Province of Castellón (June 28). The "Madrid Gazette" of May 25 and 26, containing particulars, may be seen at 73, Basinghall-street, London, E.C.

Fuses and Fuse Boxes.

SYDNEY (N.S.W.) Council want tenders by 3 p.m. July 19 for Fuses and Fuse Boxes (contract 397). Specification from the City Electrical Engineer.

Tramway Construction.

The DIRECTOR-GENERAL OF PUBLIC WORKS, MADRID, will receive tenders until noon July 31 for the construction and working (for 60 years) of an Electric Tramway between Mongat and Tiana, Province of Barcelona. The minimum rolling stock required to commence working is three motor tramcars. An option on the concession is held by Don Juan Gari.

The Director-General of Public Works, Madrid, requires tenders by noon Aug. 3 for the construction and working of an Electric Tramway between DENSTO and IBARRECOLANDA (Province of Viscaya), Spain. An option on the concession is held by the Cia Vizcaina de Electricidad.

TENDERS RECEIVED AND ACCEPTED.

EDINBURGH.—Last week the Corporation confirmed the recommendation of the Electric Lighting Committee to accept the tender of the Stirling Boiler Co. (at £32,286) for water-tube boilers for the new power station at Portobello.

RUGBY.—The Council have placed an order with the Macintosh Cable Co. for the supply of cable, and with the British Thomson-Houston Co. for a transformer control panel.

SCHOOL LIGHTING.—West Ham Education Committee have accepted the tender of J. T. Halsey (at £163) for wiring the Knox-road special school. There were eight tenders, varying £288 to £163.

WOLVERHAMPTON.—The Corporation have accepted the tender of Ferranti Limited for the supply of two sets of e.h.t. switchgear at £438.

LUTON.—The Electricity Committee recommend the acceptance of the tender of the Brush Co. for a 3,000 3,700 kw. Ljungström turbine at £11,175.

ELECTRIC RADIATORS.—The tender of the Alpha Mfg. Co. (at £32) has been accepted by the Metropolitan Asylums Board for installing electric radiators at the head office of the Board.

STEPNEY (LONDON).—The Electricity Committee recommends the acceptance of the tender of W. Badger (at £61. 10s.) to supply 1-in. piping valves, &c.

Owing to the high prices quoted no tenders for the supply of coal have been accepted, and purchases will continue to be made in the open market.

CARLISLE.—The Corporation have renewed for 10 years the agreement with the Tudor Accumulator Co. for the maintenance of the lighting battery, at £55 per annum.

WEST HAM.—The Education Committee has accepted the tender of J. T. Halsey (at £163) to carry out the electric lighting work at the Knox-road special school.

BOURTON-ON-THE-WATER.—Last week the Parish Council agreed to accept the tender of the local electric lighting company for the public lighting.

HULL.—The Education Committee have accepted the tender of T. W. Vaughan & Co., at £1,009, for wiring and fittings for the new girls' secondary school.

BARNET.—The Guardians have accepted the tender of Baxter & Counter, at £35, for wiring the infants' nursery.

MILTON.—W. N. Walters has secured the contract for the electric lighting of the new girls' hostel.

WATFORD.—The Guardians have accepted the tender of E. Brook (Ltd.), at £28. 14s., for the supply of an electric motor.

SYDNEY (N.S.W.)—The City Council have accepted the following tenders:—

Peters Bros., pole erecting waggon £207; Australian General Electric Co. Nitro-incandescent lamps, £481. 5s.; steel lamp fittings for nitrogen lamps, £1,543. 10s., and transformer testing apparatus, £269. 5s.; W. G. Watson & Co., insulator pins, £64.

RICHMOND (VICTORIA).—Mr. T. K. Steanes (agent for Messrs. Heenan & Froude) has secured the contract for the installation of a refuse destructor for the Municipality, at £10,217.

HAWTHORN (VICTORIA).—Hawthorn (Victoria) Tramway Trust have placed the following contracts in connection with the Melbourne-Burwood electric tramway:—

Horrocks, Roxburgh Pty. (representing Hadfield's Steel Works), wheels and axles, £899; Noyes Bros. (representing J. G. Brill Co.), trucks, £1,600; Duncan & Fraser, car bodies, £12,860; British Insulated & Helsby, overhead material, £1,009; Sands Hall Mfg. Co., overhead material, £423; Horrocks, Roxburgh Pty., special work, £2,330; Australian General Electric Co., motor equipment and brakes, £3,638; and British Westinghouse Co., ditto, £5,135; Geo. Wills & Co., steel poles, £5,252. The car bodies are to be built of Australian woods, and in all its

[illegible] the Trust [illegible], whenever possible, to Australian materials.

Government Contracts. [illegible] tenders were accepted by the British Government Departments during May :—

[illegible] : T. B. Rose & Co., Accumulator apparatus : Brown, Boveri & Co., blowers for converters ; Accumulator Industries and Houghton-Butcher Mfg., Co., battery boxes ; Bayliss, Jones & Bayliss, Bullers, Ltd., Ed. Bourne & Real, Bourne & Phillips, S. Bowes & Co., Frias Morton & Co., and Spencer, Bowes & Co., insulating materials ; British Insulated & Helsby Cables, Callender's Cable & Construction Co., Connolly Bros., Craigpark Electric Cable Co., I. Frankenburg & Sons, General Electric Co., W. T. Glover & Co., W. T. Henley's Telegraph Works Co., Hooper's Telegraph & India Rubber Works, India Rubber, Gutta Percha & Telegraph Works Co., Liverpool Electric Cable Co., Chas. Macintosh & Co., Ransomes, Sims & Jefferies, Shropshire Iron Co., Siemens Bros. & Co., Union Cable Co., Ward & Goldstone, Western Electric Co. and Yorkshire Cable Co., [illegible] and wire ; Siemens Bros. & Co., parts of electric cells ; Automatic Telephone Mfg., Co., India Rubber, Gutta Percha & Telegraph Works Co. and Telegraph Cordage Co., cord sets ; Albion Clay Co., conduits ; British Insulated & Helsby Cables, London Electric Wire Co. & Smiths, Siemens Bros. & Co. and Western Electric Co., telephone cords ; Kartret Engineering Co. and Park Royal Engineering Works, distribution [illegible] ; British Ebonite & Insulation Co., New Exeter Rubber Works and Peel-Conner Telephone Works, rod and sheet ebonite ; Robey & Co., oil engine and dynamo ; Armorduct Mfg. Co., Barton & Sons, Credenda Conduits Co., Eureka Conduits & Fittings Co., General Electric Co., Peerless Seamless Steel Tube & Conduit Co. and Simplex Conduits, electric light fittings ; Edison & Swan United Elec. Light Co., A. Kershaw & Sons, Record Electrical Co. and Walters Electrical Mfg. Co., galvanometers ; Edison & Swan United Elec. Light Co. and Pope's Elec. Lamp Co., electric lamps ; C.L.A.M. Mfg. Co. and Sperryn & Co., electrical instrument terminals ; Callender's Cable & Construction Co., electric cables, Rhyl, Oswestry, Cannock and Mansfield ; V. G. Middleton, electric wiring Salisbury, Rhyl, Oswestry, Cannock and Mansfield, and electric light and power installation, South Farnborough ; Electrical Contracts & Maintenance Co., electrical work, Swanage Camp.

India Office.—C. Macintosh & Co. and Siemens Bros. & Co., cable ; Siemens Bros & Co., cells ; General Electric Co. and British L. M. Ericsson Mfg. Co., telephones ; Marconi's Wireless Telegraph Co., parts of Wireless telegraph apparatus.

H.M. Office of Works.—T. Clarke & Co., wiring of Public Trustee Office.

Post Office.—Automatic Telephone Mfg. Co., telephone apparatus and [illegible] exchange equipment, Newport Mon ; India Rubber, Gutta Percha & Telegraph Works Co., telephone apparatus ; Western Electric Co., telephone apparatus and extension of exchange equipment, Edgbaston, Finchley and Belfast ; Creed, Bille & Co., telegraph apparatus ; Callender's Cable & Construction Co. and W. T. Glover & Co., telephone cable ; Siemens Bros. & Co., telephone cable and pulley weights ; General Electric Co., telephone lamps ; Bullers Ltd., insulator spindles ; T. Bolton & Sons and F. Smith & Co., bronze wire ; British Insulated & Helsby Cables and Connolly Bros., insulated bronze wire.

Post Office Lamps. The G.P.O. has accepted the tender for a six months' supply of "Royal Edswan" (Tungsten) drawn wire lamps.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The [illegible] are printed from some of the specifications recently published have been [illegible] to us by Messrs. Marks and Ellis & Prior, Chartered Patent Agents, Kingsway, W.C., from whose [illegible] copies of [illegible] specifications may be obtained.

Applications for patents from the date on which the application was lodged at the Patent Office are printed in bold type after the title.

[illegible]

[illegible]

[illegible]

11,987 Genders & Genders. Electrical apparatus for automatically locking railway [illegible].

12,047 B.T.-H. Co. (G.E. Co. of America.) Self-propelled vehicles.

12,350 Ford. Magnetos and the like. (Addition to 15,636 13.)

12,386 British Insulated & Helsby Cables & Wilson. Electric meters. (Cognate application, 15,615 14.)

[illegible] rings, or coil or coils, surrounding the iron body between the poles of the shunt magnet, and adapted to be moved by means of micrometer or like device in one direction or the other, so that the ring or rings, or coil or coils, when so moved, act upon and influence the rotor or disc.

12,551 Berry. Electrical heating apparatus.

12,599 Simplex Conduits & Waterhouse. Fittings for metallic conduit systems for housing electrical conductors.

12,885 Theedam. Electrical signals in mines and collieries.

12,906 Wharram. Lamp-locking and anti-vibrator device to incandescent electric lamp-holders of the bayonet socket type.

13,095 Thomas & Stott. Galvanic batteries.

13,374 Lenz. High-frequency current rectifier for rectifying high-frequency wave impulse in a wireless receiving circuit.

15,356 Highfield & Duddell. Electric inductance coils for the protection of electrical machines and circuits.

A graded inductive coil for the protection of electrical machines and circuits against surges and oscillations in which the condenser action between adjacent turns is smaller at one end of the coil than the other, and gradually increases from end to end, the end with the smaller condenser action being connected to the line or cable, and the other end to the machine or circuit to be protected.

15,681 Pierce. Apparatus for receiving or re-laying electric signals. (5/8/13.)

15,868 B.T.-H. Co. (G.E. Co. of America.) Electric meters of the induction type.

An induction electric motor meter having a friction compensating plate of conducting material adjustably secured to a fixed part of the meter, and a phase lagging plate of conducting material adjustably mounted in an aperture on the friction compensating plate.

16,612 Sence. Electric hair brushes.

16,833 Lichtenfeld Burglar Alarm Co. & Litchfield. Control gear for electric burglar alarms.

17,964 Western Electric Co., Western Electric Co. and Western Electric [illegible] switching telephone systems.

17,811 Benitez. System for the generation of electric currents.

18,092 Coles. Electric accumulators or secondary batteries.

18,143 Railing & Taylor. Electrical conduit systems.

21,498 Midgley & Vandervell. Automatic cut-outs for electrical installations.

21,804 Thompson. Telephone call registering devices.

22,435 Barnum & Date. Electric switches. (13/11/13).

22,915 Miller & Miller. Electrically-heated shaving pots.

[illegible]

823 Savoys. Automatic switching apparatus for electrically illuminated signs and the like. (20/1/14).

3,672 Vandervell. Electric cigar or cigarette lighters.

5,848 Zimmerman. Commutators for dynamo-electric machines. (17/4/14.)

APPLICATIONS FOR PATENTS

*Note.—The undermentioned Applications (except those marked *) are not open to public inspection until after acceptance of complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Numerals in parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

May 17, 1915.

7,358 Ges. für Drahtlose Telegraphie m.b.H. Receiving arrangement for wireless telegraphy. (Addition to 5,342 15. 30/5/14. Germany.)*

7,366 Daimler Co., Lanchester & Milligan. Electrical transmission for automobile vehicles.

7,367 B.T.-H. Co. (G.E. Co., U.S.) Wireless signalling systems.

7,368 [illegible] Schappij. Sound receiver for thermic telephones. (16/4/15, Germany.)*

7,374 Milton. Electric generators. (15/5/14, U.S.)*

7,389 Bevan & Bevan. Variable gearing for the transmission of power. (18/5/14, Australia).*

May 18, 1915.

7,449 [illegible]

7,467 Hamilton, Wall & Fersanti (Ltd.). Current-limiting devices.

May 19, 1915.

7,481 [illegible]

7,493 Railing & Ide. Electric soldering irons.

7,498 Scott. Electric conductor rail anchor clip.

7,510 Sturge. Adjustably suspending electric and other lamps, electroliers, gas pendants and other articles.*

7,517 Enefer. Electrically-operated railway signals.

7,546 Smith. Electric accumulators or storage batteries for use in electric battery [illegible].

May 20, 1915.

7,554 Railing, Garrard & Searle. Combined electric switches and fuses.

7,574 Cadenel. Electrical switches. (Addition to 7,151/15.)*

7,579 Heurtley. Telegraphy.

7,599 [illegible]

May 21, 1915.

7,641 [illegible]

7,664 [illegible]

May 22, 1915.

7,675 Smith. Electric cables. (23/5/14, U.S.)*

7,680 [illegible]

7,684 [illegible]

7,685 [illegible]

7,704 [illegible]

May 25, 1915.

7,722 [illegible]

7,723 [illegible]

7,726 [illegible]

7,728 [illegible] tances.

7,754 [illegible]

7,757 [illegible]

[illegible]

[illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Blackpool. The accounts of the electric supply department for the year ended March 31 show gross capital expenditure £215,870 increase £22,509), of which £22,450 has been repaid. The sinking fund amounts to £89,331, and the reserve to £10,725.

Revenue was £47,326 (compared with £44,997 in 1913-14), and working expenses were £24,066 (£23,562), leaving gross profit £23,260 (£21,435). Capital charges were £14,761 (£13,972), and net profit was £8,499 (£7,463), of which £3,499 (£3,463) has been placed to reserve, and £5,000 (£3,000) devoted to relief of rates. Units generated were 5,842,433 (5,440,377), of which 4,634,186 were sold, and 66,549 applied to municipal loans, illuminations, trades exhibition, and various purposes, &c.

Bolton. The capital expenditure of the electricity department to March 31 was £533,887 (increase £78,911), of which £179,963 has been redeemed.

Revenue was £76,546 against £78,333 in previous year, and working expenses were £46,629 (£48,031), leaving £29,917 (£30,302) gross profit. After providing for capital charges and depreciation (£27,773 (£24,808) and allowances to employés on military service £292 and payments for sub-stations battery, mains outside borough, new meters, &c., £2,072 (£2,416), the surplus was £145 (£2,365). Fuel cost 0·335d. (compared with 0·364d.) per unit, works cost were 0·524d. (0·537d.), total working expenses 0·645d. (0·657d.) and total costs, including capital charges, depreciation and other charges 1·137d. (1·103d.). Average price obtained was 1·11d. (1·13d.). Units generated were 17,670,110 (16,895,590) and sold 13,688,272 (13,727,819). Total maximum demand was 5,557 kw. (6,467 kw.). Motors installed are 1,546 (1,444), the aggregate H.P. being 16,641 (15,279).

Coventry.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £384,279 (increase £17,036), of which £17,063 has been repaid.

Revenue was £77,913 (compared with £71,208 in previous year), and working and general expenses were £33,142 (£28,376), leaving gross profit £44,771 (£42,832). After providing for capital and other charges, including the placing of £15,250 to reserve (compared with £11,000), a balance of £23,148 (£21,943), of which £22,830 is the net profit for the year, is carried forward. Units generated were 22,899,550 (18,842,280) and sold 20,249,018 (16,508,338). Total maximum demand was 10,514 kw. (92,240 kw.). Works costs were 0·351d. per unit, capital charges 0·260d. and special charges (repairs to motors, works and goods for consumers, purchase of motors and meters, exhibition expenses, filter sets, &c.) 0·063d., and attending public lamps 0·003d., total 0·652d. Average price obtained was 0·88d.

Loughborough. The accounts of the electricity department for the year ended March 31 show gross capital expenditure £15,265 (increase £7,086).

Revenue was £6,505 (compared with £6,018 in 1913-14), and working and general expenses were £3,511 (£3,258), leaving gross profit £2,992 (£2,760). After providing for interest, sinking fund, &c., the net balance was £104 (£392). Works costs were 0·253d. (0·261d.) and total (including capital charges) 0·836d. (0·944d.). Units sold were 929,051 (779,600). Total connections were equal to 1,505 kw. (1,245 kw.). Maximum load on feeders was 559 kw. (539 kw.). Motors connected aggregate 940 (881) H.P.

Lowestoft. The accounts of the electricity supply department for the year ended Sept. 30, 1914, show capital expenditure £101,[illegible] (increase £1,931), of which £38,[illegible] has been repaid or placed to sinking fund.

Revenue was £17,982 (compared with £16,[illegible] working expenses £9,330 (£9,[illegible]), leaving gross profit £8,[illegible] (£7,[illegible]). After providing for interest, sinking fund, &c., the net balance was £[illegible] (£[illegible]), of which £[illegible] has been placed to reserve, £[illegible] to renewals fund, £[illegible] to depreciation fund, and £[illegible] carried forward. Units generated were [illegible] (1,[illegible]) and sold 1,[illegible] (1,[illegible]). Works costs were [illegible] (1·[illegible]d.), and total costs, including capital charges, depreciation, and other charges, [illegible] (2·[illegible]d.). Average price obtained was [illegible] (2·[illegible]d.). Maximum demand was [illegible] kw. (1[illegible] kw.). Motors connected aggregate [illegible] (1[illegible]) H.P.

Leeds. The account of the electricity department for the year ended March 31 show total capital expenditure £1,384,413, for the purchase of £927,675.

Revenue was £700,021 (compared with £144,925 in previous year) and working expenses were £[illegible] (£[illegible]), leaving gross profit £[illegible] (£[illegible]). Interest and sinking fund required £[illegible] (£[illegible]), and redemption fund £45,024 (£40,731). £12,054 (£6,983) was contributed out of revenue for capital expenditure, and the surplus, £12,[illegible] (£11,[illegible]), has been carried to credit of consolidated rate. The receipts include £[illegible] on account of lamps, £77,814 (£70,[illegible]) for power, £[illegible] (£[illegible]) for heating, £74,[illegible] (£[illegible]) for lighting, £65,017), traction £14,543 (£6,054) and residential bulk supplies £218 (nil). Average price obtained [illegible] and total [illegible] (1·[illegible]d.). Total working expenses [illegible] (1·[illegible]d.) and capital charges and contribution to capital expenditure made total expenses 0·88d. (1·01d.). Units sold were 43,145,978 (31,011,268).

The manager (Mr. C. N. Hefford) states in his report the increase in units sold was 39·1 per cent., but the reduction in average price caused the growth of revenue to be only 17·3 per cent. The increase in sales for private lighting is unprecedentedly large, the units having increased 11·1 per cent. and the income 10·7 per cent. The effect of the use of more economical lamps, aided by a reduction in price of current, is that Income for current for private lighting is £3,065 lower than in 1907-8, while the number of that class of consumers has increased from 5,504 to 10,759. Horse-power of motors connected increased by 15·9 per cent. and heating apparatus by 54·7 per cent. The supply for traction has increased by 159·1 per cent. The new alternative tariff for current for private consumers for lighting, heating or any other purpose was introduced on Jan. 1. Under that tariff a fixed charge based on the rateable value of the consumers premises is made, and an additional charge of ¼d. per unit. Up to March 31 165 consumers elected to be charged on the tariff and 100 more had adopted it as from April 1. Up to March 31 £793 was paid in allowances to dependents of employees on military service, of whom there were 72. The actual profit for the year was £24,224 (increase £2,926). Maximum load was 16,460 kw. (increase 2,580 kw.). The capacity of the plant has been increased by adding a 7,500 kw. turbo-generator, but reduced by discarding 3,840 kw. of obsolete machinery, the total capacity now being 26,600 kw. Applications on behalf of the department for loans amounting to £218,504 were before the L.G. Board at March 31, and a large proportion of the sum has since been sanctioned. The total number of consumers is 14,121 (12,133), and of (equivalent) 35 watt lamps connected (exclusive of traction) 1,192,607 (1,039,975).

Luton.—The accounts of the electricity department for the year ended March 31 show gross capital £129,325, and £102,037 is outstanding, of which £15,190 is in the sinking fund.

Revenue was £32,822 (compared with £27,361 in previous year) and working expenses were £19,048 (£15,693), leaving gross profit £13,773 (£11,668). Loan and other charges required £9,343 (£6,875), and net profit was £4,430 (£4,793). The total maximum supply demanded was 3,189 kw. (2,521 kw.). Motors connected are equal to 5,996 H.P. (5,265 H.P.) and heating connections 1,465 kw. (1,058 kw.). Units generated were 9,399,750 (7,308,191) and sold 8,380,731 (6,200,697).

Sunderland. The tramways department's accounts for the year to March 31 show gross capital expenditure £306,765, of which £132,265 has been re-paid.

Revenue was £75,880, working expenses were £41,549. Interest required £6,464 and repayment of capital £10,374, leaving net balance £17,493, of which £1,273 has been contributed for capital work, £1,218 paid as income tax, £9,602 placed to reserve fund, and £5,000 (=0·807d. per car-mile, against 0·798d. in previous year) devoted to relief of rates. Average traffic revenue per car-mile was 12·1d. (11·9d.), and working expenses (including power) were 6·7d. (6·8d.) and receipts per mile 0·68d. per mile. Passengers carried were 18,619,364 (against 18,475,671), car-miles run 1,486,201 (1,504,356), and units used 1,802,694 (=1·21 per car-mile).

Mr. A. R. Dayson, general manager and engineer, says in his report, the track has been on the whole well maintained during the year. 225 joints have been welded by the oxy-acetylene process, and a new electric welding plant has been put into use, with which worm joints can be filled at much less cost than by the oxy-acetylene process, and the rail itself can be welded electrically where necessary. Of the regular staff, 53 men are serving in H.M. Forces.

COMPANIES' MEETINGS AND REPORTS.

Globe Telegraph & Trust Co. (Ltd.)

[illegible] holders will have observed from the report that certain changes had taken place in the investments, [illegible] have, as in past years, been somewhat reduced, while the smaller ones have been considerably increased. The [illegible] of the Board to carry out [illegible] the interests of the company [illegible] various holdings are more nearly equalised and our capital more evenly distributed. [illegible] ended May 31 last, after deducting the usual working expenses, amounted to £[illegible], [illegible] £[illegible] carried forward from the preceding year, [illegible] £[illegible]. We have [illegible] holders. [illegible] £[illegible] per share, [illegible] £[illegible] per share net to the ordinary shareholders. [illegible] £[illegible] per share net

and your directors now recommend a final dividend of 3s. per share, less income tax, on the preference shares, making 6 per cent for the year, less income tax, and of 6s. per share net on the ordinary shares, making, with previous distributions, a total dividend on those shares of 6 per cent. net. These final distributions will absorb £78,111, and leave a balance of £27,655 to be carried forward. The decrease of £609 is accounted for in two ways. It is partly due to the increased income tax, which has been deducted from some of our dividends, and partly to the fact, as stated in the report, that some of the proceeds resulting from the paying off of the Submarine Cable Trust certificates have not yet been re-invested. The net result of the year's working is that we are continuing to pay 6 per cent. to our ordinary shareholders, and carrying forward a balance of £27,655, compared with £25,723 at this time last year, or an increase of £1,932. With regard to the present market value of the securities we hold, taking the lowest present market price, shows a surplus over the original capital of £220,575.

With regard to the auditors for 1915. Mr. John Newton, who is in his 82nd year, has been connected with these companies for considerably over 40 years, and has been auditor for this company since 1898. Some three years ago he underwent a very serious operation, and has never fully recovered. Although, owing to his present enfeebled state of health, he does not feel equal to offering himself for re-election as auditor, the directors, being reluctant to part with such an old friend, have made arrangements whereby his association with the company will not be entirely severed. Meantime Messrs. Deloitte, Plender, Griffiths & Co. will represent the shareholders as auditors to the company. I now move the adoption of the report and accounts.

This was seconded by Sir JAMES PENDER and carried unanimously.

Sir James Pender was re-elected a director, and, on the motion of Mr. J. T. Maitland (a shareholder), seconded by Mr. F. O. Stevens, and carried unanimously, Messrs. Deloitte, Plender, Griffiths & Co. were unanimously appointed auditors to the company. A vote of thanks to the chairman, directors, secretary and staff of the company terminated the proceedings.

ALUMINIUM CORPN. (LTD.)—The net profit for 1914 was £7,812 and £120 was brought forward. It is proposed to write £4,646 off plant, &c., and to carry forward the surplus of £3,286. With a view to providing capital to extend the water-power, &c., the first mortgage debenture stock has been increased from £50,000 to £150,000. The chairman (Mr. K. M. Clark) said that if they were to bring the company to a really successful position the output of metal should be increased, and that could only be done by additions to their water-power. They had remedied the difficulties in connection with the carbon works by removing them from Wallsend to Dolgarrog. Last year he told them that work had been commenced upon the tunnel to bring the Dulyn water into the Eigiau lake, but they regretted that the failure of the contractor to carry out his contract had deprived them of the benefit from that water during the present year. In order to provide another dam and a second pipe line debentures had been created. From the gross profit there had to be deducted debenture interest and interest on loans (£4,843), and legal expenses, directors' fees, &c., together amounting to £6,088. A very large proportion of the company's output was prior to the war sold to Germany, and they would understand that a position of very considerable difficulty was created in August last, but he was glad to say by careful handling the crisis was tided over. The demand for aluminium continued to increase, and he was satisfied that there was ample scope for the uses of the metal to be developed sufficiently to consume the output. They had had great labour and other difficulties to contend with, and in all the circumstances the directors considered it wise to transfer £4,645 18s. 4d. to depreciation and to carry forward £3,286

BIRMINGHAM DISTRICT POWER & TRACTION CO.(LTD.)—Mr. C. S. B Hilton, who presided at the meeting on Monday, and that the Shropshire, Worcestershire & Staffordshire Electric Power Co. had obtained the sanction of the Treasury to raise further capital to the extent of £150,000, either in debentures or preference shares, and negotiations, in which the company was taking part as the largest shareholder, were in hand. That would relieve the company from the necessity of making further loans to the Shropshire Company. The total revenue from investments was £38,185, compared with £30,849 in 1913. That represented a return of 3·71 per cent. on the cost of their investments, against 3·05 per cent. The war had affected certain of the companies in which they were interested. Birmingham Corporation had increased all fares inside its boundaries and where running powers existed between the company (or any of its allied companies) and the Corporation certain difficulties threatened to arise, but by a judicious rearrangement of stages they had been overcome.

GREENWOOD & BATLEY LTD.—For the year ended March 31 the profit (after providing for debenture interest, expenses of management and doubtful debts) was £68,395. 5s. 11d., and with balance (£4,824. 15s. 9d.) from 1914 the total was £73,220. 1s. 8d. The directors have appro-

[illegible] cent. per annum on the cumulative preference share capital and of 12½

[illegible] and leaving £6,417. 16s. 11d. to be carried forward. Major-Gen. E.

[illegible] Colonel O. C.

[illegible] General Maddison as

[illegible] & M

IMPERIAL TRAMWAYS CO. LTD.—The [illegible] for the Middle-

[illegible] 1914 were

[illegible] 1913 [illegible] £1,261,624 [illegible]

12,006,616, and net profit was £17,604. 0s. 4d., against £17,824. 9s. 4d. The services of cars and 'buses have been maintained, but naturally not without difficulty, owing to the war conditions prevailing on the north-east coast and to the fact that one-third of the staff have joined His Majesty's Forces. The company holds 122,230 5 per cent. cumulative preference and 112,451 ordinary shares of £1 each in the London & Suburban Traction Co., and it has received the full dividend for the year on the preference shares and a dividend on the ordinary shares at rate of 1 per cent. per annum for the half-year to June 30, 1914. The year's net revenue account shows a balance of £31,231. 12s., and after payment of year's interest on debenture stock and interim dividend on the preference shares for half-year to June 30 (£18,084. 7s. 6d.) it is proposed to pay a final dividend at 6 per cent. per annum on the preference capital and at 4 per cent. for the year on the ordinary capital, carrying forward £313. 17s. 10d.

MADRAS ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold during 1914 was 4,703,849, an increase of 149,966. The gross revenue was £46,177. against £41,175. The revenue account shows a surplus of £315. against a deficiency last year of £5,309. The net result of the years working, after providing for debenture and loan interest and the cost of redeeming £4,200 debentures under the sinking fund, shows a loss of £11,710, which has been carried to suspense account. The result of the working of the tranways showed, after providing for debenture interest and transferring £7,000 to depreciation and renewal fund, an available balance (including amount brought forward) of £12,621, compared with £12,553 fro the previous year. A dividend of 5 per cent. was paid on the ordinary shares and £3,258 was carried forward.

MANILA ELECTRIC RAILROAD & LIGHTING CORPN. (LTD.)—Gross earnings for 1914 were $1,602,001, decrease of $96,592 compared with 1913 : operating expenses and taxes increased $27,628, while net earnings from operation were $783,586, decrease of $124,220 (13·68 per cent.), Interest charges were $277,716 and sinking fund requirements were $28,250, leaving surplus earnings of $477,619. The annual appropriation for replacement and renewal fund was $80,000, and available surplus was $397,619. Four dividends of 1¾ per cent. (7 per cent. for the year), aggregating $350.000 have been paid, leaving $47,619, which has been transferred to surplus account, making the total accumulated surplus (with reserve) $1,691,092, increase $91,964 The electric supply department earnings only fell behind a little over $9,000, the balance of the shrinkage being caused by the closing down of the trucking department.

A dividend of 1½ per cent. has been declared for the quarter ending June 30.

PEEL-CONNER TELEPHONE WORKS (LTD.)—At the recent meeting it was reported that the net profit for the year ended March 31 was £21,542. 10s. 4d., out of which £5,000 was placed to reserve for depreciation and £4,000 to general reserve, leaving £12,542. 10s. 4d., and with amount brought forward (£4,658. 13s.) the balance available was £17,201. 3s. 4d. An interim dividend paid on the preference shares in November absorbed £2,500, and the directors recommended payment of the balance dividend on the preference shares (£2,500) and of 2s. per share on the ordinary shares (£8,000), leaving to be carried forward £4,201. 3s. 4d. The directors reported that they were satisfied with the result, more especially as during the past year the flow of contracts had been irregular. The outlook was more satisfactory for the present year, as a number of orders had already been received which promised a more continuous and full output for the factory.

TUBES (LTD.)—The trading profit for the year ended April 30, including interest and dividend on investment, and after providing for directors' fees, depreciation, maintenance, &c., was £28,496, and with £12,481 brought forward the total was £40,978, out of which the directors have transferred £15,000 to reserve, and they recommend a dividend of 2s. per share and a bonus of 6d. per share, leaving £13,478 to carry forward.

WAYGOOD-OTIS LIMITED.—The directors' report states that the profit for the year ended March 31 (including £6,156 brought forward) amounted to £19,972. Depreciation absorbed £3,621, directors' fees £5,512, dividend on preference shares £8,987, and national service grants to dependents of employés £1,901, making a total of £20,111, which leaves a debit balance of £139.

J. G. WHITE & CO. (LTD.)—The directors' report states that the effect of the war on the business of the company has been very serious. Work in progress has had to be reduced or entirely suspended, and no new contracts are likely to be obtainable under present adverse conditions. Collections of accounts have in some cases been delayed. Financial business, from which the company had made considerable profits in the past, has also stopped. The directors have made drastic reductions in expenses. Under the circumstances the profit earned of £19,772 is not unsatisfactory. Investments have not been re-valued, their valuation having been on so conservative a basis that, even with the heavy depreciation in all securities during the year, their book value is believed to be below their intrinsic value. They are, however, not readily marketable at present, and the company's assets are thus less liquid than is desirable. The cash balance is not far above the amount required for working capital. The directors, therefore, in spite of the large reserves accumulated, did not feel justified in paying an interim dividend in January, and are now unable to recommend a dividend above the rate of 6 per cent. on both classes of shares. The balance to credit of profit and loss, after bringing in £21,786 from previous account, is £41,559. The directors recommend payment of dividends of 6 per cent. (less tax) on the cumulative preference shares (£9,000) and on the ordinary shares for the year to Feb. 28 (£3,000), leaving to be carried forward £29,559.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

BARRACLOUGH BROTHERS (LTD.) (140,589).—Reg. June 8, capital £3,000 in £1 shares, to take over the business of electrical engineers recently carried on by Reside & Co. (Ltd.), at Brighouse and elsewhere, to carry on the same and the business of mechanical and motor engineers, millwrights, tool makers, &c., and to adopt an agreement with W. H. Sayers. Private company. First directors are W. Barraclough and F. Barraclough.

BUTTEVANT ELECTRIC CO. (LTD.) (4,252).—Reg. in Dublin June 11, capital £800 in £1 shares, to carry on at Buttevant and elsewhere the business of an electric light and power company. Private company. First directors are C. G. Crofts, S. E. Crofts and S. Nolan. Reg. office: Buttevant, Co. Cork.

CALVO BOX CO. (LTD.) (140,634)—Reg. June 11, capital £1,600 in £1 shares, to carry on the business of manufacturers of and dealers in all kinds of boxes and receptacles for carriage or storage of goods, electricians, dealers in electricity, engineers, &c. Private company. First directors are J. L. Hanman and L. Harrison. Reg. office: Station-road, Colwall, Herefordshire.

H. GARSTANG (LTD.) (140,580).—Reg. June 7, capital £2,000 in £1 shares, to take over the business of an electrical and motor engineer, carried on by H. Garstang at Blackburn. Private company. First directors are H. Garstang and Mrs. M. E. Garstang (both permanent). Reg. office: Mincing-lane, Blackburn.

LOUDON TELEPHONE (NEW SYSTEM) CO. (LTD.) (94,15)—Reg. in Edinburgh on June 14, capital £10,000 in £1 shares, to carry on the business of making, selling, erecting, maintaining and working private telephones or telegraphs, whether electrical or otherwise. Private company. First directors are C. Cochran, F. T. Jackson, J. Levy, R. Logan and J. MacMahon. Reg. office: 55, West Regent-street, Glasgow.

NORTH BRITISH ELECTRICAL CO. (LTD.) (9,414)—Reg. in Edinburgh on June 12, capital £3,000 in £1 shares, to carry on the business indicated by the title, and to adopt an agreement with Geo. Robertson and Jas. Robertson and Joseph B. Tannahill. Private company. First directors are G. Robertson, J. Robertson and J. B. Tannahill. Reg. office: 15, New Sneddon-street, Paisley.

MORTGAGES AND CHARGES.

BRITISH BATTERY CO. (LTD.)—Second mortgage dated June 7, 1915, to secure £300, charged on all company's assets, present and future. Holders, A. H. Rose and T. A. Rose.

T. JACKSON, SONS & CO. (LTD.)—Debenture, and as collateral security thereto, a mortgage, both dated May 21, 1915, to secure £1,000, charged on certain lands and premises at Bexley Heath and Northumberland Heath, Kent, and company's other assets. Holder: O. O. Dale.

OZONAIR LIMITED.—Debenture dated June 5, 1915, to secure £4,000, charged on the company's undertaking and property, present and future. Holders: British Electric Traction Co.

CITY NOTES.

MEMORANDA (June 24).—Bank rate 5 per cent. (since Aug. 8, 1914. Consols 65 $\frac{1}{8}$. Consols Pay Day July 1. Stocks and Shares Ticket Days July 13 and 28. Pay Days July 14 and 29. Price of silver, 23$\frac{1}{4}$d.

BULUWAYO WATERWORKS CO. (LTD.)—At a recent meeting of the first mortgage debenture stockholders a resolution was passed modifying the rights of the stockholders against the company. It was stated that the electric supply department continued satisfactory, the profit for last year being slightly higher than in 1913. The war had affected the revenue to some extent, but prospects for the current year were considered as good as those for 1914.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold to consumers during the five weeks ended April 30, 1915, amounted to 2,17,6193 compared with 1,713,988 units in the corresponding five weeks of 1914.

EASTERN TELEGRAPH CO. (LTD.)—This company announce the payment on the 15th prox. of dividend at rate of 3$\frac{1}{2}$ per cent. per annum (less tax) on the preference stock for the quarter ending 30th inst., and a first quarterly interim dividend of 1$\frac{1}{4}$ per cent. on the ordinary stock (tax free), in respect of profits for the year ending Dec. 31, 1915. The transfer books of the ordinary stock will be closed from July 7 to 14 inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) The directors have declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share (tax free), payable on July 15 next. The share register will be closed from the 7th to the 14th prox., inclusive.

MONTREAL LIGHT HEAT & POWER CO. (LTD.)—The directors have declared a dividend of 2$\frac{1}{2}$ per cent. on the stock for the quarter to July 31.

NAIROBI ELECTRIC POWER & LIGHTING CO. (LTD.)—It is announced that in consequence of the present irregularity and delays of mails from Nairobi, it will not be possible to present the accounts for 1914 to the annual meeting until a later date than last year. The Nairobi accounts are to hand, but certain other matter necessary has not yet arrived. The directors declared a final interim dividend of 4 per cent. for the year on both preference and ordinary shares, making 10 per cent.

RADIO-TELEGRAPHIC FINANCE.—The "Financial News" of June 15 contained the following:—

"We understand that a Company [illegible] of the Parabon Wireless Telegraph Co., Ltd.) by Steadman, Van Praagh & Gaylor, solicitors. The company has a nominal capital of £450,000 in £1 shares, and will adopt an agreement with the British and Overseas Engineering Syndicate (Ltd.). The first directors (to number not less than two nor more than six) are: Sir Leigh Hoskyns, Bart., Cotefield, Banbury, Oxon; A. Davidson, 23, Upper Thames-street, E.C.; S. F. St. J. Steadman, 4, Suffolk-street, Pall Mall East, S.W. (solicitor to Mr. Godfrey Isaacs); L. S. Robertson, 28, Victoria-street, S.W.; V. Gandil, 11, Park-lane, W. (all London); and C. Hage, Stockholmsgade, 43, Copenhagen, Denmark. In view of the presence of the company's own solicitor on the board, the following article has a unique interest. We italicise certain provisions which are so sweeping that they would practically deprive shareholders of any recourse whatever against the board if a case arose where the interest of the directors could be shown to have conflicted with, and overridden, their duty:—

"(92) No director shall be disqualified by his office from contracting with the company, either as vendor, purchaser, or otherwise, nor shall any such contract, or any contract or arrangement entered into by or on behalf of the company in which any director shall be in any way interested, be avoided, nor shall any director so contracting, or being so interested, be liable to account to the company for any profit realised by any such contract or arrangement by reason of such director holding that office, or of the fiduciary relation thereby established; but it is declared that the nature of his interest must be disclosed by him at the meeting of the board at which the contractor arrangement is determined on if his interest then exist, or in any other case at the first meeting of the board after the acquisition of his interest. A director *may as a director vote in respect of any contract or arrangement in which he is so interested as aforesaid, and if he do so vote his vote shall be counted.* Without prejudice to the generality of the foregoing provisions of this article it is declared that a director may be also *the solicitor to the company, or a member of the firm who [illegible] and [illegible] such solicitor or a member of such firm shall not thereby vacate office, or be in any way disqualified as a director, or precluded from voting as a director on any question relating to the conduct by him or his firm of any legal business for the company, or the remuneration for such business*; and any such director shall be entitled to receive or participate in his or his firm's remuneration from the company for professional services rendered, as well as to receive his remuneration as a director. A general notice that a director is a member of any specified firm or company, *and is to be regarded as interested in any subsequent transaction with such firm or company shall be a sufficient disclosure under this clause*, and after such general notice it shall not be necessary to give any special notice relating to any particular transaction with such firm or company."

SHAWINIGAN WATER & POWER CO.—The directors announce a dividend of 1$\frac{1}{2}$ per cent. on the Common stock for the quarter ending June 30.

WINNIPEG ELECTRIC RAILWAY CO. (LTD.)—A quarterly dividend of 2$\frac{1}{2}$ per cent. has been declared for the quarter ended June 30.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, June 23. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Wed. June 23,	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	93½	7 3 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	91½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	104	5 17 9	Feb Aug
5	10%	Brompton & Kensington Ord.	6⅝	6 0 2	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs...	90½	4 8 5	Jan, July
5	2/3	Do. 4½% Pref.	4⅝	5 9 10	..
5	5%	Do. Ord.	4	6 5 0	Aug, Feb
10	9%	City of London Elec. Lt. Ord.	13⅜	6 9 1	Feb, Aug
10	6%	Do. 6% Pref.	12⅜	4 17 0	Mar, Jly
St.	5%	Do. 5% Deb. St.	110	4 10 11	Jun, Dec
10	7%	County of London Ord.	11⅛	6 5 10	Mar. Sept
10	7%	Do. 7% Pref.	11⅛	6 5 3	Feb, Aug
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs...	80	5 12 6	July
5	9%	Kensington and Knightsbridge Ord. ..	7⅛	6 4 2	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, Jly
5	3/0	London Elec. Supp. 6% Pref.	5⅛	5 19 3	..
St.	4%	Do. 4% Mort. Deb.	86⅛	4 11 11	Jan, Jly
St.	3½%	Metropolitan E. Supp. Ord.	3⅛	5 11 7	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	94½	4 15 3	Jan, Jly
St.	..	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, Jly
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs ..	96½	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar. Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1⅛	5 11 7	Apl, Oct
St	5%	South London E.S. 1st Mort. Debs. ..	95	5 5 3	Jan, Jly.
St.	3½%	Thames Elec. Supp. 4½% Db. St. ..	83½	5 5 7	Apl, Oct
1	..	Waste Heat & Gas Elec. Gen. Stations..	1⅝	7 12 9	Mar, Aug.
5	9%	Westminster E.S. Corp. Ord.	7	6 8 6	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4⅝	4 17 8	Jan, Jly.
		Electric Railways & Tramways.			
St.	4%	British Elec. Traction 4% Debs.	86½	5 15 7	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	71	8 9 0	Feb, Aug
St.	4%	Central London Gaur. Assented Ord. ..	7⅜	5 6 6	..
St.	4%	Do. do. Assented Def. Ord. ..	7⅜	5 8 3	..
St.	4%	City & S. London Deb.	84	4 15 6	May. Nov
10	4%	Do. Pref.	80	6 5 0	Feb, Aug
10	5%	Lancashire Tramways	92	5 17 11	Feb, Aug
1	8%	London Electric Ry. Ord.	1⅜	5 9 0	Jan, July
St.	4%	Do. 4% Pref.	62	6 7 3	Mar. Sept.
St.	4%	Do. 4%	86	4 14 1	Jan, Jly.
St.	4½%	Metropolitan Electric Tramways	96	4 12 11	Feb, Aug
St.	4½%	Do. 4½% Pref.	77½	4 10 6	Feb, Aug
St.	5%	Do. 5% Cum. Pref.	71½	4 14 3	Feb, Aug
St.	4%	Do. 4% A Debs.	85½	4 4 9	Jan, July
St.	4½%	Do. 4½%	84½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	14⅜	..	Feb, Aug
St.	4%	Do. 4% Perp. Debs.	92	4 7 0	May. Nov

†Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name.	Price, Wed., June 23.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*	£ s. d.		
St.	4½	Metropolitan Elec. Tramways Pref.	73¾	6 2 0	Feb. Aug
100	6	Do. Do. Deferred	124½	4 12 0	Jan. July
	4	Do. Do. 4% Debs.	94	4 5 0	Jan. July
St.	4%	Do. 4% Debs. (1903-5)	94½	4 11 7	Jan. July
St.	4%	Do. 4% Guar. Stock	91	5 5 0	Mar. Sept
10	..	Underground E. Rys. of London Shares	..	..	..
10	..	Do. A	1	..	..
St.	6%	Do. Do. Deferred	114	5 5 11	Mar. Sept
..	6%	Do. Do. 6% Debs.	97½	6 3 0	Mar. Sept
..	4½%	Do. Do. B	94	4 15 2	Jan. July
..	..	Yarmouth & M.R.	..	..	Mar.
..	6%	Do. Pref.	43	6 11 0	Jan.
		Electric Manufacturing, &c.			
1	1½	Brotherhood & Wilcox Ord.	2	.. ..	Apl. Oct
1	1	Bull	1¾	4 11 0	Mar.
100	5	Do. Pref. Deferred	94	5 1 0	Jan. July
1	7½d.	Do. Def.	1¼	5 0 0	Jan. July
	3/0	Bruce Peebles & Co.	11½	5 1 0	Aug. Sep
	3/0	Do. Pref.	6	5 0 0	Jan. July
1	6%	British L.M.Ericsson Mfg.Cm.6% Pref.	13	4 12 11	Mar. Sep
1	1	Brit. Westinghouse Pref.	1¾	5 14 3	Apr.
10	4½	Do.	101	4 15 5	Apl. Oct
St.	4%	Do. Do.	73	5 9 4	Jan. July
	15	Callender's Cable, &c., Co. Ord.	15	5 0 0	Jan. July
	2%	Do. 5% Pref.	34	4 17 7	Feb. Aug
	15%	Crompton & Co.	32½	4 13 1	May Nov
1	6%	Dick, Kerr & Co. 6% Pref.	6	6 17 1	Sept
	1	Edison & Swan U.Elec.Lt.A. £3 pd.	1	.. ..	Feb. Aug
1	6%	Elec. Construction Ord.	9	.. ..	May
1	7%	Do. 7% Cum. Pref.	1	6 12 0	Jan. July
St.	4%	Do. Do.	84	5 10 1	Jan. July
10	6	Ferranti	13	5 15 11	Jan. Dec
	2%	W. T. Henley's Teleph. Wks. Co. Ord.	14½	7 0 4	Feb. Aug
		Do. Def.	4½	5 0 0	
St.	4½	Do. Do.	98	4 11 10	Jan. Dec
10	5	India Rubber, G. P. &c., Ord.	9	5 1 –	Feb. Aug
10	5%	Do. Pref.	9¾	5 1 11	Apl. Oct
100	4%	Do. Do. Debs.	98	4 1 6	Apl. Oct
12	36/0	Telegh. Con. & Main. Co.	37	6 9 9	Mar. July
100	4	Do. 4½% Debs.	96	4 4 3	Jan. Jly
1	..	Yokogawa Electric	1½	4 11 0	May Aug
1	..	Do. Def.	1	4 11 0	Feb. Aug
St.	4½	Do. 1st Debs.	93	4 16 1	Jan. Dec
100	4½	Do. 4½% Do.	101	4 9 4	Jan. Dec
		Telegraphs.			
St.	3	Anglo American 6% Pref. Ord.	45	6 13 3	Jn. July
St.	3/0	Do. Def.	105	5 14 3	Fb. My Aug N
St.	4%	Do. Def.	22½	6 14 13	Fb. My Aug N
1	4%	Commercial Cable 4% Debs.	80	4 19 1	Ja. Ap. Jy. O
1	5%	Cuba Submarine Ord.	8⅜	5 13 6	May, Nov.
1	10%	Do. 10% Pref.	15½	6 9 0	..
5	5%	Direct Spanish 10% Pref.	7½	5 13 4	..
10	4%	Direct United States	9	5 5 1	Ja. Ap. Jy. O
St.	65/0	Eastern Tel. Co. Ord.	101	5 5 1	Ja. Ap. Jy. O
St.	13%	Do. 4½% Pref.	96	4 12 1	Ja. My. Jy. O
St.	7%	Do. 7%	97	4 7 0	My. Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	93	4 15 5	Feb. Aug
		Do. Do.	121	5 6 0	Ja. Ap. Jy. O
10	22%	Gt. Northern Tel. Co. with Coup. 7	41½	6 19 5	Ja. My. Jy
25	13%	Indo-European xd and bonus	5	6 0 4	May Nov
1	2/0	Marconi	1¼	10 15 1	Apr.
1	1½	Do.	1¼	1 12 4	July
10	..	Western Union Telegraph	1	8 13 11	May Nov
10	6%	Do. 1st Pref.	9¾	7 3 4	May, Nov
10	3/0	Western Teleph. Co.	10	5 5 –	My. Jy. O Dec
St.	4%	Do. 4% Deb. St.	93	4 5 0	Jan. Dec
		Do. Pref.	91	4 14 1	Jan. Dec
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	120½	6 5 7	Ja. Ap. Jn. O
..	5%	Cuban Telephn. Co. 5% Bds.	5	5 0 0	Jan. July
1	7	Monte Video Telephn. Ord.	8½	5 12 0	Nov.
..	..	Do. Def.	2½	4 15 1	May, Nov
1	..	Do. Pref.	2	4 15 0	Apl. Oct
St.	4%	Do. Db. St.	94	4 12 0	Jan. July
St.	4½	Telephn. Co. of Egypt Do. St.	94	4 15 3	Jan. July
		United River Plate Ord.	8½	5 1 3	Apl. Oct
		Do. Pref.	4	5 0 0	Jan. July
St.	4½	Do. Db. St.	94½	4 15 1	Jan. July
		Financial and Investment.			
1	..	Globe Telegh. & Trust	1	5 0 0	Jn. Dec Jn
		Do. 6% Pf.	1	6 0 0	Jn. Dec Jn
1	..	Mackay Companies' Common	1	5 0 0	Ja. Ap. Jy. O
		Do. Pref.	1	5 11 3	Ja. Ap. Jy. O
10	..	Submarine Cable Trust Certs.	11½	4 1 0	Apl. Oct
		Colonial and Foreign Railways, Tramways, &c.			
10	..	Anglo Argentine Trams. 5% Debs.	86	5 16 4	Jan. Dec
St.	4½	Antofagasta	94	4 14 0	Jan. July
St.	4½	Buenos Ayres Great Southern	94	4 15 0	Jan. July
		Do. Pref.	87	5 3 0	Jan. July
1	..	Buenos Ayres Pt. Rly.	1½	1 11 1	Ja. My. Jy. O
		Do. Def.	1	5 0 0	Ja. Ap. Jy. O
		Buenos Ayres Western	94	4 15 0	Jan. July
		Do. Pref.	94	4 15 0	Jan. July
		Callao Rly.	2	5 0 0	May, Nov
		Canadian Pacific	179	5 11 0	Mar. Sep
		Do. Pref.	141	4 19 0	Feb. Aug
		Central Argentine	94	4 15 0	Jan. July
		Do. Pref.	94	4 15 0	Jan. July
		Do. Def.	94	4 15 0	Jan. July
		Do. 4% Debs.	94	4 5 0	Jan. July
		Do. 4% Do.	94	4 5 0	Jan. July
		Do. 4½% Do.	94	4 15 0	Jan. July
		Do. 5% Do.	94	5 6 0	Jan. July
		Do. 5% Do.	94	5 6 0	Jan. July
		Do. 6% Do.	94	6 7

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NOTES.

Alternating Current Cable Telegraphy.

IN his Paper read before the Physical Society last week, of which we give an abstract in our present issue, Lieut.-Col. SQUIER attacks the problem of improved cable signalling in a new manner. He regards the cable as a power line along which energy from a single-phase alternating-current generator of low frequency is conveyed to the receiving end, where the recorder is classed as a form of alternating-current motor. The question which he asks himself is: What minimum departure from this ideally simple arrangement is unavoidable if it is to be rendered capable of transmitting telegraphic signals? The solution adopted is to communicate a dot by an increase in the amplitude of a semi-cycle, and a dash by a still further increase. To attain this object a resistance is put in series with the sending-end transformer, part of which, by the action of the automatic transmitter, is short-circuited for a dot, and the whole of which is short-circuited for a dash. Micrometer adjustments ensure that the changes at the sending end take place in correct phase. At the receiving end the usual pattern of Muirhead gold-wire relay is ingeniously modified. Normally the alternating current on reception is just too weak to actuate the relay, and a space is the result, but the increased current of a dot makes contact, and the still greater current of a dash causes the gold wire to move out still further, and close a second contact. A local circuit is completed through these contacts, and a specially light printer automatically records the message on the receiving tape. In order that as nearly as possible an uninterrupted alternating current may be obtained, the adjustments at both ends are made in such a way that the amplitude of the space current is as great as possible, and the amplitudes of dot and of dash differ from it by as little as possible. On the delicacy of these adjustments and the accuracy with which they can be maintained in practice the success of the system will depend.

SUCH a great departure from existing methods has naturally many points of interest, a thorough discussion of which would require much study. It will suffice to draw attention to two important aspects. In the first place the system incidentally secures all the advantages that were intended in the use of inverse currents as applied by the late Mr. GOTT. Again, in employing a smoothly varying E.M.F. the best conditions for adjustment of the duplex balance are secured. Hitherto the great difficulty in bringing the artificial cable to equality with the real cable has been the necessity of performing all adjustments by trial and error. The use of a single-phase alternating current enables currents and voltages to be measured with great ease in all parts of the bridge. In case it should be thought that the received signals will suffer by rounding-off the corners of the sent signals, it may be pointed out that in a long cable these corners are inevitably lost by the processes of attenuation and distortion. It is to be hoped that a system apparently possessing such great advantages may be given a thorough trial in order that it may have an opportunity of undergoing whatever modifications may be needed, if any, for successful working.

London County Council Tramways.

FROM the summary of the accounts of the L.C.C. tramways, which we give in another column, it will be seen that the financial position of the undertaking is still unsatisfactory. At the same time it must be remembered that the greater part of the year under review has been worked under conditions which are entirely abnormal. It is, therefore, quite impossible to compare in a satisfactory way the results now given with those of previous years. Briefly, after paying working expenses and capital charges, there is a deficit of £33,172 on the year's working. This figure was obtained without, of course, providing any sum for the purpose of renewals, and it is necessary to meet the deficit by drawing upon the general reserve fund, which is thus reduced to £163,050. We are glad to note that the receipts per car-mile have increased from 9·21d. to 9·77d. per car-mile. On the other hand, the working expenses have

increased from 6·50d. to 6·71d. These figures, however, show a net increase of a satisfactory kind. The number of passengers carried has increased by some 26½ millions. Part of this increase is, no doubt, due to the fact that the motor omnibus service has been very considerably curtailed since the war began, for the reason that these vehicles have been required to a large extent for war purposes. The financial results are further complicated by the fact that the working expenses include allowances to employés serving with the forces, this sum amounting to £42,209. Looking forward to the current financial year, the position is distinctly uncertain, and although the Committee had estimated under normal working a surplus of £39,386 it would seem that this will be more than wiped out by the loss due to the recent strike, which is likely to amount to something like £100,000. In due time, no doubt, matters will right themselves to a considerable extent owing to the diminishing capital charges as the loans are repaid, but for the next few years it will be necessary to look for other expedients, notably an increase in traffic. Much can yet be done by improving facilities, by linking up certain parts, and by the more extended use ot transfer tickets. Now that the whole of the system has at length been electrified there is no reason why the service, from the passengers' point of view, should not be brought to a maximum of efficiency.

The Municipal Wiring Clause.

From the report of the proceedings on the third reading of the Plymouth Corporation Bill in the House of Lords recently it is evident that that branch of the Legislature will not allow any deviation from the standard form of the wiring and motor hiring clause in the Model Bill. The present form of the clause permits wiring work and motor hiring by municipal electricity departments, but only through electrical contractors, and though we are not advocates of indiscriminate municipal trading, we think that the peculiar circumstances of the Plymouth case justified a departure from the usual practice. The borough of Plymouth now comprises Plymouth, Devonport and Stonehouse, and the present Bill aimed at consolidating and unifying the electricity supply and gas powers of the Corporation. It appears that the old Devonport Corporation possessed full wiring powers for many years, and the Bill proposed to extend these to the whole of the new borough. Naturally the local wiring contractors opposed this portion of the Bill, but after hearing evidence, the Select Committee of the House of Lords allowed the clause. The contractors continued their opposition, and it was announced in the House last week that as a result of negotiations between the parties a settlement had been made. The promoters had agreed to withdraw the electric fittings clause and substitute for it the model clause. The gas fittings clause was not in the model form, and the Corporation would be allowed to [illegible] on the same lines as the old Devonport Corporation had been allowed to trade. On the faith of a clause in the old Devonport Corporation Bill, the old Devonport Corporation had spent £70,000 in building up their business under a Parliamentary title and it was thought unreasonable for expenditure made on the faith of a Parliamentary title to be wasted through any action of their lordships. The compromise was ratified and the Bill was then read a third time. The net result appears to be a restriction of powers in so far as the Devonport part of the borough is concerned, but in all probability the capital so affected is small so far as electrical work is concerned. The moral of all such difficulties is, of course, that the sooner the position is defined once for all by the I.M.E.A. Bill the better, but such legislation is obviously out of the question at the moment.

New Standard Measure.—On June 25th H.M. the King ordered that a new denomination of standard measure of length of 1¼ or 1·25 metres shall be a Board of Trade standard as if it were mentioned in the second schedule of the Weights and Measures Act of 1878.

Control Apparatus for Steel Mill Auxiliary Rolls.—Erratum.—We regret that in the article in our last issue on this subject the contactor panel shown in Fig. 4 was stated to be for alternating current, whereas it is for controlling continuous-current motors. Also the block of Fig. 1 is inverted.

City & South London Railway.—It appears probable that the consolidation of interests among the London Underground Railways will result in the supersession of the three-wire system of distribution on the City & South London Railway in favour of the usual three-phase high-tension transmission from the central station, with conversion at sub-stations to direct current. This line is the only example of the application of the three-wire system to electric traction in this country.

United States Steamship Lighting.—As from July 1 the new rule of the United States Steamship Inspection Service, requiring an auxiliary lighting system on steamers under its supervision, will apply. The rule applies to all steamers subject to the regulation of the service and carrying passengers. When such are lighted by electricity and the dynamos are located below the deep loadline, they shall have on board an auxiliary lighting system located above the deep loadline sufficient to light the steamer to enable passengers and crew to find their way to the exits. The system shall be ready for use in case of emergency such as failure of the main lighting system.

Scheme for Training Munition Workers at King's College, London.—The engineering department of King's College, London, is organising a scheme for training unskilled and semi-skilled men in the use of tools, so as to fit them for work at the munition factories. The work is to begin at once, and will proceed throughout the summer vacation, and, if the need is still great, will be continued during the winter. The Industrial Reserve, 227, Strand, is helping the college both in the supply of men who can be usefully trained for such work, and in finding places for them in factories when trained. The work will be done in two shifts from 9 to 12·30 and 1·30 to 5 p.m., Monday to Friday inclusive, so that 40 men can be taken each day. The average course is expected to last for three or four weeks, though this will naturally depend on the previous training and progress of the student. The fee charged will be only the nominal one of 2s. 6d. per week, which will only go a small way towards defraying the running expenses of the scheme. A sum of £150 has already been contributed by a subscriber to the Industrial Reserve, and it is hoped that further contributions will follow. There is no doubt that such a scheme, which has already been initiated at Sheffield, Birmingham and Manchester, will be of the utmost use in making available for the public service a great amount of willing help which is at the present moment unfocussed and untrained. The college and the Industrial Reserve are already in touch with firms manufacturing munitions, and there should be no difficulty in finding places for sufficiently qualified men. This scheme, as well as the advanced testing work which the department will be able to do for the Ministry of Munitions, will be under the direction of Prof. A. H. Jameson. Inquiries and applications should be made to the Secretary, King's College, Strand, W.C.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Mr. G. H. Eardley-Wilmot describes in an article the practical use and construction of the Circle Diagram (p. 476).

Mr. Donald S. Munro contributes an article on "The C.T.S.I. Concentric System of Wiring" (p. 478).

Last week Lieut.-Col. G. O. Squier read an important Paper before the Physical Society, describing the use of low-frequency, unbroken, alternating currents in submarine cable telegraphy (p. 466).

We give an abstract of the annual report of the Director of the National Physical Laboratory for the year 1914-15 (p. 463).

We publish a Paper on "Radio Frequency Changers," by Mr. Alfred N. Goldsmith (p. 461).

Our leading article deals with the Enlistment of Labour (p. 474).

We describe the electrification of the main line of the Norfolk and Western Railway of America (p. 469).

Companies' Meetings and Reports.—Meetings of the British Electric Traction Co., Credenda Conduits Co., Rangoon Electric Tramway & Supply Co., Waygood-Otis and J. G. White & Co. are reported, and the directors' reports abstracted include those of the Bombay Electric Supply & Tramways Co., Compagnie Française Thomson-Houston, Crompton & Co., Edmundson's Electricity Corpn., Marconi's International Marine Communication Co. and South Brazilian Railways Co. (pp. 494-495).

Legal.—The hearing of the action brought by Osram Lamp Works (Ltd.) against Pope's Electric Lamp Co., for an injunction in regard to alleged infringement of patent and for damages, &c., is reported (pp. 483-484).

OBITUARY.

Charles Ernest Paolo della Diana Spagnoletti. With great regret we record the death of Mr. C. E. P. Spagnoletti, one of the best known pioneers in the electrical industry. Mr. Spagnoletti was born at Brompton, London, on July 12, 1832, and died at Hampstead, London, on the 28th ult. Educated at Blemmell House, Brompton, in 1846 he entered the National Debt Office for a short time, until he secured an appointment under Mr. Alex. Bain, the inventor of the chemical printing telegraph, with whom he worked and assisted in carrying out many early experiments in the development of his system. When the Electric Telegraph Company opened their central station at Founder's-court, Lothbury, in January, 1847, he entered that company's service, representing them in several towns in England until 1885, when he became chief of the telegraph department of the Great Western Railway Co. Mr. Spagnoletti at once began to organise a system, and drew up a book of rules and special codes to meet the requirements of railway working, which laid the foundation of the regulations now in general use, thus earning the title of "Father of Railway Telegraphy." In order to meet the requirements of an anticipated heavy traffic due to the opening of the Metropolitan Railway in 1865, he brought out his disc block instrument for controlling the traffic of the line, and subsequently he introduced various improvements in railway signalling, including an instrument to indicate to signalmen the position of the semaphore arm when from any cause it was out of sight of the signalman, and an apparatus for showing whether the signal lamp was "in" or "out" at such signals. Mr. Spagnoletti also patented many improvements in this line of work, such as electrical signals, electrical appliances for working railway drawbridges over rivers and docks, lock and block instruments of various kinds, a system for electrically locking the signal and point levers, and for controlling immediate sidings, drawbridges, &c., a fire alarm system for towns and for large establishments, electric bells, electric tell-tale clocks, &c. In 1873 he brought out a polarised and other relays, and in 1881 he patented a dynamo-electric machine and a system of communication between passengers and guards, an electric motor and an arrangement for protecting trains in station yards while shunting and standing on the wrong lines; and also a system for electric railways for controlling approaching trains from the signalmen's cabin at the station in advance in connection with the electric locking of signals, so that the current is cut off from the charging rail or conductor if the signals are put to danger to stop a train, or, in case of emergency, the signalman can, if it is necessary, stop an approaching train by depriving it of its power of motion. In 1889 Mr. Spagnoletti was appointed consulting electrical engineer for the City & South London Railway (the first electric railway in this country), and advised as to the mode of working the line and in drawing up the specification for the mechanical and electrical plant. Mr. Spagnoletti was President of the Society of Telegraph Engineers and Electricians in 1885. He was a member of the Institution of Civil Engineers, the Society of Arts, the Physical Society, &c. He was a juror of the Paris Exhibition in 1878 for the electrical department, and member of the Congress and exhibitor at the Electrical Exhibition of Paris, 1881, and received a silver medal; juror and exhibitor at the Crystal Palace, 1882; on the General Committee and juror of the Electric Lighting Department of the International Health Exhibition of 1884, and the Inventions Exhibition, 1886; and on the London, General and Executive Committees of the Chicago Exhibition, 1893. He was for 37 years chief electrician and telegraph engineer of the Great Western Railway, and was subsequently consulting electrical engineer to that company. On his retirement from the Great Western Railway in 1892 he became managing director of the Phonopore Co. He developed on the Phonopore system a new telephone, which could be worked on telegraph wires simultaneously with the telegraph, and subsequently brought out a new and most sensitive relay. For some time he acted as consulting electrical engineer to the London Electric Omnibus Co.

The funeral will take place to-day at West Hampstead Cemetery, at 4 p.m.

Killed in Action.—We regret to learn that *Mr. A. P. Featherstonhaugh*, who has been 14½ years on the staff of the County of London Electric Supply Co., has been killed in action. Mr. Featherstonhaugh had served in the London Rifle Brigade since November, 1908, and held the rank of sergeant.

Mr. G. Boast, in the service of the County of London Electric Supply Co., was killed in action while serving with the 23rd County of London Regiment.

Mr. P. G. M. Brown, also in the service of the County of London Electric Supply Co., was killed in action while serving with the London Rifle Brigade.

Private George Robinson, of the Liverpool Scottish, who was killed in action on the 16th ult., was 30 years of age, and an electrical engineer with Messrs. Dick, Kerr & Co., of Preston.

Lieut. A. Gunn.—Lieut. Arthur Gunn, son of Mr. Thomas Gunn (Thomas Gunn (Ltd.), electrical engineers, &c.), has been killed in action.

PERSONAL.

It was reported to Nuneaton Council last week that the electrical engineer, Mr. S. Cameron Gibson, had accepted a commission as Lieut. Commander, R.N.V.R. The Council granted Mr. Gibson an allowance of £200 per annum during his absence on duty.

Capt. A. B. Layton, of the 4th South Lancashires, electrical engineer and departmental manager at Messrs. J. Crosfield & Sons, has been slightly wounded.

APPOINTMENTS VACANT AND FILLED.

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply department. Applicants must have had thorough training as an engineer, experience in design and operation of large electric supply systems, of distribution of e.h.t. current over large areas, &c. Salary £650, rising to £700 per annum. Applications to the town clerk (Mr. Thos. H. Nesbitt), Town Hall, Sydney, N.S.W., by Sept. 13. *See also an advertisement.*

A fitter is required to take charge (under superintendent) of power-house plant and to attend to maintenance and repairs. *See also an advertisement.*

A mains tester is required for H.M. Dockyard, Devonport. Wages 45s. per week of 48 hours, with war bonus of 3s. Applications to the Electrical Engineer, H.M. Dockyard (North), Devonport.

A prime cost clerk is required for electricity supply works during the period of the war. *See advertisement.*

Leek Urban Council require a chief assistant electrical engineer. Commencing salary £120. Applications to the Clerk by July 12.

Leicestershire Education Committee require a principal of the Loughborough Technical Institute and Inspector of County Evening Schools. Salary £300, rising to £400 per annum. Applications to Director of Education, 33, Bowling Green-street, Leicester, by July 5.

Mr. Geo. Marshall Harriss, chief electrical engineer, has been appointed general manager of the Dublin United Tramways Co.; Mr. Lamman has been promoted to the position of chief electrical engineer; Mr. M'Hugh, chief accountant, has been appointed secretary; and Mr. Rathbone chief accountant of the company.

Mr. G. F. Goodchild, M.A., B.Sc., principal of Wandsworth Technical Institute, has been appointed registrar of the Council for External Students of the University of London.

Mr. V. S. Goulding, assistant shift engineer at Battersea (London), has resigned, and out of 39 applicants for the vacancy Mr. C. E. Acock, of Rochester, has been appointed.

Mr. A. C. Bertoli, electrical engineer to Swan Hill (Victoria) Shire Council, has been appointed to a similar position at Rochester (Victoria). He is succeeded at Swan Hill by Mr. W. W. Auslebrook.

INSTITUTIONS AND SOCIETIES.

Nottingham Society of Engineers.—This Society is meeting the local Munitions Committee to consider in what way they may be able to give assistance to the Committee.

Society of Engineers.—On June 17 members of the Society of Engineers (Incorporated) and their friends visited the works of the Edison & Swan Electric Light Co., at Ponders End, and inspected the manufacture of metal filament lamps. The filament is now made principally from pure tungsten drawn wire. Tungsten was, at one time, only procurable abroad, but can now be prepared from a tungsten concentrate obtainable in Cornwall, which enables the Ediswan Company to be absolutely independent of imported raw material. Briefly the tungsten in a powdered state is compressed under great hydraulic pressure into thin rectangular bars, which are kept at a very high temperature in a hydrogen flame, so that all impurities are removed. Then after electrical treatment, which makes the bars more solid, the material is ready for beating or swaging, which is carried out under great heat, and the finished article is a long thin rod of tungsten, which is gradually "drawn" down to the thread-like wire seen in lamps. After the delicate process of assembling glass foot, stem, leading in wires, and supporting spiders (or arms) is completed and these form one piece, the filament is wound on the supporting spiders. In bulb lamps the upper supports for the filaments are of strong and rigid nickel wire; the lower ones are of molybdenum, which is thinner and more elastic.

Employment of Disabled Sailors and Soldiers.—Referring to the note on this subject which appeared in our last issue we are asked by the Council of the Institution of Electrical Engineers to state that the Committee which deals with the question of the employment of these men is The Association for the Employment of Ex-Soldiers, 119, Victoria-street, Westminster, London, S.W., to whom all applications for further information and lists of the local branches of the Association should be addressed. Many of the men could no doubt, after some training, do useful work as switchboard attendants. Attention is also drawn to the Report of the Local Government Board Committee upon the provision of employment for sailors and soldiers disabled in the war, copies of which can be obtained from any bookseller at the price of 1½d. each.

Diesel Engine Users' Association.—At the June meeting of the Diesel Engine Users' Association the question of a suitable allowance for depreciation of Diesel engine plant in connection with income tax assessment was considered. It was generally felt that the present practice of allowing only 5 per cent. for depreciation, and that only on the diminishing capital value, was quite insufficient for the purpose. A somewhat larger percentage had recently been offered in the case of the Diesel engine plant of an electrical undertaking, but the increase offered was only small, and it was thought that if Diesel engine users generally would take some action in the matter, and protest against the inadequacy of the present allowance the income tax authorities might be persuaded that a more liberal treatment in this respect was only just and reasonable. Mr. Arthur D. Bird, of Messrs. Humphreys-Davies & Co., who had been invited to attend the discussion, referred to sec. 12 of the Customs and Inland Revenue Act, 1878, which enacts that a "just and reasonable allowance should be granted as representing the diminished [illegible] or plant used for the purpose of the concern." The two principal questions, therefore, for consideration were: (1) What was wear and [illegible]? With regard to the first question, the legal allowance was limited to [illegible] able. For this reason, among others, it was important that the [illegible] In support of this point, he mentioned the decision in the appeal of the [illegible] &c., which had been replaced by electric traction, was not an admissible deduction in arriving at the taxable profits. He quoted other [illegible] and reasonable," and not relying upon an ultimate allowance of any unexhausted balance of value. Mr. Bird referred to the case of a company generating current, subsequently ceasing to do so, and purchasing its supply elsewhere; also to the case of new plant being installed upon a larger site. In these cases the losses arose from causes other than the obsolescence of plant; in the first case there was a change of business, and in the second case the plant had become useless due to the original site having become too small. It was also pointed out that any allowance other than an annual deduction for wear and tear was a concession by the Board of Inland Revenue, and had no statutory force; further, that it was conditional upon the replacement of the obsolete plant. Mr. Bird also referred to the method adopted by the Inland Revenue authorities in granting allowances for wear and tear, viz., upon the reducing balances of value, and he pointed out that where an allowance was limited to 5 per cent. per annum on the diminishing value, a residual or scrap value of 4 per cent. was only reached after about 60 years. An allowance at the rate of 10 per cent. per annum reduced the capital figure to about 4 per cent. after 30 years. At the time the arrangement was come to for granting allowances for depreciation in respect of machinery and plant at electricity generating stations, the Diesel engine was practically unknown for central station work, and it could, therefore, not be urged that such an arranged allowance covered depreciation of that particular class of plant; further, any such arrangement could not be considered to be binding for all time. As a matter of law, the Commissioners of Taxes were the tribunal who determined the allowances to be made, and they were empowered to vary them annually if the circumstances warranted it. Mr. Bird also made a comparison between the allowances granted to gas companies under the scheme entered into with the Inland Revenue authorities, from which it appeared that they had obtained various concessions that were not accorded to electricity generating undertakings. After some discussion the question was adjourned for further consideration.

Tramways and Light Railways Association.—The 18th ordinary general meeting will be held at the Institution of Civil Engineers, Great George-street, Westminster, S.W., on Friday, the 16th inst., at 10:30 a.m. The seventh Annual Congress will also be held on the same days, when the following Papers will be read: "Glimpses into the Obvious," by Mr. A. V. Mason; "Tramways During War Time," by Mr. J. W. Dugdale; and "Electric Battery Vehicles as Adjuncts to Tramways," by Mr. W. H. L. Watson.

EDUCATIONAL NOTES.

University College (University of London).—Two heating studentships, tenable in the Faculty of Engineering (each of the value of £50 a year, together with £11. 11s., being amount of college fees) may be awarded in July by the Institution of Heating and Ventilating Engineering. Particulars from the Secretary, Gower-street, London, W.C.

University of Manchester.—In the Faculty of Science complete courses of study (extending over three years) are arranged for the University Degrees in civil, mechanical and electrical engineering. Good facilities are provided for laboratory and research work, and the electrical engineering laboratory is housed in a new building. Complete theoretical and practical training is given to students preparing for the higher positions in the electrical engineering profession. Particulars of the courses can be obtained from the Registrar. The new session commences on Oct. 7.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses, giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

Aberdeen University.—The late Mr. Wm. Jackson, of Aberdeen, after giving various legacies for charitable purposes, has left the residue of his estate (subject to Mrs. Jackson's life-rent) upon trust, to apply one-half of it in establishing or assisting in establishing in connection with the University of Aberdeen, a chair of engineering.

ARRANGEMENTS FOR THE WEEK.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. E. Clay, V.D.

The following orders have been issued for the week ending July 10th:—On Mondays, Wednesdays and Fridays. Drills at 6:30 p.m. and 7:30 p.m. Technical instruction will be given by instructors of the London Electrical Engineers for one hour, and squad and platoon instruction for one hour on Monday and Wednesday. On Friday company and squad drill.

RADIO FREQUENCY CHANGERS.*

BY ALFRED N. GOLDSMITH.

Summary.—The author deals with the various frequency changers that have been proposed for use in radiotelegraphic stations, including the static method, the Goldschmidt alternator, and methods dependent upon the arc electrolytic rectifier and transformers.

The first method we shall consider is dependent on electrostatic induction and involves the use of moving parts. It was first described by Petersen.† The principle of the [illegible] is illustrated in Fig. 1. As will be seen, the terminals of a battery are connected to the plates of the condenser C. The capacity of the condenser C may be cyclically varied; either by altering the separation of its plates or by altering the dielectric constant of the medium between them.

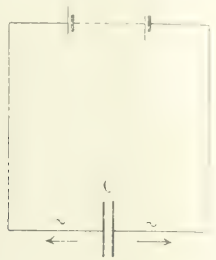


FIG. 1.

If either of these expedients is adopted, current will flow into the condenser and out of it cyclically, and by appropriate means alternating-current energy can be obtained from the arrangement. It involves a simple type of transformation of mechanical energy into alternating electric energy. The type of machine just described produces the fundamental frequency which is increased by the method shown in Fig. 2. We have a high voltage source, *e.g.*, a storage battery of many cells. Its terminals are connected through large inductances to the field plates of generator I. Within the strong electric field thus produced, two sets of insulated plates rotate. Alternating differences of potential appear at the terminals of the rotating armature plates. By properly constructing the machine, with due regard to the necessary limits of tensile strength of the materials used, it may be possible to secure a fundamental frequency of 15,000 cycles per second. The terminals of the armature of generator I are connected through the carefully adjusted inductance L_1 with the field plates of the second machine, which is a frequency changer. The inductance L_1 is so chosen that the circuit in which it is placed is resonant to the frequency n_1 of generator I., which may

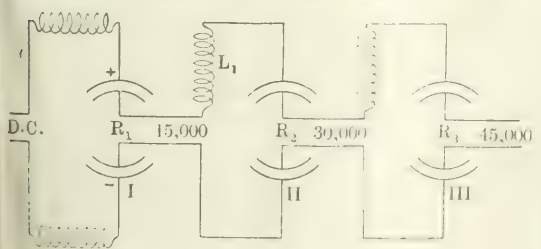


FIG. 2.

be, say, 15,000. In the electrostatic field of machine II [illegible] they are changed) there rotate the armature plates, and their speed of rotation is chosen so that they revolve [illegible] with the electric field in which they rotate. There will [illegible] alternating potential of frequency $2n_1$. [illegible] is the following.

Physically the [illegible] the [illegible] field which is due to the [illegible] two rotating electric fields, each of [illegible] directions. If now the [illegible] shall be stationary relative to one of the rotating component fields and will rotate with twice synchronous speed relative to the other component rotating field. The first of these rotating fields will therefore produce in the armature no alternating P.D., whereas the second will produce an alternating P.D. of twice the fundamental frequency. This principle should be remembered, since it is also extensively applied in radio frequency changers dependent on electromagnetic induction. As an example of an important machine wherein this method of frequency doubling is employed, the Goldschmidt alternator may be mentioned.

Still considering rotary machinery we pass to those frequency changers based on electromagnetic induction. One of the simplest of these is that one worked out independently by E. Arnold and D. Korda in 1893. The circuit diagram is shown in Fig. 3. In this

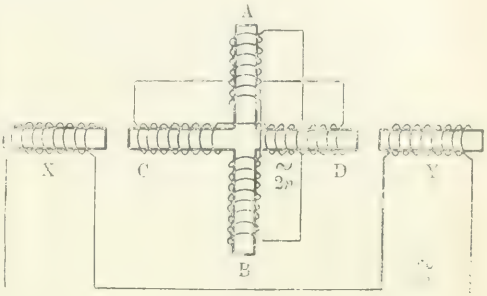


FIG. 3.

diagram X and Y are two field coils through which a single phase alternating current passes. As a matter of practical construction a great number of arrangements of such a field can be employed; for example, a Gramme ring connected to the alternator at two opposite points of its circumference. There will be produced, then, between the coils X and Y a stationary alternating field. The two coils A B and C D, which are mutually perpendicular, rotate in this field. In the figure each of these coils is shown as short-circuited, but instead their terminals may be connected to a slip-ring. If now the two coils mentioned rotate at synchronous speed, it can be shown that there will be induced in each of them, E.M.F.s of double frequency. The proof of this is quite similar to that already given for

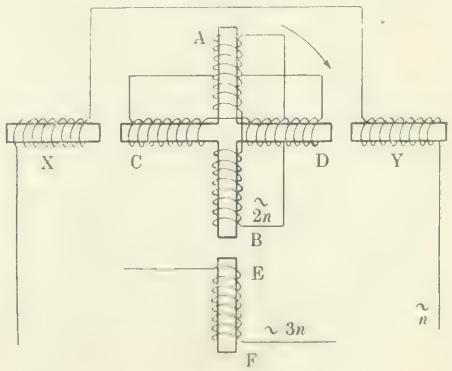


FIG. 4.

the case of the electrostatic generator. Two alternating currents [illegible] maximum by appropriate tuning through inserted condensers in the [illegible] that the sum of the torques for an entire revolution is zero if the coils [illegible]

[illegible] the [illegible] field coil. [illegible] through any number of [illegible]

The [illegible] may be modified, as Korda has shown, by using stationary armature coils and rotating field coils. A number

* Paper read before the Institute of Radio [illegible], New York, somewhat abbreviated.

† Petersen, German Patent No. 2,578.

of ingenious modifications of this method are possible whereby direct-current field rotation can be employed and also two phase alternating-current excitation. In this latter case, it is possible to produce currents of double frequency but of cyclically varying amplitude; and such a method may well be applicable for tone production in radio frequency generators. Korda has worked out a very ingenious method whereby the frequency of an alternating current may be directly tripled. In Fig. 4 is shown the arrangement previously described with an additional coil E F. The field of the two coils A B and C D compound to a single field having an angular velocity of rotation which is twice that of the coils; that is, twice synchronous speed. If now this field were to rotate in the same direction as the coils rotate, its absolute angular velocity in space would be three times synchronous speed, and if this could be accomplished, there would be induced by it, in the stationary coil E F, a current of three times the fundamental frequency. Unfortunately, in the arrangement shown, the field of the rotating coil rotates in the opposite direction to the coils, and, therefore, induces in the stationary coil E F a current of the fundamental frequency. In order to cause this rotating field to have the same direction of rotation as the coils themselves it is necessary to displace the alternating current in one of these coils by 180 deg. in phase. This can be done readily enough in the arrangement shown in Fig. 5. Coils 2 and 4, which are mounted parallel to each other on the same shaft, are wound in the same direction and connected as shown. Coils 1 and 3 are mounted parallel to each other on the same shaft, wound in opposite directions, and then connected. Coils 1 and 2 correspond respectively to coils A B and C D of Fig. 4. It will be seen that inasmuch as the current in coil 3 has been displaced 180 deg. through the use of the reversing connection, the field coils 3 and 4 combined will rotate at twice synchronous speed relative to these coils and in the same direction

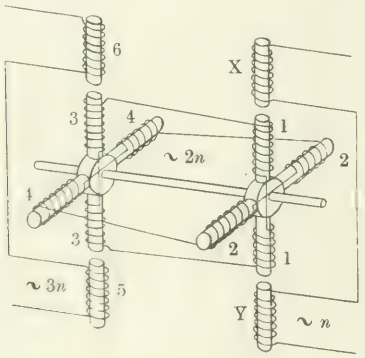


Fig. 5.

as that of their rotation. There will therefore be induced in coils 5 and 6 a current of triple frequency. The device described is directly applicable to multipolar machines and it is easily seen that a rapid multiplication of frequency can be produced by its use. It is further advantageous in that no brushes or slip-rings are employed.

A further method based on electromagnetic induction and employing moving parts was described by Cohen in the "Eectrical World" in 1908. It was proposed to place a number of alternating-current generators on the same shaft, as shown in Fig. 6. The field of the first generator was excited by direct current. The armature of each generator was connected through an appropriate tuning condenser to the field magnets of the next. The device shown is perfectly analogous to Petersen's method previously described. As in that former case, there will be a doubling of frequency in each step. The alternators used in any process of this sort must be particularly adapted to their purpose. A minimum of iron should be used, particularly when working on the higher frequencies. Such machines should have a small number of poles and should be very lightly loaded. If more power is required than the armature reaction of the light load machines will permit, correction of the frequency changer, this correction being different for each different load. The reactive [illegible] employed will introduce a certain error in the tuning, and somewhat diminish the overall efficiency. It remained for Dr. R. Goldschmidt to work out [illegible] in German patent No. 258,300, [illegible] the [illegible] [illegible] [illegible]

current of the choke coil q also has the choice of two paths. It may pass to the cathode K by means of the anode d and thence return to the point p through the circuit i. Another portion thereof will flow through the section $f\,q$ of the transformer secondary into the double frequency circuit and thence back to p.

It is to be noted that while the current amplitude was increasing, the current flow in the double-frequency circuit was *away* from p, but that during the second half of the positive portion of the alternating current wave (that is, during the decrease of current amplitude) the direction of current flow in the double-frequency circuit was *toward* the point p. Evidently then, during a half cycle of the primary current there is produced in the double-frequency circuit a complete cycle of current changes. It is evident, therefore, that the device is a frequency changer. The function of the extra choke coils m and n is easily understood. The losses in the core of the inductance q during the time that its core is being magnetised are necessarily greater than during the time of its de-magnetisation. A disymmetry in the double-frequency current is minimised by the use of the extra

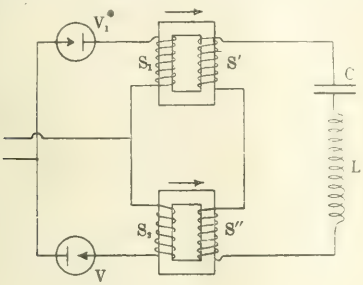


FIG. 8.

inductances m and n and the resistance R. The current through the inductances s and q is thereby made larger than the arc current. The resistance R also prevents the arc current passing into the double-frequency circuit through the conductors 1 and z and then through i. A nearly uniform alternating double-frequency current is thus produced. Inasmuch as it has been shown that mercury arc rectifiers can be operated at a good efficiency even at radio frequencies, it would seem that the method of Kruh might be applicable in radio work.

We pass to the methods of frequency change involving the use of the electrolytic cell rectifiers. If we study the behaviour of an electrolytic cell employing a solution of alum as the electrolyte and carbon and aluminium as the electrodes, we discover that it permits the passage through it of current only in one direction, namely, from the aluminium to the carbon. In Fig. 8 is shown an application of such a cell to a frequency changer. V and V_1 are two such electrolytic cells; and S_1 and S_2 are the primaries of the transformers

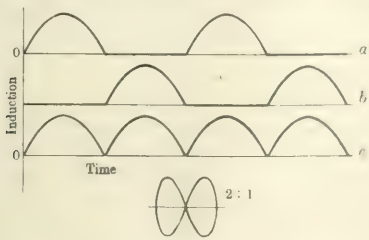


FIG. 9.

of which S′ and S″ are the secondaries. It will be noticed that V and V_1 are connected with opposite polarity [illegible] circuits, and that in consequence current [illegible] through S only in one direction and through S_2 in the opposite direction. Furthermore, coil S_1 is wound in the opposite direction to coil S. On the other hand, S′ and S″ are wound in the same direction. In Fig. 9, curve *a* shows the current passing through S and the consequent magnetic flux through the core bonding the two coils. Curve *b* shows similarly the induction in the core of the second transformer. The total magnetic induction for both transformers is shown in curve *c*. It will be seen that during the time [illegible] of the supply current there are two maxima and [illegible] of the magnetic induction in the transformer cores. It is therefore clear that there will be produced in the circuit containing the two secondaries a current of double frequency although the wave-form of this current will be noticeably distorted in view of the non-sinusoidal character of the magnetic induction.

If it is desired to draw any appreciable amount of energy from the frequency changer, the inductance L and the capacity C are connected in series with the two secondaries, thereby bringing that circuit to resonance with the double frequency. Zenneck has done a considerable amount of valuable work along these lines and has found these cells to be usable at radio frequencies. However, the passage through them of considerable energy is attended with certain difficulties based on excessive heating and deterioration of the electrodes. Using a cell having lead and aluminium electrodes in a 5 per cent. solution of ammonium phosphate, Zenneck has demonstrated the production of the double frequency in an admirably clear way by the Lissajous figures. A Braun tube oscillograph was employed. Near the cathode stream were placed two mutually perpendicular coils, one of which was connected to the primary circuit of the frequency transformer and the other to the secondary circuit thereof. The familiar Lissajous "figure of eight," which signifies a ratio of frequencies of two to one, immediately appeared on the screen (Fig. 9).

(*To be concluded.*)

NATIONAL PHYSICAL LABORATORY.

(*Concluded from p.* 423.)

In our last issue we gave extracts from the annual report of the Executive Committee. The following extracts are taken from the report of the Director for the year ended March 31, 1915: –

PHYSICS DEPARTMENT. I. ELECTRICITY.

Absolute Measurement of Resistance. In July Dr. Giebe and Dr. Schultze, of the Reichsanstalt, paid a visit to the Laboratory, the former's visit extending over about three weeks. Dr. Giebe had been occupied at the Reichsanstalt in the absolute measurement of resistance, and he brought with him a resistance coil, the absolute value of which he had measured. The coil was compared with the N.P.L. wire standards of resistance, and its absolute value directly determined with the Lorenz apparatus. From the results we have: One international ohm = 1·00052 ohms (10^9 C.G.S. units), a result identical with that obtained with the apparatus in 1913.

Wire Resistance Standards. As usual, the wire resistance standards of the Laboratory have been kept under close observation. With regard to the main hermetically sealed standards the changes in resistance during the year do not amount to 1 part in 100,000, except in the case of a 10,000-ohm coil. The main low resistance standards are not hermetically sealed, and these show much greater variations. Other hermetically sealed coils of manganin of nominal resistance 1 ohm also show marked changes in resistance; these coils were made in 1908, and the changes in them appear to be due to structural change in the manganin.

Standard Cells. The investigation of the Weston normal cell has been completed during the year, and the results are being prepared for publication. In view of the fact that at the present time a large number of Weston cells, valued at several thousands of pounds, are in regular use, it was essential to ascertain the cause of the slight irregularities which are known, in many cases, to exist. It was pointed out in last year's report that the mere hydrolysis of mercurous sulphate does not afford a complete explanation of the changes commonly observed, and that there was evidence of another disturbing agency. The result of last year's work indicates that complex ions exist, not only in solutions of cadmium sulphate, but also in solutions containing mercurous sulphate and cadmium sulphate. In the latter case it appears probable that a molecule of H_2SO_4 attaches itself to an ion of SO_4. One great difficulty in the work was the correct estimation of the acidity of many of the solutions. An acidity of 1 part in 10000 has, in many instances, a marked (though temporary) effect on the concentration of the mercury ions, and in consequence the preparation of neutral solutions was essential. A summary of the [illegible] made [illegible] is as follows:

1. The solubility of cadmium sulphate in water at various temperatures.

2. The conductivities at 20° C. of cadmium sulphate solutions of various concentrations. The results are of considerable interest, the conductivity [illegible] about 60 per cent. of that [illegible]. A saturated solution has the [illegible] 0·25 [illegible] are [illegible] [illegible] [illegible] A method [illegible] [illegible] [illegible]

5. The solubility of mercurous sulphate in water and acid solutions, the normality of the acid varying from 0·005 N to 10 N.

6. The solubility of mercurous sulphate in cadmium sulphate solutions of varying concentrations : (*a*) In the absence of acid ; (*b*) in the presence of acid.

7. The change in the E.M.F. of a Weston normal cell when the acidity of the solution is varied (*a*) in the positive limb ; (*b*) in the negative limb ; and (*c*) throughout the cell. It is of interest to note that when the solution in the positive limb is made up with normal sulphuric acid (1 part of acid to 48 of water) the E.M.F. is diminished by 0·01030 volt : that when the solution of the negative limb alone contains this quantity of acid the E.M.F. is increased by 0·00965 volt ; and when the whole of the solution in a cell is made up from normal acid saturated with cadmium sulphate the E.M.F. is diminished by 0·00065 volt.

8. The extent of hydrolysis of mercurous sulphate in water and in cadmium sulphate solutions of varying concentration.

In addition, a very large number of cells have been constructed with materials, some normal, some hydrolysed, some acid. Observations on these cells have been regularly made. A review of the results obtained indicates that a cell will decrease in E.M.F. if the depolariser is partly hydrolysed, the rate of change depending on the extent of hydrolysis in the layer of salt next to the mercury surface. The formation of complex ions leads to an increase of E.M.F., but the mercury ion concentration diminishes somewhat rapidly in the presence of a large surface of mercury. A cell containing a small quantity of free acid with a grey depolariser (the grey colour being due to the presence of minute globules of mercury) appears to be the most constant form of cell.

[illegible] Standards.—Apart from the comparisons of the [illegible] with the N.P.L. resistance standards there has been no international comparison of wire resistance standards during the year. In Japan, the five mercury resistance standards made at the N.P.L. for the Electrotechnical Laboratory at Tokio have been compared with five mercury resistance tubes, the whole of the constants of which have been determined in Tokio. The mean difference between the N.P.L. resistance tubes and those of Japan is 8 parts in 1,000,000. This agreement is most satisfactory.

During the year four Weston cells were brought to Teddington from the Bureau of Weights and Measures at Petrograd. The mean E.M.F. of these agreed with the mean E.M.F. of the N.P.L. standard cells within 1 part in 100,000, but two of the cells showed slight hysteresis effects. A few N.P.L. cells have been forwarded to Petrograd, Washington and Tokio for comparison with standard cells at these places, but the results are not yet to hand. Comparisons with three cells from the Board of Trade have also been made, the agreement between these and the N.P.L. standard cells being within 15 microvolts. Very slight hysteresis effects were observed in these cells, which were made at the N.P.L. in 1911.

Magnetometer.—The new magnetometer, towards the cost of which Prof. Schuster generously gave £100, is practically complete.

Magnetographs.—The magnetographs for measuring the changes in H and D are described in the "Proceedings" of the Physical Society for August, 1914. The horizontal instensity instrument proved to be so sensitive to sudden small changes in H that an investigation, theoretical and experimental, was made of the instrument. The result was very gratifying, and clearly showed that changes as small as 0·1γ (one-millionth of the C.G.S. unit of magnetic intensity), lasting for one second, could not only be detected but evaluated.

In connection with the electrification of the London & South-Western Railway, an arrangement was made with the company to measure the variations in H and D on certain days during a period of six months. During this period 51 one-hour records of the changes in H and 51 one-hour records of the changes in D were made. In addition, eight records, each showing the variations in H over a period of approximately 24 hours, were made ; each of these latter records is over 30 ft. in length. The records show that the *sudden* changes in H due to earth currents produced by the local electric tramway system are in general of the order of 3γ. The *sudden* variations in the declination are of the order of 2′. There appears to be no particular connection between the state of the surface of the ground—*i.e.*, whether wet or dry—and the magnitude of the disturbances.

[illegible] A [illegible] with a wide range of self-[illegible] the [illegible] range is from 0·7 up to 6 millihenries, but by putting all the four coils in parallel a range of 45 to 380 microhenries is obtained. As the instrument is intended mainly for [illegible] The distributed capacity, even for the minimum inductance, is not excessive.

A series of experiments were made in collaboration with the Physikalisch-Technische Reichsanstalt. Two standard self-inductance coils [illegible] alternating current of 100 ∼ per second. The result was in agreement with former comparisons to within 1 part in 100,000. The P.T.R. coils were then compared against the inductometer, using (*a*) an equal arm bridge for the lower, and (*b*) a 5 : 1 ratio for the higher coil. Bridge (*a*) is, from its nature, more accurate than (*b*), as the nearly equal ratio arms can be interchanged to eliminate residual inductances and other inequalities. On the other hand, the inductometer reading in (*a*) was only about 5,000·0, while in (*b*) it was 10,000·0 ; thus the accuracy of reading was of the order of 1 in 50,000, and in 1 in 100,000 in the two cases respectively. The temperature coefficient of the inductometer is about +10 in 1,000,000 per degree C. As a very sensitive vibration galvanometer of low resistance was used, the sensitivity was greater than the accuracy of reading the scale, a difference of 1 in 1,000,000 giving an appreciable deflection. The frequency was in all cases 100 ∼ per second, and the currents carried by the coils (*a*) 0·1 ampere and (*b*) 0·06 ampere respectively. A number of observations were made on each coil at various temperatures ranging from 16°C. to 22°C. The coil of higher inductance gave results which were consistent among themselves : those obtained from the lower coil were slightly variable, but the experiments were insufficient to locate the cause. No variability or uncertainty could be detected in the inductometer.

Standard Mutual Inductance.—The dimensions of the primary standard of mutual inductance (L 191) were all carefully re-measured by Mr. Attwell in the Metrology Division, using the new measuring machines. The measurements were much more elaborate than the original ones made in 1908, and the probable accuracy is much greater. In order to allow the new measurements to be made, the paraffin wax which covered the windings was removed by repeated washing in petrol. The mutual inductance was very carefully measured against the secondary standard (inductometer) before the removal of the wax, and these measurements were repeated afterwards. To keep a check on the inductometer, at the same times tests were made on a very invariable pair of coils wound on one marble bobbin immersed in paraffin oil. The windings were of copper and aluminium wire, and the temperature coefficient of their mutual inductance was small and definite (about 7 in 1,000,000 per degree C.). These check tests showed that the inductometer behaved consistently. The primary standard showed a decrease of about 5 parts in 100,000 due to the removal of the paraffin. The measurements of the geometrical dimensions are fully discussed in the Report of the Metrology Division (p. 84). The value now found for the mean diameter is about 5 parts in 100,000 greater than that found in 1908 ; while the axial lengths are about 1 in 10,000 greater.

The calculations were repeated (by two methods) and included corrections for the conicality and for small periodic variation in the pitch. The apparent changes in the diameter and the axial length so compensate one another that the final value for the mutual inductance is $10{\cdot}0177_8$ millihenry, which is almost identical with the old value ($10{\cdot}0178_5$).

[illegible] Measurement of Large H.F. Frequency Currents.—It is comparatively easy to measure small currents (up to 0·1 or 0·2 ampere) at the high frequencies such as are used in wireless telegraphy. With currents of 1 to 10 amperes and upwards there is much more difficulty. Several methods of measuring such currents were investigated. As an intermediary instrument of comparison a thermopile with a separate heater of thin wire was immersed in paraffin oil, and this allowed the range of measurement to be extended with safety to 5 amperes. The use of air core current transformers, suggested several years ago by Mr. T. L. Eckersley, was found to give very accurate results up to frequencies as high as 2,000,000 ∼ per second (λ=150m.) when the damping of the oscillations is not excessive. Under the same conditions it was also found that small iron-cored transformers gave excellent results, the ratio of transformation being practically equal to the inverse ratio of the turns, when the thermal ammeter in the secondary circuit has reasonably low resistance. Current transformers of this kind are quite suitable for very large high-frequency currents.

Magnet Steel.—Progress has been made with the research on magnet steel which is being carried out for the Institution of Electrical Engineers. Test pieces have been turned from all the samples received, and complete chemical analyses have also been made. For the determination of the thermal magnetic change points, a special furnace has been set up with independent heating and magnetising coils. The magnetic condition of the rod is determined by means of a search coil (protected by a water jacket) connected to a ballistic galvanometer. The research is still in progress.

[illegible]

[illegible] The [illegible] realisation of the pentane unit of light in electric sub-standards is now complete, and the results are included in a Paper which was read in March before the Physical Society. The chief points of interest in this are the agreement of the unit so obtained with the original N.P.L. unit of candle-power to within less than 0·1 per cent., and the information afforded as to the corrections to the lamp for atmospheric [illegible]. Previously [illegible] it was found that the [illegible] of candle power which are usually ascribed to the humidity of the atmosphere may in part be due to [illegible] of the carbon. As, however, in practical photometry [illegible] low-[illegible] vacuum lamps which can readily be [illegible] to constant temperature, the usual method of [illegible] the results does not readily permit the two effects to be differentiated.

The work on sets of higher efficiency lamps, mentioned in previous reports, has now been [illegible] up to the [illegible] of 1·5 watts per candle. The results of these [illegible] determinations have been analysed, and [illegible] probable error of about 0·25 per cent. for the value of the unit

held in lamps which work at 1·5 watts per candle. The direct comparison between the fundamental set and that running at 1·5 watts per candle gave the same result as that by the cascade method within the error of the experiment. All these determinations were made with the Lummer-Brodhun photometer head. Attempts to make the same determination with a flicker photometer did not yield results of an accuracy comparable with that obtained with the Lummer-Brodhun photometer head, and were not, therefore, proceeded with.

All the sets of sub-standards (six in number) are now defined by the temperature at which their filaments operate. The group of lamps having light of the same colour as that from the pentane lamp operates at 1,610°C., whilst that running at 1·5 watts per candle (approximately) has an operating temperature of 2,300°C. Experiments are now in hand to continue the series by means of gas-filled standard lamps, up to an efficiency of 0·6 watts per candle.

The experimental work in this connection indicates that if in optical pyrometers identity of colour were made the criterion, instead of equality in the amount of light flux radiated from unit area, the black body temperature so determined would, in some cases at least, be much more nearly the true temperature than in determinations made by existing means. The method is shown to be correct for melting platinum radiating in the open, which departs greatly from the black body condition. The work has led to the formulation of the following expressions connecting the lumens per watt of carbon and tungsten lamps and the temperature of their filaments :—

$$\text{Log}_{10}\text{L W} = 21{\cdot}51 - 4{\cdot}58\log_{10}\text{T} - 185\log_{10}(\text{T} - 155\text{ T})$$
$$\text{Log}_{10}\text{L W} = 23{\cdot}31 - 5{\cdot}1\log_{10}\text{T} - 185\log_{10}(\text{T} - 155\text{ T})$$

Experiments were made at the same time to determine the colour of light from molten platinum, as bearing on the usefulness of the Violle standard of light for practical photometry. The colour of light from molten platinum was found to be identical with that from a carbon filament glow lamp operating at 4·75 watts per mean spherical candle, corresponding with about 3·8 watts per mean horizontal candle.

Measurements and investigations, &c., in connection with the Home Office Committee on Factory Lighting have again occupied much of the time and attention of the department.

Electrotechnics.—Two new water-tube resistances of 0·001 ohm to carry normally 2,000 amperes with an overload to 3,000 amperes have been completed and taken into regular use during the year ; also a set of three 0·04 ohm tubes for 500 amperes. These complete the standard resistances required at present for large currents, and it will be of little use extending the range and building resistances for 6,000 amperes until the transformer capacity for obtaining large currents has been increased. Some useful resistances have also been made up for currents up to 25 amperes, consisting of resistance wire wound on frames, with air cooling. The wire is silk covered and again silk wound into parallel twin wires, so rendering the inductance as low as possible. Each wire is arranged to carry 0·5 ampere, dropping 2 volts across the terminals. As many of these lengths as necessary are put in parallel to make up a resistance of the required magnitude. They will replace the resistances which have been used hitherto for smaller currents, and which consisted of a network of some 20 exceedingly fine bare manganin wires in parallel stretched between terminals and immersed in oil. The large cooling surface and low inductance of these left nothing to be desired, but with the very fine wire transmitting heat rapidly to the oil sufficient constancy could not be obtained, although every effort was made to protect the alloy with varnish. A gradual change has been taking place in the resistance values for several years, and it has, therefore, been decided to discard them for use in routine work, where the application of corrections is to be avoided wherever possible.

The new three-phase switch for operating the electrostatic wattmeter on three-phase circuits up to 20,000 volts has been in use throughout the year, and three-phase meters have been tested for accuracy with both their current and potential transformers. This represents a considerable step forward in assuring the highest possible overall accuracy of meters for large powers, and has also helped to accelerate the operation of testing them.

At present, for lack of suitable dividing resistances, it has not been possible to use this switch on circuits above 6,600 volts. Nor, in fact, have single-phase tests to the best accuracy been possible above 11,000 volts. For this reason resistances have now been put on order to increase the range of the highest precision tests up to about 40,000 volts, and at the same time to permit three-phase meters to be tested with their potential transformers up to 11,000 volts.

A number of tests have been made on the [illegible] to determine their rating. The principle followed in carrying out these tests is to ascertain the current which [illegible] voltages, and also the current which [illegible] Curves can then be drawn, connecting [illegible] Such curves show that a 50 per cent. increase [illegible] exacting than a 50 per cent. increase of current. In breaking a circuit with constantly increasing currents a point is reached when the arc is drawn out far enough to bridge the contacts. As a rule, when this point is reached, there is a marked increase in the [illegible] denotes more the character of a flame, and [illegible] will continue to break the circuit, however, beyond this point ; but in double pole cut-outs with the presence of a [illegible] is a source of danger, since short-circuits often occur through the agency of this flame ; generally, therefore, the point of flaring marks the maximum possible breaking current for such switches.

Heating of Buried Cables.—The research [illegible] in the test work and the decrease in the [illegible] during the year. The experimental work was commenced at Bristol, a series of tests extending over a period of three weeks being carried out on a number of cables, of size ranging from 0·1 sq. in. to 0·3 sq. in., laid direct in the ground. The supply was alternating current, and on one of the larger cables tests were made with frequencies of 50 and 93 cycles per second.

For the measurement of the resistance of the conductor a double bridge method was used, a small continuous current being superimposed on the alternating current by means of an accumulator connected in series with the secondary winding of the transformer. This method proved to be quite satisfactory, allowing of mean observations being taken, with the portable apparatus used, to an accuracy of 0·1 per cent.

Other tests were made at St. Marylebone with some 2 sq. in. machine feeder cables when carrying their normal load of from 2,000 to 2,400 amperes, and at Wolverhampton with two cables, one laid solid in bitumen and the other drawn into a duct.

Heat.—At the fifth general conference of weights and measures, held at Paris, October, 1913, certain resolutions were adopted, as the result of which the National Physical Laboratory adopted as its fundamental scale of temperature the Centigrade thermodynamic scale. In order to realise this scale conveniently with the highest accuracy the hydrogen thermometer is used between 0 deg. and 100 deg. The platinum thermometer is used for other temperatures. The temperature T on the international scale is deduced from the resistance of the platinum thermometer by the formula

$$T = t_{100} + \delta\left[\left(\frac{T}{100}\right)^2 - \frac{T}{100}\right]$$

where $t_{100} = 100 \cdot (R_t - R_0)/(R_{100} - R_0)$, R_0, R_t and R_{100} are the observed resistances of the thermometer at temperatures T, 0 and 100 deg. respectively. The platinum of which the thermometer is made shall be of such degree of purity that the value of δ in this equation shall not be greater than 1·52 and R_{100}/R_0 shall not be less than 1·386.

One of the features of the work on resistance thermometry during the year has been the installation of an equipment for use with platinum thermometers with potential leads. This type of thermometer has some advantages over the usual compensated Callender type, when employed at fixed temperatures, which can be maintained sufficiently steady to allow the necessary commutations to be made, since under these conditions the resistance of the leads is totally eliminated. A study is in progress concerning the influence of constructional details on the indications of thermometers of various types.

The Laboratory has repeatedly been asked to determine coefficients of expansion of metals and alloys up to high temperatures. For this purpose a simple apparatus (shown in detail in the Report) was devised last year by Dr. Harker for use up to a maximum temperature of about 800 deg. with specimens consisting of metal rods up to 15 mm. diameter and 50 cm. long. It consists of a closed quartz tube about 84 cm. long, with re-entrant lower end. The specimen to be tested, of total length 50 cm., is turned down at each end for 20 mm. and carries graphite collars closely fitting the narrower portions. A second quartz tube with closed ends rests on the upper end of the specimen and slides freely in the larger tube. Measurements are made by a micrometer at one end, and vapour baths are used for heating. The apparatus was used during the year for the determination of the expansion of some bars made of alloys used by a firm manufacturing boiler fittings. The results obtained for these materials showed in each case that the coefficient of expansion over the range 0°C.—500°C. is very appreciably greater than the value between 0 C and 50 C.

The British Portland Cement Co. submitted to the Laboratory some considerations relating to the thermal balance-sheet of cement kilns, and the work involved a certain amount of investigation as to the general question of the loss of heat from hot surfaces and its prevention by thermal insulators or other means.

One of the first points to be investigated was the variation of heat loss with character and colour of a surface. The effect of various paints and other coatings on the total emissivity was first investigated, particularly with a view to the possibility of diminishing appreciably by some sufficiently cheap process the radiation from a surface whose emissivity was nearly that of a black body. As all methods of imparting to the metal a smooth and bright reflecting surface were impracticable by reason of cost, a study was made of the different processes for metallising the surface by application of metallic paint or by the new spray process.

As instances of the nature of the results obtained, may be mentioned first, that over the range of temperatures met with in steam engineering the true radiation loss, this fraction dependent on the nature of the surface, is approximately half the total loss in pipes of ordinary iron under the usual conditions, and, secondly, that the true radiation from an iron surface may be diminished to one-half of its normal amount by suitable application of a coating of aluminium paint, and even to a less fraction by [illegible] application to engineering problems. Thus, for example, the useful radiant heat reaching the centre of a room from radiators round the walls is diminished to one half of its proper value by the addition of the customary coating of aluminium paint [illegible] the "efficiency" of the [illegible]

On the other hand, the application of metallic paint to the unlagged [illegible] battleship, should materially increase the comfort of the stokers working in confined spaces, since it would diminish to half value the true radiation, which is uninfluenced by any amount of artificial ventilation.

Thermal Conductivity of Refractory Materials.—An investigation was carried out on the thermal conductivity of some [illegible] and some

in thickness from 1 in. to 3 in. Experiments over different ranges up to a maximum temperature of 1,400°C. showed that with some materials there is a large increase in the conductivity with temperature, and that, therefore, if values of the conductivity determined at low ranges are extrapolated to high temperatures the results obtained may be greatly in error. As refractories are used in the industries at temperatures up to 1,600°C. or 1,800°C., it is desirable that direct determinations of their thermal conductivity should be made at much higher temperatures than has hitherto been the practice.

ON AN UNBROKEN ALTERNATING CURRENT FOR CABLE TELEGRAPHY.*

[author block illegible]

[illegible] system of submarine cable telegraphy [illegible] to flow continuously through the cable. The signals are made by varying the amplitude, the variation in the impedance being made at the moment when the current is zero, with the result that the pure sine character of the wave is maintained.

[illegible] to propose a new angle of view in the method of [illegible] signals in the submarine telegraph cable, and to [illegible] operating on the general principles [illegible]. Experiments have been conducted during the past [illegible] Messrs. Muirhead & Co. (Ltd.) with a view of determining the practical application of the sine-wave type of E.M.F. to cable signalling. The results thus far obtained have only been made possible through the wide range of experience and practice which this distinguished firm of cable engineers have been able to bring to bear on the subject, and they have taken a leading part throughout the experiments carried out.

An Ocean Cable Considered as a Power Line.

If an engineer were required to design a system for operating an [illegible] through an Atlantic cable, no form of generator could

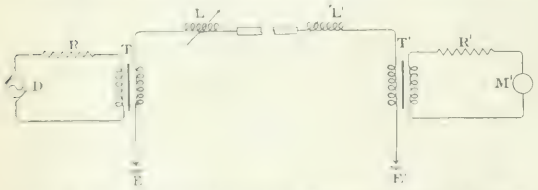


Fig. 1.—[illegible] Ocean Cable considered as a Power Line.

[illegible] that a single-phase alternating current of the sine-wave type. This form, we know, will deliver power at the receiving end of the cable more efficiently than any other shape of wave. Furthermore, during the operation of such a motor, the [illegible] would be efficient to use reversals, and, in particular, the generator circuit would never be metallically opened or closed during operation.

[illegible] really at present [illegible] experiments were made using the Muirhead automatic [illegible] transmitters with various modifications of the sine wave of E.M.F.

In the last analysis it was always the opening and closing of the [illegible] part in the [illegible]. [illegible] be remembered that, from a [illegible] more severe [illegible]. It was found after many variations of the simple alternating current had been [illegible] the [illegible] of the [illegible] cable recorder, amplifier or relay is determine by experiment how near this solution may be retained in practice for the purpose of transmitting cable signals according to the present alphabet. In this plan it will be the continued experimental purpose to determine the minimum possible variations in such a system to enable the alternating current received to be interpreted into dots, dashes and spaces.

A siphon recorder placed in the receiving end of such a cable plant would trace on the recording slip an uninterrupted sine-wave of current which may be considered as the theoretically perfect form of siphon record always to be aimed at, although never to be actually attained in practical telegraphy.

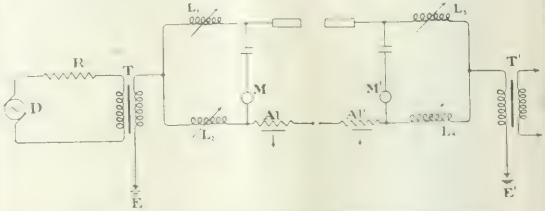


Fig. 2.—Duplex Circuit for Ocean Cable considered as a Power Line.

In Fig. 1, D represents a single-phase alternating-current dynamo, R and R′ are resistances and M′ is a motor to be operated.

Since a circuit comprising an ocean cable is largely overloaded with capacity, and already includes a large ohmic resistance, it will be in the direction of increasing the resultant harmonic current flowing in such a circuit, to insert in the sending end of the cable a variable inductance, L_1. For symmetry, L′ is a variable inductance similar to L_1. T and T′ are iron-cored transformers or auto-transformers, the coils of which are of low resistance, and connected directly to earth at E and E′. The circuits in Fig. 1 are closed circuits throughout.

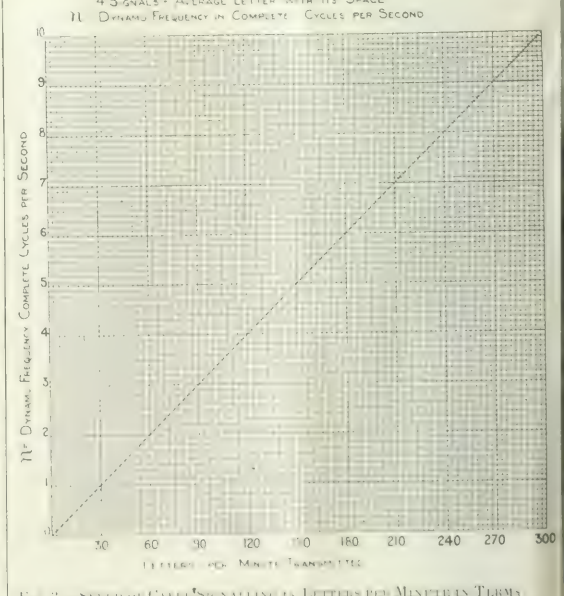


Fig. 3.—Speed of Cable Signalling in Letters per Minute in Terms of the Frequency of the Alternator.

For duplex working Fig. 1 becomes Fig. 2, in which L_1, L_2, L_3, L_4 are the inductance arms of the bridge, and the motors M and M′ are inserted in the usual manner for cable working. A and A′ are the artificial lines.

It now remains to inquire as to what modifications must be made in the typical duplex power circuit in Fig. 2 to enable the motor recorders to indicate the elements of the cable alphabet. These elements are three in number, and only three—*i.e.*, the dot, the dash and the space—and each of them is equally important in inter-

* [illegible]

preting the record, and for this reason they will each be considered in the general sense as signal units, rather than the usual way of regarding only the dots and dashes as the signals, and not the spaces.

It is also usual to speak of cable speeds in terms of standard letters per minute transmitted; but for our present purposes it will be more convenient to convert this speed into terms of the frequency of the dynamo. The graph (Fig. 3) exhibits the linear relation between n, the frequency of the dynamo, and letters per minute transmitted, based on the assumption that the average cable letter, with its space, requires four units of alphabet time.

Careful experiments on an Atlantic cable confirm the theory of the subject—that, no matter what the shape of the alternating current transmitted, approximate sine waves are received at the distant end

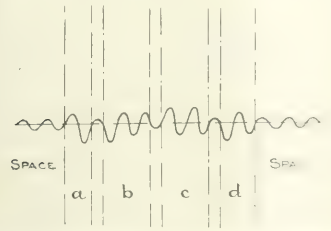


FIG. 4.—CURRENT WAVES FOR TRANSMITTING THE LETTERS *a*, *b*, *c* AND *d* BY THE ALTERNATING CURRENT.

of the cable. Battery reversals produce just as accurate sine-wave signals on the receiving recorder as does the alternator itself. In other words, it is the fundamental term of the Fourier analysis which is alone concerned in making the record at the receiving end of the cable.

Since, therefore, both theory and experiment show that a sine form of wave is the only one which can pass through the cable without changing its characteristic shape, it should be an advantage to so alter the typical power circuit in Fig. 2 as to preserve the sine characteristic as far as possible.

mental frequency of the current will not be changed, and the sine characteristic of the wave will be very approximately maintained. Varying the impedance of the primary circuit will change the amplitude of the individual alternations of the current.

Dots, dashes and spaces are each transmitted by impulses of either sign, differing from each other only in amplitude. Fig. 4 shows diagrammatically the form of current waves transmitted for the letters *a*, *b*, *c* and *d* with the accompanying spaces required.

Although an alternating current operated upon as above outlined could be read directly from a standard siphon record, yet it would be considered an advantage if the final received record could be printed in Morse characters on the usual receiver slip. To accomplish this it will be necessary to provide an apparatus which operates solely by the amplitude of the current waves received, and not by their sign. Furthermore, since the impulses transmitted and received for the spaces are not required on the printed slip, the apparatus should be capable of sorting out and omitting these parts of the record automatically.

DESCRIPTION OF CIRCUITS USED.

Fig. 5 shows diagrammatically one form of circuit arrangement based on the above principles for transmitting and receiving messages. The usual transmitting condensers are shown in the arms of the duplex bridge, instead of the inductances L_1, L_2, L_3, L_4. The ordinary transmitting tape is caused to move synchronously with the generator by being geared directly to its armature shaft. The perforations in the tape are of such a size that the tape advances a distance corresponding to one semi-cycle of the alternator for each individual perforation.

Since in a circuit comprising an ocean cable on which is impressed an alternating E.M.F. the current leads the E.M.F. by an angle which in an infinite cable is constant at 45 deg., it is necessary to provide in the transmitter, mechanism for moving the tape carriage longitudinally relative to the perforations in the tape. A micrometer screw is provided for this purpose, and by its use the current can be operated upon accurately at any angle of its phase, and in practice it is so adjusted that the impedance of the primary circuit will be changed at the instants of zero phase of the current. Since also the angle by which the current leads the E.M.F. is dependent upon the resistance of the primary circuit, there is also provided in

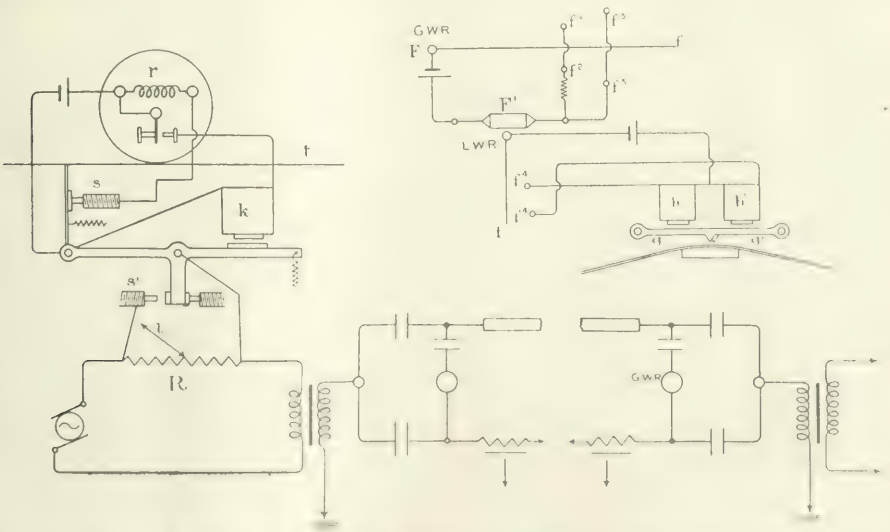


FIG. 5.—USUAL FORM OF DUPLEX CIRCUIT WITH [illegible]

This can be done in a simple manner by [illegible] circuit of the transmitter containing the [illegible] impedance of the circuit is synchronous [illegible] The problem is the more simple from the [illegible] because we are dealing with frequencies [illegible] per second, and, therefore, it is easy to operate [illegible] on this primary current at any angle of phase. If the changes of impedance of the primary circuit always take place [illegible] when the current flowing in the circuit is passing [illegible] the [illegible] additional [illegible] [illegible] circuit of [illegible] [illegible] operations on the primary current [illegible] are adjusted to take place at the zero point of current.

The general operation of the transmitter mechanism is as follows: When no holes are perforated in the tape *t*, the whole resistance R is in the primary circuit and an alternating current is transmitted, which corresponds to spaces between letters and words, and when a perforation in the tape is on its downside part of the resistance R is

short-circuited, and when a dash perforation occurs, all of this resistance is short-circuited. The relative values of these resistances being adjustable, the amplitude of the individual alternations are under complete control by the ordinary transmitting tape.

In the figure is shown diagrammatically the arrangement for causing a dash impulse to be sent by the transmitter by short-circuiting the whole of the resistance R for a time corresponding to one semi-cycle of the alternator: r is an ordinary relay, k is an electromagnet which operates at the end of each signal or group of signals. The line l leads to an exactly similar arrangement which is provided for the dot impulse by which a certain proportion of the resistance R is short-circuited. In practice these two arrangements are side by side, and in the figure the dot arrangement would be immediately behind the one shown for the dash.

One practical arrangement for receiving the signals on a Morse printer is shown diagrammatically in the lower part of the figure.

F is an adaptation of the well-known Muirhead gold-wire cable relay, in which f' is the gold wire which oscillates between the platinum contact posts f^3, f^3, about a fixed point at F. A second pair of posts f^2, f^2 is provided, and each of these pairs has an adjustment for altering their distance apart and also for moving them longitudinally along the gold wire and relatively to each other. Instead of being separate contacts, as in the usual case with this relay, each of the pairs are electrically connected as shown. F′ is a local wire relay of similar principle, and f is its moving part which in its oscillations makes contact with the posts f^4, f^4 adjustable as above; h and h' are electromagnets for operating the dot and dash arms of the printer; q and q' are two arms pivoted at their outer ends, adapted to make a siphon record at their free ends in the centre upon the moving tape shown beneath. The arm q' is forked to record two ink marks on the tape symmetrically on either side of the central mark made by the arm q, and in line with it across the tape, so that both arms can make a record simultaneously on the tape for a dash.

The incoming alternating current thus causes the gold wire f' to oscillate back and forth with different amplitudes depending upon whether dots, dashes or spaces are being received, and the posts f^2, f^2 are adjusted so that the space amplitude just does *not* make contact, but does make contact for a dot amplitude of either sign. In like manner the posts f^3, f^3 are adjusted so as just *not* to record a dot impulse, but to make contact for the larger amplitude of a dash of either sign. It is seen that both a dot and a dash contact are made whenever a dash amplitude is received. The flexible gold wire f' in its motions about F first strikes the posts f^2, f^2, and there is a bending or wrapping effect produced in the wire, which for the stronger dash impulses causes contacts with f^3, f^3 also. The relay F′ operates similarly through a moving arm, making contact with the posts f^4, f^4 separately or both together, depending upon the amplitude of its swing.

The printer itself becomes an apparatus of marked simplicity, and is nothing more than two small siphons adapted to mark on the slip in the usual manner.

One of the chief attractions in the use of an unbroken alternating current for operating the cable is the fact that for the first time we are enabled to measure the constants of the different elements of the bridge and cable circuits employed under actual signalling conditions. Since one particular frequency is used and the current is never broken, it is necessary and sufficient to use the ordinary commercial hot-wire ammeters and voltmeters which are now available over suitable ranges.

A calculation is given of the current (sine wave) through a definite cable. The transmitting impedance is most sensitive to change of frequency at the lower frequencies, and by increasing the speed from [illegible] to 9, or 270 letters per minute, the cable impedance is decreased in the ratio of 3 to 2, and the current correspondingly increased. The same values of impedance and current deduced above apply to the equivalent artificial line, which is [illegible]

By inserting a hot-wire ammeter in the cable itself beyond the bridge, and also connecting the transmitting end of the cable to [illegible] balance, we have the means at hand for determining the best transmitting conditions [illegible]. Heretofore the value of the transmitting condensers in the duplex arms [illegible]

[illegible]

flowing into the cable as measured by a hot-wire ammeter should be a maximum for any particular signalling frequency.

Submarine cables are at present operated by primary batteries giving an open-circuit voltage of from 50 to 80. The main reason for this is, of course, the constant fear of subjecting the cable itself to undue electrical strain, particularly in the deep sea portion, where repair is difficult and expensive. This is not the only reason, however, although it is the principal one.

The direct influence which increase of voltage of the alternating current produces on the amplitude of the record received as the frequency changes is shown in the graph (Fig. 6). These data were obtained over a submarine cable from New York City to Canso, Nova Scotia, of R=13,700 ohms, C=231·4 mfd., length = 880·6 nauts. The cable was used at the transmitting end simplex, without condensers, and at the receiving end the ordinary duplex arrangements were employed with 50 mf. condensers, and the cable recorder was adjusted once for all, and remained unchanged throughout the experiments. The receiving arrangements were not particularly sensitive, and the recorder was not readjusted as the frequency was increased. It will be observed that, within the limits of these experiments, the amplitude of the excursions of the siphon increased with the voltage for any particular frequency of the dynamo, and as the frequency was increased, the voltage remaining constant, the double amplitude of the siphon record gradually decreased. Theoretically,

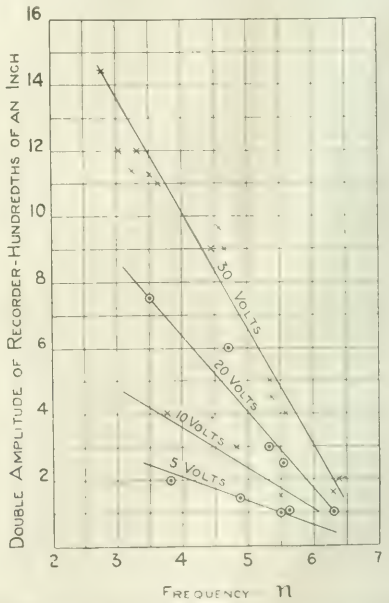


Fig. 6. Variation of Double Amplitude of Siphon Record with Change in Frequency, Voltage Constant.

these lines are curved lines, but for observations up to 30 volts, with but one adjustment of the recorder, the right lines in this figure best represent the actual observations at each voltage.

It is seen that these lines converge towards a common vanishing point at somewhere about $n=7$, which means that, with the limited sensibility of the particular recorder used (which may be considered as an ammeter if properly calibrated), we cannot expect by any increase of voltage to signal faster than about $n=7$ with this particular cable. Under present conditions this figure would be considerably higher.

Calculated figures are given showing the voltage stress on a cable. With a battery it is possible to subject every centimetre of the cable to the full voltage stress of the battery, as occurs whenever the usual insulation resistance test of the cable is made, or in case the transmitting condenser should be accidentally short-circuited. With the alternating-current dynamo, however, it is impossible either by accident or by design to produce in the cable in the deep sea portion any voltage, even momentarily, or more than a small fraction of the voltage used at the transmitting end.

In a long cable there is no reactive influence upon an ammeter or voltmeter placed in any circuit at the transmitting end due to any

variation in the form of apparatus inserted at the receiving end of the cable. Opening and closing the cable circuit produces no perceptible indication. The energy of the waves may be considered as leaving the transmitting end of the cable along the conductor path never to return.

We are, therefore, at liberty to consider the electrical conditions for best receiving, separately and independently of the conditions for sending, and then inquire how far these two sets of conditions can be made to harmonise with each other.

The alternator has been designed for the particular purpose of operating a cable, and possesses some novel features. Since we cannot reduce the number of poles to less than two, we must rely on a high magnetomotive force, and a minimum clearance for the armature to produce, at such low frequencies (4 to 10 cycles), the voltage required (100 volts or more). In addition, it is especially desirable to generate an accurate sine wave of E.M.F. These objects have been satisfactorily obtained in the design of the machine used in these experiments. The resistance of each of the field coils is nearly 1,000 ohms, and the inductance of the armature largely controls the current in the armature circuit, so that the machine can be short-circuited at full voltage without harm.

In starting and stopping the dynamo no form of switch is used, but, instead, the motor which operates the dynamo, starting from rest, gradually builds up the E.M.F. from zero, which gradually dies down to zero at stopping. In this manner there is never any possibility of a "break" in any metallic circuit connected with the transmitting apparatus.

Since the dynamo transmitter comprises the power plant for an ocean cable, it must, therefore, take its place on the instrument cable, where the transmitter is directly geared to it. The armature is mounted on ball bearings, and runs with remarkable silence and smoothness under load.

THE NORFOLK & WESTERN RAILWAY (U.S.A.).

The "Electric Railway Journal" gives a description of the electrification of the main line of the Norfolk and Western Railway from Bluefield to Vivian, which is about 30 miles. On this portion of the line the gradients are very heavy, and 60 per cent. of the line is on curves. The traffic consists mainly of the haulage of coal from the mines to the classification yard at Bluefield, which is very suitable for electric traction in that trains can be sent at uniform intervals, giving an even load on the system. Not only does electricity make for efficiency over the heavy grades, but less time is required to handle the trains, and the delays caused by taking in coal and water are avoided. Also the up-grade speed in the Elkhorn tunnel had to be reduced when working by steam to ensure adequate ventilation.

Where two heavy Mallet engines were used to haul a train over the whole division, with one extra as a pusher on the steep grades, only one electric locomotive is now necessary with another behind on the gradients. Also approximately twice the speed is obtained. The power plant is sufficient to send 20 loaded freight trains eastward over the division each day; but at present the daily total is about 12, while electric engines also assist the through passenger and goods trains on the heavy gradients.

The scheme was planned by Messrs. Gibbs & Hill, engineers for the railway company, and all construction, excepting the power house and repair shop, and some of the power-station equipment, was carried out by a specially organised railroad force under the supervision of the engineers.

Probably the most interesting of the many striking features of the installation is the Baldwin-Westinghouse, single-phase-three-phase locomotive. The traffic on the electric zone is handled by 12 of these machines, each consisting of two 135-ton units or halves so that the total locomotive weight is 270 tons.

In the case of the Norfolk & Western electrification the train weights are so great that it is obviously necessary to have part of the motive power at the rear in order to avoid excessive strain on the draft rigging of the cars. However, the trains are of such great length that there is difficulty in signalling from the locomotive at the head end of the train to the one at the rear, and thus the locomotives are subject to treatment which would be considered impossible in ordinary service. For example, it is not unusual for the rear locomotive to receive a signal to go ahead one full minute or even more before the head locomotive has come into action. In consequence, the rear locomotive will stand still during this period, although it is exerting full tractive effort in an endeavour to start the train. This condition arises most frequently when the rail is wet and permits slipping the drivers, or when the air brakes do not release promptly. Under such circumstances, the train must frequently be allowed to drop back a little and the attempt to start must be repeated. Also when a train on an up grade comes to a stop the head engine will shut off power and will apply the brakes while the rear engine keeps pushing the train until its tractive effort is exceeded by the bunching of the front cars.

Ordinarily, these requirements would involve exceedingly careful handling, but the locomotives have been designed especially to meet these severe conditions so that their manipulation does not even involve especial attention. The rugged construction of the three-phase induction motor, with its freedom from commutator troubles, together with the liquid rheostat that is installed on the locomotive, is of the greatest importance in meeting these conditions. The rheostat not only gives the smoothest possible gradation of tractive effort, but the latent heat of the steam that is generated within it makes possible the dissipation of an extraordinarily large amount of heat without difficulty. It may be said also that the inherent characteristics of the induction motor enable the locomotives automatically to hold the train at a constant speed without the use of brakes on descending grades by regenerating and returning power to the line. This is accomplished without additional or complicated apparatus. Conditions are such that full advantage of this form of braking can be secured, in that the trains are very heavy, the grades are severe, and the speed relatively high. In actual service the performance of this feature of the installation has proved to be highly satisfactory, the heaviest train being handled down the mountain grade by a single locomotive at a uniform speed of about 15 miles per hour with the air brakes held in reserve to bring the train to a standstill when desired.

Features of the Locomotives.

Each unit or half locomotive has two main trucks connected by a Mallet-type hinge, and each main truck has two driving axles included in a rigid wheel base with a radial, two-wheel, leading truck. The buffing and pulling strains are transmitted through the main truck frame and through a twin draft rigging mounted on the main truck at each end of the unit. The cab is of the box type, and is supported on the main truck entirely by spring cushion friction plates, and there is no weight on the centre pins, which serve only to maintain the cab in its proper position on the truck. An engineer's compartment is provided at one end of each unit, the two units being so coupled as to provide for operation from either end of the locomotive. Fig. 1 is an illustration of the locomotive.

Each locomotive has eight pairs of drivers connected in pairs by side rods to a jack shaft between the two wheels. Each jack shaft is driven by two motors geared to it so that the locomotive has eight traction motors. These are of the three-phase induction type with wound secondaries and with field-windings arranged for four-pole and for eight-pole operation. They are ventilated by forced draught, the air being supplied from the main ventilating duct which also delivers cooling air to the phase converter and to the cooling towers for the liquid rheostat. The arrangement of the motors is shown in Fig. 2.

Provision is made for two running speeds, respectively 14 and 28 miles per hour. When the locomotive is starting, resistance is inserted in the secondary circuit of the motors by means of the liquid rheostat, the amount of resistance being varied by hand at the controller. For the 14-miles-per-hour speed all motors are connected in parallel, and the eight-pole combination is set up for each one. For the 28-miles-per-hour speed the motors are also connected in parallel, but four of the poles of each motor are cut out, thus doubling the synchronous speed. The locomotives are equipped with the unit-switch type of control, and are arranged for the simultaneous operation of the two units from the control end of either one.

The single-phase current collected from the 11,000-volt line by the pantograph is fed through an oil-type circuit breaker to the main transformer. The phase-converter, which changes the single-phase current to the three-phase form, is connected to the low-tension side of this transformer, and it operates constantly when the engine is in service. To the extended shaft of the converter are coupled a ventilating blower for the motors and transformers and an air-compressor for the train brakes, the latter being connected through a clutch.

The phase converter is a single-phase induction motor with a short-circuited squirrel-cage rotor or secondary, and with two primary windings on the stator. One of these windings is connected across the secondary of a transformer, and when the rotor is running there is generated in the second winding an E.M.F. of 90 deg. phase displacement from that of the secondary of the stationary transformer. This device is quite new for railway work, and a brief explanation of the principle will be of interest. Suppose a two-phase induction motor to be run by current in one phase only. There will then be two secondary currents in the rotor, one due to trans-

former action and another, displaced 90 deg. from this, due to the cutting of the single-phase field by the rotor bars. These combine to produce a rotating magnetic field, and it is this field that generates in the second phase an E.M.F. in quadrature with that in the first. The diagram (Fig. 3) shows how this second phase has one end connected to the centre of the transformer secondary, and another to one terminal of the motor, the other two terminals being connected to the extremities of the transformer winding. Thus a T-connection is used to produce three-phase from two-phase current, a large part of the motor current coming direct from the main transformer. This avoids an over large phase converter.

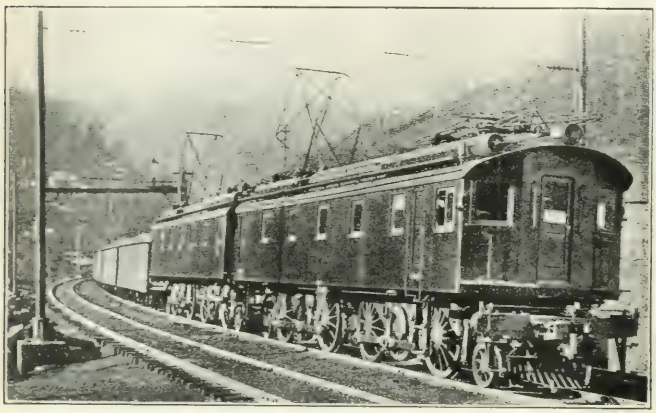


FIG. 1.—NORFOLK AND WESTERN ELECTRIC LOCOMOTIVE.

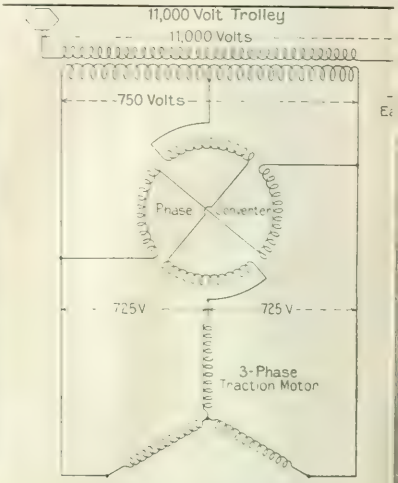


FIG. 3.—DIAGRAM SHOWING CONNECTIONS OF PHASE CONVERTER.

For starting the rotor a single-phase, series, commutator-type motor is mounted directly on the converter shaft. The converter is forced ventilated, having a connection at its centre to the main ventilating air duct of the unit.

Two pantographs are mounted on the roof of each half-locomotive. These are unique in that they have been arranged to be fitted, if necessary, with end horns which will automatically fold in when the pantograph is lowered by the tunnel trolley wire, and in this way the unusually wide sliding surface will accommodate itself to the restricted tunnel clearances.

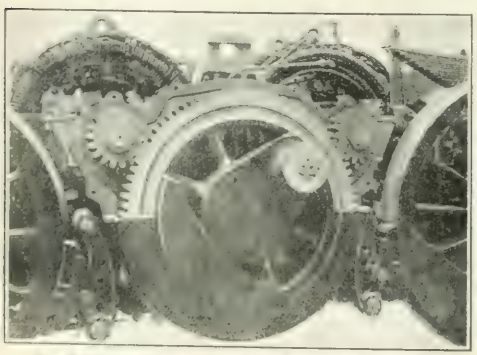


FIG. 2.—MAIN GEARS AND AXLE SHAFT OF LOCOMOTIVE.

There are four liquid rheostats on each half-locomotive, one for

and this is raised or lowered by an operating mechanism. There is also a motor-driven centrifugal circulating pump by which the liquid is continuously circulated to prevent excessive heating. This forces the liquid up through the bottom of the tank and over the top of the hollow plunger when the plunger is raised, and back through the inside of the plunger to the storage reservoir.

When the liquid is raised so as to submerge the lower ends of the plates, current may flow between the motor-connected plates and the adjacent ground-connected plates, the circuit between the three phases of the motor being thus established. The higher the liquid rises on the plates the lower the resistance becomes. When the plates are entirely submerged, the liquid going all the way up, the resistance is reduced to the minimum.

To keep the temperature of the circulating liquid as low as possible, a portion is by-passed through a cooling tower containing a series of trays so arranged that the liquid will flow over them in a thin sheet and be cooled by air from the main ventilating duct to which the towers are connected.

This main ventilating duct is supplied by a 36 in. Sirocco fan mounted on the shaft of the phase converter. It is built into the cab floor under the deck, and runs lengthwise through the cab, being arranged with openings at various points where connections are made to the traction motors, converters, cooling towers, &c. The general arrangement can be seen in the longitudinal section and plan (Figs. 4 and 5).

The locomotive has an overall length of 105 ft. 8 in. and a total weight of 270 tons. The driving wheels are 62 in. in diameter. The highest recorded draw bar pull is 180,000 lb.

POWER STATION.

The power station at Bluestone that supplies power to the locomotives is of the usual type, using steam boilers and turbines for the prime movers.

It is equipped with 10 Babcock & Wilcox Stirling-type boilers, each having 6,772 sq. ft. of heating surface. These operate at 200-lb. steam pressure with 150 deg. superheat. The main units are three 10,000-kw. Westinghouse double-flow reaction turbines operating at 1,500 revs. per min., and provision has been made for the future installation of a fourth unit. The generators are designed for 11,000 volts and 25-cycle current with a 24-hour rating of 10,000 kw. A five-minute overload capacity of 25 per cent. is provided, the ratings being based on 80 per cent. power factor. The fields are of the two-pole revolving type designed to operate under a temperature rise of 60° C., but they are capable of withstanding a temperature of 150° C. without injury.

The generator armatures are designed to withstand a temperature of 90° C. and are wound for three-phase current. Thermo-couples are embedded in the armatures, and these furnish continuous temperature records. Separate excitation is provided by two steam-driven units and one motor-driven unit, voltage regulation being effected by a Tirrill regulator.

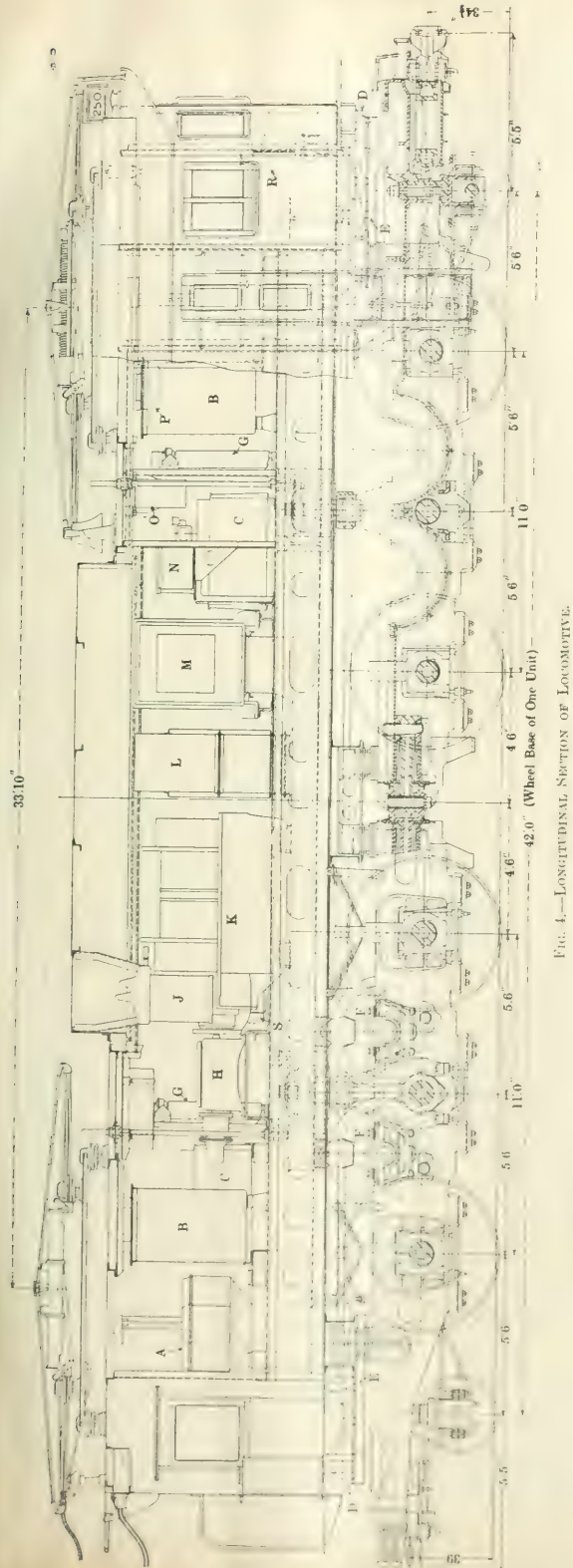


FIG. 4.—LONGITUDINAL SECTION OF LOCOMOTIVE.

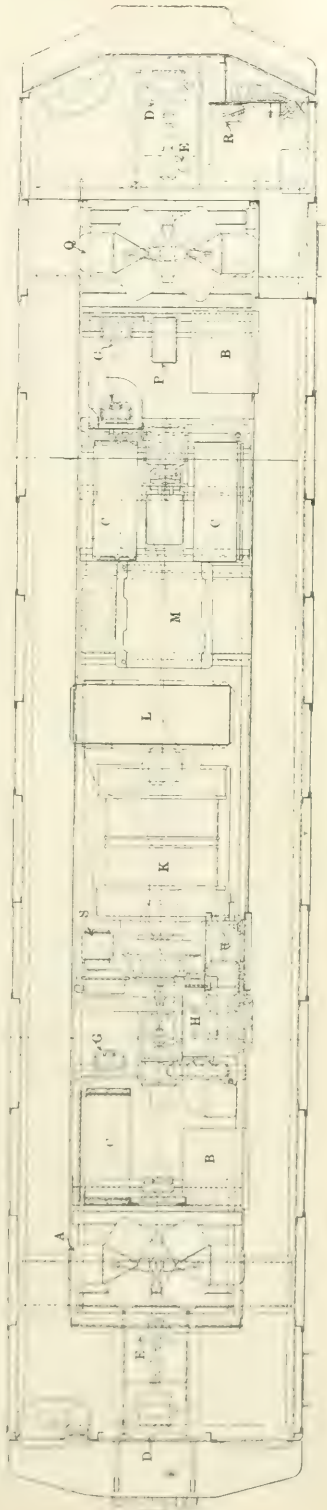


FIG. 5.—FLOOR PLAN SHOWING ARRANGEMENT OF EQUIPMENT.

D.—Reversing Switch.
H.—Auxiliary Transformer.
J.—Oil Circuit Breaker.
K.—Phase Converter.
L.—Blower.
M.—Transformer.
N.—Reverser.
O.—Line Switch.
P.—Control Changeover Switch.
Q.—Load Regulator.
R.—Motor Generator.
S.—Motor Generator Set.

Switching arrangements are provided in the usual operating galleries. The main 11,000-volt 'bus is sectionalised, and three-phase power for auxiliary purposes is taken from it. No brick or concrete 'bus compartments are used, the 'bus being of copper tube carried on insulators mounted on a pipe frame work. Copper tubing and bare wire are used wherever possible, insulated wire being installed only where conductors are carried in conduit, the Fibre Conduit Company's product being largely used for this purpose. The generator voltage of 11,000 for one of the phases is raised to 44,000 by step-up transformers, the 44,000-volt 'bus being sectionalised, and two high-tension feeders are taken from each side of this for feeding the sub-stations.

Excess regenerated power from locomotives on down grades that is returned to the power house passes through the 11,000-volt 'bus through the various transformers back to the generators if the generators are running under very light loads. If no other load should be provided the regenerated power would reverse the generators and operate them as motors, and to prevent this a loading device, consisting of electrodes immersed in the intake canal, is provided, this being controlled by suitable switches.

The operation of the switches is made automatic by means of a group of relays and magnetic switches, current transformers, &c., so connected as to give the following results: When the amount of excess regenerated power reaches, say, 300 k.v.a., the closing relays throw in one water rheostat on the 11,000-volt 'bus. As soon as the regenerated power exceeds the capacity of one water rheostat by 300 k.v.a. another closing relay throws in the second water rheostat on the 11,000-volt 'bus. The difference between the amount of excess regenerated power and the capacity of the water rheostats in service is made up by the generator.

When the excess regenerated power has become reduced to zero with one rheostat in service and all of the rheostat load is supplied by the generators, one of the tripping relays trips the circuit breakers and this cuts the rheostat off from the 11,000-volt 'bus. With two rheostats in service when the excess regenerated power drops to 2,000 k.v.a. one of the relays opens the breaker which was closed first and cuts one rheostat out of service, the other rheostat remaining in until the excess regenerated power drops to zero, when this, too, is cut out of service.

The water rheostats are located outside of the transformer house at the power station. Each consists of a steel cone carrying a lead from the circuit breakers and a 6-in. iron plate located at the bottom of the intake canal and grounded to a copper plate embedded in the earth outside of the canal. The power-dissipating capacity is adjusted by varying the distance between the cone and the iron plate.

High-tension power is transmitted at 44,000 volts, 25 cycles, single phase. The wires are carried on catenary supports except in the tunnels, where the line goes above ground over the summit. There are two single-phase lines, each of which consists of four No. 00, seven-strand, hard-drawn copper wire. A $\frac{3}{8}$-in. steel ground wire is carried on the poles for the length of the line.

The high-tension insulators are of the four-petticoat, pin type, with a maximum diameter of 12 in., and these are tested at 165,000 volts and at 120,000 volts respectively for dry and wet flashover.

All power for trains is obtained from transformers which step-down the voltage from 44,000 volts to 11,000 volts. These are located at five points on the line and are housed in suitable buildings except at West Vivian, where the apparatus is only temporary and of the out-door type and unhoused.

No attendants are required in the substations because the oil circuit breakers are remotely controlled from adjacent signal towers or passenger stations or from yard masters' offices.

The total capacity of all substations is 28,000 k.v.a. All of the transformer units are of the Westinghouse, single-phase, oil-insulated, waterproof type, the water for cooling being taken from the company's pipe line.

In the distribution system no supplementary feeders are required as the power supply is effected entirely by means of the contact lines. For supporting these two distinct types of structures are used. The [illegible] line has wires suspended from overhead beams, and the other, which is used only in the yards, has an overhead cross catenary cable to support the longitudinal catenary wires for the [illegible]

The [illegible] supporting structures are about 300 ft. apart on [illegible] and [illegible] on curves.

Reinforced concrete foundations are used in all cases and a proper [illegible] is made underneath one of the two foundations for each [illegible]

In the case of the catenary carrying structure consisting of two or more high-tension steel poles, the guy or tail supporting from the tops of which a cross-catenary cable of extra high tension, galvanised, steel stranded cable runs across the tracks to support the longitudinal catenaries.

The catenary system is designed to hold a No. 000 grooved, phono-electric contact wire at a uniform height of 24 ft. above the top of the rails in such a location that it will not vary horizontally more than 12 in. from the centre of the track, allowing for super-elevation. Above the contact wire is a horizontal auxiliary messenger wire, and above this is the main messenger wire that supports both of the other wires. In this section of the country the temperature ranges from about 110°F. to minus 10°F., and this changes the stresses in the wires from almost zero to approximately the elastic limit.

Spaced at 30 ft. intervals along the messenger wire are bent-strap clips which hold the hanger straps. To the bottom of each hanger is bolted a pair of malleable iron trolley clips which, however, on tangent track do not grip the contact wire, but hold only the auxiliary messenger wire. This auxiliary messenger wire is a No. 0 round copper or steel wire, depending on whether the load conditions require the added carrying capacity of copper over steel. The various wires required for the overhead construction were furnished by the Bridgeport Brass Co., the Standard Underground Cable Co., and the John Roebling's Sons Co.

From the auxiliary messenger wire the No. 000 grooved contact wire is supported by a pair of clips bolted together and spaced 15 ft. apart. These are so spaced, however, that they are equi-distant from the hangers holding up the auxiliary messenger wire, and the result is an extremely flexible and smooth-running trolley.

Steady strands are used on long tangent stretches, sectionalised between tracks by an impregnated, wood-stick insulator 4 ft. long.

At the section breaks which are provided to permit isolation of parts of the line for repairs, but which are normally connected through electrically, specially-designed disconnecting switches are mounted on top of the wood insulators. These can be opened or closed by means of a long impregnated wooden switch-stick.

At certain locations the catenary system is anchored longitudinally, or dead-ended, by being solidly attached to the cross girders of special structural bridges provided to limit the zone of trouble should a wreck or unforeseen accident break a messenger wire. The normal messenger-wire support at the bottoms of the strings of insulators is so designed that in general the messenger wire will slip through. Hence, should a messenger break between anchors it is expected that it will slip through several supports adjacent to the break and distribute the abnormal strain over several bridges instead of concentrating the load on the structures at either side of the break.

On curved tracks the hangers from the messenger wire are 15 ft. apart and the clips at the bottom hold both the auxiliary messenger and the contact wire. This is essential to keep the contact wire and the auxiliary messenger wire in a vertical plane. The holding of both wires by the same clip at the end of the hanger, however, does not result in hard spots in the trolleys. Since all such hangers lie on angles to the horizontal, the whole system is sufficiently free to move vertically under a slight upward pressure of the pantograph, and this assures smooth riding.

To avoid an uneconomically close spacing of structures on sharp curves pull-out poles are used in some cases between bridges.

In the yards the catenary system is, of course, very similar to that on the main line except that only two of the suspension-type insulators are used between live wires and grounded structures. The auxiliary messenger wire is omitted, and the clips at the ends of the hanger straps hold the contact wire in tangent as well as in curve construction. This, of course, makes the contact wire in tangent yard construction less flexible than where the auxiliary messenger is used, but it gives quite satisfactory results when the speed is low.

In the Elkhorn tunnel special catenary construction was necessary, and after experiments in a sample metal-lined tunnel where high voltages were submitted to the smoke and steam from a locomotive, the arrangement finally adopted was to have a supporting structure every 75 ft., the structure consisting of two cast-iron brackets on each side of the tunnel held to the brick lining by large bronze expansion bolts. Each bracket carries a 44,000-volt, transmission-line insulator. Supported by the pair of insulators on each side of the tunnel is a 2-in. brass pipe parallel to the tracks, and mounted on this piece of pipe is another line insulator upon which rests a cross pipe that is bent to follow the arch of the tunnel. The cross pipe is used as a support for the bronze messenger wire. All line catenary parts have, therefore, double insulation to ground. Notwithstanding the necessarily limited clearance, the overhead construction in this tunnel stood a test of three times the normal trolley voltage.

A special type of track bond had been designed for this installation, the construction permitting it to be installed by removing only one bolt in the fish-plate. These track bonds, together with the impedance bonds installed for the signal system, were furnished by the Ohio Brass Co., the Electric Service Supplies Co. and the American Steel & Wire Company.

To provide against the effect of induction in telegraph wires it was decided to place the transformer sub-stations somewhat closer together than would have been required by considerations of voltage regulation and losses and to place the end sub-stations near the ends of the line. This has resulted in feeding each important or long section of trolley from both ends, and in consequence the current fed to the trains in a section between sub-stations goes in both directions in the trolley and track circuits, the induced voltage in parallel telephone and telegraph lines being thus largely localised and neutralised. In addition, however, in order to provide for such disturbances when one sub-station might be out of service, as well as for the excessively high currents which occur in cases of short circuits and grounds, it was decided to install the so-called "track-transformers," or boosters, in both trolley and track circuits at intervals of about 1 mile.

The track transformers are series transformers having the primary windings connected in series with the trolley and the secondary connected in series with the tracks at the middle points of the impedance bonds which are required at each signal location. These booster transformers are mounted on signal bridges, the track connections being carefully worked out so as not to interfere with the functioning of the signals. They cause the return current, of which a considerable amount would ordinarily leak through the ground, to flow in the track rails so that it is kept at a fixed distance from the trolley wire and the telephone and telegraph wires. The rails and the trolley wire occupy approximately symmetrical positions with relation to the telephone and telegraph circuits, and as the current is flowing in opposite directions in trolley and in track the effect is largely to neutralise the exterior inductive effect.

There are two sets of coils wound on the core of each transformer, one for the eastbound and the other for the westbound track. Hence only one transformer is required at each point. Since this arrangement has been in service it has been found that the telephone and telegraph service is not interferred with in any way by the operation of the electric trains.

A great deal of attention has been given to the provision of adequate facilities for the inspection and maintenance of all parts of the installation. The natural headquarters of the electric zone is at Bluestone, where the power house was necessarily located on account of the water supply, and it was decided to locate the inspection building and machine shop for maintenance of electric locomotives at that point. The line maintenance force is also located at Bluestone, and is in constant touch with all parts of the electrified section by means of a patrol telephone line having telephones placed at signal bridges in addition to the usual telephone facilities. Thus the general foreman and the foremen of all departments of the electrical maintenance work are located at one central point and provided with means by which constant connection is maintained with all points, including train despatchers, yard masters, and the superintendent and other division heads.

The locomotive inspection building is designed primarily for the electric locomotives, but the machine shop provided in connection therewith also serves the power plant, and thus the necessity of installing machine shop facilities in the power station is avoided.

A brick building at Bluestone, formerly used as a pumping station for locomotive water supply, is used as headquarters for the line inspection and maintenance force. On a near-by siding is stationed an emergency repair train, consisting of a tower car, tool car and flat car, which is constantly held in readiness for heavy emergency repairs.

Wherever possible repairs are made from the overhead bridges or from ladders. In order to avoid interruption to electric service to the greatest extent possible, specially treated and impregnated wooden ladders are provided and these can be used for light repairs to trolley fingers, clips, and other details on the 11,000-volt catenary system while it is alive.

The patrol telephone line is installed over the entire length of the electrified section and it has telephones in locked boxes at certain signal bridges spaced about 1 mile apart. This patrol line is connected with the power house and it is valuable for use in reporting either line or locomotive troubles.

Through the telephone operator located at the power house communication can be established with the train despatcher and other officials. The power director is located at the switchboard in the power station, and he is also in constant telephone communication with the signal power operators, passenger station agents, yard masters, and others who are responsible for manipulation of switches in the sub-stations or along the line. By means of these facilities power can be switched off or on quickly whenever necessary, or the line may be sectioned and service restored in part after interruptions.

THE WINDING OF FLAT RINGS.*

BY H. CHIREIX.

We shall suppose in the following discussion that the flat rings have a rectangular section, that there is only one layer of winding, and that the permeability of the medium is unity. The formulæ can easily be modified for cases where the conditions are different. Let us take a flat ring of external diameter D, of internal diameter d, and of height b. Let us call its self-induction L, and the number of turns n. The flux then is given by the equation

$$\frac{Li}{n} = \int_{\frac{d}{2}}^{\frac{D}{2}} b\,\mathrm{H}\,dx,$$

where i is the current, and H is the magnetic field given by the equation

$$2\pi \mathrm{H}x = 4\pi n i.$$

Therefore we get

$$\frac{Li}{n} = \int_{\frac{d}{2}}^{\frac{D}{2}} 2bni\frac{dx}{x},$$

or

$$\mathrm{L} = 2bn^2 \log_e \frac{\mathrm{D}}{d}.$$

Let us now suppose that we get a flat ring by winding n_1 turns per unit length on the inside face. Then $n_1 = \frac{n}{\pi d}$, and the self-induction is given by the equation

$$\mathrm{L} = 2l\pi^2 n_1^2 \left(d^2 \log_e \frac{\mathrm{D}}{d}\right).$$

This quantity passes through a maximum for a certain value of the ratio D/d. By differentiating, we find that this maximum occurs when $d = 0{\cdot}6\mathrm{D}$. The self-induction of the ring in this case is given by the equation $\mathrm{L} = bn^2$.

It is now possible to consider the case where there is a second concentric ring inside the first; this arrangement is quite simple in as far as the calculations are concerned. In order to obtain the maximum self-induction, we will suppose the internal diameter of the second ring to be 0·6 times that of the first. It then becomes necessary to find the new value of D/d so as to get the maximum self-induction for the whole.

We therefore have

$$\mathrm{L} = \pi^2 n_1^2 b \left(2d^2 \log_e \frac{\mathrm{D}}{d} + 0{\cdot}36\,d^2\right)$$

or

$$\mathrm{L} = \pi^2 n_1^2 b \left(2d^2 \log_e \frac{1{\cdot}2\,\mathrm{D}}{d}\right).$$

In order to make this a maximum, we have

$$2\log_e \frac{1{\cdot}2\,\mathrm{D}}{d} = 1, \quad d = 0{\cdot}72\,\mathrm{D}.$$

The induction is given, as before, by the equations

$$\mathrm{L} = \pi^2 n_1^2 d^2 b$$
$$\mathrm{L} = bn^2;$$

but in this case, d and n have higher values. The new inductance is to the old in the ratio of 1·44 to 1, and the internal diameters of the rings are respectively 0·72D, and 0·43D. In a similar manner it is possible to consider the case of three concentric rings. By similar calculations it can be shown that $d = 0{\cdot}785\mathrm{D}$ for the maximum self-induction in this case. The respective internal diameters of the rings are then 0·785D, 0·56D, and 0·335D. The total self-induction is then 1·7 times that of a single ring. In the case of four rings, the diameters are 0·825D, 0·65D, 0·46D and 0·275D; the self-induction being 1·9 times that of a single ring. For five rings, the internal diameters are 0·85D, 0·71D, 0·55D, 0·39D and 0·25D.

Let us take a numerical example, and suppose n to be 200, b to be 10 cm., and the self-induction to be 0·0004 henry. Let us suppose that 10 turns of wire can be wound in a centimetre, and let us have five concentric rings. Thus the internal diameters will be 64, 52·5, 41·5, 29·5 and 17·4 mm. respectively. We thus have a variable self-induction, capable of having five values, and wound very compactly; any portion not utilised is without effect on the rest, and it is entirely free from any external influence.

* Abstract of an article in "La Lumiere Electrique."

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THE ENLISTMENT OF LABOUR.

We are sure that all who realise that this country is at present engaged in a life and death struggle will welcome the steps that the Government is now taking to enlist labour, so that the output of munitions of war shall be sufficient to meet the needs of ourselves and our Allies. The present struggle demands sacrifices of a kind to which we are unaccustomed, but we must be prepared to make them, and to make them cheerfully. For the moment these sacrifices are to be made voluntarily, and, in our opinion, this has the advantage that voluntary work is always better than that which is compulsory. We therefore trust sincerely that the effort which is being made to obtain the required services by voluntary means will be successful.

The position has now been rendered clear by the publication of the Munitions Bill. This measure seeks to overcome certain obstacles which hitherto have proved insurmountable. One of the principal difficulties has been the limitation of output by means of Trade Union rules. Whatever opinions may be held about such rules, it must be admitted that the present moment is far too serious for them to be allowed to endanger the safety of this country. On the other hand, we quite sympathise with the feelings of the workman who is unwilling to exert unusual efforts merely to enrich his employer. We have always been in favour of the limitation of profits during a time like the present, because, in our opinion, large profits should not be made through sacrifices of the community, and we are glad to see that the Government is adopting a step of this kind. Nevertheless, it will be necessary to take a broad view of what profits really mean; they are often misunderstood. In order to increase his output largely, a manufacturer may find it necessary to put down a considerable amount of new plant which may be of little use to him after the end of the war. It is necessary then that his profits should enable him to wipe off this capital expenditure as well as to provide a fair dividend on the rest of his capital. In some cases the figure of profit so obtained might seem to be high, but in reality it is nothing more than is reasonable. The basis on which profits are to be allowed, according to the Bill, seems rather

too rigid, but we gather that there will be a certain elasticity which we hope will meet the conditions to which we have referred.

Having secured the limitation of profits there is no reason why the Trade Unions should not relax their rules, provided always that their position is not prejudiced when normal conditions return. We are glad to see that the unions have realised the position. The only rules that may now give rise to trouble are those to which Mr. LLOYD GEORGE refers as being "unwritten." We hope that all such rules, whether written or unwritten, will be relaxed loyally by the workmen at the present time of national necessity.

We believe that the increase in output due to relaxation of rules is really more important than the provision of additional labour, although this also may be very necessary. We trust, however, that the method now being followed by the Government will not lead to serious dislocation in certain directions. As far as we can judge there seems to be no discrimination as to where the industrial volunteer is at present working, yet it is most important that certain branches of industry, among which must be included the public utilities in all their forms, should not be disorganised beyond a certain point. Undoubtedly, the manufacture of munitions must come first, but some regard must be paid to the maintenance of our exports, and to the resumption of our home industries later on with a minimum of loss.

There seems to be a tendency for the layman to speak as if munitions can be turned out quite easily from any works, however small, and of whatever character. We need scarcely say that this is certainly not the case. Some of the work that is required is of the highest accuracy. It is by no means every engineering works that is capable of turning out this class of work, and if it is scattered over numerous small factories there is the further difficulty of inspection. It appears to us that the Government would be better advised in many cases to commandeer plant from the smaller works and to collect it together into one large works which might very well be temporary in its construction; the effect would be to centralise production in larger works, and thus to have it carried out far more efficiently than is possible by means of numerous small works in a large area, such as London. By so doing it appears to us that there would be greater efficiency all round; and efficiency means not merely lower cost but less time, which is quite as vital.

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1. **Small Power Wireless Installations.** By MARCUS CHOD. Pp. 123. (London: P. Marshall & Co.) 1s. net.

2. **The Elementary Principles of Wireless Telegraphy.** By R. D. BANGAY. Pp. viii. 160. (London: The Marconi Press Agency.) 1s. net.

Wireless telegraphy is peculiar amongst what may be called the hobby-ridden arts in that, while its true theory and its best practice are especially difficult of attainment, some sort of results reward the amateur equipped with only the crudest apparatus and the vaguest notion of "how it works." To get the best is very hard; to be "in daily communication with the Eiffel Tower and other stations" is extraordinarily easy, requiring only a modicum of apparatus and the licence of His Majesty's most tolerant Postmaster-General. Thus it is that in this country there is a large body of wireless experimenters, nominally students of a subject demanding the closest study and the ablest teaching, who are in fact burning enthusiasts, but who are ignorant to a degree. These form a voracious public for any popularly written and low-priced treatise purporting to explain in intelligible terms the mysteries of wireless.

1. The former of the two works under review may well be a tempting little volume to the amateur of the schoolboy class. It contains 12 chapters with titles which are sure to attract the novice who has already run against difficulties. He has heard conflicting opinions as to the nature and value of resonance: Chapter IV., on "Tuning or Resonance," should clear his confusion. He has serious doubts as to his earth connection: then he must read Chapter XII., on "Aerials and Earths." Or he has tried in vain to construct a point for an electrolytic detector: Chapter VII., on "The Electrolytic and other Receivers," is there to help him. Moreover, the book is well printed on good paper and the diagrams are numerous.

Unfortunately, the schoolboy we have imagined is just the person who requires sound instruction if he is to attain to those fundamental ideas which alone can guide him through the maze of weird phenomena he will encounter, if his interest and his pocket money hold out. And this book is not one which could lead anyone to clear thinking. The author appears neither to have himself the requisite understanding of the point he wishes to make, nor has he the ability to put it into plain English. The wording is painfully loose and even ungrammatical. "Radio-telegraphy is the art of projecting through space waves of ether of predetermined duration" (p. 1) is an introductory definition. "Each wave train radiated from an aerial represents a very large amount of energy in proportion to the amount used for its production" (p. 46). "As to how far the loosening can be carried out will depend on the transmitting station, which, if well tuned, will cause an increase in strength when the receiving circuits are loosely coupled than when tight" (p. 66). A wise father would remove a book containing many such sentences as these from the hands of his son.

There is no indication that the author has given any thought to the order of treatment of his subjects. Chapters I. and III. deal with transmitting apparatus, II. and VI. with receiving apparatus, while IV. and V. deal with "tuning or resonance" and "coupling." In Chapter IX., entitled "Tuning," one might expect a postscript to Chapter IV. on "Tuning or Resonance"; the practical construction of tuning apparatus is, however, the actual subject.

If the author were less vague it is likely that he would be more inaccurate. There are, nevertheless, several rather palpable errors. The capacity of a typical antenna is given on p. 13 as of the order of $\frac{1}{1000}$ mfd., and is referred to later (p. 24) as $\frac{1}{100}$. On p. 18 it is implied that the specific gravity of condenser oil is $1\frac{1}{4}$; 2 would be nearer the fact. The author is surely mistaken in asserting (p. 68) that "without doubt the Marconi nickel-silver coherer is by far the most sensitive detector devised." The electrolytic receiver whose connections are shown in Fig. 23 would not work, the dectector being short-circuited for high-frequency currents. The same mistake is made with a carborundum detector in Fig. 27.

On p. 72 is a rough tabular statement of the relative properties of a number of detectors. There are columns for "sensitiveness," "reliability," and "how affected by transmitter." The table is likely to be helpful, and we do not remember to have seen a similar collected statement elsewhere.

2. The second book under notice is addressed to a similar class of reader. The author states in his preface that "It has been his aim to make the subject intelligible to persons who do not possess much technical knowledge, and to be at the same time brief and accurate." He has in the main been successful. Words are carefully chosen, and statements are at once concise

and accurate. The book may be read by a student who is too far advanced to learn much from this elementary treatise, with a distinct intellectual appreciation of the way in which the author handles his subject. The writer is conscious all the while that he is writing down to his readers' level, but just because he is capable of offering stronger meat his food for babes is healthy and nourishing.

The first 30 pages are devoted to an introduction to the science of electricity in general. The treatment is so extremely condensed that we doubt whether any useful purpose is served, and it is here, perhaps, that the author is at his weakest. There are several inaccuracies, and the analogy between a condenser, which in the normal condition holds no charge, and a football bladder, which "will normally hold a definite quantity of water," is not of the best.

In the next 30 pages the principles of wave motion are outlined with reference, first, to mechanical and then to electrical systems. The various forms of ether waves, from "X"-rays of 2·5 millionths of an inch to "electric" rays of 30,000 ft. in wave-length are mentioned. On p. 74 a diversion is made from the discussion of principles and methods, and the construction of an induction coil is described. This seems to be a little out of place, but the author perhaps thought it well to clarify the reader's ideas by telling him without further delay how the sparking voltages of which he has been hearing may be obtained. In describing the function of the condenser across the hammer break, the not uncommon mistake is made of supposing the energy stored in the condenser after the break to be utilised in the coil at the next make.

The difficult subject of coupling between circuits is next discussed. Pages 97 to 144 consist mainly of various items of apparatus, accompanied by instructive references to the theory of their operation. A page on the proper windings for telephone receivers is particularly instructive, and the rectifying property of the carborundum-steel detector is rather fully and admirably analysed. The last few pages deal with aerials, and should be very illuminating to many readers.

A detailed alphabetic index is provided, but there is no table of contents or list of chapters. It is, perhaps, a pity that the main divisions of the book have not been scheduled. A table of contents is always desirable to aid one in getting a grasp of a book, and its preparation here would, we venture to think, incite the author somewhat to rearrange the order of his matter. A minor criticism in a book of this size is that, in effect, Marconi apparatus alone is considered. L. B. T.

PRACTICAL CONSTRUCTION OF THE CIRCLE DIAGRAM.

BY G. H. EARDLEY-WILMOT.

Summary. In this article the practical construction and use of the circle diagram is given, as distinct from the more theoretical treatment often found in text-books.

The circle diagram is of such great value, not only to the purely technical engineer, but also to the practical man, that a few notes on the construction thereof will, no doubt, be of use to those who are not intimately familiar with this method of calculating the data of various motors. It is generally recognised that the proof of the circle diagram is not altogether satisfactory, although the results obtained are sufficiently accurate for all practical purposes, and it is undoubtedly useful to be able to construct the diagram even though the proof is not known. I have avoided going into the technical proof, and have restricted these notes to the geometrical construction of the diagram, and the method of calculating the data of the motor from the circles thus obtained. On this account it will be necessary for the reader who is not familiar with the proof of this construction to take certain statements which follow as facts, the object being simply to explain the construction in such a way that any non-technical reader may be able to use the diagram to his advantage.

To construct the Heyland circle we require first to determine the position of three points. These are usually readily obtained, as we know, or, at any rate, can measure without any difficulty, the values of the current under the following conditions :—

1. Full-load
2. No-load.
3. Short-circuit.

Having obtained these values of the current, and also the power-factors under these conditions, we can proceed to construct the diagram as follows :—

Input Circle and Power Factor.

Take a horizontal axis OX and a vertical axis OY as a base for construction (*see* Fig. 1). Now, from O draw OP equal to the no-load or magnetising current (to any scale preferred), so that the cosine of the angle YOP is equal to the power-factor at no-load. To the same scale set off OS and OK to represent the full-load and short-circuit currents respectively, so that the angles they make with the axis OY give the power factors under the respective conditions. Thus, we have three points on the circle—namely, P, S and K—and the circle drawn through these points is the input circle.

From this circle we may calculate the power-factor at all loads, and to make this as simple as possible it is advisable to adopt a further construction in order that the values of the power-factor may be read direct from the diagram without having to refer to tables.

Along the vertical axis OY cut off any length OY and divide this into 100 equal parts. With centre O and radius OY de-

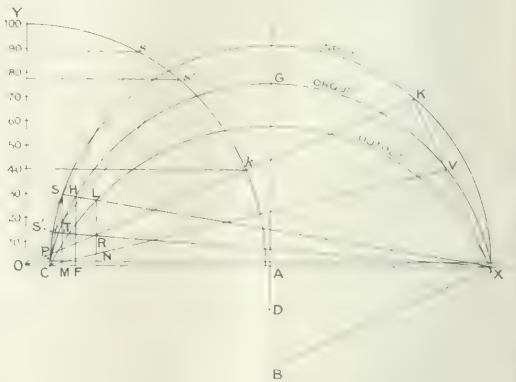


Fig. 1.

scribe a quadrant. Now, the power-factor at any load is given by the ordinate of the point of intersection of the current vector with the quadrant. For instance, at full-load the stator current vector is OS, which, if produced, cuts the quadrant in *s*. Drawing a perpendicular from S on to OY, we find that the power-factor at full-load is about 0·89. Similarly, the power-factor of the short-circuit current is given by the ordinate of the point *k*, where the vector OK cuts the quadrant—*i.e.*, about 0·40. Of course, these two particular values were originally known, and they are only mentioned here to explain the method, and so as to avoid drawing more lines on the diagram than necessary.

Since the point S is the end of the full-load current vector, the perpendicular SM on the axis OX represents the input of the motor, and thus the value of the stator current and power factor may be obtained at any input load. As for example, at the load MT the current is given by OS′, S′ being the point where the horizontal through T cuts the circle. Producing OS′ to cut the quadrant in *s*′ we find that the power-factor is about 0·775.

Before passing on it will be well to note that the line PS represents to a certain scale (which is not necessarily the same as that to which OS is drawn) the rotor current at full load, and

since the value of this is probably known, it is clear that at other loads the rotor current may easily be calculated. At the load MT the rotor current is PS′, thus we have

PS : PS′ :: rotor current at MS : rotor current at MT,

or the rotor current at the load MT

$$= \frac{\text{full-load rotor current}}{\text{PS}} \cdot \text{PS}'.$$

Output Circle and Efficiency.

So far we have considered only the input of the motor, but since the efficiency of the motor is the relation between input and output, we must find some way of obtaining this relation on the diagram. This is done by means of another circle which may be called the output circle. This circle is obtained by joining KX, and drawing from X a line XB perpendicular to KX, cutting the horizontal through A in B. With centre B and radius BX draw the circle CLX.

Now, if we join SX and drop a perpendicular LN from the point L, where SX intersects the output circle, on to the horizontal through P, LN represents the output of the motor. Since SM represents the input and LN the output of the motor at full-load, we have

$$\text{Full-load efficiency} = \frac{\text{LN}}{\text{SM}} \times 100 \text{ per cent.}$$

When considering the power-factor above we were working from the input load, but it is usually required to find the power factor at a given output of the motor. We have seen that LN represents the output of the motor at full load, and that the

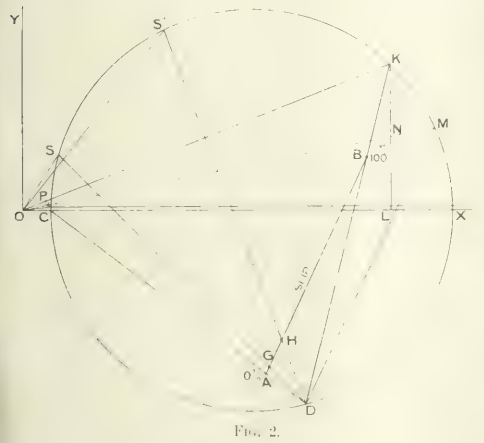


Fig. 2.

line joining XL, if produced to cut the input circle in S, gives the stator current OS. Similarly for any other load. Take for instance the load corresponding to RN. Join XR and produce to cut the input circle at S′. This gives the current vector OS′ from which the power-factor may be obtained as before. The perpendicular from S′ on SM gives MT as the input at that load, and we have the efficiency at load NR $= \frac{\text{NR}}{\text{MT}} \cdot 100$ per cent.

Thus, we can now calculate the power-factor and efficiency from the diagram at any output or input load.

Torque Circle.

From C draw CV to cut KX in V, so that CV represents to scale the drop in the stator winding with locked rotor. Now, if OX is taken to represent to scale the stator voltage, KV and VX are proportional to and represent to the same scale as OX the ohmic drop in stator and rotor respectively. Through C, V and X draw the circle CVX. This is the torque circle. At the output load LN when the stator current is OS the torque developed is given by dropping a perpendicular HF on OX from the point H, where SX cuts the torque circle, and similarly at other loads.

Slip.

The simplest way to obtain the slip from the diagram is to complete the input circle as shown in Fig. 2. As before, we have OP, OS and OK, representing the no-load, full-load and short-circuit currents respectively.

From K drop the perpendicular KL on the axis OX. Bisect KL in N, join ON and produce to cut the circle in M. Take any piont D on the lower half of the circle, join CD, MD and KD. From any point A on CD draw a line AB parallel to MD to cut KD in B. This line gives the slip at the various loads.

Since at no-load the slip is 0 per cent. and at short-circuit current the motor is standing still, or, in other words, the slip is 100 per cent., it is clear that the points A and B represent these two values. To obtain the slip at other loads, say, at S and S′, join SD and S′D, then the slips are represented by relation between AG and AH respectively and AB. For instance, at the load S,

$$\text{Slip} = \frac{\text{AG}}{\text{AB}} \cdot 100 \text{ per cent.}$$

Let us now take a concrete example of, say, a 320 B.H.P. three-phase 500-volt 50-cycle motor, the particulars of which are as follows :—

Full-load current	= 333 amperes.
Full-load power-factor	= 0·92.
No-load current	= 75 amperes.
No-load power-factor	= 0·13.
Short-circuit current	= 1,840 amperes.
Short-circuit power-factor	= 0·29.

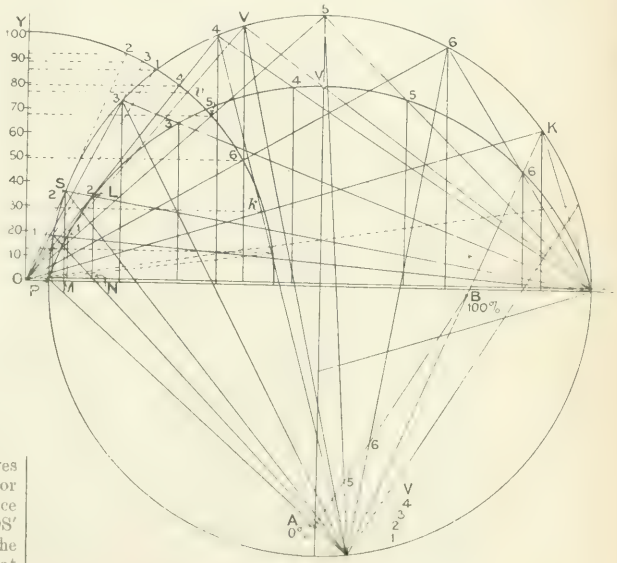


Fig. 3.

The above particulars will enable us to obtain the input and output circles, and the complete diagram is shown in Fig. 3. The power-factor quadrant should be drawn first, as then there is no need to measure out the angles for the various current vectors. In the diagram we have,

OP = no-load current = 75 amperes.
OS = full-load current = 333 ,,
OK = short-circuit current = 1,840 ,,

These are drawn to scale, 1 cm. representing 100 amperes. Now, we know that LN represents the full-load output = 320 B.H.P., and, measuring LN, we find that it is equal to 28 mm., so that we know the scale of the input and output lines—*i.e.*, 28 mm. = 320 B.H.P. Thus, we have SM = full-load input, SM = 31 mm. = 350 B.H.P., and the full-load efficiency is

thus 90·4 per cent. The slip at full-load is given by $\frac{AH}{AB} \times 100$ per cent. Measuring AB, we find that it is equal to 95 mm. and AH = 3 mm., so that the slip = $\frac{3}{95} \times 100$ per cent. = 3·16 per cent. All the full-load values are marked by the figure 2, the other figures representing any points on the circle. The pull-out load would be the point V between 4 and 5, and the values above this are unstable. If the construction is repeated for each of these points as shown, we can tabulate the results, and if required plot curves to represent the power-factor, efficiency and slip. The following table gives approximately the results obtained from Fig. 3 in the present instance.

Load.	B.H.P. input.	B.H.P. output.	Efficiency. Per cent.	Cos ϕ.	Slip. Per cent.
1	171	154	90·0	0·86	1·45
2	354	320	90·4	0·92	3·16
3	715	613	85·6	0·89	6·32
4	923	755	77·6	0·8	12·2
V	1,018	767	75·4	0·77	13·3
5	1,062	715	67·2	0·68	14·2
6	950	435	46·0	0·5	35·8

These results are plotted in Fig. 4, and we now have curves for the three chief characteristics of the motor, efficiency, power-factor and slip.

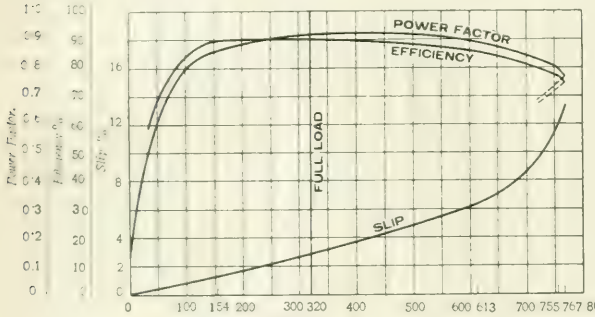


Fig. 4.

The above notes only touch on the main construction of the diagram, the subject being far too comprehensive to go into in detail in a short article such as this, but it will no doubt serve as a guide to those readers who are not called upon to calculate these data often, and may, therefore, not be familiar with the use of the diagram.

THE C.T.S.I. CONCENTRIC SYSTEM OF WIRING.

BY DONALD SMEATON MUNRO.

The changing conditions of labour and certain troubles incidental to methods of wiring now in common use have led to the introduction of a method of wiring in which the conductors are arranged concentrically. It differs, however, from familiar concentric cables, as used for indoor wiring, in that the spiral external conductor is both insulated and protected by a special covering. The facts which have led to the introduction of this method are :—

1. The troubles which have arisen by the use of conductive metallic conduits. These troubles are not merely those due to faint leakage into the protective metal and thence to chance earths, with consequent electrolytic corrosion. Corrosion is reduced, but not abolished, by the formal earthing of the conduit at a definite point. The chief source of danger arises from the electrical continuity of the conduit system, the very quality relied upon to make them safe. The moment that a serious fault occurs the whole conduit system is live. The prevailing idea is that the leakage current flows along the conduit to the proper earth bond, and that the increased flow in the faulty cable will melt the fuse. Usually, though [illegible] it does so. But the process, though quick, takes appreciable time. During the time part of the current finds other paths to earth, to chance contacts, and gas or water pipes or by structural metal work. In practice, metal conduits cannot be or remain assuredly free from such chance contacts. Metal sheathed cables, and also concentric cables with uninsulated external conductors, share these disadvantages, and, notwithstanding their undoubted merit, have certain minor disadvantages peculiar to themselves.

2. Another point considered in designing the C.T.S.I. concentric system is that, in modern methods of electrical supply, one conductor, such as the mid-wire of a three-wire direct-current system, is usually at approximately earth potential. For this reason the chief insulation should be concentrated upon the live wire or wires ; but the use of uninsulated "return" conductors is commonly forbidden for several good reasons. Such bare conductors would possess to a certain extent the disadvantages described above in 1. The small differences of potential due to fall of voltage along the various outer conductors also might suffice to produce harmful stray currents. Nor must we forget the temporary conditions set up by short-circuits, and perhaps by interrupted return conductors or earth connections. Some insulation of the outer of concentric cables for indoor wiring is therefore necessary. It must be reliable, but it need not be high so long as it can withstand for a time such accidental dielectric stresses.

3. The form of the cable must lend itself to safe and rapid adaptation, not only to special appliances, but to the electrical fitments in common use.

4. The whole should be durable and provide reasonably adequate protection against all adverse conditions likely to be met with during and after installation.

To secure these advantages and obviate those dangers, as well as the deteriorating influence of moisture and rust in conduits, the new form of cable has been constructed as described below. The system may be used with single-pole switches and fuses, but is designed for use in towns where it is the practice to employ double-pole main switches and double-pole branch fuses on each circuit.

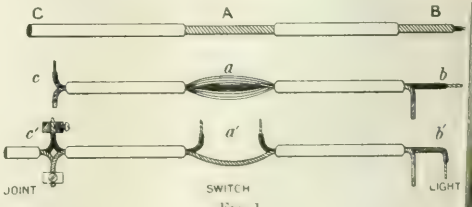


Fig. 1.

A branch circuit cable, for example, consists generally of a 3/22 S.W.G. tinned copper core. This is highly insulated with pure and vulcanised rubber to the C.M.A. specification, and is then lapped with tape. The inner core just described forms the vital wire of the circuit.

Lapped round the foregoing is the external conductor. It consists of 36 separate wires of tinned copper of No. 30 S.W.G. These are laid side by side to form a ribbon. They are so laid that side contact is maintained generally. The effect of this side contact between the tinned surfaces, and of the long "lay" of the 36 strands, reduces to a minimum the inductive effects and the fall of potential. This long lapping is also of much advantage to the wireman by presenting the outer conductor in a form sufficient, safe and convenient for joints and for connections to fitments of standard type. It also permits soldered joints to be made at a safe distance from the important rubber insulation ; or soldered joints may be omitted and terminals may be employed instead. A braided conductor or a short lapped conductor, however excellent for specific purposes, would not afford these conveniences of manipulation, and therefore are excluded from the system.

The external copper conductor described affords a degree of armouring protection to the interior insulation. It is connected to the "neutral" supply wire, and is not normally interrupted at the branch switches. Double-pole fuses control the circuit.

The outer conductor is insulated, preferably, with a layer of impregnated tape. Such insulation would be very slight and fleeting if used, say, in steel conduit. But kept dry by the outer coating to be described, it gives, if properly treated at the cut ends, a fair degree of permanent insulation. Further insulation, as by pure rubber lapping, may be added where desired, but of course, at some additional cost.

Over the tape the protection is completed by a substantial layer of cab-tyre sheathing. This form of sheathing has been hitherto put upon the market solely as a highly efficient mechanical protectio

for cables otherwise completely insulated. In durability and in resistance to nearly all the enemies of cables the material is of unique effectiveness. But its insulating properties also are not to be despised. Used over tape or other forms of insulation described, the combination gives ample insulation to a neutral wire normally at or near to earth potential, and is of sufficient dielectric strength to withstand all probable incidental pressures. In ordinary buildings no further conduit is needed.

Figs. 1A, 1*a*, and 1*a'* indicates how the cable is dealt with at switches. A piece of the outer cover for a length of, say, 2 in., is removed. The tape surrounding the external strands is then unwound (1A). The cable is held on both sides of the opening and is given a slight twist in the opposite direction to which the wires are wound. The strands will then open out like a cage (1*a*), and the interior insulated wire can be cut through the centre. The two cut ends are next prepared for entering the switch terminals. If the

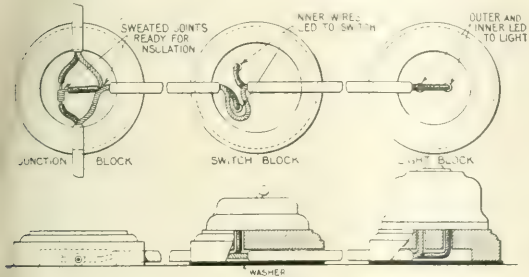


FIG. 2.

cable now receives several turns, the external strands will twist into a neat and compact copper rope (1*a'*), which may in certain circumstances be lapped with an insulation of pure rubber tape.

Figs. 1B, 1*b* and 1*b'* show how the cable is treated at lighting points. A short length of sheathing is removed (1B). The external strands are unwound and twisted into a rope (1*b*). It is not always necessary to insulate this external connection, as in most cases it can be bent sharply at right angles through its proper hole in block or ceiling rose and secured directly into its terminal. The interior insulated wire passes on and then bends sharply down into its own hole in block and terminal (1*b'*).

The preparation of the ends for a junction is similar to the last description. The inner and the exterior cables may be bent in

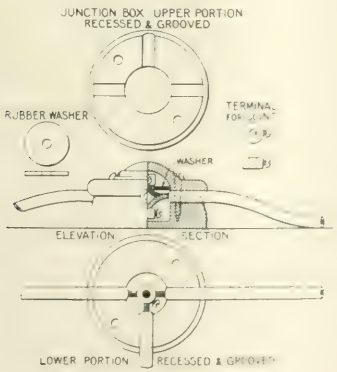


FIG. 3.

opposite directions at the point where they leave the sheathing (Fig. 1c). Two or three branches similarly prepared are butted up against these. The external cables are then all twisted together on one side and the inner cables are twisted together on the other side. The joints may be soldered or simply held in tinned clamp terminals (1*c'*). It is not necessary to have any special fittings for the system. Ordinary shallow recessed teak blocks properly grooved to fit the cable are used for everyday installation conditions of lights and switches. It is recommended that a disc of thin rubber insertion be interposed between block and wall or ceiling. This keeps out damp and dust. These are shown in Fig. 2. Similar blocks may serve for joints if the latter are first insulated. But joint boxes of the type in Fig. 3 are more serviceable and ornamental and they serve better to take any stress which may be put on them. If the two surfaces are coated with shellac before joining then protection from damp is assured.

When an ordinary teak fuse-box is used grooves are cut in back edge of frame to admit cables. It is good practice to have a thin sheet of asbestos slate the exact external size of box to protect the wires from wall. The cable at fuses is treated in a similar manner as at lights, only, of course, the sheathing is stripped further back to suit the considerable distance between positive and negative fuses.

When the conditions are very severe then malleable cast boxes of the well-known universal pattern may be used. The cables enter these through screwed glands. The boxes have insulated linings, and are finally filled up solid with bitumen compound. The system is then more watertight than any lead-covered system would be, and the result is attained without trouble and without the harmful heating which lead sweating requires.

At switch and fitting points the boxes have fibre discs to which these attachments are screwed. Fig. 4 gives some examples of this method. A typical circuit is sketched in Fig. 5.

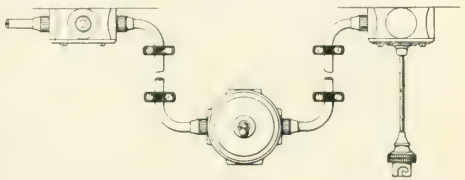


FIG. 4.

It should be particularly noted that the utmost economy and the greatest neatness are attained when the cables are passed through the switch block—or box—before continuing on to the lamp. This is different to the usual method employed in the ordinary systems where the switch feed is taken from a box on the way to the lamp, and the switch return passes through the same box and then on to the light.

It will be found advantageous to run the system beneath floors,

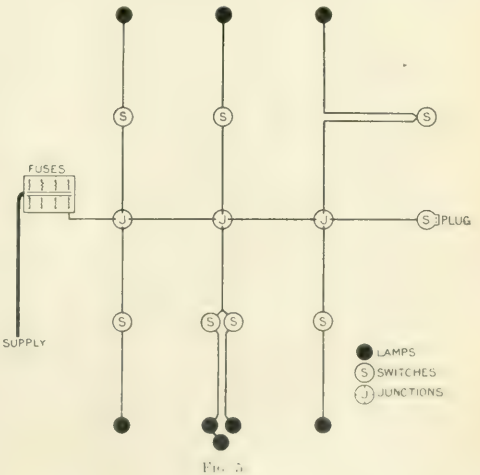


FIG. 5.

or along skirting, on the flat to be lighted and to feed upwards through the switches. This has the additional merit in buildings of the tenement type that an installation may be confined to the one house, and does not encroach beneath the floor of the flat above.

The cable is also manufactured with more than one interior insulated wire. For simplicity of parts, however, most erectors will prefer to utilise the single-core type wherever possible. Thus, where two switches are mounted on one block to control, say, a five-light fitting, two complete separate concentric cables will be led from the switches to the fitting. The external wire of one cable will be the lamp return. The two internal wires will feed the lamps, and the

external wires of the second cable will serve simply as a mechanical protector for its core.

Suppose that a third switch was desired then it is better to run a third cable rather than utilise the external of the second cable. The reason being, of course, that switch-to-lamp wires are always at the higher potential from earth unless the switches are in "off" position.

On test, a mile of the above cable has an insulation resistance of 1.700 megohms between the two conductors and 52 megohms per mile is obtained between the external conductor and "earth."

The construction of the cable is the essential feature of the new wiring system. It will be noted that the important wire has the highest insulation and, in addition, it is double armoured by copper and cab-tyre sheathing. The neutral conductor, owing to the number and size of its strands and the method of its application, has an ohmic resistance approximately half that of the "live" wire. There is some virtue in this for reducing fall of potential and heating. It being the return wire has most current to carry, as it serves more lamps than the individual switch wires, on the majority of circuits.

This composite circuit cable, whilst almost ideally protected, has a diameter of only $\frac{3}{16}$ in., so it is easily concealed and neat when it is visible. Its circular form is much more easily adapted to glands and the like than the elliptic cables now common. The system involves the very minimum of labour costs in erection.

Owing to the structure of the cable it is difficult to injure or penetrate, but should this be accomplished, say, by a sharp nail, then the live wire cannot be reached without making contact with the neutral, so a clear indication is given by the fuse blowing. In twin-wire systems such an accident frequently results in a partial and, therefore, more dangerous short-circuit.

PHYSICAL SOCIETY.

At the meeting held on June 11th, at the Imperial College of Science, Dr. A. Russell, M.A., Vice-President, in the Chair, a Paper on

"The Coefficient of Expansion of Sodium,"

by E. A. Griffiths and E. Griffiths, M.Sc., was read by the latter.

The thermal expansion and increase in volume on liquefaction of sodium were determined by a method based on the following principle :—

The difference in expansion of a volume of sodium and an equal volume of glass (or quartz) was measured by differential weighing under oil at various temperatures.

A volume of about 250 c.cs. of sodium was suspended from one arm of a short beam balance and a weighed glass bulb of equal displacement from the other arm.

The experiments show that sodium expands quite uniformly with the temperature up to its melting point.

The value 0·000226 was deduced for the coefficient of expansion. In changing from the solid to the liquid state, an increase of 2·57 per cent. occurs in the volume.

Mr. F. E. Smith expressed his admiration for the method employed and the wide range of accuracy over which the observations appeared to have been made. Would it have been possible to obtain sufficient accuracy with the apparatus at the disposal of the author, the remainder of which could be [illegible] in the case of the metals ?

Mr. A. Campbell asked if there had been no trouble from convection in the oil at the higher temperatures. Had the authors noticed any hysteresis effect in the expansion of the glass globe such as the behaviour of [illegible] would lead one to suspect ?

Dr. C. Chree stated that the two curves which Mr. Griffiths had drawn on the board representing the theoretical and experimental results were very similar in form, which might indicate that the theory had something to do with it. Had the coefficient of elasticity been determined for the actual specimen used, or were general results assumed ? He believed that [illegible] varied considerably in different specimens.

Mr. J. Guild asked what precautions had been found necessary to [illegible] due to the very minute capillary effects where the [illegible] enter the oil. Was the compensating bulb evacuated ? If it contained air at atmospheric pressure when cold, the pressure would [illegible] at 200° C., which would produce appreciable changes in the volume of the compensator. The neglect of a correction for this pressure effect would be to give less than [illegible] for the expansion of the sodium. He had not had time to [illegible] and theoretical values of C_v, but it seemed advisable in future [illegible] to examine the compensator, or to determine its total [illegible] by a blank experiment.

Mr. S. D. Chalmers asked if a check was made to see if the volume of the bulb was the same before and after the experiment. Had the authors tried Lorédemann's formula would agree with their results.

Mr. Griffiths, in reply, said that in the dilatometer method the difference in expansion of sodium and oil would be measured. The coefficient of expansion of oil is about 10 times that of a metal, and would have to be determined with considerable accuracy. The method described was intended to measure the expansion relative to that of fused quartz, of which the coefficient is about 1·200 that of a metal and is accurately known. The expansion of the oil only affects the ratio of the densities at the two temperatures. The effect of convection was greatly reduced by the symmetrical disposition and closeness of the bulbs. No secular changes were found, the results obtained before and after heating to the higher temperatures agreeing (*see* Table I. and Fig. 2). With quartz bulbs no secular effects would be possible. The formulæ of Einstein and Debye were able to represent the general form of the atomic heat-temperature curve, but systematic divergencies from the experimental results occur and the theories fail to account for the abnormal increase near the melting point. Nernst and Lindemann's formulæ gave a curve very similar to Debye's (*see* "Phil. Trans." R.S., A., Vol. 214, page 343, 1914). He had assumed Richards' value for the elasticity. The suspensions were of fine tinned steel wire. As the oil wetted the surface the capillary effect would probably be constant, and the same for both wires. The compensator was heated to about 200°C. when sealing off and, being stout walled, would be little affected by the changes of pressure of the residual air when heated. The expansion of the compensator was checked by weighing it alone in water at different temperatures.

A Paper, entitled

"Notes on the Calculation of Thin Objectives,"

was read by Mr. T. Smith, B.A.

Lens systems which are symmetrical about an axis have in general six degrees of freedom for first order aberrations. Thin systems have only three degrees of freedom, and in consequence of the limited range of glasses only two degrees of freedom are practically available. In achromatic combinations of two lenses these two degrees of freedom are controlled by the general shape as distinct from the total power of each lens. In general when two given conditions are satisfied the curvatures of the inner surfaces are not equal, so that a cemented combination of two lenses is not possible. Owing to the increased light transmitting powers it is often necessary to have only two glass air surfaces, and thus more than two component lenses are necessary. The effect of bending any thin system as a whole by increasing the curvature of each surface by the same amount is investigated, and it is shown that with two given kinds of glass a triple cemented lens can be formed satisfying two arbitrary aberration conditions. The problem reduces to the solution of quadratic equations, and in general there are four solutions. Illustrations are given of astronomical objectives of both double uncemented and triple cemented forms, and the glasses are determined for which a doublet can be cemented.

Mr. S. D. Chalmers expressed his appreciation of the Paper. One could get a rapid survey from it of the results which were possible. The special problem of a lens corrected for spherical aberration and coma had been discussed by Harting and also by Von Hoegh. The latter had solved the problem on lines which seemed to him rather simpler to use. He did not quite agree with the author's statement that the use of phosphate crowns had been entirely discontinued. Glasses very like these have been used fairly frequently, especially by Continental makers. There were cases where in computing a lens it was not desired to achromatise completely; where, for example, after correcting for spherical aberration and coma, some residual chromatic aberration was desirable to neutralise the chromatic aberration of the prisms in binoculars.

Mr. A. Campbell asked if the small thickness of the cement used in cemented lenses made an appreciable difference, and if its refractive properties entered into the calculations. What was the range of refractive index available in the modern optical glasses ?

The Author, in reply, was surprised to hear that phosphate glasses were still employed in any case in which they could possibly be avoided. The cement used was always Canada balsam and was entirely neglected in all computations. A range of refractive index of 1·47 to 1·79 was available, but the extreme values were rarely used, 1·49 to about 1·65 or so being the range usually utilised.

A Paper

"On Tracing Rays Through an Optical System"

was read by Mr. T. Smith, B.A.

Trigonometrical formulæ have been used for tracing rays not lying entirely in one plane through optical systems, as these can readily be arranged in a form suitable for logarithmic calculation. When a calculating machine is available such computations can be carried out more expeditiously by using algebraic formulæ given in the Paper; in form these exactly correspond with the expressions for paraxial rays, and a comparison of the numerical result appears likely to suggest what alterations should be made when a general ray does not behave as desired. It is pointed out that if the two points in which a general ray meets an axial plane are defined as conjugate points, all pairs of conjugate points on a ray are connected by the same relations as hold for object and image points for paraxial rays.

and the theory for paraxial rays can be extended to rays in general by placing a suitable interpretation on magnification, &c. The definition of conjugate points can be extended to include rays lying in axial planes, in which case the one point marks the intersection of the ray with the radial focal line formed by rays passing through its conjugate.

Mr. S. D. Chalmers was particularly interested in the method of tracing rays through a system. The [illegible] the various quantities involved was of considerable [illegible] The author's methods of treatment seem to present many [illegible] to the cases actually quoted. By extending them he may simplify very considerably many important computations. Some time ago he had used somewhat similar methods to express the image position of an object in terms of the separations of the surfaces and the height of the intercepts of a standard ray on the different surfaces.

Mr. T. Smith, in reply, agreed that if one had time to go into all the cases which might arise many interesting and useful results would follow. It was easy from the formulæ he had quoted to obtain an idea of what other general relations are likely to exist in an optical system, and to extend the meaning to be attributed to various conditions, such, for example, as the sine condition of Abbé. He hoped to treat more fully of these matters later.

A Paper on

"The Accuracy of the Lens and Drop Method of Measuring Refractive Index"

by Mr. H. Redmayne Nethercot, B.Sc., was taken as read in the absence of the author.

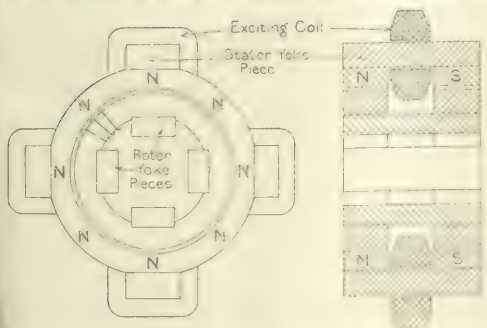
The Paper describes a simple arrangement for comparing on an optical bench the refractive indices of liquids for monochromatic light by the lens and drop method. The accuracy and sensibility of the method are discussed, special stress being laid on the choice of lenses and on the manner of correcting for the thickness of lens used. Attention is drawn to the accuracy obtainable in measuring a small radius of curvature of a lens face in terms of the well-known refractive index of water, and in measuring the refractive index of the glass of a lens.

CORRESPONDENCE.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The subject of "The Laws of Induction" is of particular interest to me, as some years back I devised certain



models in the endeavour to determine the correct method of expressing these laws. At first my experiments tended towards the rejection of the statement that the E.M.F. is due to the cutting of the magnetic lines. In fact the results seemed so conclusive that I wrote up a lengthy Paper and submitted it to a high authority, who strongly advised me against it. However, a further test caused all my previous deductions to fall to the ground, and at the same time convinced me that, in the case of a closed circuit, both statements of the laws are correct and true, *i.e., if correctly considered*, both the rate of change of flux theory, and that of the cutting of magnetic lines will give identical result.

A brief description of one of my models may be of interest. The model was of the double armature [illegible] type shown in the accompanying diagram. The stator yoke was magnetised by coil, wound on the four stator yoke pieces, the coils all carrying current in the same direction. The essential parts of the rotor consisted of the two armature rings joined by four yoke pieces. The magnetic lines entering the rotor rings at its outer periphery are led out by means of the yokes, there being no magnetic field in the space on the inner side of the rings, and the flux distribution in the rotor ring being constant and independent of its rotation. This was quite confirmed experimentally with the rotor at rest, and in addition, the flux density in the air-gap was found to be constant.

A coil was wound ring fashion upon the portion of the rotor rings between the yoke pieces. It would appear that the case corresponds to that of an ordinary ring winding of a continuous-current machine in so far as the outer conductors *only* cut the lines of magnetic force. On the other hand, the rate of cutting of the lines by the outer conductor is constant, and the flux embraced by the winding is quite constant.

The two formulæ then seemed to be at variance for this machine, which, on being tested, gave the expected result, no E.M.F. being set up in the ring winding.

The explanation of the apparent discrepancy was found by measuring the *E.M.F. set up in a single conductor, placed on the inner side of the rotor ring:* instead of being zero, *an E.M.F. equal and opposite to that set up in a conductor on the outer periphery was established*, in spite of the fact that with the model at rest no field could be detected on the inner side of the ring.

A careful consideration of the facts led to the conclusion that the case is analagous to that of a slotted armature, where, although there is no appreciable field in the slots when the machine is at rest, the lines of force cross the slot laterally during its rotation in order to conserve their identity with their remaining portions in the poles, &c.

In every known case correct results can at once be obtained from the formula: $e = \frac{n d\Phi}{dt}$; in addition a *proper* consideration of the passage of the lines of force transversely across the conductors will also give correct results, although in some cases —as in transformers—the cutting, although present, is not so obviously apparent as in others. It is impossible to conceive of any change in the number of magnetic lines embraced by a circuit without a corresponding passage of magnetic lines taking place across the conductors forming the circuit, no matter whether the change is due to motion as in the case of a dynamo, or to alternating currents as in the case of a transformer. A correct conception of the growth and disappearance of a magnetic field is all that is necessary to make it apparent that, even in the case of the static transformer, cutting of lines of force by a circuit always accompanies any change in the magnetic field embraced by the circuit, and will prevent it from being concluded, as your correspondent Mr. J. G. Lakeman concludes—that the "cutting of lines of force theory" completely fails in the case of a single-phase transformer. It is to be regretted that our teachers and text books in general do not make a better attempt at dealing with this very important branch of the subject of electro-magnetism.

Your correspondent, Mr. B. Davies, appears to be confusing symbols. I fancy that he is using N for the number of magnetic lines instead of the Φ of Prof. Robertson, and that he has not read correctly the latter's formula. In short, it appears to me that he is pursuing a mere shadow. I am, &c.

Leicester, June 25. A. E. Clayton.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It is not at all obvious why in opening Mr. Davies attacks to the symbols employed in his letter on page 442 of your current issue. Apparently, rather he or the printer has made a mistake and written dN where $d(N_{\rho})$ was intended. But even then we have the difficulty that his ρ stands for something which according to his statement is zero for the case of a wire moving sidewise across a uniform field, which is certainly not true of the quantity expressed by the symbol used in the original article of which my previous letter. The mention of "rotation" in connection with one of his cases points to the possibility of there being some confusion between "turns" of wire (conductors) and "turns" of a shaft (revolutions).

In my letter I did *not* draw any conclusion whatever from Prof. Blondel's experiments, but I did draw one from the law of conservation of energy, and I pointed out that Prof. Blondel had given an experimental verification of that conclusion. The experimental evidence should be of especial value to those who do not accept the well-established principle of the conservation of energy, or who are unable to follow the simple reasoning by which the law of induction can be deduced from it.

Your other correspondent, Mr. Jakeman, in his letter on page 441, discusses the best verbal statement of Faraday's principle. (Incidentally, he also applies $Nd\varphi/dt$ with perfect ease to a case to which, in Mr. Davies' mind, it is "obviously inapplicable.") I have found it best to standardise two forms for use in different cases. These are :—

Local Form.—When a body cuts across a magnetic field, an E.M.F. is induced in it proportional to the rate of cutting flux and in the way of a current opposing the relative motion.

Total Form.—When the flux through a circuit is changing, an E.M.F. is induced in it proportional to the rate of change and in the way of a current opposing the change.

Notice that neither form is restricted to conductors ; they apply also to insulators, in which the induced E.M.F.'s produce dielectric strain, causing sufficient dielectric E.M.F. to balance that induced. The second form, which Mr. Jakeman prefers and states in somewhat different language, can be readily deduced from the first, but the converse is more difficult owing to the fact that there may be induced E.M.F.'s in different parts of a circuit and yet no resultant E.M.F.

The first form is the more convenient when dealing with the E.M.F.'s in parts of a circuit, such as individual armature bars, homopolar induction, and so on (in fact most, but not all, cases of motion E.M.F.), while the second is better when considering the total E.M.F. in a coil or closed circuit, such as in a transformer or induction coil (inductance E.M.F.'s and a few cases of motion E.M.F.) Thus, if a closed loop be moved parallel to itself and in its own plane, across a magnetic field, the local form shows at once that E.M.F.'s will be induced in the sides of the loop, while the total form shows at the same time that the resultant E.M.F. round the loop will be zero if the field be uniform. The latter fact is easily enough deduced from the former, but the presence of the individual E.M.F.'s with the consequent differences of potential between one part of the loop and another, is certainly not a consequence of the absence of a resultant E.M.F. Knowing the components, the resultant follows ; but knowing only the resultant, the way in which it is built up is indefinite.—I am, &c.,

Bristol, June 26. DAVID ROBERTSON.

TRANSIENT PHENOMENA IN A CIRCUIT OF CAPACITY AND INDUCTANCE IN PARALLEL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : In the Paper entitled "Apparatus for Protection of Electrical Machinery against Abnormal Electrical Conditions," by Dr. C. C. Garrard, the author covers such a broad field that it is obviously impossible for him to dwell at length upon any particular conditions which he has brought up. For this reason it occurs to me that a short discussion on one of his sub-topics of "Making and Breaking a Circuit containing both Self-induction and Capacity" may be of interest to your readers.

In particular, let us study the transient phenomena which occur in a parallel circuit of inductance and capacity where the values of these are such that at some definite frequency of the impressed voltage the reactance and capacity in ohms are equal, or, in other words, that $2\pi fL = \frac{1}{2\pi fC}$, and we find a very [illegible]

[illegible] be closed upon the circuit from a source of [illegible] the equation of the current may be [illegible]

$$I = \frac{E}{Z}\left[2 \sin \omega t \cos \gamma - \frac{X_C}{R} e^{-\frac{1}{CR}t_1} \cos(\omega t_1 - \gamma) - e^{-\frac{R}{L}t_1} \sin(\omega t_1 - \gamma)\right].$$

Where I=total instantaneous current at time t.
E=impressed voltage.
$\omega = 2\pi f$.
L=inductance in henrys.
C=capacity in farads.
$X_C = \frac{1}{2\pi fC} = X_L$.
R=resistance of either branch.
t_1=time of closing switch referred to E.M.F. wave.
t=time for which current I is desired.
$\tan \gamma = \frac{X}{R}$.
Z=total impedance of circuit.

For the maximum value of current the switch is closed at the time $t=0$; substituting, we have when $t_1=0$

$$I = \frac{E}{Z}\left[2 \sin \omega t \cos \gamma - \frac{X_C}{R} e^{-\frac{1}{CR}t} \cos \gamma + e^{-\frac{R}{L}t} \sin \gamma\right].$$

If we plot the transient curve of current for various values of t when the switch has been closed upon the above circuit at the zero point of the E.M.F. wave, or where $t_1=0$, we find the current rising instantaneously to a value several times normal and dying down to normal in a period of from 1 to 10, or possibly even 20, cycles, depending upon the amount of resistance in the circuit.

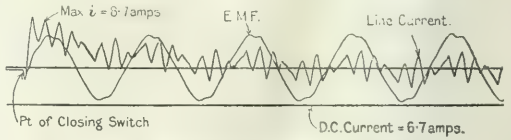


FIG. 1. OSCILLOGRAM IN CASE OF AIR CORE.

From this we see that, theoretically, if we had a parallel tuned circuit of inductance and capacity only (no resistance), we would, on closing the circuit on the zero point of the E.M.F. wave, obtain an unidirectional pulsating current from an alternating-current source.

To obtain a check under actual conditions, a circuit was constructed keeping the resistance as low as was feasible with ordinary apparatus, and a special switch attached to a four-pole 110-volt alternator running at the critical frequency of 50 ∼, such that it could be closed at any desired point of the E.M.F. wave.

By means of an oscillograph set to operate just at the point of closing the switch, it was possible to obtain oscillograms of the transient current wave under various conditions. It was found, as expected, that when the switch was closed at the maximum point of the E.M.F. wave the current wave is normal from the beginning and is maximum when the switch is closed at the zero point of the E.M.F. wave.

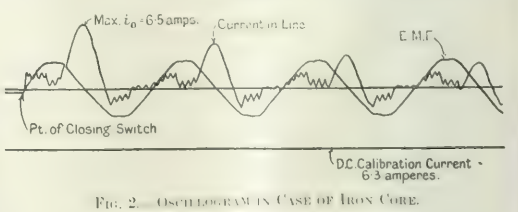


FIG. 2. OSCILLOGRAM IN CASE OF IRON CORE.

Oscillogram No. 1 shows this maximum condition very clearly, and, owing to the comparatively high resistance, the transient is damped in two cycles.

Oscillogram No. 2 shows similar conditions, but with an iron-cored reactance instead of the air core, as in the first instance.

The theoretical solution of the case with iron in the reactance circuit is more difficult than the case given, but may easily be worked out by the increment method.—I am, &c.,

London, June 15. O. E. GRIGSBY, M.Sc.

LEGAL INTELLIGENCE.

Osram Lamp Works (Ltd.) v. Pope's Electric Lamp Co. (Ltd.)

The hearing of this case has been continued by Mr. Justice Joyce.

Dr. Francis Wm. Passmore, consulting chemist, said that for the purposes of the case he had studied the specification sued upon and the prior documents which were urged against its validity: on several occasions he had attended when the defendants afforded inspection of their process, and he had also carried out a large series of experiments. Following out the invention described in the specification it was true that one got filaments of pure tungsten, or substantially so, which did not possess the defects mentioned in respect of those where tungsten had been applied as a coating. Having regard to the state of the art, in his view no further direction was necessary for a filament maker to carry out that stage of the manufacture of the filament. Prior to the date of that patent there had been processes in which filaments were squirted from a paste. For the manufacture of artificial silk from nitro-cellulose, collodion or cellulose in chloride of zinc or a cupreous ammonia solution of cellulose, all those were employed for the manufacture of articles of silk, and, of course, some of them for the manufacture of carbon filaments. All of those, as applied to the carbon filaments, would be what were called the soft paste process. So far as the carbonisation was concerned it was the result simply of heating. He found no difficulty or insufficiency in the following description of the process: "First of all the carbon which has only served as a binding medium is removed by subjecting the filaments to the passage of a current in an atmosphere of steam and hydrogen, and thus raising it to a high temperature. By this process the carbon is completely oxidised so as to form carbonic oxide and a filament of tungsten is left. These filaments are then rendered uniform in a manner similar to that employed in the treatment of the usual carbon filaments by submitting them to the action of current in an atmosphere of volatile tungsten compounds in the presence of a large quantity of hydrogen whereby the tungsten deposited equalises the filaments." As a matter of fact it had been found that the process could be so successfully carried out that the stage of making the filaments uniform could be dispensed with if the paste was uniform and the dies were well cut and the mechanical details had been perfected by experience. Then there was no need to equalise, they were already uniform. Assuming that the object to be attained was a filament of pure tungsten, in none of the documents pleaded against the patent did he find disclosed the idea of using a filament of pure tungsten, except in the case of drawn wire. That one was No. 20,277 of 1904, the patent granted to Abel on a communication from Siemens & Halske. There was another German patent of Just and Hanaman, but he did not know whether it had been published. He should say that Just and Hanaman's invention was an "epoch making" one. He had never heard of any filament that could give the same candle-power for the consumption of electrical energy as that in Just and Hanaman's patent, and so far as he knew no method had been disclosed by which one could obtain such a filament. He was not aware that any means were known at the date of Just and Hanaman's specification by which one could obtain a drawn wire filament, and by the means Abel suggested he did not think it could be obtained now. You could make a tungsten filament as a result of the suggestion of Just and Hanaman in their German specification No. 154,262, but it was not pure; at any rate he had not been able to make it pure. At the date it was known, of course, that steam and hydrogen would remove carbon, but whether or not it would leave the tungsten filament intact no one knew. Welsbach's specification 1,535 of 1898 referred entirely to osmium or a metal of the platinum group. Although Welsbach said that one could deal with osmium by getting rid of the carbon by oxidation and at the same time retaining the osmium, the publication of that would not tell one anything as to what was possible with tungsten. Supposing tungsten in the finely divided state in those filaments, although mixed with a binding medium, it would be easily oxidisable. Carbide of tungsten was a very stable body; at any rate, it was thought so in 1904. So far as one could assume anything in chemistry, to remove the carbon from tungsten one would have to oxidise more energetically in the case of tungsten and carbon than in that of an osmium and carbon mixture. Welsbach's specification would have told anyone in 1904 of the possibility of making a built-up filament by the Just and Hanaman process, and he did not think any assistance could have been got from the specification of Gülcher. The latter related mainly to iridium which Gülcher proposed to sinter. Bottome dealt with tungsten, but his object was merely to produce carbon filaments strengthened by tungsten, and there was no suggestion in Bottome's specification of a paste of tungsten and carbon and of tungsten and a binding material from which the carbon could be subsequently eliminated and the tungsten retained. Similarly the two Ledyguine specifications related not to a paste process but to the coating of a body containing a fillet without any process for getting rid of the fillet. He did not find any help from that leading him to a built-up tungsten filament, except built up in that fashion of filling it up round the fillet. Taking the specification of Just and Hanaman he found sufficient directions to enable him to put the invention into practice. Witness said in regard to defendants' two processes, he took them as a distinction, but he could not see what made them use one or the other. The one which was shown to him first was the one in which the steam of hydrogen was used and the other was mentioned more by way of an alternative process.

His Lordship: I apprehend the greatest possible latitude as to whether the process which defendants are operating is the patented process. The other questions as to the validity of the patent and such one can understand, but I suppose defendants are going to say it is not the process patented.

Mr. Colefax: Presumably.

His Lordship: Your witnesses will have to explain this to me clearly. It is an issue I don't look forward to with any pleasure.

Mr. Terrell: It seemed to me that for the purpose of enabling your Lordship to deal with this particular issue it would be desirable that you should see the process at work.

His Lordship: I don't think I am going to do that. In these cases I bear in mind that I am not bound to be an expert. I have no doubt scientific witnesses will be called and I shall have to do the best I can.

Dr. Passmore proceeded to describe defendants' processes. He said that in the vacuum process, filaments were, after the first furnacing up to 950 deg., put into an exposed oven heated up to 220 degs. In the next stage the filaments were transferred to the furnace and the first operation repeated. Finally, the filaments were transferred to a platinum-iridium furnace in which a stream of hydrogen passed down, and which was heated to 1,850 degs. Analyses of samples taken at defendants' works were produced by witness. From one of these it appeared that a filament, after squirting and drying, contained 2·32 per cent. carbon and 93·04 per cent. tungsten. The balance was made up of oxygen, hydrogen and nitrogen. At that stage he said that carbonisation had not commenced. In another sample analysed witness said the records showed that the carbon had dropped to 0·013 per cent. and the tungsten had risen to 99·95 per cent. after heating to 1,850 deg. At the very last stage the tungsten was brought up practically to 100 per cent.

Cross-examined by Mr. Terrell, Witness said he thought a pure tungsten filament could be made without using the process specified in the patent—*i.e.*, by using a binder and not using the process. In 1904 metal filaments had not been very successful commercially, but he should say there was a usual process for making metal filaments. It was something more than an experimental process, because he read of machines being obtainable for making pastes for metal filaments. There was, therefore, a usual practice of making filaments for lamps at the date of the patent other than the process for making carbon filaments. From the literature on the subject it was quite evident there must have been. He should think there was a furnace known in which one could raise a filament to a temperature of 1,850 deg., at the same time keeping it in a gas such as hydrogen. There would have been no difficulty in constructing one if necessary. He knew that the specification of Just and Hanaman prescribed heating by an electric current, and he knew perfectly well that the heating adopted by defendants was in a furnace at which a temperature of 1,850 deg. was reached in an atmosphere of hydrogen. It never occurred to him that there was any distinction between heating in a furnace up to 1,850 deg., the furnace being warmed by electric current, and in the other case the filament.

Mr. Terrell, K.C., said that some part of the process had been desired to be kept secret; but keeping that secret would, he found, hamper him in his cross-examination, and, as the importance of keeping it secret had gone, he would abandon the idea of trying to do so. The binder used by defendants was composed of 20 parts of binding material and 100 parts of metallic tungsten.

Witness said that was only right in respect of some filaments; for the others it was 30 grammes of tungsten to 6 grammes of binder. There was a difference in the proportion; in one case it was 4 to 1 and in the other 5 to 1. It was always 4 to 1 for thin filaments and 5 to 1 for thicker filaments. As to the composition of the binder, what he had was: "Mix 243 grammes of amyl acetate and 30 grammes of castor oil; dissolve therein 30 grammes of camphor, then add 50 grammes nitro cellulose; heat up to 130°C. in an oil bath for about half an hour, filter through asbestos." In defendants' process they did not denitrate in the size of filament he saw. Denitration was not common in the very thin filaments and not necessary. He was not sure whether the 50 grammes of nitro-cellulose would leave any carbon residue; he thought it would, but it depended on the degree of nitration. He thought it very likely that the 243 grammes of amyl acetate would leave carbon if heated under the conditions in which that got heated. The camphor would leave no carbon, but he thought the castor oil would. By heating the castor oil alone it might leave no carbonaceous matter at all. Under that process of manufacturing the filaments the castor oil would leave a carbonaceous residue, but he could only answer the question by giving an analysis of the carbonised filaments. Whether that came from the castor oil or from the nitro-cellulose or what not he could not say, but it came from the binding agent as a whole, or from what might be present in the tungsten. In 1898 Welsbach, in his osmium specification, told how they could produce a filament which would bring about efficiency by reason of its being able to stand a very high temperature. After describing Welsbach's second method, witness was asked if one read "metal tungsten" wherever the word osmium occurred was there any difference in the process described in Welsbach and the process described in the specification sued upon. In reply, witness said there were two processes dealt with there, one with steam and hydrogen, and that would work. He should [illegible] that the [illegible] process mentioned by Welsbach for osmium would [illegible] work equally well for tungsten. It might be that they did so, but reading that specification would not convey to his mind that they did, because his experience had been that, even with a small amount of hydrocarbon, if tungsten were heated in an atmosphere of that kind, there was carbon deposited. It might be that you might discover some conditions under which it would work.

Mr. Terrell read a portion of Mr. Justice Warrington's judgment in the Z. Company's case, in which the value and that Welsbach process of decarbonising in steam and hydrogen had been tried by Dr.

and hydrogen. He did not know until he tried it that those four metals would not produce a coherent metal, and he did not think that Dr. Liebman, who was with him at the time, knew it. It was a matter of text-

hydrogen. In 1904 everyone would not know perfectly well that the Welsbach process, so far as the steam and hydrogen part of it were concerned, would work. He would want to know what oxide was produced, at what temperatures, where reduction commenced, where oxidation commenced, before he could form any idea, and all that would not have been told by the common knowledge of the day. He did not know that the Siemens & Halske specification of 1904 suggested tungsten as one of the metals for filaments made with the use of agglutinants. It might have

the question was how. The defendants' filaments were made by grinding together metallic tungsten and a binding material; that binding material when it was destroyed by heat left a substantial quantity of carbon in the form of coke. The common process of making gas was similar to what happened, except that in the present case one had a large quantity of mineral present as well: it was like taking coal with a large quantity of slate mixed with it. What was left behind was coke with the metal (in a finely powdered state) mixed with it and held together by it. That was plaintiffs' case.

Mr. [illegible] said that defendants' case was that the quantity of what had been called binding material used was so small that the residue of coke was not sufficient to bind the particles together, witness said plaintiffs' specification pointed out that to get rid of the carbon and at the same time not to convert the metal (which one wanted to keep as metal) into oxide one used a mixture of steam and hydrogen. He said that the defendants had got a filament which contained carbon. They put the filament in a flowing stream of hot hydrogen, and the hydrogen defendants used was free from vapour when it came in at the top before it reached the filament, but he said in that filament there were left the products of the stuff that was used for binding and at the high temperature at which the filament was some of the product was discharged from the filaments, but of the product which was discharged part was water vapour. Plaintiffs' case was that that hydrogen, although it was perfectly dry when it came in, formed water vapour, and the water vapour acted in the way of plaintiffs' specification. For the defendants' it was said that when carbide of tungsten was made red hot in contact with the oxide of tungsten the reaction that took place was that the carbon from the carbide combined with the oxygen of the oxide and produced carbonic acid or carbonic oxide. (Carbonic acid or carbonic oxide was the result of both what plaintiffs and defendants said happened, but plaintiffs' case was the formation of a vapour first and the vapour acting upon the carbon. Defendants' case was that there was no formation of vapour, but the carbon acted upon the oxide directly and formed carbonic oxide. Witness said moisture was given off, and it acted on the carbon, but plaintiffs did not say the whole of the moisture came from the destructive distillation; it was present in the tube; it probably came from the walls of the tube. They started with the atmosphere of the

pumped the greater part of that air out, and they pumped the greater part of the moisture out, but they still had some left in. They did not prove that experimentally. The invention in Just and Hanaman's

struck-out part of plaintiffs' specification. That invention was one of forming the filament which was not a tube or a mere covering, but was a substantial filament similar to the filaments made under plaintiffs' other invention. It was a process for getting the carbon out chemically. According to the equation, carbon was converted into carbonic oxide. Of course, he did not admit that it took place, but it might be that some carbon was removed. As to Bottome's specification, witness said Bottome did not give one any proportions or anything like that, but he told one the result was a carbon filament strengthened with tungsten; that was what he put, and, therefore, one now used quantities which removed all the carbon. Bottome had no idea that all the carbon should be removed; apparently he would remove some of it. If he removed it all he would have to repeat it several times as to the soaking

Bottome told him, because he told him to work under the conditions in

put himself back to that time, and he should say, knowing the quality of tungsten metal and that it was not a ductile but a very refractory

Workmen's Compensation.

At Bow County Court recently (before Judge Smyly, K.C., and a jury), Arthur E. Attwell, engineer's fitter, claimed an award of compensation against the West Ham Corporation electricity department.

Applicant was, said his counsel (Mr. C. T. Williams), engaged in cleaning out transformer sub-stations. The electricity was generated at the main station at a pressure of 6,000 volts, and at the transformer sub-stations the pressure was reduced to 200 volts. Defendants had to regulate the working of those transformer stations in accordance with the regulations of the Home Office and to safeguard those dangerous places, so that no accident could occur. Applicant was a workman and not an expert electrician. On April 6, 1914, applicant was dusting the main incoming cable when he received a shock and was rendered unconscious.

Applicant gave evidence and said his hand was shockingly burned and charred. In his opinion there was a defect in the insulation. He was paid full wages, 37s. 6d. a week for 10 weeks, and then it was suggested that he should do light work. He did do a little walking round with the men, but was unable to do any of his former work, and his money was stopped. He was asking for an award of half wages. He was 31 years of age, and had no technical knowledge of electricity. The transformer chamber was 5 ft. square, with a barrier to keep one away from high-tension switches. When the accident happened he was dusting the porcelain where the main cable was connected with the transformer. His left hand became like a piece of bad meat. He now suffered with suffocating pains in the chest. After the accident he was asked to say that he was burnt by the lead that enclosed the wire and not the porcelain, as if he said porcelain there would have to be a Government inquiry. He had never been supplied with rubber gloves to work with. He never saw a notice stating that a high-tension switchgear might not be touched unless one wore rubber gloves or stood on the insulating stool or mat. Copies of time sheets were put in to show that the man had been used to high-pressure work, but he said somebody was always with him. Other sheets suggested that he had been working since the accident, but he denied this, and said he only walked round with the men, making out the time sheets.

The defence was that the man had never really been "shocked," only burned, and was capable of working. A mass of medical evidence was called to that effect, and the hearing was adjourned.

LEGAL INTELLIGENCE *continued on page 186.*

BOOKS RECEIVED.

[Copies of the undermentioned [illegible] The Electrician Offices, post free, unless otherwise stated. [illegible] Abroad 3s. 6d. or as outlined under 2s. and 5 per cent. for [illegible] Add 10 per cent. if abroad or for foreign books.]

"A Treatise on Hand Lettering for Engineers, Architects, Surveyors and Students of Mechanical Drawing." By W. J. Lineham. (London: Chapman & Hall.) Pp. xii + 282 [illegible]

"Constant Voltage Transmission." By Herbert B. Dwight. Pp. vii. + 115. (London: Chapman & Hall.) 5s. 6d. net.

"Transactions" of the North-East Coast Institution of Engineers and Shipbuilders. Edited by E. W. Fraser Smith. (Newcastle-on-Tyne: The Institution.) Vol. XXXI., Part 2. Pp. xxvi. + 30. 5s.

[illegible] Electricity [illegible] By [illegible]. (London: Harper & Press.) Pp. [illegible] + 127. [illegible]

Archives d'Electricité Médicale. By Prof. J. Bergonié. (Bordeaux: J. Hamel.) No. 391. Pp. 31. 1.50 fr.

Journal of the [illegible] (Philadelphia: Franklin Institute of the State of Pennsylvania.) Vol. CLXXIX., No. 6. Pp. 429. 50.

"Journal" of the Washington Academy of Sciences. (Baltimore: The Warwick Press.) Vol. V., No. 11. Pp. 305. $0.25.

American Journal of Science. By E. S. Dana. (New Haven: Tuttle, Morehouse, Taylor Co.) Vol. XXXIX., No. 234. Pp. 79. $6 per year.

The Physical Review. Vol. V., No. 5. [illegible] Pp. 395. (Lancaster, Pa.: American Physical Society.) $0.60.

Bulletin of the Bureau of [illegible] (Washington: Government Printing Office.) Vol. II., No. 3. Pp. 169.

Determination of Ammonia in [illegible] Gases." By J. D. Lewis. (Washington: Government Printing Office.) No. 34. Pp. 23. 10 cents.

A Study of Some Factors Affecting the Determination of Total Sulphur in Rubber. By J. B. Tuttle and A. Lucas. (Washington: Government Printing Office.) [illegible] Pp. 15. [illegible] cents.

Proceedings of the Royal Meteorological Society. (Westminster: Edward Stanford.) Vol. XVII., No. 1[illegible] (Annual Meeting. Presidential Address.)

Rules to be Observed in the Operation and Maintenance of Electrical Equipment and Lines." (Washington: Government Printing Office.) No. 49. Pp. 50. 15 cents.

"Proposed National Electrical Safety Code." (Washington: Government Printing Office.) No. 54. Pp. 137. [illegible] cents.

Report des Expériences [illegible] Pont de [illegible] Mesnil-Pat des Abaques. By André Blondel. (Paris: La Lumière Électrique.) Pp. 63. 3 fr.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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TRADING WITH ENEMY FIRMS.

Our attention has been called by a correspondent to the following clause which the Birmingham Corporation electricity department has introduced into all orders issued by them: "A condition of this order is that the goods supplied have not been manufactured in Germany or Austria." We understand that this matter would, had there been sufficient time for the purpose, have been discussed at the recent annual Convention of the Incorporated Municipal Electrical Association. It is regrettable that it could not have been brought forward, because we gather that many prominent borough electrical engineers hold strong views on the subject, and many others who have not hitherto expressed themselves would have welcomed the opportunity of doing so. The progress of the war and the international situation at the present time in regard to trading in general have, if anything, thrown into greater prominence the need for extreme caution in dealing with firms whose associations, directly or indirectly, with the manufacturing element are liable to give rise to the least suspicion. We have not taken the opportunity of analysing the statistics relating to the direct connection between enemy firms and the principal manufacturing industries in this country, so that we are not able definitely to state what proportion of the whole the electrical industry in this country represented at the outbreak of the war. We believe, however, that this figure must be fairly high, because electrical science and practice play so important a part, not only in the productive industries of the country, but also in the art and practice of war. We realise that every possible step has been taken by the Government to stop trading with Germany and Austria by way of such neutral countries as afford access to the Central Empires. But the sly ways of commerce are many and devious. Doubtless the Birmingham Corporation electricity department had this fact in mind when it decided to make the above stipulation a condition of any orders which it might issue. We can but feel that this stipulation is in every way justifiable, and we think that central station engineers having charge, not only of municipal but company undertakings, should make any business placed by them contingent upon a similar condition. If the British manufacturer is to be encouraged at all, now is the time to do it, when there are many firms who are in a position to do business outside the range of the Government work for which they may have contracted. It virtually amounts to this, that trading firms and individuals must break themselves of their former habit of turning to the Continent for something which the home manufacturer was either unwilling, or at the moment unable, to produce. The example set by the Birmingham Corporation will, we hope, encourage the newer fashion of trading with the home rather than with the enemy manufacturer. After so many years of depreciation of British electrical engineering work it may be a little difficult to acquire this fashion, but we think no effort should be spared to put a check upon any form of dealing with enemy countries. So far as neutrals are concerned, the contributions of Swedish, Danish and Swiss mechanical and electrical engineers to the advancement of our knowledge in the many problems with which the industry has to deal are of so great importance that we can only hope the march of events will relieve these countries of any responsibility in taking an active part in the war. Much of their experience of the heavier classes of electrical machinery and electro-chemical industries is of a unique character, and, provided always they are able to show, as many of them have done, that they are entirely unconnected financially and technically with enemy individuals or firms, it is in every way desirable that this experience should be at our disposal, more particularly for use in our Colonies and dependencies. In view of the fact that the subject was left undiscussed at the Convention, and that we have been asked to broach it in our columns, we shall welcome for publication any communications from our readers putting forward their views.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week June 21, 1915, to June 26, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]

LONDON.—*U.S.A.:* Elec. machinery, £3,599; elec. lamps, £673; elec. carbons, £604; unenumerated, £818—139 pkgs. *Switzerland:* Elec. machinery, £247. *Holland:* Elec. lamps, £4,412—9 pkgs.; flow lamps, £32; unenumerated, £15. *Sweden:* Elec. machinery, £705; telephone apparatus, £669; lamp parts, £106; unenumerated, £18. *France:* Elec. carbons, £366; lamp parts, £38; unenumerated, £179. *Canada:* Elec. carbons, £16; elec. machinery, £176.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £55. *Melbourne:* Elec. machinery, £160; wire and cable, £3,338; unenumerated, £3,254. *Sydney:* Elec. machinery, £2,017; wire and cable, £2,091; unenumerated, £1,916. *Wellington:* Elec. machinery, £167; unenumerated, £576. *Brisbane:* Elec. machinery, £28; wire and cable, £2,398; unenumerated, £669. *Dunedin:* Wire and cable, £85. *Christchurch:* Unenumerated, £173. *Perth:* Wire and cable, £234; elec. machinery, £88; unenumerated, £113. *New Plymouth:* Unenumerated, £32. *Nelson:* Unenumerated, £19. *Lyttelton:* Unenumerated, £180. *Fremantle:* Wire and cable, £18. *Adelaide:* Elec. machinery, £46. *Bundaberg:* Wire and cable, £57. *Cairns:* Wire and cable, £75. *Launceston:* Unenumerated, £21.

[illegible] £44

ated, £474. *Port Elizabeth:* Elec. machinery, £112; unenumerated, £843. *Cape Town:* Elec. machinery, £1,009; wire and cable, £51; wireless telegraph material, £275; unenumerated, £124. *East London:* Wire and cable, £19; elec. machinery, £297; telegraph material, £19; unenumerated, £586. *Beira:* Unenumerated, £17. *Lobito:* Telegraph material, £28. *Mauritius:* Unenumerated, £51. *Madeira:* Telegraph material, £86.

EGYPT.—*Port Sudan:* Telegraph material, £15. *Alexandria:* Unenumerated, £177. *Port Said:* Wire and cable, £326.

ADEN.—Wire and cable, £99; unenumerated, £25.

RUSSIA.—*Petrograd:* Wire and cable, £520; unenumerated, £82. *Archangel:* Unenumerated, £279.

SPAIN.—*Huelva:* Unenumerated, £19. *Bilbao:* Unenumerated, £150.

PORTUGAL.—*Lisbon:* Unenumerated, £242.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £5,645; elec. machinery, £136; unenumerated, £592. *Montevideo:* Unenumerated, £55. *Rio de Janeiro:* Unenumerated, £14. *Rosario:* Wire and cable, £166. *Santos:* Unenumerated, £97. *Savanilla:* Unenumerated, £166. *Talcahuano:* Unenumerated, £122.

FIJI.—Unenumerated, £8.

HOLLAND.—*Amsterdam:* Wire and cable, £1,384; unenumerated, £68.

SWEDEN.—*Stockholm:* Wire and cable, £51.

DENMARK.—*Korsor:* Telegraph cable, £10,000. *Copenhagen:* Unenumerated, £182.

NORWAY.—*Christiana:* Wire and cable, £4,640; unenumerated, £88.

JAPAN.—*Yokohama:* Unenumerated, £234. *Kobe:* Unenumerated, £260.

CHINA.—*Hongkong:* Unenumerated, £199. *Shanghai:* Unenumerated, £32. *Tientsin:* Unenumerated, £172.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £807; elec. machinery, £75; unenumerated, £848. *Calcutta:* Wire and cable, £1,287; unenumerated, £735. *Colombo:* Unenumerated, £21. *Madras:* Wire and cable, £42; unenumerated, £200. *Singapore:* Telegraph material, £32; unenumerated, £510. *Kilindini:* Telegraph material, £147; unenumerated, £138. *Karachi:* Unenumerated, [illegible]

CANADA.—*Toronto:* Unenumerated, £23. *Montreal:* Elec. machinery, £392; unenu-

FRANCE. *Boulogne:* Unenumerated, £30. *Paris:* Unenumerated, £258. *Dieppe:* Elec. machinery, £49; unenumerated, £139. *Rouen:* Unenumerated, £114.

FOREIGN GOODS (duty paid and free).

[illegible]

nerated, £39. *Dieppe:* Unenumerated, £465. *Gothenburgh:* Unenumerated, £106.

[illegible]

IN TRANSIT.

NOTE.—The large number of items in these official returns under the [illegible] relate to what is described as [illegible] and [illegible] materials.

LEGAL INTELLIGENCE.

[illegible] v. [illegible]; Institution of Civil Engineers.

[illegible] connection with any work, &c. Plaintiff, a civil engineer, became a member of the Institution in 1891. At that time he was employed professionally by a Mr. Mouchel, the sole agent in the United Kingdom for Hennebique's ferro-concrete system. In 1907 Mr. Mouchel's business was turned into a company under the name of L. G. Mouchel & Partners (Ltd.), and plaintiff became a director of the company. On June 27, 1914, plaintiff received a letter from the Council of the Institution stating that they had under consideration certain allegations of the following actions on the part of firms holding themselves out to act in a professional and consultative capacity in connection with engineering works: (1) The issue of Press advertisements and circulars containing offers to render engineering services; (2) proposals of guarantees to secure the execution of designs on certain estimates; and (3) receipt of remuneration or emoluments from contractors. The Council added that they had decided that such proceedings on the part of individuals or firms acting in an advisory or consultative capacity as professional engineers were at variance with the rules of the Institution as to professional conduct, and that some of the allegations affected the firm of L. G. Mouchel & Partners.

[illegible] denied that [illegible] had broken any of the rules of the Institution and a long correspondence ensued between the Council and plaintiff and his legal advisers, and ultimately on April 22, 1915, the Council wrote the plaintiff that at a special meeting held on April 13, 1915, they had, after consideration of the advertisement on p. 34 of the issue of a journal called "Ferro Concrete," for Aug., 1914, found that he had not discharged the onus of showing that he did not know or approve of the advertisement, and that he had, therefore, been guilty of a breach of the regulations in sec. IV. of the by-laws; and that they (the Council), acting under the powers conferred upon them by the by-laws and regulations, had ordered his name to be erased from the register, and had declared him to be no longer a member of the Institution. Plaintiff began an action and now moved for an [illegible] pending the trial.

Mr. Justice NEVILLE said he could not say what the trial of the action might disclose, but, on the evidence before him he thought there had not been an infringement of natural justice. It seemed to him that plaintiff had an opportunity of meeting the case against him and was ably advised throughout, and he did not seem anxious to give more information than he did. All he had then to consider is whether there was an irregularity in the judicial proceedings of the Council, and he did not think there was.

BUSINESS NOTICES.

Patent Development. The proprietors of patent No. 13,991 of 1910, relating to "Method of and means for controlling from a distance electric apparatus, and especially telegraph apparatus and the like," desire to dispose of the patent or to grant licences thereunder. Applications to Messrs. Cruikshank & Fairweather (Ltd.), 65/66, Chancery Lane, London, W.C.

Increase of Prices. The Bastian Meter Co. state that, owing to the very great increase in the cost of raw material and labour, they are compelled to advance their prices by 20 per cent. on all orders received after July 1.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against the [illegible] Co. (Ltd.) are to be sent by Aug. 5 to Mr. A. C. W[illegible], of Mitre [illegible], Reading.

Claims against the W[illegible] Patterns, electrical engineers, Kingsland Road, Shoreditch, London, N.W., are to be sent by July 31 to Mr. [illegible], Liquidator, 5a, Chancery Lane, London, W.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bristol. An inquiry was held in Bristol into the application of the Corporation for [illegible] to borrow £[illegible] for the electricity undertaking.

[illegible] £6,000 [illegible] £[illegible] for [illegible] hours, &c., the balance being [illegible] expenditure.

The Town Clerk, the city electrical engineer (Mr. H. Faraday Proctor) and the chairman of the Electricity Committee (Ald. Pearson) gave evidence in support of the application.

Mr. H. FARADAY PROCTOR said the most important point was the question of the present and prospective load and the capacity of the plant. The power supply and lighting supply were distinct. In the last few days applications for electrical energy had been made from munition factories. In one of the [illegible] of machinery of large capacity, the load would be in excess of the [illegible] plant capacity. He gave technical particulars of the plant [illegible] proposed to [illegible]. In reply to Mr. Robb[illegible], Mr. Proctor [illegible] said the demands for electricity were [illegible] and not [illegible]. He could not say that the [illegible] would be [illegible] in part. He did not suppose [illegible] the war, but the high [illegible] of material

they could manage to do without what was applied for. The most profit was not made from lighting, but from power.

The TOWN CLERK pointed out that the Council ought to be prepared to give a much larger supply for the making of munitions.

Coventry.—The Corporation decided on Tuesday to a site for a sub-station in Park Side.

It was reported that there was a net profit of £102 on the past year's working of the tramways, and £1,193 was carried forward.

Darlington.—An inquiry was held here last week into the application of the Corporation for sanction to borrow £31,950 for additional generating plant at the electricity works.

The town clerk (Mr. H. G. STEPHENSON) explained that but for the exceptional circumstances the Corporation would not have entertained the idea of such expenditure. They were supplying electrical energy to numerous works which were engaged on Government work, and in January last, in consequence of the probable large increased demand upon their works, he wrote to the L.G. Board, pointing out that the Council considered it necessary to prepare estimates at once and obtain tenders for the additional plant required. The position the Corporation had to face was the probable requirements of all the works and what machinery was most likely to be useful and economical after the war, and they were advised that a 3,000 kw. set was the best, and they made their estimates on that basis. The present maximum capacity of the whole plant was about 3,500 kw., and it was estimated that the maximum load in the coming winter would be about 3,600 kw. The maximum output at present with the largest set disabled was 2,400 kw., so that it would be impossible without additional plant to supply the prospective demand if one of the sets was disabled as had happened recently.

Mr. A. C. STAMER, assistant mechanical engineer to the North-Eastern Railway Co., said that about half the machinery at North-road, as distinct from Stooperdale, was steam driven, and they intended to substitute for it electric power. They would require at least 1,100 kw. to 1,200 kw., and they were anxious to secure the supply as soon as possible. Their generating plant was working up to its maximum capacity and if they took on more work and had to put down more tools and machinery they had no power to work it with.

Technical evidence was given by Mr. J. R. P. Lunn, electrical engineer, and the inquiry closed.

Luton.—The electrical engineer (Mr. W. H. Cooke) has reported that the expenditure on the recently completed extensions of generating plant and buildings will probably exceed the loan sanctioned by about £1,800.

The excess expenditure is chiefly attributable to the increased cost of materials, and a sum of about £600, although it is capital expenditure, cannot be included in a loan. The Electricity Committee has deferred the question of applying for sanction to borrow until the precise figures are ascertained.

The committee has decided to increase the amount paid to the Corporation for the services rendered by the various departments to the undertaking from £63 to £200 per annum as from April 1 last.

Manchester.—The L.G. Board have authorised the Corporation to borrow £432,470 for the erection of a new generating station at Barton.

The Corporation asked for leave to borrow £543,000, but at the local inquiry the deputy town clerk (Mr. P. M. Heath) announced that they were willing to limit the loan to £432,470, leaving the balance to be dealt with at a later date. The sanction only relates to the completion of the first section of the new station. Many large engineering firms, who are engaged in the manufacture of the munitions of war, are dependent on the Corporation for electrical current and energy, and no doubt this fact influenced the L.G. Board in sanctioning the scheme.

Northampton.—[illegible] Mr. A. P. TRIPP, [illegible] to the Board of Trade, held an inquiry into [illegible] the proposed of the Northampton Electric Light & Power Co. to erect a new generating station on the [illegible] Mr. [illegible] the Borough Council.

Mr. H. H. [illegible] proposals, and produced plans, &c. He said the machinery and generating plant [illegible] The boilers and fur[illegible] the [illegible] Lodge. The output [illegible] in the last [illegible] output not being [illegible]

Mr. [illegible] which dealt with the interference with the local [illegible] more sorry than he to spoil the beauty of a piece of country, but, unfortunately, the Act of Parliament did not take count of that.

The [illegible] was that the chief work of the company would be [illegible] borough boundary. He asked the [illegible] the Corporation [illegible] the works would not affect the [illegible] premises in the borough.

The [illegible] Mr. [illegible] value did not affect [illegible] works and the [illegible]

The [illegible] and the question of [illegible] gate. The only object [illegible] of numerous [illegible]

Mr. W. A. WALKER (a shareholder in the company) and others objected on the ground that the chimneys of the proposed building would not be high enough to carry away what smoke there might be.

Nuneaton.—Mains are to be extended in two thoroughfares at a cost of £130.

St. Pancras.—The L.C.C. recently asked the Borough Council to consider the possibility of postponing the installation of four new boilers at [illegible] station.

The Electricity Committee has reported that the Borough Council are committed by contract to the total expenditure (£22,530), that two of the boilers are approaching completion, and the contractors have asked for payment in respect thereof. However, they suggest that the contractors should be communicated with to see if anything can be arranged with them to postpone for the present the completion of the other two boilers.

The committee is of opinion that, in view of the exceptional conditions prevailing, the Council should increase the charges for current by 10 per cent. Mains are to be extended in two streets at a cost of £151.

Salford.—At a special meeting of the Council last week the proposal to purchase and erect a new 5,000 kw. Westinghouse turbo-alternator at the electricity works was confirmed, but the purchase price (£19,225) is to come out of the depreciation fund.

Some members of the Council opposed this course and thought the money should be raised on loan, but it was decided by 28 votes to nine to find the money as stated.

Southwark (London).—Mains are to be extended to the works of the Atlas Joinery Co. (who intend to install two additional 35 h.p. motors) at a cost of £130.

Stepney (London).—On Tuesday the London County Council sanctioned a loan of £21,000 for extensions of the electricity supply department.

Wolverhampton.—Last week the Electricity Committee was authorised to purchase two automatic stokers for the electricity works at a cost of £900.

GENERAL.

Aberdare.—The Council have decided to adopt electric lighting for the Council's tenement houses at Aberaman. The cost of wiring and fitting each tenement will be about £3, and the electric current will be supplied at 6d. each per week.

Bromley (Kent).—The charge for electric current has been increased by 10 per cent. for all purposes.

Castletownbere (co. Cork).—An inquiry was recently held here into the application of the Rural Council for urban powers to enable them to carry out an electric lighting scheme for the town.

Dumbarton.—Last week the Dean of Guild Court granted permission to Messrs. Babcock & Wilcox to erect an electric sub-station at Dumbruck works.

Epsom.—The Council has adopted the following alternative scale of charges for current :—

Up to 1,800 units per annum 5½d. per unit, from 1,800 to 3,000 4d., from 3,000 to 6,000 3½d., from 6,000 to 9,000 3d., from 9,000 to 12,000 1½d., and over 12,000 units 3d. per unit. The present price to ordinary consumers is 5½d. per unit.

Hornsey.—In accordance with the terms of the Order of 1912 arrangements have been made for the Tottenham District Light, [illegible] Co. to take over the supplying of electricity to St. Andrew's Church and other premises in Alexandra Park-road, Wood Green.

The L.G. Board have sanctioned the raising of an additional £2,000 for the extension of mains. This is a part of £6,000 loan to which they gave assent before the war broke out.

Kingston-on-Thames.—Last week the Lighting Committee reported that Mr. [illegible] engineer to the borough electrical undertaking, had left the employ of the Corporation on April 17, and since that time his duties had been carried out by Mr. T. A. Kingham, [illegible]

On the recommendation of the Works sub-committee, the Lighting Committee resolved to appoint Mr. Kingham chief assistant and superintendent of mains at £3 a week, to be increased to £3. 10s. per week on [illegible] and to £4 per week on [illegible] 1916. There was a long debate upon the question and ultimately an amendment by Councillor Wyeth to postpone the matter until after they had received the annual engineer's report and the annual financial statement was carried.

Luton.—The Electricity Committee has reported that the charge of 2d. per unit for current supplied for street lighting to 1d. the charge for power during daytime and for heating and operating lifts to be continued at half-penny, and to fix the charge for current supplied for motive power [illegible] the opinion of each committee concerned) at 3d. per unit for the present, or at the maximum demand rate [illegible] with a reduction [illegible] of 10 per cent.

Market Weighton (Yorks).—The Rural Council have made an arrangement with Mr. C. H. Best for establishing electric supply works in the district.

Rochdale.—The price of electric current for lighting has been increased by 10 per cent., and for power by 15 per cent.

St. Pancras (London).—Owing to the advisability of having a recognised deputy electrical engineer in control of the electricity works in the absence of the chief electrical engineer, it is proposed to alter the title of Mr. J. T. Baron, resident and supervising engineer, to that of deputy electrical engineer (resident), such alteration to be made without any increase of salary.

Scarborough.—The local electric supply company has increased the charges for electric current by 10 per cent.

Wharfedale (Yorks).—Rawdon Urban Council have decided not to join with the neighbouring local authorities in the proposed scheme for supplying electricity in the Wharfedale district.

Wrexham.—The Corporation have placed the electricity works at the disposal of the local Munitions Committee.

LIGHTING, POWER & HEATING NOTES.

Electric Cooking in a Colliery.—In a coal mine of the United States Coal & Coke Co., at McDowell (W. Virginia), there is a restaurant for the miners in which all the cooking, coffee making, &c., is performed electrically. The restaurant is 200 ft. under ground and 425 ft. from the mouth of the pit.

Electric Power in Collieries.—The Blackwell Colliery Co. have decided to put down two 750 kw. mixed pressure turbo-generators at their "A" Winning Colliery.

The exhaust steam from the two winding engines and fan engine will be supplied to the turbines, and the existing underground haulage will be extended by the addition of new haulage gears, while the steam haulages will be converted to the electric drive, thus taking all steam from the shaft. The company also propose to add a 400 kw. compound engine and generator to the plant at their Sutton Colliery, and a new fan to be direct-coupled to an enclosed self-lubricating engine. The whole of the work will be carried out to the specification and under the direction of the consulting engineers, Messrs. W. C. & K. A. Mountain.

Electricity in Mining.—The directors' report of the Mount Lyell Mining & Railway Co. for the half-year ended March 31 states that the Lake Margaret hydro-electric scheme was completed and put into commission in November last, and that was the main factor in the reduction of their costs. The effect of the economies resulting from the scheme should be more fully reflected in the current half-year. The scheme had already justified itself, the expenditure to date being £164,353, including the cost of the new blower plant.

Kilkeel (Ireland).—The Rural Council have decided to obtain urban powers to enable them to adopt public electric lighting.

Poor Law Institution Lighting.—Barnet Guardians have referred to a small committee (with power to consult an electrical engineer) the question of the present plant and the possibility of its expansion, and as to whether it would not be better to take the whole supply from an outside source.

School Lighting.—Gillingham Education Committee recommend the Council to adopt electric lighting for the non-provided schools, the Council bearing the cost of the wiring, &c., and charging the Committee a sum to cover the cost of current, hire of fittings and installation.

TRACTION NOTES.

Edinburgh.—An electric-driven lorry was recently built for the Electric Lighting Committee by Edison Accumulator (Ltd.), at a cost of £665.

The lorry has a load capacity of 30 cwt. With a full charge the lorry is capable of travelling 40 miles and 50 miles with a half load. The speed is restricted to 12 miles per hour. With electrical energy at 1d. per unit the cost per mile will not exceed 7·10d. on fairly level roads with a good surface.

The corporation have agreed to supply electricity for charging lorries, &c., at 1d. per unit, and have made arrangements not only for charging the lorries at Morningside station.

L.C.C. Tramways.—For the year ended March 31 there was a deficit of £33,172 on the tramway undertaking of the London County Council after providing for debt charges (£105,005) and other charges, and this sum is provided out of the general reserve fund. The [illegible] proposed to be raised by the County Council on [illegible].

The gross receipts were £2,760,817, working expenses were £1,700,571, [illegible] £690,074, but [illegible] required £732,418. After [illegible] the reserve fund [illegible] to £167,050. The [illegible] by electric traction was £1,617,034 (including [illegible] £42,300), or 0·61d. per car-mile run, compared with 0·66d. in 1913-14. Included in [illegible] £9,185 [illegible] the approved [illegible] to send a car mile. The total receipts in respect of electric traction were £2,389,046, or 9·77d. per car-mile, compared with 9·21d.; from lines operated by horse traction the receipts were £10,800. 11s. 9d., or 9·51d. a car-mile, compared with 8·15d. The total number of passengers carried was 550,497,993, against 522,952,640. This figure is, however, not altogether comparable with that for 1914-15, as in 1913-14 a passenger purchasing a transfer ticket was usually in effect counted as two, owing to the fact that two tickets (one on each car) were issued to him. During the last four months of the past year the use of apparatus obtained for cancelling tickets obviated the necessity of issuing exchange tickets. The capital expenditure at March 31 was £13,315,723, of which £287,604 represents expenditure during the past year. The total debt incurred to that date was £13,744,806, but the net debt (debt outstanding less sinking fund and less £122,216 in respect of value of surplus land) was £9,836,187. The remaining horse tramcars having been withdrawn, the system in operation now consists entirely of electric tramways. The horse lines will be electrified as soon as circumstances permit. The sum paid as rates on the permanent way amounted in 1914-15 to £87,827. 18s. 11d., and represented an average relief to the rates of London as a whole of nearly ¼d. in the £, or over ½d. in the £ in regard to those metropolitan boroughs in which tramways were operated. It was estimated by the Council's officers that the annual saving to the road authorities in consequence of the obligation of the Council to maintain the paving along the tramway routes amounts on the present mileage to about £134,400. The expenditure incurred by the Council in respect of the maintenance of the tramway tracks during 1914-15 was 0·411d. a car-mile.

The Highways Committee refer to the steps taken to improve the financial position of the tramway undertaking, and they state that they attach great importance to consolidation and linking up of the present tramways, a matter which has been in abeyance for the present. The conditions under which the undertaking has been worked since the outbreak of war have been abnormal, producing results not fairly comparable with results under normal conditions. During the first four months of the financial year the tramways were worked under normal conditions, the results being satisfactory. The receipts from April 1 to Aug. 5, 1914 (the day after the declaration of war), were about 5½ per cent. more than the receipts for the corresponding period of 1913, clearly showing that an upward tendency had set in, and that the efforts made to improve the position of the undertaking were being attended with success.

Southampton.—The Council has adopted the suggestion of the tramways manager (Mr. W. T. Robson) for the institution of a merit badge system for motormen.

Tottenham.—The Urban Council are negotiating with the Metropolitan Electric Tramways (Ltd.) as to the repair and maintenance of the tramway tracks in Tottenham under the jurisdiction of the Company.

TELEGRAPH AND TELEPHONE NOTES.

Radiotelegraph Note. It is announced from Washington that Messrs. Lansing, Daniels & Redefild, Secretaries of State (Navy Department and the Department of Commerce), have held a conference on the working of the radio stations in the United States, and that it has been decided by the Government to keep a stricter watch upon messages received and sent by wireless telegraphy. It is reported that the Germans are violating the neutrality of the country by sending information and war orders over their system, which comes in at Sayville, Long Island. This big Telefunken station has recently been changed from 35 kw. to 100 kw., and three 500 ft. towers have been placed in position, making the Sayville one of the most powerful transatlantic stations. The extended plant has been duly licensed and all messages are presumably under the supervision of the U.S. Government Department, but it is said to have become evident there is [illegible] stating more careful supervision.

Scottish Trunk Telephone Service.—A meeting was held last week of the Glasgow Committee appointed to advise the Postmaster-General on the telephone and telegraph service, when statistics relating to the Glasgow, Scotland South-West and Scotland North-West districts were submitted.

At the previous meeting the Committee had under consideration the question of the interruption of the telephone trunk service caused by storms, and they represented to the Postmaster General that at least a portion of the wires on all the principal trunk routes should be placed underground. A letter from the Postmaster-General was now submitted, to the effect that he recognised the desirability of laying underground cables on the most important trunk routes, and that further works of that kind would be undertaken as opportunity afforded. In September it was announced that additional underground cables were being laid from Glasgow to Edinburgh and Glasgow to Paisley, and also between Glasgow and Coatbridge, Airdrie, Motherwell, Hamilton, Wishaw and Kilmarnock, and that cables to other towns would be laid as soon as suitable opportunity arose. It also that when these arrangements were completed the telephone service between Glasgow and the differens towns would be as rapid as the telephone services between exchanges in one and the same area. The Committee also considered a further letter from the Postmaster General, in which he stated that the time was approaching when he could carry out arrangements whereby an accelerated trunk

service would be given between Glasgow and Paisley telephone areas, and that he hoped to be soon in a position to accelerate the service between Glasgow and Edinburgh.

EMPIRE NOTES.

Australasia.—"Tenders" (Melbourne and Sydney) says Subiaco (W. Australia) Council has asked Perth Council if the latter will be prepared to supply electrical energy in bulk for lighting in Nedlands, and, if so, on what terms.

A statement was submitted to Nunawading (Victoria) Council recently showing that the electric light plant, although it has only been in operation eight months, has 336 private consumers, and that the receipts amount to £676, and the expenditure to £431.

A company is being formed in Melbourne to take over the plant of the Toora (Victoria) Electric Light & Power Supply Co., and to extend the mains to Foster. It is proposed to utilise the Franklin River Falls, in lieu of the present gas-suction plant.

An Order in Council has been issued by the Queensland executive, authorising Barcaldine (Queensland) Council to supply electricity to the town.

The ratepayers of Albany (W. Australia) have considered the question of constructing electric tramways. Mr. H. Stirling offered, in consideration for a 40 years' concession, to lay tramlines from the deep water jetty along Brunswick-road and Stirling-avenue and along Middleton-road to Middleton Beach. The Council have promised their support but ask for a concrete proposal. The ratepayers have also asked the Council to consider the matter further and to send Mr. Stirling tentative conditions on which a concession would be granted.

Sir John McCall, Agent-General, having suggested that the Tasmanian Government should place orders for Government requirements direct with the manufacturers, representatives in Australia of overseas firms have expressed the opinion that such a scheme would be unworkable and be subversive of the best interests of the Government and those in whose charge is placed the supply of requirements. Mr. L. C. Hinwood, president of the Electrical Traders' and Contractors' Association of Victoria (writing to the "Commonwealth Engineer"), says Sir John overlooks many important features which are well known to business men and their clients. The man who purchases machinery in London buys at a better price than in Australia, because he takes all the risks, whereas when the purchase is made in Australia the Australian representative takes the risks. If a machine is purchased in London the customer does not know how much it will cost him to land it, and when the machine is put into service troubles may develop, and he finds that there is no one to whom he can turn to get over those troubles. If he purchases his requirements through the Australian representatives they stand behind machinery which they have supplied, and their expert advice is available.

In some cases machinery has been ordered direct which has been unsuitable and unworkable. Mr. Hinwood asks whether Sir John suggests that Australian traders should retire altogether from the field, and all purchases be made direct in London, or does he propose that Australian traders should engage expert men at good salaries and maintain staffs simply to take care of the emergency conditions of people who, whenever they can do so, place their orders direct with the factories?

Mr. G. L. Just, the Edison & Swan Co.'s manager at Melbourne, says all the best British electrical manufacturers are represented in Australia by branch houses, and they are able to quote the same terms as the London offices. Sir John McCall referred in a recent report to machinery on which £137 was saved by buying in London, but past experience goes to show that in the majority of cases the conditions of purchase in London are distinctly in favour of the supplier, as against the conditions for local purchase in Australia. Generally speaking, payment is made by Tasmanian cheque for local purchases, whereas when purchasing in London payments are generally made cash against documents in London, making a difference of about three months in the terms asked for by the purchaser, and practically abandoning all hope of claim should there be any material supplied not in accordance with the specification. Primage charges were mentioned by Sir John, but he did not make it clear that private firms also received a rebate of 10 per cent.

The proposal to create in New Zealand a Board of Trade and Industries, which would be investigatory and advisory, would be always at work in the four centres simultaneously, and would have a permanent head so as to ensure continuity though Governments may change, is favoured by the Prime Minister (Mr. Massey). The Board would consist of 40 members, 24 of whom would constitute various committees, while 12 would form a central committee, but Mr. Massey thinks the numbers too large, and a small representative committee would be more likely to discuss the matter.

When the Victorian Railways Commissioners recently submitted the proposed extensions of the Melbourne northern tramway service through Brunswick to Coburg, they did so on the condition that the Trust undertook not to enter into any arrangement with the Melbourne Tramway & Omnibus Co. in regard to the construction of [illegible] electric lines and the company's cable lines, and [illegible] over any of the lines controlled by the company. The Commissioners have now withdrawn the conditions.

British North Borneo.—In a report by the Director of Public Works (Mr. O. N. Anderson) it is stated that the electric lighting of Kuala Lumpur continues to give satisfaction, and a tender has been accepted for an electric lighting scheme for Seremban.

India.—"Indian Industries and Power" says the Lawrence Asylum authorities are not favourably disposed towards the utilisation of St. Lawrence Lake in generating electrical energy for the lighting of Cotacamund. It is reported that the Kalhutty Falls have been investigated, are likely to prove more suitable, and in all probability power will be generated there.

The "Indian Engineer" says there have been many complaints regarding the electric lighting in Bangalore, but this is to be rectified by July 16, when plant which has been in use for 12 years at Sivasamudram is to be replaced by modern machinery. Mr. H. P. Gibbs (formerly chief electrical engineer to the Mysore Government) is consulting engineer.

The position of electrical engineer to the Punjab Government has been recently created. The holder of the position will advise the Government in all electrical matters and will have charge of the staff on electrical work under the buildings and roads branch. Unless otherwise ordered by the Local Government, he will rank as an executive engineer, Public Works Department, in charge of a division, and he will be empowered to accept tenders for works up to R.5,000 (about £333).

FOREIGN NOTES.

Algeria.—The Chamber of Commerce of Algiers has been authorised to lend a sum of £2,976 to the Government-General of Algiers for the provision of a telephone system between Warnier, Malakoff, Masséna, Lamartine, Beni Indel and Bou-Ceid.

Berlin.—It is reported that the Municipal Council propose to issue a loan of £14,430,000 for the purchase of the Berlin electricity works and for constructing a new subway.

China.—The British Consul-General at Yunnan-fu, reporting on the trade of Mengtsu for 1914 says:—

The great drawback to British trade in the Province of Mengtsu has been the lack of any British firm to represent United Kingdom manufacturers, but there is a good prospect of this deficiency being remedied in the near future. The two German firms which have supplied local buyers with machinery, &c., can now obtain no further supplies, and the Chinese would welcome the establishment of a British firm in Mengtsu. There are inquiries for pumps, electric light machinery, locomotives and trucks for the Pishihchai Railway, &c. Contracts must be made c.i.f. at Haiphong, and it may be necessary to assist in the erection of the machinery and to arrange the question of exchange. The representative of the machinery department of a Hong Kong firm is now in the province looking into these matters, and there is a good prospect of some of the inquiries resulting in the placing of orders with United Kingdom manufacturers.

The British Consul at Dairen says the purchases by the South Manchurian Railway Co. in 1914 included electrical apparatus from the United Kingdom value £601 (compared with £7,132 in 1913), from U.S.A. £655 (£280), Germany £32,417 (£14,139); and machinery, U.K. £15,270 (£43,194), U.S.A. £7,596 (£12,302), Germany £14,515 (£45,354).

Electric Cooking Progress in America.—It would appear from a short article in the "Electrical World" that electric cooking is making rapid progress in the United States.

In the district supplied by the Puget Sound Traction, Light & Power Co. (Seattle, Wash.), over 500 electric ranges of one make, in addition to a number of ranges made by other manufacturers, were installed last year. The majority of the users of electric ranges belong to the middle class, but some wealthy consumers use electricity exclusively for cooking.

Venezuela.—The Puerto Cabello & Valencia Electric Railway Co. recently secured a 99 years' concession for constructing an overhead cable tramway from Valencia to Naguas, about 37 miles.

For the first 6½ miles from Valencia the line will be operated electrically, and electric current will be supplied from the electricity works in Valencia, but oil, gas or steam power will be employed on the remainder of the tramway.

MISCELLANEOUS NOTES.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade have issued lists 26 and 27 of articles inquired for and of which the sources of supply or members have been interfered with by the war.

The articles wanted include permanent magnets, wood or chonte separators for portable batteries, clocks for electrical signs, commercial [illegible] powder, &c. British firms should communicate with the Director, 73, Basinghall street, London, E.C.

Heroic Conduct Rewarded.—Last week the Lord Mayor of Birmingham, on behalf of the Society for the Protection of Life from Fire, presented to Edward Macdonald, an employé of the electric supply department, a silver medal and a gratuity of five guineas, and to Police-constable Morgan a bronze medal and three guineas.

Ald. BOWATER explained that Macdonald and Morgan acted in a brave

and noble manner in attempting to rescue a workman engaged at the Alma-street power station, who, in an awkward and almost inaccessible place, had by some means touched a "live" wire and formed a short circuit, which produced a fusion of the wires and covered him with flames, burning him terribly. While Macdonald was making efforts to get out his fellow workman Police-constable Morgan arrived, and after a lot of trouble, and in spite of the fumes and flames and the cramped position, the man was rescued.

Inquests. The adjourned inquest on the lad Thomas Lewis, who was killed on the 18th ult. at the Redheugh Steel & Iron Co.'s works, Gateshead, was resumed last week.

Evidence was given that deceased had worked there for about six months. On June 18 he and another lad went to work at 6 p.m. on the night shift. They had been told that the lights might be put out in a certain event. At 11:40 p.m., during a rest interval, the two strolled through the works, and deceased put his hand on a pole from which an electric lamp was hanging and tried to touch the electric wire. The lad fell back, and his companion said that when he touched him he received an electrical shock. Efforts were made to get him off the wire, and when assistance arrived Lewis was apparently dead.

Richard Stamp, a fitter's man at the works, said there was a low-rating wire attached to the hanging electric lamp. The lamp was not alight at the time of the occurrence. Witness saw Lewis holding the lamp wire with both hands, and he made several attempts to free him from the wire, and received a severe shock. He succeeded in freeing him eventually, and witness was so badly shaken that he had to go home.

Another witness said the lamp was alight at 11:45 p.m., but when his attention was called to Lewis the lamp was out. He had had to warn the lads against shouting "Lights out." The wires were properly insulated. The lamp had gone out through the carbon sticking.

Mr. Thos. R. Parry, electrical engineer of the County of Durham Electric Supply Co., said there was evidently a fault in the insulation of the lamp, which caused the casing to be alive. He suggested that the suspension wire became alive through coming into contact with the shade of the lamp, and that could only be done by pulling the lamp up by the suspension wire.

The jury found that the boy had been "Accidentally killed by improperly taking hold of a lamp suspension wire, which had by some unaccountable means become charged with electricity."

At Manchester last week an inquest was held on a fitter named Marshall, who died while being taken to Ancoats Hospital on the 19th ult.

Evidence was given that while deceased was attending to an electric starter at the works of Messrs. J. & W. Bellhouse, of Miles Platting, the electric current was switched on, and he was fatally injured.

Robert Lilley, a wood machinist, stated that when he had done his work deceased and he went to the sub-station at the works to switch off the current, and about two minutes later he switched it on again at the request of the head horsekeeper. Afterwards he found Marshall by the starter with very little life in him. Although the cover of the switch had not been replaced, witness did not know Marshall was going back. It was suggested that Marshall was about to replace the cover when he noticed something which needed attention, and, assuming that the current was still off, touched a "live" portion of the mechanism.

Mr. H. Seal, H.M. Inspector of Factories, said the requirements of the Factory Acts were carried out, and the jury returned a verdict of accidental death.

Trading with the Enemy. On June 25 H.M. the King issued a Proclamation that the Proclamations in force relating to trading with the enemy shall, as from July 26, apply to any person or body of persons corporate or unincorporate, residing or trading in China, Siam, Persia or Morocco.

Prohibition of Exports. On June 25 H.M. the King issued a Proclamation that the export of all articles to the Netherlands is prohibited, unless such articles are consigned to the Netherlands Oversea Trust (or, in the case of any prohibited or restricted goods which are authorised by licence to be exported, the person named in the licence as consignee).

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during May, 1915, and (*b*) the aggregate figures from Jan. 1 to May 31, with the increases or decreases compared with the corresponding periods of 1914:

Electrical machinery, (*a*) £181,230 (including generators and motors other than for aeroplanes, motor cars and cycles, £39,673, and electrical machinery unenumerated, £141,557) (increase £17,323), (*b*) £770,694 (including generators and motors other than for aeroplanes, motor cars and cycles, £126,728, and electrical machinery unenumerated, £643,966) (increase £70,252); telegraph and telephone cables other than submarine, (*a*) £3,516 (decrease £1,053), (*b*) £12,525 (decrease £18,301); telegraph and telephone apparatus, (*a*) £12,125 (decrease £12,010), (*b*) £30,486 (decrease £78,967); other electrical wires and cables, rubber insulated, (*a*) £11,024 (decrease £19,140), (*b*) £40,716 (decrease £11,314); with other insulations, (*a*) £949 (decrease £5,829) (*b*) £107,502 (decrease £28,099); carbons, (*a*) £7,496 (decrease £7,696), (*b*) £43,066 (decrease £31,522); glow lamps, (*a*) £9,614 (decrease £547), (*b*) £53,446 (decrease £19,273); arc lamps and electric searchlights, (*a*) £290 (decrease £249), (*b*) £1,153 (decrease £13); parts of arc lamps and searchlights (other than carbons), (*a*) nil (decrease £382), (*b*) £1,153 (decrease £395); primary and secondary batteries, (*a*) £11,202 (increase £3,631), (*b*) £54,271 (increase £16,060); meters and measuring instruments.* (*a*) £2,988, (*b*) £10,992; switchboards,* (*a*) £183, (*b*) £3,146; electrical goods and apparatus unenumerated, (*a*) £20,244, (*b*) £75,008. Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £87,588 (decrease £39,269), (*b*) £371,300 (decrease £308,944).

Exports.—The exports of electrical machinery, material, &c., (*a*) during May, 1915, and (*b*) from Jan. 1 to May 31, with the increase or decreases compared with the corresponding periods of 1914, were as follows:—

Electrical machinery, (*a*) £150,656 (including railway and tramway motors, £15,001, generators and motors other than for aeroplanes, motor cars and cycles £78,748 and electrical machinery unenumerated, £56,907) (decrease £65,961), (*b*) £593,008 (including railway and tramway motors £70,507, generators and motors other than for aeroplanes, motor cars and cycles, £260,804, and electrical machinery unenumerated, £261,697) (decrease £541,048); telegraph and telephone cables, submarine, (*a*) £3,379 (decrease £134,386), (*b*) £149,654 (decrease £89,076); other than submarine, (*a*) £45,531 (increase £8,657), (*b*) £184,265 (increase £20,855); telegraph and telephone apparatus, (*a*) £17,760 (decrease £9,656), (*b*) £87,141 (decrease £39,501); other electrical wires and cables, rubber insulated, (*a*) £28,105 (decrease £4,762), (*b*) £117,083 (decrease £40,870); with other insulation, (*a*) £37,395 (decrease £8,549), (*b*) £158,060 (decrease £37,757); carbons, (*a*) £803 (increase £121), (*b*) £2,539 (decrease £1,601); glow lamps, (*a*) £10,558 (decrease £1,407), (*b*) £54,408 (decrease £2,594); arc lamps and searchlights, (*a*) £354 (decrease £1,007), (*b*) £1,696 (decrease £5,047); parts of arc lamps and searchlights (other than carbons), (*a*) £3,550 (increase £1,861), (*b*) £7,517 (decrease £8,449); primary and secondary batteries, (*a*) £13,952 (decrease £5,431), (*b*) £82,443 (increase £4,628); meters and measuring implements.* (*a*) £14,855, (*b*) £64,385; transformers,* (*a*) £2,714, (*b*) £22,246; switchboards,* (*a*) £6,190, (*b*) £22,630; electrical goods and apparatus unenumerated, (*a*) £48,414 (decrease £22,468), (*b*) £239,125 (decrease £149,606). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £233,560 (decrease £153,268), (*b*) £1,193,192 (decrease £239,757).

* Not enumerated separately in previous years.

TENDERS INVITED.

Turbo-Alternator and Condenser.

The Electricity Committee of [illegible] Corporation invite tenders for the supply, erection and setting to work, of one 5,000 kw. Turbo-alternator, with Exciter, and one Condenser Outfit. [illegible] Tenders addressed to the chairman of the Electricity Committee, Guildhall, to be sent post Thursday, July 15, [illegible]

Carbons.

The Electricity Supply Committee of Dublin Corporation invite tenders for the supply of various classes of Carbons. Particulars and forms of tender from the City Electrical Engineer, and tenders to the Secretary of the Committee, Lord Edward Street, Dublin, by noon July 12. [illegible]

Turbo-Alternators, Motor Generators, Transformers, Boilers, &c.

Edinburgh Corporation invite tenders for the supply and erection of One 1,000 k.w. Motor Converter and Transformer. Copies of specification, forms of tender, &c., from the engineer, Mr. E. A. Newington, Dewar place, Edinburgh. Specification, general conditions and drawing can be seen at, but not obtained from, the office of the electrical engineer, Sir A. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders, addressed to the town clerk, Sir Thomas Hunter, W.S., City chambers, Edinburgh, by 10 a.m. Monday, July 12.

Erith Urban Council require tenders by noon July 5 for supply and erection of Water-tube Boiler, with Superheater, Economiser, Automatic Stoker, &c., 2,000 kw. Turbo-alternator, Condensing Plant, and Switchgear. Specifications from the Engineer and Manager of the Electricity Department.

Turbo-Alternators, Motor Generators, Transformers, Boilers, &c.

SYDNEY (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

Tenders are invited for the supply and delivery in MELBOURNE of one 1,000-kw. direct-current Generator with Field Regulator and accessories, one Liquid Starter with accessories, &c. Tender forms, &c., from the agents for City Council (Messrs. McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-bldgs., London E.C. Tenders to Chairman of Electric Supply Committee, Town Hall, Melbourne, by 10 a.m. Aug. 11.

Tenders are required by noon July 14 for the supply of two Three-phase Oil-cooled Transformers (75 kva. each), and by July 21 for a 250 k.v.a. Turbo-generator, for the NEW SOUTH WALES GOVERNMENT RAILWAYS DEPT. Specifications from the Electrical Engineer, 61, Hunter-street, Sydney.

Wiring and Fittings.

The WALSALL and WEST BROMWICH Unions Joint Committee require tenders by 4 p.m. July 5 for the Electric Lighting of new buildings in Great Barr Park. Specifications from the Clerk to the Committee, 22, Lombard-street, West Bromwich.

Telephone and Telegraph Material, Wire, Instruments, &c.

The Deputy Postmaster-General, Perth (W.A.) will receive tenders until 3 p.m. July 7 for 3140 Porcelain (or Stoneware) Insulators (schedule 432 W.A.) for the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department. Sample may be seen at the offices of the High Commissioner for the Commonwealth, 72, Victoria Street, London, S.W.

The Deputy Postmaster-General, Perth (W. Australia) requires tenders by 3 p.m. July 21 for 40 Trembling Bells, 3 lb. Gran. Carbon, 1,000 Earth Clips, 33,000 Fuses in tubes and 6 Galvanometers (Schedule 423 W.A.) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification, &c., from the Deputy Postmaster-General.

The Deputy Postmaster-General, Adelaide, will receive tenders until 2 p.m. July 14 for the supply of Galvanised Iron Wire to the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department. Specifications, &c., may be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Perth (W. Australia), requires tenders by 3 p.m., Aug. 11, for Telegraph Instruments and parts (Lightning Arresters and Mica Discs, Resistance Boxes, Condensers, Galvanometers, Pandographs, Morse Sounders and Switches (schedule No. 422 W.A.) for the AUSTRALIAN COMMONWEALTH, Postmaster-General's Dept. Specifications from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Adelaide, S. Australia, requires tenders by 2 p.m. Aug. 18 for 4,850 yds. Silk and Cotton Insulated Switchboard Cable, 6,160 yds. Lead-covered Paper-insulated Cable (schedule 387) and 3,080 yds. Silk and Cotton-insulated Switchboard Cable and 250 yds. Three-conductor Cord (schedule 388) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specification from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Fuses and Fuse Boxes.

SYDNEY (N.S.W.) Council want tenders by 3 p.m. July 19 for Fuses and Fuse Boxes (contract 397). Specification from the City Electrical Engineer.

Tramway Construction.

The DIRECTOR-GENERAL OF PUBLIC WORKS, MADRID, will receive tenders until noon July 31 for the construction and working (for 60 years) of an Electric Tramway between Mongat and Tiana, Province of Barcelona. The minimum rolling stock required to commence working is three motor tramcars. An option on the concession is held by Don Juan Gari.

The Director-General of Public Works, Madrid, requires tenders by noon Aug. 3 for the construction and working of an Electric Tramway between DENIA and BENIDORM (Province of Valencia), Spain. An option on the concession is held by the CIA VALENCIANA de Electricidad.

Meters and Maximum Demand Indicators.

Tenders are invited for the supply of a.c. and d.c. Meters and md. Indicators to the City of Melbourne. Copies of specification, &c., from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Propy. (Ltd.), Billiter Square-buildings, London, E.C., to whom tenders by noon July 27.

SYDNEY Municipal Council require tenders by 3 p.m. July 19 for supply of Electric Meters and Maximum Demand Indicators. Specifications from the City Electrical Engineer. (The Council will grant 10 per cent. preference on British goods and 5 per cent. preference on those of the allied countries [illegible])

Armature Winding Machines, Instruments, Converter, Cables, &c.

The VICTORIAN RAILWAY COMMISSIONERS, Spencer-street, Melbourne, require tenders by 11 a.m. July 14 for supply of two Armature Winding Machines; and Voltmeters, Amperemeters and Wattmeters. Specifications, &c., from Commissioners' Offices.

LAUNCESTON (Tasmania) Council want tenders by 4 p.m., July 26, for converter, switchgear, underground feeder cable, &c. Specifications, &c., from the City Electrical Engineer.

Electric Light Wire.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Aug. 11 for supply of 100 tons c.i. Scrap (contract No 28,924), 20 miles v.r. Electric Light Wire (No. 28,925), and 270 lengths of Seamless Copper Tubes (No. 28,936). Specifications from the Commissioners, Spencer-street, Melbourne.

H.T. Links.

JOHANNESBURG Council require tenders by noon Aug. 3 for 200 h.t. Links for power station (contract 998). Specifications from the Controller of Stores, Municipal Offices, Plein-square, Johannesburg.

TENDERS RECEIVED AND ACCEPTED.

SALFORD. The Corporation recently accepted the tender of W. T. Glover & Co. for the supply and laying of a high-tension cable from the Frederick-road electricity station to the works of the Broughton Copper Co. at £1,457.

LUTON.—The Corporation is recommended to accept the following tenders:—

British Thomson-Houston Co., two 500 kw. converters, £2,250; British Insulated & Helsby Cables, about 5,600 yds. of 0·15 sq. in. h.t. cable, at £990 per mile. The acceptance of the tenders is subject to the L.G. Board sanctioning the requisite loan.

NUNEATON.—The following tenders have been accepted by the Council for supplies for the electricity department:—

W. Lucy & Co., house service cut-outs, 10 and 25 amperes, 5s. 8d. per set, 50 amperes, 9s. per set, and street lighting brackets 16s. 9d. and 15s. each. Nuneaton Engineering Co., joint boxes, small size 4s. 6d. each, large size 5s. each.

SCHOOL LIGHTING.—The following tenders have been received by the London Education Committee for wiring in two schools:—

County Secondary School (N. Hackney)—Alpha Mfg. Co (*accepted*), £562. 1s.; A. Hawkins & Sons, £564; G. Weston & Sons, £697. 8s. 6d.; Titan Lift Co., £746.

Sclater-street (Shoreditch)—T. W. Vaughan & Co. (1914) (*accepted*), £306. 4s.; A. Hawkins & Sons, £383; Alpha Mfg. Co., £391. 4s.; T. H. Smeedon, £417. 19s.; Albion Electrical Co., £420; Titan Lift Co., £431. 10s.; G. Weston & Sons, £431. 19s.; Temple Bros., £445.

LONDON COUNTY COUNCIL.—The following contracts have been accepted for the supply of articles to the asylums:—

A. F. Goodwin & Co., electrical sundries, £111. 8s. 10d.; Pope's Electric Lamp Co., electric lamps, £261. 16s.

Orders for electrical engine have also been placed with the General Electric Co., Veritys (Ltd.), Cox-Walkers (Ltd.), Geo. Maclellan & Co., and Falk, Stadelmann & Co.

WESTMINSTER.—The Guardians are recommended to continue, for 12 months further, the agreement with the Dowsing Radiant Heat Co. for the hire of the radiant heat plant, at £12. 12s. per annum.

OLDHAM. The Education Committee have accepted the offer of the Electricity Committee to wire the Higginshaw mixed school at £200.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments:—

Postmaster-General's Dept., Adelaide—F. Kannemann, insulators £58. 2. 10d.; H. Johnson, Clapham & Morris, cut wire £574. 5s. 6d., Curtis, Palmer & Pearson £121. 17s. 6d.; Western Electric Co., cord £1. 14. 7d., do. £17. 17s. 6d., line £42. 10., do. £25. 13., plug £1. 10., do. Ericsson & Co. £10. 10., telephone meter £144. 0., do. Lineman's Set, United Elec. Light Co., cord, condite £28. 6. 3d., India Rubber Gutta Percha & Telegraph Works Co., cable £91. 17. 6d., do. £53. 12. 6d., W. G. Walton & Co., cable, insulated £39. 14. 2d.

Postmaster-General's Dept., Perth—Western Electric Co., coils for quadruplex, testing type multimeters, £7. 10., Hiram Eggers, coils Nalder Bros. type), £15.

Postmaster-General's Dept., Melbourne—Isles & Wraygood, steel beams (for use as masts), £5,182. 10.

Postmaster-General's Dept., Perth—North Western Electric Co., cords, £16. 13. 4d., J. Barraud & Son, protectors, 0·03 S. Terminal drop, £56. 6s. 8d., heat coils £4. 3s. 4d., fuses £12. 10s., carbon blocks £4. 3s. 4d., testing [illegible] £20.

Railway Engineer—A. Reynolds & Co., steel fuel hoppers, with [illegible], £1,142. 0. [illegible] & Co., electrically operated [illegible]

shed cranes £4,480; British Insulated & Helsby Cables, track bonds, £7,085. 7s. 2d.; Australian General Electric Co., railway motors and control gear for State coal mine, at rates; Richard Johnson & Nephew, galvanised telegraph wire, £45. 7s. on application; Gray Bros., steel masts, at rates.

W. Australia Government Tender Board.—Elder, Shenton & Co., electric generator, £356.

Metropolitan Board of Water Supply, &c., Sydney.—W. G. Watson & Co. (*recommended*), electric conduits at rates; Lawrence & Hanson, electrical sundries to June, 1916; W. T. Henley's Telegraph Works Co., electric wires and cables; John Keep & Son, engineers' sundries.

Argentine Government Contracts.—The Direccion General de Obras Hidraulicas has purchased from J. anha Bm & Son a motor generator for the electric light supply on the steamer 325 B. at $1,437.50 m/n. (about £124).

The tender of Siemens, Schuckert & Co. for electric lighting, heating and power installation work at the National Central College, at $25,388.62 m/n. (about £2,208), has also been accepted by the Direccion General de Arquitectura.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

4,822 AKTIESELSKABET ELEKTRISK-BUEREA. Automatic telephone systems. (5/4/13.)

12,361 PELLISSIER. Receiving telegraphic and telephonic signals [illegible] atmospheric influences on such receivers.

An aerial for wireless telegraphy and telephony, including one or more firmly coupled circuits and a receiving circuit coupled to same, in which the division of amplitude of the free oscillations produced by sudden alterations of the electric conditions of the antenna (impulses) is such that only a small part of the joint total energy of impulses can through resonance act on the receiver.

12,720 MARQUISE DES LIGNERIS. Light, high-power electric accumulator.

12,867 BASTIAN. Electrical resistances. (Cognate application, 22,872/14.)

12,926 HAMILTON & FERRANTI LIMITED. Mercury motor meters.

13,147 B.T.-H. Co. (G.E. Co.) Series parallel control systems for electric motors.

A system of series, series parallel, parallel control for electric motors grouped in a plurality of pairs, in which the motors of each pair are permanently connected together, without any motor being open circuited on any control point.

13,152 COMPAGNIE DE L'INDUSTRIE ELECTRIQUE ET METALLIQUE. Dynamo-electric machines. (30/5/13.)

13,247 MARCONI'S WIRELESS TELEGRAPH CO. & ROUND. Vacuous tubes used as magnifiers and producers of continuous electrical oscillations.

A vacuous tube containing a hot cathode and an anode and having a constricted portion, a metallic coating round the constricted portion, an electromagnet adjacent thereto, and a generator connected to the filament and to the coating.

13,248 MARCONI'S WIRELESS TELEGRAPH CO. & ROUND. Production of continuous electrical oscillations and the utilisation thereof for wireless telegraphy and telephony.

Improvements in the production of continuous electrical oscillations by means of a unilateral valve or vacuous tube containing a hot filament, a screen or grid and an anode, the circuits containing the latter being so arranged that they interact on one another.

13,362 HULTMAN. Telephone exchanges. (2/6/13.)

14,557 BROGGER. Electrical measuring instrument of the moving-coil type.

15,082 GOLDSCHMIDT. Mechanical selector for electromagnetic waves applicable to wireless telegraphic receiving apparatus. (2/5/14. Addition to 14,595/14.)

A system of selection for electromagnetic waves in which mechanical, electrical, [illegible] as well as at the receiving station, to ensure at the former a regular and uniform succession of trains of waves and at the latter to cause the receiver to come into operation only during the time of transmission of such trains.

16,130 PIEPER & PIEPER. Automatic electric switching mechanism for controlling fluid compressors. (7/2/14.)

17,686 WALKER. Compound for making watertight the joints of covers of boxes for underground electric mains and distributors, and similar joints of boxes fixed in exposed positions.

18,713 FULLER, FULLER & FULLER. Electric batteries.

21,538 WILEY. Printing telegraphs.

22,879 BELLINI. Apparatus for directed wireless telegraphy and telephony. (24/6/14.)

Apparatus for directed wireless telegraphy and telephony which allows, in regard to transmission, of controlling the direction of maximum projection of electromagnetic waves without turning the antennæ, and in regard to reception of making adjustment for reception from selected directions and ascertaining the direction of the transmitting station, also without moving the antennæ.

23,070 RENAULT. Starting devices for motors. (27/11/13.)

23,359 PETERS. Electric reactance coils. (5/2/14.)

1915 SPECIFICATIONS.

1,328 LUCAS & EDWARDS. Electric switches.

1,870 FARNSWORTH. Vapour electric rectifier systems. (5/2/14.)

2,728 HIGHFIELD. Electric smelting furnaces and the like. (Divided application on 4,937/14. Feb. 25.)

6,476 MARCONI'S WIRELESS TELEGRAPH CO. & ROUND. Cathodes of vacuous tubes suitable for use in wireless telegraphy. (Application on 13,247/14.) Cathodes of vacuous tubes suitable for use in wireless telegraphy. (Application on 13,247/14. May 29.)

APPLICATIONS FOR PATENTS

NOTE. *The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

May 26, 1915.

7,796 REID. Cable drums for field telephones and telegraphs.

7,805 JANDUS ARC LAMP & ELECTRIC CO. & MURRAY. Lamps for signalling.

7,811 ALLEN. Train-stopping device.*

7,826 FERRANTI & FERRANTI (LTD.). Electrical transformers.

7,827 FERRANTI, ROOTHAAN & FERRANTI (LTD.). Electrical transformers.*

7,829 NISHIMOTO. Manufacturing metallic filaments for incandescent electric lamps and for other purposes.*

May 27, 1915.

7,847 MILLER. Sparking-plugs.

7,864 BURTON. Sparking-plugs for internal combustion engines.

7,[illegible] [illegible] (Siemens & Halske Atk.-Ges., Germany.) Röntgen or X-ray apparatus.*

7,[illegible] BUPDON. (Siemens & Halske Akt.-Ges., Germany.) Rontgen tube apparatus.*

May 28, 1915.

7,923 SIEMENS-SCHUCKERTWERKE G.M.B.H. Short-circuiting devices for dynamo electric machinery and other electric apparatus. (30/5/14, Germany.)*

7,946 RUTLEY & RUTLEY. Portable or field telegraphs.

7,953 ROBERTS. Wireless telegraphy.

7,963 TURRI. Telephone instruments. (1/6/14, Australia.)*

7,964 DEUTSCHE GASLUHLICHT AKT.-GES (AUERGES). Electric cooking apparatus. (12/12/14, Germany.)*

May 29, 1915.

7,979 BERRY & MARKHAM. Protected or armour-clad electric switches.

7,987 B.T.-H. Co. (G.E. Co., U.S.) Rotary converters.

8,004 MACFARLAND & SHOEMAKER. Insulating material and method of producing same.

8,020 BACHELET. Electro-magnetic shuttle driving apparatus for looms for weaving.

May 31, 1915.

8,012 FORRESTER. (Piersen Telegraph Transmitter Co., U.S.) Transmitter.*

8,019 STEEL, PEECH & TOZER & BOWEN. Construction of electromagnets.

8,028 WEST. Electrical measuring instruments.*

8,041 SIMMONDS & MATHEWS. Electrical targets.

8,047 BOSCH. Switches for lighting installations. (9/6/14, Germany.)*

8,052 LUND. Magnetic sundial.*

8,060 CADENBEL. Electromagnetic locking devices. (Divided application on 13,715/14 10/6/13, France.)*

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Glasgow. As noted in a brief abstract in our issue of June 18, the net balance on the working of the Corporation tramways for the year ended May 31 was £12,951, and this has been handed over to the Common Good Fund.

The total capital expenditure is £3,751,508, of which £1,282,275 has been redeemed. The general reserve fund amounts to £32,239, and depreciation and permanent way renewal fund to £2,291,306. Average total revenue per car mile was 10·67d. compared with 10·65d. in 1913/14, and working expenses, including power, track and permanent way renewals were 8·178d. (8·042d.). Average fare charged per mile was 0·44d. Passengers carried were 336,260,758 (336,654,624), or miles run 24,214,460 (24,103,482) and coal used for traction and car heating 33,818·94 (33,685·59). Payments in connection with the [illegible] amounted to £1,815, including [illegible] to dependents (£29,457), and [illegible] (£6,231), were borne by [illegible] (£3,000).

By [illegible] to the Corporation on Thursday last Bailie [illegible] said that [illegible] there had been a decrease in revenue [illegible] £8,000, but a year ago they thought the Council would agree that the position was very [illegible]. The Committee had agreed to [illegible] depreciation to the extent of £100,000, as they had no money to spend on [illegible] and [illegible] that had never had to be found before. [illegible] applied last year to the King's Bench, and he was sorry to say that [illegible] had failed in [illegible]. They had decided to suspend extension work until after the war, as they were of opinion that when peace was restored that work would give considerable employment to men when work would be scarce. The Council decided at the beginning of the year to carry their own third party risks, and the amount expended by the department in compensation, law expenses, salaries, &c., amounted to £13,129. The Corporation agreed to take up £31,000, being the amount that they would have had to pay if they had insured. There were outstanding claims, but the Committee believed that when these had been met a considerable sum would have been saved.

The accounts were adopted.

Hampstead (London). The capital expended by the electricity department at March 31 was £473,209 (increase £8,810), of which £212,053 is outstanding.

Net income was £69,724 (decrease £2,163), and working and general expenses were £38,088, gross profit was £32,955 and net surplus (after providing for interest and repayment of debt) £2,767 (£6,258). Average price obtained was 2·88d. (2·99d.) per unit and total costs (exclusive of capital charges) were 1·59d. (1·43d.). Units generated were 6,884,959 (7,018,489) and sold 5,550,078 (5,872,308). Maximum load was 3,184 kw. (3,673 kw.). Consumers and equivalent 30-watt lamps connected are 8,384 (8,121) and 425,927 (404,767) respectively.

In his report the engineer and manager (Mr. W. Wyld) says the war has had a serious effect on the year's working. Previous to the war contracts had been entered into with Fraser & Chalmers for a 1,500 kw. turbo-alternator and with Mirrlees Watson Co. for a condenser, pipework, &c., and it is expected the plant will be erected this summer

Motors connected are 251 (1,277 H.P.), increase 35 (104 H.P.); heaters hired out are 200 (compared with 101), cookers 55 (24), miscellaneous (fans, &c.), 28 (9). Thirty-nine members of the staff (25·49 per cent.) are serving in the military forces.

Hereford.—The accounts of the electricity department for the year ended March 25 show capital expenditure £59,220 (increase £2,470), of which £23,142 has been repaid.

Total revenue was £8,215 (compared with £7,249 in 1913-4), working expenses were £4,610 (£3,608), leaving gross profit £3,605 (£3,641). Interest required £1,186 (£1,149), and sinking fund £2,478 (£2,387), the net deficit being £59 (compared with £105 profit). Maximum load was 585 kw. (513 kw.), and load factor 25·44 (18·29 per cent. Generating costs were 0·651d. (0·771d.), rates and taxes 0·053d. (0·066d.), management and establishment charges 0·142d. (0·178d.), interest 0·218d. (0·324d.) and repayment of loans 0·456d. (0·675d.). Units generated were 1,450,230 (1,126,320) and sold 1,303,800 (850,011).

The city electrical engineer (Mr. W. T. Kerr), in his report, states there has been a loss of £300 in lighting revenue during the first eight months of the war. The cost of a condenser (£275) and for alterations of plant (£225) have been charged to revenue. Cost of coal and carriage increased from £1,441 to £2,240, and as a lower grade coal is now used in consequence of increase of coal prices, the coal used per unit sold is 0·884 lb. to 0·469 lb.). The generating costs have reached the lowest possible figure with the class of plant installed, and until the scheme adopted by the Electricity Committee of installing turbine generating plant so as to reduce steam consumption is carried out, no further economy can be effected.

Poplar (London).—The accounts of the electricity department for the year ended March 31 show aggregate capital expenditure £431,753 (increase £30,042). Loans outstanding amount to £315,048.

Income was £74,177 (against £68,609 in 1913-14), total cost of production was £35,954 (£38,534), and gross profit £37,485 (£29,113), net revenue charges were £22,962 (£21,359), and with profit from sales department, &c., the surplus was £14,749 (£8,010). Units generated and purchased were 20,768,512 (20,642,467) and sold 16,899,548 (16,716,705). Total maximum demand was 7,250 kw. (7,450 kw.).

The engineer and manager (Mr. J. H. Bowden) says in his report net increase of revenue from sale of current increased £5,791, and working expenses decreased £2,580. The agreement entered into between Poplar and Stepney Councils obviates the necessity for further extensions until the maximum demand on the Poplar undertaking reaches 10,000 kw. This provision will allow for an output of 25,000,000 per annum, which will probably answer all demands until the winter of 1917. Gross profit showed an increase of £8,371. 16s. 11d., or 28·8 per cent. The output was 172,843 units more than in the preceding year and the average price obtained 0·072d. per unit more. The supply to Stepney was 1,325,517 units less than in previous year and public lighting was reduced 332,982 units, therefore, the private supply increased by 1,831,342 units. In the previous record year the average price of coal delivered to bunkers was 14s. 2d. per ton, but last year the price was 12s. 5½d., equal to a saving of £2,029. 3s. 7d. on a consumption of 23,576¾ tons. The better efficiency of the new boilers, economies effected in the boiler house and engine room, the reciprocal supply with Stepney and the close attention of the generating staff, all combined to effect a saving of 2,000 tons of coal compared with the previous year, equal to £1,246. Reciprocal supply with Stepney was the dominating factor in the improvement of the efficiency of the system from 80·98 per cent. to 81·37 per cent. by saving works' units when shut down. Working costs were reduced from 0·55d. to 0·51d. per unit, the record for the Metropolitan area. Average price obtained (1·043d. per unit) is also a record, and if the supply to Stepney is deducted, the resultant figure for energy sold in the Poplar area (viz., 1·11d.) is still a record to date. The amount of capital employed per kilowatt of plant installed (£30·4) is stated to be about the lowest in the country. The output is the largest yet published in connection with any Metropolitan municipal undertaking, with the exception of Marylebone (where the output reached 17,038,516 units last year). The load-factor (26·61 per cent.) is well up to the average. The average price obtained by (*a*) London companies was 2·26d., by (*b*) London local authorities 1·71d., and by (*c*) Poplar 1·04d.; working expenses were (*a*) 1·14d., (*b*) 0·86d., (*c*) 0·51d. Load factor was (*a*) 20·07 per cent., (*b*) 21·11 per cent., (*c*) 26·61 per cent. Showrooms and commercial offices were opened in July, 1911. This departure has proved an unqualified success in respect of propagation of business. At no time in the history of the undertaking has the influx of new business been so great as at present. In addition to the increased sale of current the net profit resulting from the sale of lamps and fittings was also 96 per cent. The amount of sales was 15¼ per cent. greater than in the previous year.

Superannuation and pensions' funds were commenced on Jan. 1, 1912. The actuary appointed by the Council to report recommended that the primary annual contribution should be 4·11 per cent. of the total salaries of officers and 7·62 per cent. of the wages of workmen. He admitted that the true actuarial valuation as far as the electricity department was concerned should be 9·34 per cent. on the salaries and wages, but as the Act stipulated that the electricity department should bear an equal proportion to the general department, the rate from the latter was reduced from 11·42 per cent. on salaries and 7·74 per cent. on wages by the combining figures quoted. The actual amounts paid into the fund by the department for 1912, 1913 and 1914 were £856 1s. 6d., £931 0s. 9d. and £925 13s. 11d. respectively. The reason for the small increase last year was due to the fact that a number of men left the service and that their places had not yet been filled. Mr. Bowden is making a recommendation to the Council in regard to this which will increase the annual contribution considerably. He is of opinion that £500 is an ample contribution to cover all claims likely to be made on the funds by servants in the electricity department, and he has hitherto charged this amount in the revenue accounts. He is advised that it is impossible to avoid payment of the amount fixed by the actuary without an amendment to the Act. He, therefore, proposes to take from the appropriation account all balances over £500 and show in future annual reports the condition of the funds from electricity contributions (i.) on the basis of £500 primary annual contributions and (ii.) on the actuarial basis, so that at the next quinquennial valuation of the funds it may be possible to obtain a substantial modification of the present actuarial basis.

Swansea. The accounts of the electrical undertaking for the year ended March 31 show total capital expenditure £228,480 (increase £23,318), of which £54,144 is paid off or in sinking fund. The balance of the reserve fund is £8,996.

Revenue was £33,246 (against £32,973 in 1913-14), working expenses were £18,915 (£18,549), and gross profit was £14,331 (£14,424). Loan charges were £12,545 (£11,111), leaving net profit £1,786 (£3,313). Units generated were 4,001,788 (3,700,333) and sold 3,401,961 (3,440,350). Total maximum demand was 2,199 kw. (2,115 kw.). Average price obtained was 2·28d. (2·23d.) per unit, working expenses were 1·33d. (1·29d.) and capital charges 0·88d. (0·77d.).

In his report Mr. J. W. Burr (borough electrical engineer) states that the lighting units increased 113,116, but power units decreased by 18,088, although there was an increase of 14,940 prior to the war. Traction units also decreased 102,006. Station load-factor was 20·8 per cent. Mr. Burr recommends the opening of a showroom for electrical apparatus in charge of an engineer, the loaning of heating and cooking apparatus and the encouragement of the use of electric vehicles, which would develop an off-peak load. The supply of electricity by the Department to the English Crown Spelter Works (the agreement for which is completed) will displace a large suction gas plant, and Mr. Burr thinks this should induce other large power consumers to inquire into the cost of the Corporation's supply of power compared with that of private plants. Mr. Burr recommends that a minimum charge of 30s. per annum be made to every consumer. In April, 1914, two new three-phase alternators were put on the load: each generator is capable of supplying sufficient energy to light 50,000 30-watt lamps under normal conditions, or 75,000 in case of emergency. The three-phase current is transformed by rotary converters to direct current. Six rotary converters have been ordered. Three of these are erected at the generating station, two at Uplands sub-station, and it is proposed to erect the remaining one at the dust destructor sub-station. It will be probably necessary to duplicate a portion of the auxiliary plant during the coming year. This particularly refers to the forced draught fan for the water-tube boilers. It may also be necessary to re-arrange some of the steam and water-circulating pipework.

The capital expenditure on the tramway undertaking amounts to £118,930, of which £18,389 is paid off or in sinking fund. Revenue was £7,791 (£7,655), and loan charges, &c., amounted to £5,929 (£5,707), leaving a surplus for the year of £1,862 (£1,946).

Tunbridge Wells. The annual report of the electricity department shows a total income of £18,613, an increase of exactly £2,000 over the previous year.

The units sold for private purposes increased by 23 per cent. The capital expended on the undertaking amounts to a little over £100,000, whilst the liability is under £30,000. The gross profit increased from 8·9 to 9·8 per cent., and the net profit increased from £2,165 to £3,167. The total increase of units sold was £208,000.

Walsall. The accounts of the electricity department for the year ended March 31 were adopted by the Corporation last week. The gross capital expenditure is £170,732 (increase £8,741), of which £121,472 is out of loan.

Revenue was £25,879 (against £29,877 in 15 months ended March, 1914 (the date of closing the accounts having been changed from Dec. to March), working costs were £14,293 (£18,613), interest required £4,381 (£5,293) and sinking fund £5,820 (£6,015), leaving net profit £1,385 (£926). Cost per unit sold was 1·07d. (1·30d.) or 1·83d. (2·02d.) including capital charges. Average price obtained was 1·93d. (2·08d.). Total maximum demand was 1,712 kw. (1,365 kw.). Units generated were 4,543,023 (4,537,471) and sold 3,220,987 (3,452,551).

The tramway capital expenditure was £182,926, of which £34,056 has been repaid, while the sinking fund amounts to £33,860. Revenue was £34,089, and working expenses were £21,821. Interest required £4,962 and sinking fund £3,975, leaving £2,479 net, of which the committee propose to pay £2,000 to the general rate. Average total receipts per car-mile was 11·353d. (compared with 11·234d.), and working expenses, including power, were 7·267d. (7·206d.). Average fare charged per head was 0·79d. Passengers carried were 6,752,727, car-miles run 720,634, and units used 838,649.

West Hartlepool. At March 31 the total capital expenditure of the undertaking (electricity department) was £84,732 (increase £9,329).

Revenue was £19,506 (compared with £17,613 in previous year), working expenses were £11,574 (£11,641), leaving £7,931 (£5,972). After meeting capital and other charges, the net profit was £3,048 (£1,663), which has been placed to reserve. Average total revenue per car-mile was 9·77d. and working expenses, including power, were 5·80d. Pas-

sengers carried were 4,261,917 (3,678,116), car-miles run 479,382 (476,327) and units used 680,972.

[illegible] that parcel department profit was £192 (decrease £11), and parcels carried were 44,602 (decrease 4,160). More miles have been run, while power expenses have been reduced by £452. Twenty-four employés (26 per cent. of the staff) are serving with the military forces.

Yarmouth. [illegible] March 31 the gross capital expenditure was £125,919 (increase £6,809), of which £87,894 is [illegible]. The [illegible] fund is £24,553.

Revenue was £23,901 [illegible] £20,080 of previous year, and working expenses, including depreciation, were £14,282 (£17,922). Interest, sinking fund and income tax required £8,085 (£7,402), and discounts, bad debts, &c., £601 (£790), leaving net profit £433 (£466). Units generated were 2,225,002 and sold 1,860,501. Total maximum supply [illegible].

COMPANIES' MEETINGS AND REPORTS.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—The total [illegible] for 1914 [illegible] from Advertisement to Tramways) was £302,569, an increase of £26,101 over that of 1913. The expenditure was £144,987, an increase of £14,091, and net profit was £157,582, an increase of £12,010. After deducting interest on loans and debenture debt, carrying to sinking fund account £6,732, and depreciation fund £27,000, providing for redemption of second debentures and contribution to officers' and employés' provident fund, the balance is £75,972, making with amount brought forward (£4,349) an available total of £80,322. The directors recommend payment of dividend on the 6 per cent. cumulative preference shares to Dec. 31, 1914, and a dividend on the ordinary shares at rate of 6 per cent. per annum (tax free) leaving [illegible] £8,326. The gross [illegible] were £169,884, compared with £170,672; the working expenses were £85,297, against £81,123, leaving £84,587, compared with £89,548. The progress of the electric supply branch continues satisfactory, the net revenue increase of £17,700 having considerably more than wiped out the decline in net earnings from the traction branch.

BRITISH ELECTRIC TRACTION CO. (LTD.)—At the meeting last week the chairman, Mr. Emil Garcke, in moving the adoption of the report, said that they were paying the same dividends on the preference stocks as in the previous year, and they placed to reserve and carried forward £82,589, compared with £73,615. The first half of the year gave promise of better results, but the outbreak of war altered that promise, as it had altered everything. The war had affected not only the volume and net profits of the business in the various departments; questions affecting both capital and labour had been placed on entirely new planes and the war conditions had uprooted many of their former theories and had upset their normal business practice. The associated companies had encouraged their employees to enlist and altogether about 2,500 (about 20 per cent. of the total number) were now serving in His Majesty's forces. Of their head office staff about 60 young men, including several of their secretaries, had gone to the front. Immediately on the outbreak of war the directors inaugurated a mutual aid fund for providing financial assistance to the dependents of employees who joined the forces. The directors had granted either increased rates of pay or bonuses in addition to wages for the period of the war or so long as the high cost of living [illegible] and others who had electrical contracts to place would not again be [illegible] in price. Therefore, despite present and future anxieties, he looked forward with confidence to the companies being able to maintain the position they had attained and the progress they were making. Referring to the scheme for the reduction and rearrangement of capital, he stated that the replies received by the directors showed that the majority of the stockholders considered the scheme fair and equitable to all classes, but as a result of discussions the directors suggested that a few small modifications should be made. At present all stocks behind the debentures ranked equally as regarded capital. The total capital was £2,947,380, besides £266,371 income certificates. The net effect of the proposal was to write down the capital by £908,372 and to divide the capital into two [illegible] stock (with priority as to capital) and ordinary stock, ranking after the [illegible]

COMPAGNIE FRANCAISE THOMSON-HOUSTON. The gross profit for [illegible] was 5,180 fr., compared with 1915. After paying expenses and interest charges, the net profit was 4,549,279 fr., [illegible] 680,088 fr. for costs of experiments and patents (including patents for automatic telephones and law costs), 304,921 fr. war account, 385,000 fr. [illegible] an increase of 539,407 fr. From the balance (3,195,848 fr.) a dividend [illegible] 3,000,000 fr., leaving 195,848 fr. to be carried forward. The directors [illegible]

CREDITA CONDUITS CO. LTD. [illegible]

The directors have written £1,000 off goodwill account, and they recommend a dividend at rate of 8 per cent. per annum on the ordinary shares for the year, carrying forward £862.

At the meeting last week the chairman (Mr. P. Schloss) said that one of the directors, Mr. John Chamberlain, who had offered his services to his country early in the war, went to the front and was wounded; but, as they could see, he had made a splendid recovery. He would shortly rejoin the forces for active service, and they wished him good fortune and a safe return. Soon after the commencement of the war the company naturally felt a falling off of orders for the home and export trade. They were fortunate later on to receive a good many orders, especially in connection with the War Office requirements. The result was that the year showed a profit slightly greater than that of the previous year. Though the future was uncertain, the returns for the first two months of the current year were very satisfactory, and many orders were to hand which would ensure good business for the next two or three months.

CROMPTON & CO. (LTD.)—The directors' report for the year ended March 31 states that the reorganisation of the company's business and management continues to show beneficial results, and, with economies in manufacture, accounts for the improvement in the year's working. The gross profit for the year is £57,911. 5s. 4d. After deducting general charges, depreciation, interest on debentures and other items, there remains, with sum brought forward from previous year, an available balance of £28,648. 18s. 4d. The directors recommend that £6,500 be placed to general reserve fund, £3,500 to special depreciation account, and that £1,608. 1s. 3d. be written off preliminary expenses, and after paying the dividend on the 7 per cent. preference shares (£9,349. 10s. 9d.), the balance to be carried forward is £7,691. The works continue to be fully employed, preference in all cases being given to Government orders.

EDMUNDSON'S ELECTRICITY CORPN. (LTD.)—The net profit, after providing for administration expenses and for mortgage and debenture stock interest and redemption, amounts to £23,240. 7s. 4d. After adding balance brought forward (£2,125. 4s. 11d.) and deducting the interim half-yearly dividend paid in January last on the cumulative preference shares, there remains £19,365. 12s. 3d. The directors recommend that £10,000 be carried to reserve, and after payment of the final half-yearly dividend on the cumulative preference shares (£6,000) a balance of £3,365. 12s. 3d. remains to be carried forward.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The net profit for 1914 amounts to £55,695. 1s. 1d., after allowing £28,000. 8s. 10d. for depreciation and debenture interest, compared with a net profit of £37,029. 5s. 7d. for 1913. The revenue from ships' telegrams, subsidies, &c., was £175,021. 1s. 10d., a substantial increase over the amount of £146,316. 18s. 11d. for 1913. The number of telegraph stations owned and worked as public telegraph stations on the high seas increased from 788 at the end of 1913 to 905 at the end of 1914. The increase would have been more satisfactory had normal conditions prevailed, and during the current year further progress is being made, the number of steamers fitted to June 19 having increased to 970. There are now over 2,000 ships, exclusive of ships of war, fitted with Marconi telegraph stations, and for the most part worked under the direction of this company and its associated companies. The Amalgamated Wireless (Australasia) (Ltd.), in which the company is interested, has paid a dividend of 4 per cent. in respect of the period to June 30, 1914, and an interim dividend of 2½ per cent. in respect of the half-year ending Dec. 31, 1914. The amount to credit of profit and loss account now stands at £64,855. 14s. 11d., including £6,067. 13s. 10d. carried forward. The directors have pleasure in recommending payment of a final dividend for the year of 5 per cent., which, with the interim dividend of 5 per cent. paid in February last, will make 10 per cent. for the year. The company has sustained some loss in consequence of the attacks upon the mercantile fleet by enemy submarines, for which it is contemplated compensation will be received. However, the directors think it desirable that £10,000, a sum far in excess of all losses to date, should, in the meantime, be placed to the credit of a special reserve account, and having regard to the prevailing circumstances and the desirability of their holding a strong financial position, with ample cash resources to provide for the continuous increase of telegraph installations on board ships, it is deemed prudent to carry forward £20,747. 6s. 11d., after allocating £3,500 to the repay-[illegible]

RANGOON ELECTRIC TRAMWAY & SUPPLY CO. (LTD.)—At the meeting [illegible] the chairman [illegible] E. [illegible] said that [illegible] a profit of £2,766. Up to July 31, 1914, the tramway receipts showed a considerable increase over [illegible] Rs.40,000 and had [illegible] receipts of Rs.49,000. The private lighting and power department showed an increase [illegible] per cent. The working expenses exhibited a small increase, which was unfortunately likely to advance considerably in future owing to the increased cost of coal and other stores. Negotiations were proceeding between the municipality and the company for an increased amount of lighting and a revision of the existing arrangement.

SOUTH BRAZILIAN RAILWAYS CO. (LTD.)—The [illegible] for the year ended March 31 [illegible] April 1, 1914, the company has been operating the Tramway, Light & Power undertakings in Rio [illegible] The results of the past year have been [illegible] by the most political economical and financial crisis in Brazil. The gross earnings of the [illegible] year £28,056 and the [illegible] £17,806, [illegible] £7,963, [illegible] £3,512 [illegible] £22,440. Interest [illegible] and [illegible] £1,884.

leaving a deficit of £29,454. The board has been compelled to ask for an extension of the loans outstanding at the close of the year and have also had to contract new loans in order to meet liabilities. The demand for electric light and power is increasing.

WAYGOOD-OTIS (LTD.) –At the meeting on Monday the chairman (Mr. Hy. C. C. Walker) said that hitherto they had been able consistently to pay a dividend on the preference and ordinary shares, but this year they were not able to recommend an ordinary dividend. At the meeting business was still suffering from the building trade strike, but the directors were anticipating that there would be a revival in building which would result in further business for the company. The circumstances had, however, been entirely changed by the war. 300 of their men had joined H.M. forces. On the declaration of war they offered to place their factories at the disposal of the Government, and during the last few months they had been doing an increasing amount of work, and would probably be doing much more in future. They had secured some important contracts. The company's departments under the new conditions were working harmoniously together, and they might look forward with confidence to the future.

J. G. WHITE & CO. (LTD.)—Mr. J. Beaver White, who presided at the meeting on Tuesday, said the effect of the war had been very serious, but considering the character of their business, and being largely dependent for additional contracts on the development of new enterprises, they were to be congratulated on being able to meet under as favourable conditions as were shown by the accounts. Economies had been effected, the expenses showing a great reduction. The directors believed that the business of the current year would meet all expenses and leave a substantial profit. It was difficult to forecast anything beyond that period, but they saw no reason why the company should not continue its successful career.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ELECTRIC LAMP REPAIRS CO. (LTD.) (140,740).—Reg. June 22, capital £5,000 in £1 shares, to carry on the business of collectors and repairers of electric lamps with broken filaments or blackened bulbs, manufacturers of and dealers in electric fittings and globes, &c., and to adopt an agreement with Refilments (Ltd.). Private company. First directors are H. Lintott (chairman), G. O. Barras and E. G. K. Calder (joint man. dirs).

LONDON GLASS WORKS (LTD.) (140,783).—Reg. June 25, capital £30,000 in £1 shares (29,000 preference), to carry on the business of glass manufacturers, manufacturers of and dealers in glassware, lamp and electric light globes and bulbs, &c. Private company. C. Brooks is permanent governing director, with power to appoint other directors. Reg. office : 70 & 71, Chiswell-street, E.C.

LOWA ENGINEERING CO. (LTD.) (140,720). -Reg. June 19, capital £1,500 in 1,000 participating preference shares of £1 each and 10,000 ordinary shares of 1s. each, to carry on the business of electrical, mechanical, hydraulic and general engineers and contractors, steel converters, coppersmiths, metal workers, manufacturers of theatrical and general stage effects and scenery, fans, lamps, &c. Private company. Reg. office : 74, Vauxhall Bridge-road, S.W.

WATSON & SONS (ELECTRO-MEDICAL) (LTD.) (140,765).—Reg. June 23, capital £25,000 in £1 shares (7,000 preference), to take over the electro-medical business carried on by W. Watson & Sons and by L. C. Miller. Private company. First directors are C. H. Watson and F. W. W. Baker (both permanent). Reg. office : 196, Great Portland-street, W.

MORTGAGES AND CHARGES.

BRILLIANT ARC LAMP & ENGINEERING CO. (LTD.)—Particulars of £3,000 debentures, created June 18, 1915, have been filed (£500 amount being now issued). Property charged : Company's undertaking and property, present and future. No trustees.

Memorandum of satisfaction in full on June 18, 1915, of debentures dated Dec. 11, 1914, and Nos. 17 1913, securing £100 and £200 respectively, has also been notified.

Second debenture dated June 23, 1915, to secure £90, charged on Company's undertaking and property, present and future. Holders : S. H. Cohen and M. Nordwald.

CARLEON ELECTRICAL CO. (LTD.) –Mortgage dated June 8, 1915, to secure £1,500, charged on leasehold premises known as No. 1, Tennyson Parade, Norbury, comprising factory and [illegible]. Holders : Reinforced Surface Construction (Ltd.).

DEFRIES & GOLDMAN (LTD.)—Particulars of £200 debentures, created June 10, 1915, have been filed, which amount has been fully issued. Property charged : Company's undertaking and property, present and future. No trustees.

LONDON ELECTRICAL TRADING CO. (LTD.)—Particulars of £2,000 debentures, created March 16, 1915, have been filed, amount of issue being £200. Property charged : Company's undertaking and property, present and future. No trustees.

NORTH-EASTERN ELECTRIC SMELTING CO. (LTD.)—Memorandum of satisfaction in full on April 20, 1915, of debentures dated Nov. 15, 1911, securing £1,500, has been filed.

RECEIVERSHIPS.

ABERDARE ELECTRICAL CO. (LTD.)—Notice of appointment of T. D. Williams, 10, Cannon-street, Aberdare, as receiver on June 18, 1915, under powers contained in debenture dated Oct. 20, 1915, has been filed.

COAST DEVELOPMENT CORPN. (LTD.)—Notice of appointment of A. F. Whinney, 4B, Frederick's-place, Old Jewry, E.C., as receiver and manager of part of company's property (by order of Court dated June 18, 1915), has been filed.

TOWNMEAD ACCESSORIES (LTD.)—Notice of appointment of A. A. Yeatman, 2, Coleman-street, E.C., as receiver or manager on June 18, 1915, under powers contained in debenture dated Aug. 29, 1913, has been filed.

CITY NOTES.

MEMORANDA (June 30).—Bank rate 5 per cent. (since Aug. 8, 1914. Consols 65 $\frac{1}{16}$. Consols Pay Day Aug. 5. Stocks and Shares Ticket Days July 13 and 28. Pay Days July 14 and 29. Price of silver, 22$\frac{3}{4}$d.

BARCELONA TRACTION, LIGHT & POWER CO. (LTD.)—Mr. E. R. Peacock has been appointed president of the company in succession to the late Dr. F. S. Pearson.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The directors have declared a dividend on the ordinary shares at the rate of 10 per cent. per annum for the half-year to March 31, making, with the interim dividend of 6 per cent. per annum, a distribution of 8 per cent. for the year.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following will be struck off the register of Joint Stock Companies unless cause to the contrary is shown before Sept. 29 :—

British Automatic Telephone Synd., British Magneto Co., Circuitous Power Co., Consolidated Electric Works & Appliances, Conveyors, Gambles' Patent Telephone Recorder Co. (Continental), Haywards Heath Electric Supply Co., Magneto Separator, Pacific Radiotelegraph Synd., Premier Electric Control, Radio & Electric Power Co., Spira Turbine Synd., Santarbo Engineering Co., Tramways Construction Synd., Tungsten Metal Co., United Electrical Construction Synd.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—A bonus of 2s. 8d. per share will be paid on the ordinaary shares.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, June 30. The greatest care is taken in compiling these figures but the difficulty of verification is now much increased.

Shrs.	Last Dividend	NAME.	Price, Wed. June 30.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7½	Bournemouth & Poole E.L. Ord.	9	7 6 8	Mar, Sept
10	4½	Do. 4½% Irm. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	10½	5 17 1	Feb Aug
5	10%	Bermuda & Kensington Ord.	5/8	6 6 2	Mar, Sept
St.	4½	Central Elec. Supn. G. Deb. St	90½	4 9 9	.. ..
St.	4½	Charing Cross West End & City Debs..	91	4 5 5	Jan, July
5	2/3	Do. 4½% Pref.	4½	5 10 10	.. ..
5	..	Do. Ord.	4	6 .. 0	Aug, Feb
10	9½	City of London Elec. Lt. Ord.	13½	6 7 1	Feb, Aug
10	6%	Do. 6% Pref.	12½	4 17 0	Mar, Sly
St.	..	Do. 5% Deb. St.	110	4 10 11	Jan, Dec
10	7½	County of London Ord.	11	6 .. 3	Mar, Sept
10	6%	Do. 6% Pref.	11	5 .. 1	Feb, Aug
St.	4½	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½	Edmundson's Elec. Supp. 4½% Debs...	80	5 12 3	July
5	..	Kensington and Knightsbridge Ord. ..	7½	6 4 2	Feb, Aug
St.	4½	Do. Deb. St.	86	4 13 0	Jan, Jly
5	4½	London Elec. Supp. 4½% Pref.	5½	5 1 4	.. ..
St.	4½	Do. 4½% Mort. Debs. Mort. Debs.	84½	4 11 11	Jan, Jly
7	3½%	Metropolitan E. Supp. Ord.	3½	5 13 7	Mar, Aug.
St.	4½	Do. 1st Mort. Deb.	91½	4 15 3	Jan, Jly
St.	..	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	.. ..
5	6%	Newcastle & Dist. E.L. 6% 2nd Dbs ..	7½	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S.5%2dMt.Db.St.	100	5 .. 0	Mar, Sept
1	5%	North Metropolitan E. P. Supp. 6% Pref	5½	5 11 4	Apl, Oct
St.	5%	South London E.S. Mort. Debs. ..	94	5 .. 3	Jan, Jly.
St.	4½	Urban Elec. Supp. 4½% Db. St. ..	..	5 .. 1	Apl, Oct.
..	..	Waste Heat & Gas Elec. Gen. Stations	1½	1	Mar, Aug
..	..	Westminster E.S. Corp. Ord. ..	..	.. .. ..	Mar, Sept
5	4½	Do. 4½% Pref.	4½	4 13 3	Jan, Jly.
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	..	6 5 5	Apl, Oct
1	..	Do. Ord. Pref.	..	.. .. ..	Feb, Aug
St.	4½	Central London Cuar. Accounted Ord. ..	7½	5 7 1	.. ..
St.	4½	Do. do. Assented Def. Ord. ..	2½	5 3 3	.. ..
St.	4½	City & S. London Deb.	98	4 11 1	May, Nov
..	..	Do. Pref.	90	6 5 7	Feb, Aug
1	1½	Do. Ord.	9½	5 17 11	Feb, Aug
1	1½	London Electric Ry. Ord.	11	5 9 1	Jan, July
St.	4½	Do. Deb. St.	91	4 7 7	May, Nov
St.	4½	Do. Pref. Deb. St.	96	4 13 1	Jan, Jly.
1	1½	Metropolitan Ry. Con. Ord.	..	4 19 ..	Feb, Aug
5	5%	Do. 5% Pref.	7½	5 1 7	Feb, Aug
5	5%	Do. 5% Deb.	7½	4 13 9	Feb, Aug
1	1½	Do. Ord.	1½	4 4 7	Jan, July
St.	4½	Do. 4½% Deb. St.	1½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. 4½% Deb. St.	..	.. .. ..	Feb, Aug
St.	4½	Do. 4½% Deb.	92	4 7 0	May, Nov

†Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price, Wed., June 30.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
St.	4½%	Manchester Ship Canal 4½% First Pref	73½	6 2 5	Feb, Aug
St.	6%	Do. 6% Pref. Deb.	124½	4 12 8	Jan, July
St.	4%	Do. 4% Deb.	93½	4 10 8	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	87½	4 11 7	Jan, July
St.	4%	Do. 4% Guar. Stock	75½	5 6 0	Mar, Sept
10	..	Underground E. R. of London Shares	1⅛	.. ..	..
1/0	..	Do. A Ord.	⅝	.. ..	..
St.	6%	Do. 6% 1st Deb.	107½	5 12 1	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 15	7½	5 9 0	Mar, Sept
..	4½%	Do. 4½% Bds.	93	4 12 9	Jan, July
5	..	Yorkshire W. Riding Ord.	¾	.. ..	March
5	6%	Do. Pref.	4⅞	6 11 6	Jan, July
		Electric Manufacturing, &c.			
1	1/92	Babcock & Wilcox Ord.	24	5 17 1	Apl, Oct
1	1/0	Brit. Aluminium Ord.	1½	4 10 11	Mar
100	5%	Do. Pref. Lien Decs.	97½	5 3 0	Jan, July.
1	7½	Do. 6% Pref.	⅞	6 13 4	Jan, July
1	5½	Brit. Insulated & Helsby Ord.	11⅛	6 14 10	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	6⅜	4 15 5	Jan, July
1	6%	British L.M.E. Engine Mfg. Co. 6% Pref	1⅛	5 12 11	Mar, Sep
1	7½	Brit. Westinghouse Pref.	17½	8 2 8	Apl, Oct
100	6%	Do. 6% Pref. Lien Decs.	101½	5 5 9	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	51½	4 17 7	Feb, Aug
5	2/6	Do. 5% Pref.	20	5 3 3	May, Nov
1	15%	Castner-Kellner	¼	6 17 –	Sept
1	6%	Dick, Kerr & Co. 6% Pref.	⅛	.. ..	Feb, Aug
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅞	7 .. 10	May
1	6%	Elec. Construction Ord.	1½	7 13 0	Jan, July
1	7%	Do. 7% Pref.	6½	5 15 4	Jan, July
St.	4%	Do. 4% Debs.	100	5 18 11	Jun, Dec
10	6%	General Electric 6% Pref.	14½	7 0 4	Feb, Aug
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	4½	5 0 0	..
5	2/3	Do. 4½% Cum. Pref.	96	4 11 10	Jun, Dec
St.	4½%	Do. 4½% Deb.	93½	5 17 5	Feb, Aug
10	5%	India Rubber, G. P. &c., Ord.	8½	6 13 11	Apl, Oct
10	5%	Do. Pref.	98	4 1 5	Apl, Oct
100	4%	Do. 4% Debs.	37	6 9 9	Mar, July
12	36/0	Telegh. Con. & Main. Co.	95	4 4 3	Jan, July
100	4%	Do. 4% Debs.	11	4 10 7	May, Aug
1	7½	Vimers Ord.	..	5 3 3	May, Aug
1	6d.	Do. 5% Pref.	5⅜	4 6 0	Jun, Dec
St.	4%	Do. 1st Debs.	93	4 11 0	Jan, Dec
100	4½%	Do. 4½% 2nd Debs.	..	.. ..	..
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	102½	5 16 10	Fb,My,Aug,N
St.	30/0	Do. Def. Ord.	22½	5 14 10	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	75½	5 6 0	Ja,Ap,Jy,O
10	5%	Cuba Submarine Ord.	8⅝	5 13 6	May, Nov.
10	10/0	Do. 10% Pref.	15½	6 9 0	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	5½	6 6 1	Ja,Ap,Jly,O
St.	65/0	Eastern Tel. Co. Ord.	12½	5 ..	Ja,My,Jly,O
St.	17/0	Do. 3½% Pref.	5⅝	6 15 ..	May, Nov
St.	4%	Do. 4% Debs.	84½	4 14 8	Feb, Aug
10	7%	Eastern Extension Tel. Co., 4% Debs.	12	5 16 8	Ja. Ap, Jly,O
10	2/0	Do. Ord.	21½	6 19 8	Ja, My, Jly
25	13%	Gt. Northern Tel. Co. with Coup. 7	5½	.. ..	May, Nov
1	2/0	Indo-European Telegraph	1¾	11 17 0	April
1	1/4	Marconi's Wireless Tel. Co.	1⅛	10 12 7	July
1	1/4	Do. 7% Pref.	1⅛	6 13 11	May Nov
10	7½	West India & Panama Ord.	6⅛	7 3 4	May, Nov
10	6%	Do. 1st Pref.	12½	5 8 8	Mr, Jly, O. Dec
10	3/0	Western Telegr. Co.	8⅜	4 16 8	Jun, Dec
St.	4%	Do. 4% Deb. St.	93	4 14 7	May, Nov.
..	4½%	Western Union 50 yr. Bds.	94½		
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	126½	6 6 9	Ja,Ap,Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	80	6 5 0	Jan, July
1	7	Mexico Telephone Ord.	6½	5 12 5	Nov.
..	4½	New York Telephone 4½% Bds.	98½	4 11 2	May, Nov
1	1	Oriental Telephone Ord. (ex bonus)	2½	4 15 ..	Apl, Oct
St.	4%	Do. Deb. St.	93½	4 12 6	Jan, July
St.	4½	Telephn. Co. of Egypt Db. St	86	5 2 3	Jan, July
5	..	United River Plate Ord.	8	6 13 11	Apl, Oct
5	..	Do. Pref.	4½	5 3 3	Jan, July
St.	4½	Do. Deb. Stk.	94½	4 13 1	Jan, July
		Financial and Investment.			
10	6%	Globe Telegr. & Trust	103½	5 12 7	Sp.Dc,Mr,Jn
1	..	Do.	11⅝	5 6 1	Sp.Dc,Mr,Jn
1	..	Do.	30	5 5 0	Ja, Apl, Jly.O
100	..	Mackay Companies' Common	70	5 14 3	Ja,Ap,Jly,C
..	..	Do. Pref.	94½	5 6 1	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	126½	4 15 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	80	6 5 0	Jun, Dec
St.	4½	[illegible]	94½	5 9 1	Jan, July
St.	4%	[illegible]	86½	5 3 1	Jan, July
5	..	[illegible]	4½	6 13 4	Jan, July
5	..	[illegible]	2½	7 9 7	Jan, July
100	..	[illegible]	49	12 0 7	Fb,M,Aug,N
100	5½	Do. 6% Pref.	86½	6 17 4	Ja,Ap,Jly,O
..	..	[illegible]	..	5 9 5	May
..	..	[illegible]	4½	5 3 1	May, Nov
St.	4½	British Columbia 4½% Con. Debs.	75	5 13 4	..
..	..	[illegible]	..	6 17 6	Mar, Sep
..	..	[illegible]	85½	5 13 3	Feb, Aug
..	..	[illegible]	..	6 0 0	..
..	..	Madras Elec. Trams 6% Cum. Pref.	..	7 4 11	Jan, July
100	..	[illegible]	..	.. ..	Fb,M,Aug,N,
..	..	[illegible]	57	8 15 5	Mar, Sep
St.	4½	Montreal Street Ry. 4½% Debs. (1922)	100½	4 9 7	Feb, Aug
1	..	[illegible]	77	6 10 1	Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds.	..	4 14 3	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
..	..	[illegible]	8½	5 13 7	Mar, Sept
St.	..	[illegible]	..	4 16 7	Jun, Dec
1	..	[illegible]	..	5 14 3	..
5	9%	Calcutta E. S. Corp. Ord.	..	6 19 10	..
..	..	[illegible]	..	5 1 3	Mar, Sept
..	..	[illegible]	..	7 12 2	Ja,Ap,Jly,O
St.	..	[illegible]	102½	4 17 7	June, Dec
St.	..	[illegible]	101	4 19 0	Apl, Oct
..	..	[illegible]	102	4 18 ..	Jan, July
..	..	[illegible]	..	4 15 ..	Ja,Ap,Jly,O
St.	..	[illegible]	100	4 10 0	Jan, July
St.	..	[illegible]	..	4	May, Nov
..	..	[illegible]	..	.. ..	Jan, July
..	..	[illegible]	..	.. ..	Jan, July

‡ Less Income Tax or Interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date June 30, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	14½d.	Antimony	£122 0 0
Solid Drawn Copper Tubes	14½d.	English Lead	£25 5 0
Brazed Copper Tubes	14½d.		
Brazed Brass Tubes	15d.	**Old Metals:**	per ton.
Brass Wire	14½d.	Clean Scrap Copper	£76 0 0
Copper Wire	14½d.	Brazlery Copper Scrap	£71 0 0
Rolled Brass	14½d.	Clean Scrap Brass	£59 0 0
Brass Sheets	15d.	Old Lead	£22 0 0
		Old Zinc	£65 0 0
	per ton.	Hollow Pewter	£120 0 0
Copper Sheets	£113 0 0	Black Pewter	£85 0 0
Spelter	£105 0 0	Gun Metal	£64 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date June 29, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£66 0 0	Old Lead	£20 10 0
Clean Mixed Brass	£62 0 0	Tea Lead	£18 10 0
Clean Copper	£72 0 0	Hollow Pewter	£120 0 0
Brazlery Copper	£66 0 0	Shaped Black Pewter	£85 0 0
Gun Metal	£66 0 0		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Average No. of weeks.	Increase (+) or decrease (–).	Net for weeks.	Aggregate. Amount	Aggregate. Increase (+) or decrease (–).
			£		£	£
Aberdeen Corporation	June 23	1,832	+ 5	3	6,156	+ 195
Anglo-Argentine	.. 24	49,296	– 5,041	26	1,284,533	– 121,447
Ashton-under-Lyne	.. 19	482	+ 16	12	5,853	+ 114
Ayr Corporation	.. 20	407	– 1	6	2,206	– 181
Bath Electric Trams. Ltd	.. ..	..	..	..	..	..
Birkenhead Corporation	.. 27	1,385	– 65	13	16,991	+ 526
†Birmingham Corporation	.. 26	13,273	– 542	13	163,375	+ 2,010
Blackburn Corporation	.. 23	1,352	– 27	13	17,082	– 842
Blackpool Corporation	.. 24	1,414	– 574	12	15,440	– 4,033
Bradford and Shipley	.. 26	651	– 253	25	11,605	– 2,248
Bolton Corporation	.. ..	..	..	..	..	..
Bournemouth { Trams	.. 23	1,475	– 152	12	25,857	– 23
Bournemouth { Buses	.. 23	34	– 9	12	274	+ 4
Bradford Corporation	.. ..	..	..	..	..	..
Brighton Corporation	.. 25	1,121	– 314	138	13,266	– 1,034
Bristol Trams { Trams	.. 25	4,746	– 16	26	114,640	– 1,579
Bristol Trams { Buses, &c.	.. 25	5,056	+ 271	26	115,441	+ 22,180
Burmah E. Trams & Ltg	.. 26	R4,224	– R539	25	..	– R44,048
Burnley Corporation	.. 26	1,498	– 131	13	34,651	– 1,705
Burton Corporation	.. ..	..	..	..	..	..
Bury Corporation	.. 27	1,358	– 80	13½	17,603	– 575
Calcutta Tramways Co.	.. 26	R67,277	– R2,833	..	R1,651,155	– R85,003
Camborne-Redruth	.. 26	155	– 1	25	3,373	– 107
Cardiff Corporation	.. 26	2,701	– 262	13	33,572	– 3,075
Cork Electric Trams Co.	.. 27	959	– 85	26	12,074	– 162
Coventry Corporation	.. 27	940	– 93	13	12,141	+ 1,095
Croydon Corporation	.. 16	1,493	+ 189	11	21,047	+ 148
*Derby Corporation	.. 26	1,045	– 9	12½	13,133	– 187
Dover Corporation	.. 26	317	+ 65	12	3,742	+ 683
Dublin & Lucan Railway	.. ..	..	..	..	..	..
Dublin United	.. 27	6,765	– 139	25	149,892	+ 6,987
Dundee Corporation	.. 23	1,367	– 3	13	7,522	– 32
East Ham Council	.. 26	1,364	+ 183	12	16,582	+ 3,177
Exeter Corporation	.. 26	386	– 16	12	4,678	+ 70
Glasgow Corporation	.. 26	21,999	+ 363	12	84,935	+ 3,593
Glossop Trams	.. 26	129	– 8	26	3,054	– 143
Gloucester Corpn.	.. 23	347	– 12	12	3,997	– 137
Halifax Corpn. { Trams	.. 23	2,348	+ 89	12	27,339	– 123
Halifax Corpn. { Buses	.. 23	49	– 3	12	606	– 16
Hastings Elec Trams Co.	.. 26	1,010	– 69	25	20,898	– 1,026
Huddersfield Corpn.	.. 26	2,640	+ 283	13	34,034	+ 3,349
Hull Corporation	.. 26	2,920	– 1,303	12	38,315	– 2,555
Ilford District Council	.. 27	675	+ 58	12	8,194	+ 1,593
Ilkeston Corporation	.. 27	139	– 3	12	1,515	– 64
Ipswich Corporation	.. 26	606	+ 7	12	6,326	+ 9
Isle of Thanet Co.	.. 26	433	– 581	38	12,426	– 4,628
Kilmarnock Corporation	.. ..	177	+ 6	6	1,014	– 78
Lanarkshire Trams Co.	.. 26	2,109	+ 134	25	46,462	– 1,574
Lancaster Corporation	.. 26	1,830	+ 127	26	41,317	+ 422
Leeds Corporation	.. 26	8,878	+ 412	13	112,419	+ 4,863
Leicester Corporation	.. 26	3,176	+ 148	26	74,836	+ 1,208
Leith Corporation	.. 26	206	+ 13	6	4,774	+ 146
Lincoln Corporation	.. 26	132	– 7	13	1,732	– 69
Liverpool Corporation	.. ..	..	..	..	..	..
Llandudno&Colwyn BayR	.. ..	388	– 40	25	7,649	+ 837
London County Council	.. ..	44,012	+ 175	11	440,960	– 46,812
Lowestoft Corporation	.. ..	..	..	..	..	..
Maidstone Corporation	.. ..	205	– 11	13	2,644	– 88
Manchester Corporation	.. ..	18,317	+ 39	13	225,925	+ 279
Nelson Corporation	.. ..	186	– 37	13	2,231	– 350
Newcastle-on-Tyne Corpn.	.. ..	6,588	+ 2,103	12½	77,654	+ 8,262
Newport (Mon.) Corpn.	.. ..	813	– 6	13	10,431	– 276
Northampton Corporation	.. ..	779	– 18	12	9,338	+ 1,807
Nottingham Corporation	.. ..	3,783	+ 4	12	44,351	+ 32
Oldham Corporation	.. ..	2,338	– 7	13	31,486	– 679
Portsmouth Corporation	.. ..	..	..	..	..	..
Preston Corporation	.. ..	..	..	..	..	..
Rochdale	.. ..	1,677	– 40	13	21,895	+ 771
Rotherham Corporation	.. ..	1,139	– 140	13	13,376	+ 1,146
Salford Corporation	.. ..	5,397	– 47	13	67,146	– 494
†Sheffield Corporation	.. ..	8,680	– 739	13	115,412	+ 8,257
Southampton Corpn.	.. ..	1,478	– 8	12	17,397	+ 67
Southend Corporation	.. ..	728	– 44	12	9,790	+ 2,630
Southport Corporation	.. ..	800	– 84	11½	8,974	– 11
South Staffordshire, Its. & &c., Jt. B	.. ..	..	..	..	..	..
Sunderland Corporation	.. ..	1,505	– 197	13	18,433	– 66
Sunderland District	.. ..	588	– 7	13	18,631	– 1,15
Swindon Corporation	.. ..	206	+ 9	12	2,388	+ 2
Tynemouth Tram Co.	.. ..	808	+ 18	24	13,515	+ 6
Wallasey Corporation	.. ..	1,283	– 40	13	15,806	– 83
Walsall Corporation	.. ..	705	+ 21	24	17,739	+ 1,63
Wigan Corporation	.. ..	1,011	+ 122	13	11,574	+ 94
Warrington Corporation	.. 24	3,183	+ 166	12	37,995	+ 2,53
West Ham Corporation	.. ..	1,528	+ 84	12	18,630	– 3
Wigan Corporation	.. ..	1,085	+ 46	12	13,228	– 1
Wolverhampton Corpn.	.. ..	1,567	+ 124	26	40,002	+ 2,2
Yorkshire W.R. Trams	.. ..	..	..	..	..	..

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ‖ Plus 3 days.
¶ Plus 1 day. ** Compared with one week more last year.

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NOTES.

Automatic Control.

DURING the Session a number of Papers dealing with the subject of motor control have been read, and numerous descriptions have been given of automatic systems of control. In this country the magnet-switch system of control has not been developed to the same extent as in America. In a Paper on "The Power Supply of the Central Mining-Rand Mines Group," read before the Institution of Electrical Engineers earlier in the year, Mr. J. H. RIDER related that, with a view to obtaining competitive arrangements, he sent particulars of this system of control to a British firm, and after waiting nearly five months for a reply other than an acknowledgment to be received, the information sent him was entirely useless. We are at a loss to understand the reason for such apathy. To all electrical engineers it surely must be apparent that, sooner or later, in industrial control the hand-operated starter must inevitably give way to the automatic starter. We do not belittle the many ingenious appliances used as adjuncts to the ordinary starter, but from every point of view a press-the-button-to-start argument appeals more strongly to [illegible] than to wait on the [illegible]. We regard the instructions to start slowly in much the same light as the mischievous boy, and we are certain that in the long run it is to the manufacturers' best interests to relieve the operator of these responsibilities. Automatic starting is not a new idea. It has long been the standard practice in electric traction and in lift work. Without such control it is probable that heavy electric traction would have made little or no progress. The experience gained in the design, construction and operation of controllers for the two classes of service just named has enabled manufacturers to standardise automatic and semi-automatic control gear for practically every purpose. Although both design and construction are such as to enable the manufacturer to guarantee proper performance irrespective of the skill of the operator, it is not these things which impress us so much as the scientific manner in which the problem of automatic control has been attacked. Industrial starters which depend for their action on the skill of the operator, be this never so little, are defective in design. Manufacturers and their agents dub their machines "fool-proof" when such machines are less defective in a certain respect than those made by their competitors. We feel that this is not a strong selling point, and we are certain that such flippancy adds nothing to the dignity of the profession.

The Northumberland Clause.

ATTEMPTS are made from time to time by gas companies to have the above Clause inserted in Provisional Orders and Bills relating to electricity supply. The latest attempt has reference to the Order empowering the Corporation of Southampton to supply in certain districts beyond their present area. The object of the Northumberland Clause is to prevent an undertaking from coming seriously upon the rates, and the method by which this end is sought to be attained is by providing that at intervals of a certain number of years—say, three years—the position is to be considered, and if the undertaking is not paying its way the prices are to be raised in order to supply the needful profit. As regards the application of such a clause to an existing undertaking, we think that the general view must be that this should be quite unnecessary. In a going concern the general policy of the management should be such as to ensure profitable working, and if this profitable working does not arise in the ordinary course of things it is not likely to be provided by any such clause. In the case of new undertakings there may be some excuse for the idea that the [illegible] underlying the Northumberland Clause

should be enforced. It is very natural, if a profit is not being obtained, for a timid management to seek the remedy of raising prices. It does not by any means follow, however, that this remedy will give the desired result. If prices are raised, an almost inevitable effect is the curtailment of sales, and it may well happen that the final result will be unsatisfactory. Not only may it happen that the increase in revenue through higher prices will not be sufficient to compensate the decrease in sales, but there is every likelihood that the growth of the business will be seriously menaced. It is this fact more particularly which is often forgotten. We are afraid that in these cases the Board of Trade is too ready to listen to the argument of gas companies who very naturally desire to see the clause included in all provisional electric lighting orders. At all events, it was announced during the proceedings in the Southampton order that the East Grinstead and Connah's Quay orders had also been burdened with the clause. The initial period laid down by the clause is not sufficiently long to enable the owners of small municipal electricity works to put the undertaking on a paying basis, but in our view the most objectionable feature is that it checks the development of a power load. Most modern factories use the electric drive, but before entering into an agreement for the supply of electrical energy manufacturers must be assured of a cheap supply for a number of years. Power agreements are frequently for five, seven, or even ten years, but how can undertakers burdened with the Northumberland Clause entertain agreements of this sort?

The Small Central Station.

THE really small central station bristles with problems of all kinds, because we are faced with the necessity of providing a supply with the minimum possible amount of capital and the lowest possible running costs, and this with plant which is expensive per kilowatt and must be comparatively inefficient as compared with that which is used in large stations. Yet there are any number of small towns or large villages with a few thousand inhabitants in which the advantages of electricity supply are desired. The position is rendered much more difficult in this country than on the Continent, where it is realised that it is better to have a supply merely during the hours of darkness than to render a supply impracticable by insisting on a 24 hour supply per day. If we could only bring ourselves to adopt the more elastic methods, both of control and of equipment, which is permitted in other countries, electrical methods would certainly receive an impetus in Great Britain. In this connection we reproduce a Paper in abstract by Prof. H. Bohle on the "Supply of Electricity for Small Towns in South Africa." The figures which Prof. BOHLE puts forward will be generally familiar to our readers, but we may [illegible] to the special devices which he has used in order to avoid the use of pilot wires.

[illegible] the point of view of alternate hourly rates it is essential that the capital expenditure in such cases should be cut down to the irreducible minimum, otherwise the capital charges become such a predominant factor that it is difficult to put the undertaking upon a profit-making basis. In such cases the chance of being able to produce any large number of units per annum per kilowatt installed is somewhat remote, and it is a difficult matter to find consumers who will really lead to a good load factor. In some cases the situation is more fortunate, and we have seen load curves of small stations, more particularly in America, which would make the engineers of a purely lighting plant in this country quite envious. Doubtless more can be done at the present day than formerly to improve matters by inducing consumers to use such devices as electric flat irons, which are not out of the question even on a somewhat high tariff; and we also think that much more might be done to encourage consumers by means of contract tariffs, as is very usual on the Continent. In conclusion we would express the view that every small station of this kind should be put down with the ultimate idea in mind that a bulk supply will be available sooner or later, and that provision should be made in the designs so that such a supply can be utilised when the time comes—to which we all look forward—when a bulk supply will be available in most parts of these islands.

Engineering Development in China.

WE do not think it is sufficiently realised at the present time what an enormous opening there should be in engineering development in China in the near future. For this reason we are glad to see that Mr. DENNISON has been emphasising the matter before the Leeds Chamber of Commerce. There is no question that there are vast potentialities in China; the nation has been gradually awakening during the last few years to the desirability of utilising its resources, or at least allowing other nations to develop these resources without regarding such individuals as foreign devils to be excluded at all cost. It must be remembered that this large country is not simply one that is half developed from the engineering point of view, or one in which mistakes of an engineering character have to be rectified or accepted because they cannot be put right. It is fortunately a case of starting with a clean slate in a country which must inevitably develop to a large extent before so very many years have passed. From every point of view, therefore, our financiers and our engineers should keep their eyes open to these possibilities, and the Government should give every assistance with the consular service. Something has been done by the British Engineers Association, but apart from directing a policy it is necessary that manufacturers should be prepared to handle schemes actively. It is impossible for one firm to do all that is necessary, but there is a good deal to be said in favour of the idea put forward by Mr. DENNISON that a number of firms should combine so as to carry out the many schemes that would be required. Here again, however, it is a case of combination for mutual benefit, which idea seems to be so distasteful to the British mind or individual effort and poor returns.

Royal Institution. At a general meeting of the members held on the 5th inst., the managers reported that they had re-elected Sir James Dewar, M.A., D.Sc., LL.D., F.R.S., Fullerian professor of chemistry, for a period of three years.

The Inventions Board.—Admiral of the Fleet Lord Fisher of Kilverstone, G.C.B., O.M., G.C.V.O., LL.D., has been appointed Chairman of the Inventions Board which is being established to assist the Admiralty in coordinating and encouraging scientific effort in its relation to the requirements of the Naval Service.

International Engineering Congress, 1915.—A small booklet outlining the arrangements that have been made for holding this Congress at San Francisco in September has been issued and obtainable on application to Mr. W. A. Cattell, secretary, International Engineering Congress, 417, Foxcroft-building, San Francisco.

The Late Mr. Spagnoletti.—At the funeral of the late Mr. C. E. Spagnoletti, honorary member and past-president of the Institution of Electrical Engineers, which took place at West Hampstead Cemetery last Friday, Sir William Crookes (president of the Royal Society) was present, and the Institution was represented by Sir John Snell (president), Prof. Carey Foster, F.R.S., Dr. S. P. Thompson, F.R.S., Mr. J. E. Kingsbury, Mr. Roger T. Smith, Mr. H. Hirst and Mr. P. F. Rowell (secretary).

Gyro-Compass in the American Navy.—According to the "Scientific American," gyro-compasses have now been installed on 20 battleships, one armoured cruiser and 15 submarines of the United States Navy, and it has recently been decided to instal master compasses in duplicate on all battleships of the "Delaware" and later classes. Special attention is being paid to the instructions of officers and men in the care and use of these compasses by sending them for a month's instruction at the New York Navy Yard or at the works where the compasses are made. The Bureau of Navigation also maintains with the Atlantic fleet two chief gunners who have been specially trained as gyro-compass experts, their duty being to inspect and adjust the compasses and give instructions in their use.

Standardisation of B.A. Screws.—The standardisation of B.A. screws, taps and dies, and gauges, has been before the Small Screws Sub-Committee of the Engineering Standards Committee for some time, and though, on account mainly of the difficulty of finding satisfactory methods for the standardisation of the small screws and gauges, no definite decisions have been taken, yet certain provisional conclusions have been reached which have enabled the National Physical Laboratory to issue a tentative list of dimensions which there is reason to believe may, at the present juncture, be of service to persons using the screws and may assist in obtaining interchangeable work. The Laboratory is prepared, pending an authoritative decision on the matter, to certify screws, &c., which fall within the limits suggested.

Electrolytic Disinfecting Fluid at Poplar.—The demand for the electrolytically manufactured disinfecting fluid made by the Borough Council of Poplar has been steadily growing since the plant was installed nine years ago, necessitating the opening of six additional distributing depots. Several improvements have been introduced, notably in connection with the prevention of "creeping" from the electrodes of one cell to those of another. This is caused by the presence of metal in the slate of the cells, and it sometimes used to lead to erosion and eventually to a dead short-circuit. The present cells are of earthenware, though several firms of potters declined to undertake their manufacture, saying that the baking would be a failure. Finally they were made by a firm in the Borough, under the supervision of the medical officer of health, and they are found to be satisfactory if properly glazed. If the glazing is defective, the fluid may soak in and still cause erosion even in earthenware. The latest type of double cell, however, is again of slate, and of such a form as to prevent creeping entirely. The success of the work has been so much appreciated that plants have now been supplied to [illegible] Gateshead, Finland, Buenos Ayres and Rangoon [illegible] Portsmouth it is intended to manufacture the fluid from sea water.

Influence of Gases on the Emission of Electrons and Ions from Hot Metals. A Paper dealing with this subject was read recently before the Royal Society by Prof. O. W. Richardson. As is well known, the [illegible] saturation current i is expressed accurately and quite generally over wide ranges of temperature by the equation, $i = AT^{\frac{1}{2}}e^{-b/T}$. In the case of metals, in particular, the equation is satisfied when the metals are contaminated by the presence of a gaseous atmosphere, as well as when the surfaces of the pure metals are tested. In general, however, the effect of the contaminating gas is to cause large changes in the values of the constants A and b. The changes which are thus brought about in these constants are considered in the present Paper. So far as it may be considered reliable, the available evidence shows that A and b for a given metal always change together in such a way that the change in log A is proportional to the change in b. This linear relation is very closely satisfied by the results of all Langmuir's observations with tungsten, for which substance different gases change A by as large a factor as 10^{12}. A similar relation, with an almost equal coefficient of proportionality, is required by the best observations on the negative emission from platinum. In the case of tungsten, contaminants cause an increase in A and b, whereas with platinum a diminution occurs. All the known data point to the existence of a similar law governing the steady emission of positive ions from platinum. By applying thermodynamic considerations to the emission of electrons from contaminated surfaces, it is shown to follow from the linear relation between log A and b, that the contact potential difference between the pure and the contaminated metal is of the form $a_0(1-\alpha T)$, where the constant a_0 has opposite signs for tungsten and platinum, and α has approximately the same value for both metals. T is the absolute temperature.

City and Guilds of London Institute.—The report of the Council for the year 1914 states that the entry of students and candidates for the session ended July, 1914, was well maintained and in some directions the increase of previous years was continued.

At the City and Guilds Engineering College there were 411 students taking the regular course, against 429 in the previous session, the decrease being due to the transfer of the chemical department to the Royal College of Science; at the Technical College, Finsbury, there were 194 regular day students against 177 in the previous session, and 140 in the 1912 session. The number of Papers submitted by candidates at the examinations of the department of technology held throughout the Kingdom increased from 21,878 to 23,119. The war has had a marked effect upon the entries for the current session and both day and evening classes in all subjects—science, technology and applied art. The total students in March last were 405, against 605 for 1913-14, the main decrease being in the second and third year students. There are 633 members of the staff and past and present students of the City and Guild's Engineering College in His Majesty's Forces, the number for the City and Guilds Technical College, Finsbury, being 206.

In the report of the Chairman of the Council (Sir J. Wolfe-Barry) it is stated that the College professors have been consulted more or less informally on several engineering problems of military importance which have arisen—in one case a class for advanced work in structural engineering was suspended at short notice to enable the lecturer to carry out an urgent piece of work in the West of England for the military authorities. Prof. Meldola has rendered valuable services in connection with the proposal to establish on an adequate footing the British dye manufacturing industry. The Council urge on the members of the Institute and the Corporation and all Livery Companies the importance of carrying on and maintaining in the highest state of efficiency the work which the Institute was established to conduct, especially at a time when new industrial problems are constantly arising which require the aid of highly trained scientific workers.

In the report of the Delegacy of the City and Guilds Engineering College it is stated that the College was attended during the session by 532 students, compared with 570 in 1912-13 and 589 in 1911-12. Progress is being made towards the provision of the equipment and in the redistribution of the work of the old civil engineering department, now reconstituted into two separate departments—mechanical engineering and motive power, and civil engineering and surveying. The diploma of Associate of the City and Guilds Institute was awarded to 82 matriculated third-year students against 84 in the previous year. The Siemens Memorial Medal and premium for the students of greatest merit in electrical engineering was awarded to Mr. S. Neville, the Bramwell Medal in civil and mechanical engineering to Mr. J. B. Faber, and the Henry Medal in Mathematics to Mr. A. G. Lipscomb. Last year 53 students of the College obtained the degree of B.Sc. (Eng.) in the University of London, 18 in Honours. The students at the Technical College, Finsbury, numbered 182 against 194 in 1913-14. At the close of the session [illegible] were awarded to students engaged in the previous year, [illegible] 30 in mechanical engineering, 21 in electrical engineering and 8 in chemistry. The evening department at the College had attended by 1,701 students, compared with 2,224 in the previous session.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Dr. C. C. [illegible] with apparatus for protecting electrical machinery against abnormal electrical conditions (p. 506).

Mr. R. [illegible] "Notes on the Use of Mercury Type Electrolytic Meters" (p. 516).

A Paper was recently read by Mr. A. L. Tackley, before the Institution of Electrical Engineers, on "The Mathematical Relationship between Flux and Magnetising-Current Waves at High Flux Densities." We reproduce this Paper in part (p. 511).

We also give an abstract of a Paper on "The Supply of Electricity for Small South African Towns," by Prof. H. Bohle (p. 501).

At the annual general meeting of the British Science Guild, Sir William Ramsay delivered an address on the "National Organisation of Science" (p. 521). We deal with this subject in our leading article (p. 514).

Legal.—The hearing of the Osram Lamp Works' action against Pope's Electric Lamp Co. has been continued during the past week. [illegible] (p. 524.

Parliamentary.—The proceedings of the Parliamentary Committees who have considered the Southampton Corporation Provisional Order and the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board's Bill are reported on p. 525.

Companies' Meetings and Reports.—Meetings of Crompton & Co., Greenwood & Batley and the Singapore Elec. Tramways are reported; and the directors' reports abstracted include those of the Cape Town Consolidated Tramways and Land Co., Chili Telephone [illegible] (pp. 531-532).

OBITUARY.

KILLED IN ACTION. We regret to record the death of *Major R. P. Chapman*, of the 10th Battalion Durham Light Infantry, who has been killed in action in France. Deceased was the eldest son of the late Capt. Abel H. Chapman, formerly 19th Hussars, and chairman-director of Messrs. Clarke, Chapman & Co.'s works, Gateshead-on-Tyne. Major Chapman was educated at Uppingham; he entered the company's works in 1891 and became director in 1893. He was keenly interested in a volunteer corps of the 1st Durham Royal Engineers raised in the works, of which he became Major, and resigned with that rank. He was a member of the North-East Coast Institution of Engineers, also a member of the Institution of Naval Architects and Marine Engineers. On the outbreak of the war he volunteered his services, which were accepted; he was appointed Major of the 10th Battalion Durham Light Infantry Force, which went out to France in May, and he was killed in action on June 27. He leaves a widow and three daughters.

We also regret to record the death of *Lieut. H. B. Phillimore*, A.M.I.C.E., 8th Argyll and Sutherland Highlanders (T.F.), who died on the 15th June of wounds received in action in France.

PERSONAL.

Mr. J. Shepherd, who for the past 13 years has been with the London County Council Tramways Department, and for eight years was chief assistant electrical engineer to the Council, is terminating his engagement so as to practice as a consulting engineer with Mr. T. S. Watney, under the style of Shepherd & Watney, at 32, 33 and [illegible] Parliament Street, S.W.

APPOINTMENTS VACANT AND FILLED.

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply [illegible] Cape Town, South Africa, to [illegible] Sydney [illegible] W., by August 12.

[illegible] Public Service Commission, Pretoria. *See advertisement.*

An experienced man with good commercial and technical knowledge is required to take charge of electrical instrument department [illegible] Glasgow. [illegible]

An advertiser requires an electrician to supervise the carrying out of contracts for lighting, telephones, &c., on an estate near London.

A resident engineer is required to take charge of pumps, electric lighting, &c., at Bucks County Asylum. Commencing salary £165 (less £45 for house, &c.). Applications to the Clerk of the Asylums Committee, Aylesbury, by noon July 17.

Leek Urban Council require a chief assistant electrical engineer. Commencing salary £120. Applications to the Clerk by July 12.

Mr. S. C. Laws, of Loughborough Technical Institute, has been appointed Principal of the Wigan Mining and Technical College.

Mr. R. H. Balfour has been appointed chief engineer of the Montreal Electrical Commission.

INSTITUTIONS AND SOCIETIES.

Society of Arts.—This Society has arranged for Prof. Vivian B. Lewes to give three special lectures on "Modern Munitions of War" at 4:30 p.m. on Wednesday afternoons, July 7th, 14th and 21st. The first lecture will deal with "Guns and Propellants," the second with "Mines, Shells and High Explosives," and the third with "Poison Gases and Incendiary Bombs." The lectures will be open to all Fellows of the Society, who can admit their friends personally, or by the usual tickets. Tickets will also be issued gratuitously to any persons interested in the subject who may apply to the secretary.

EDUCATIONAL NOTES.

University of Manchester.—In the faculty of science complete courses of study, extending over three years, are arranged for the university degrees in civil, mechanical and electrical engineering. There are good facilities for research and practical work. The civil and mechanical engineering laboratories have been recently equipped with new plant and apparatus. The electrical engineering laboratory is housed in a new building. The session commences on October 7th.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

University of London, University College.—The following awards have been made in the Faculty of Engineering:

Archibald P. Head Medal and Prize: B. C. Drummond. Students' Prize in Heating and Ventilating Engineering: C. F. Mitchell.

Engineering Diplomas. E. E. Barnard, J. R. D. Bushell, P. L. Cappleman, T. C. Chua, H. Ford, G. K. Pillai and S. L. Wong, Civil and Municipal; P. W. Baker, H. N. Charles and B. C. Drummond, Mechanical. Messrs. Capper and Mr. Drummond received their diplomas with distinction.

Bradford Technical College.—At this college there are diploma courses in civil, mechanical and electrical engineering, power generation and transmission, &c. Full courses are also offered in all branches of the textile industries, including dyeing. There are well-equipped laboratories and good facilities for practical and research work. The terms commence September, January and April. Prospectuses giving full particulars of courses, &c., will be sent post free on application.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, July 16th.

[illegible] Railways and Locomotive Railways Association.

10.30 a.m. Annual Conversazione of the Institution of Civil Engineers, Great Georges Street, Westminster. Agenda: Annual General Meeting and Papers for Discussion into the Odyssey, by V. V. Mason; on Tramways During War Time, by J. W. Dundee; and on Electric Battery Vehicles as Adjuncts to Tramways, by W. H. L. Watson.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following [illegible] for the week ending July 17th: On Monday, Wednesday and Friday, Drill at 6.30 p.m. and 7.30 p.m. Technical instruction will be given by members of the Home Electrical Engineers on Monday and Friday and separate [illegible] on Wednesday. On Friday [illegible] and [illegible].

THE SUPPLY OF ELECTRICITY FOR SMALL SOUTH AFRICAN TOWNS.*

By H. [illegible].

Summary.—The author discusses [illegible] the question of electricity supply for small towns in South Africa, [illegible] to the consideration of the choice of system, plant, network, &c. Special attention is given to the measurement of feeder voltage, switching of street lamps and method of charging. In conclusion, the author gives particulars of a typical undertaking at Stellenbosch.

General Considerations.—During the last [illegible] considerable activity has been witnessed throughout the Union as regards the supply of electricity for small communities. A large number of small towns and even villages have either [illegible] in hand or have carried it out already, or are contemplating it. The conditions of supply are, of course, entirely different from those in Europe. Our country towns and villages are very small and the distances between them very great. It is, therefore, impossible for one power station to supply a number of communities except in isolated cases, and each municipality must build a station of its own. Such supply undertakings will, therefore, always be small, seeing that practically no town has a population exceed[illegible] 7,000 [illegible] and many hardly more than 2,000. The size of the plant is consequently also limited and will scarcely exceed 200 kw. It must be added that little manufacturing goes on in any of these towns, which would necessitate the installing of many motors. I doubt whether for agricultural purposes electric power will ever be used to any extent, since most farms are at considerable distances from the towns, and the little power required would not justify the transmission over long lines. Power is chiefly wanted for lighting purposes, with a little for cooking and heating. It is certain that for the latter purpose the wants will materially increase in the future, especially if current can be supplied at a reasonable cost. We must also remember that our dark days are few in number, and may be considered non-existing, while the daylight even in winter lasts till nearly six o'clock and in summer till eight and longer. Moreover, people in this part of the world go to bed early, and after 11 o'clock little light is wanted, even in the streets. Then we must remember our bright moonlight nights, when artificial street lighting is unnecessary. Adding to this the high price of fuel, whatever its nature may be, which in some cases has even to be carted for miles after it leaves the railway station, it will be obvious that in this country electricity cannot be sold at European figures. Fortunately, this disadvantage is largely counterbalanced by the greater buying capacity of the South African, one person being about equal to two Europeans.

Choice of System.—The chief consideration [illegible] to the choice of system is that the total annual costs must be a minimum. The cost of equipment should be kept as low [illegible], but it must be remembered that the cheapest plant is not always the most economical. To keep down the running costs the work of the day is usually carried out in one shift, which, of course, necessitates the employment of a secondary battery and settles the type of plant, which must be of the direct-current class. For very small towns the author advocates the use of a 220-volt two-wire system, but for the majority of South African towns the three-wire 440-volt system is superior. The author then goes on to comment on the choice of the prime mover, and gives the principal characteristics of steam, suction gas, oil, petrol, Diesel and semi-Diesel plants. In each case the applicability of these various types to South African conditions is discussed and the author also compares [illegible] types in a general way.

As regards the capital costs of prime movers there is little to choose. For a plant consisting of two 60 B.H.P. sets the difference in prices for steam, suction gas and Diesel engine plants is negligible. The slightly lower price for the suction gas plant was more than compensated by the increased cost of the building. In fuel consumption the suction gas plant is cheaper than a Diesel engine installation, wherever a town lies on or near the railway. Where fuel has to be carted [illegible] the Diesel engine will usually be given preference. For [illegible] to be used for lighting purposes, as [illegible] will usually be [illegible] and where [illegible] is supplied [illegible] general rule can be laid down.

Cooling Water.—The question of supply [illegible] in some parts of South Africa [illegible] Where [illegible] had to be carted more than [illegible] It would [illegible] of cooling towers [illegible] Where [illegible] water [illegible] Where [illegible] water [illegible] have given the principal methods which are in vogue at the present day. Where water is dear a method whereby the water is cooled by a motor-driven blower forcing air through a gilled tube radiator is suitable. For a 25 kw. gasolene set the output of the motor has to be about 2½ kw., whereby the efficiency of the whole plant is, of course, reduced. The quantity of water used is very small, the evaporation being negligible. A modification of this system, where a cooling tower with an expansion tank at the top is used, the heat being radiated from a large number of turns of loops of iron pipe, around which the air is allowed to circulate, and through which the water is propelled by a pump, can also be used. If water is cheap connection to the water mains can be made.

Generating Plant.—In considering the generating plant the author advocates direct coupling of the generator to the engine. For three-wire networks balancers are necessary. These may be of the rotary or of the static type. The latter are cheaper and less liable to get out of order, and as they can accommodate up to 15 per cent. out of balance currents, they will in most cases suffice. A large part of the load will consist of street lighting, and this can always be balanced. Some out of balance may be neutralised by controlling the station lighting from a two-way switch, whereby the light may be switched on to either side of the network. With a storage battery the voltages on the two sides of the network may be adjusted as desired. As in such cases the cells may be unevenly discharged, provision must be made to charge them unevenly. The battery must be large enough to avoid a day shift, except where the day load is considerable. There is no doubt that the battery is very often chosen too small on account of its large initial cost. The cells are then frequently overloaded, the plates buckle, and the battery lasts a few years only. The saving is then doubly lost. The battery is the weak spot in a central station in this country, as the staff in country stations is usually small and often inexperienced. This means that the battery is neglected; it is frequently placed in an out-of-the-way corner in half darkness. The battery room should always be well lighted when required and thoroughly ventilated. It should be large enough to allow the cells to be properly spaced.

With regard to reserve plant, a safe rule, when installing new power-house equipment, is to double the actual plant required and to leave room for future extensions. The chief consideration in the choice of a switchboard is that the control should be simple and effective. It should be possible to see what each machine is doing, the power entering and leaving the battery, and the total output of the station should also be recorded. The pressure at the feeding points should also be indicated so that it can be kept at its correct voltage. Care must also be taken for accidental short circuits at night when no attendant is present. Protection must also be given to the battery, so that under no circumstances can it be fully discharged. Some observations are made with regard to the station buildings, and a few general considerations for various types of stations are given.

Network.—A good deal of labour, a large number of cross arms and insulators may be saved by a judicious arrangement of the network and especially of the feeders. The smaller the number of feeders the shorter and lighter may also be the poles. This is of considerable importance where the material has to be carted over long distances after the railway line is left, and even where a station lies on the line, the freight to inland towns is considerable. The choice of poles is then also of importance. The lightest poles for a given tensile strength are those of weldless steel. Lap welded poles with cast-iron base tubes weigh at least half as much again. Steel poles are, however, not suitable at every place, especially near the sea, owing to liability to corrosion. For light steel poles a distance of 40 yds. between poles is convenient, which means that a lamp is placed on every second or third pole respectively. Even for a low-pressure distribution every pole must be properly earthed according to the ordinance. This is usually done by connecting all poles together by means of a wire and earthing a number of poles thoroughly. This is [illegible] then happen that there is a leak pressure of 70 to 80 volts between [illegible] is the distribution of the voltage, but the more expensive will be the [illegible] by a single pole, the shorter the latter may be. In this country no [illegible]

* Abstract of a Paper read before the South African Institution of Electrical Engineers.

the question of the number of feeders is important even from this standpoint. To make this number small, we may combine consumers and street lighting feeders, meter the street lighting on the poles or in feeder pillars, and provide special switching arrangements for the street lighting. The copper of the feeders may then be used to the fullest extent, as it is not necessary to make the cross section of the combined feeder equal to the sum of the cross section of the two separate ones. During periods of maximum load the pressure may easily be raised at the station to account for the drop.

Feeding Points.—For good regulation a knowledge of the voltage between the mains at the feeding points is essential. These voltages can easily be measured by installing a pilot wire from the station to each feeding point, this wire being joined at the station end to a voltmeter, the second terminal of which is connected to the middle wire. For four sets of feeders this means eight pilot wires, a large number of cross-arms, insulators and considerable expenditure for labour. The pilot wires may be totally discarded by employing the method shown in Fig. 1.

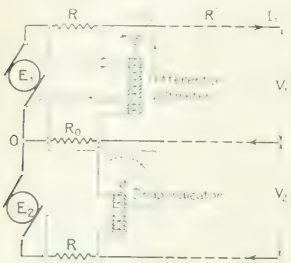


Fig. 1.

G. Rasch* showed that it is possible to measure with the help of certain suitable resistances, dependent on the circuit on which they are employed, the voltage at the end of the feeders by means of a single voltmeter, properly calibrated. A simplification of this method obtained by using a voltmeter with two coils is seen in Fig. 1.

The instrument, however, reads only the drop, so that a slight mental subtraction has to take place to get the reading at the feeding points, unless a third coil is used, as is indicated in the same figure. Care must of course be exercised in the insulation of these coils, since the one-sided network pressure reigns between them. Trouble would be experienced with moving coil instruments, but little with moving needle types. For safety, a fuse might be inserted in each circuit. This is on the assumption that each set of feeders has a

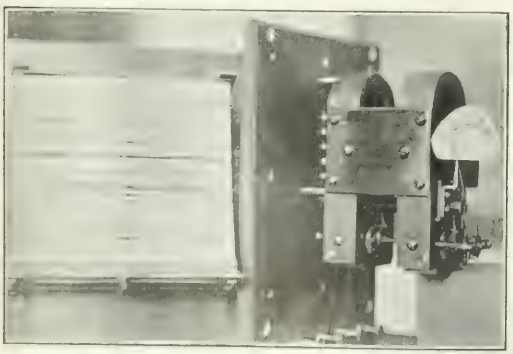


Fig. 2.—View of Voltmeter for Reading Feeder Voltage.

may then be used, whereby the average drop to all feeding points is registered, or with a three coil instrument, the average voltage of all feeding points. This method does away with a number of instruments and is in most cases sufficient for effective control.

The two or three coil voltmeter has in practice hardly been employed. The shunts required absorb considerable power, as soft iron core instruments are not very sensitive. Permanent magnet moving coil instruments were suitable, as it was almost impossible

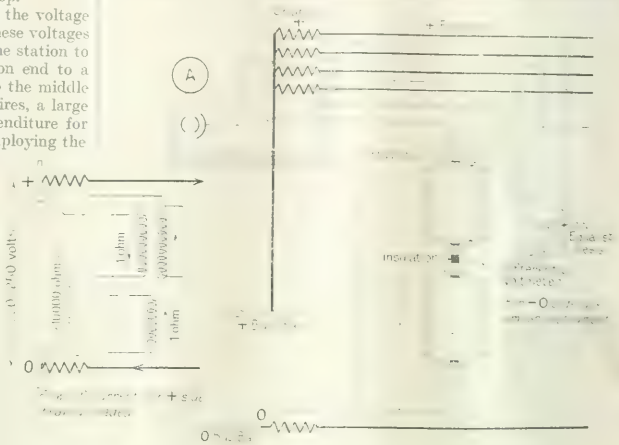


Fig. 3.

to insulate the coils properly. This difficulty has been overcome by the construction of a double instrument, as shown in Fig. 2, the connections being according to Fig. 3. There is now no danger of short circuits.

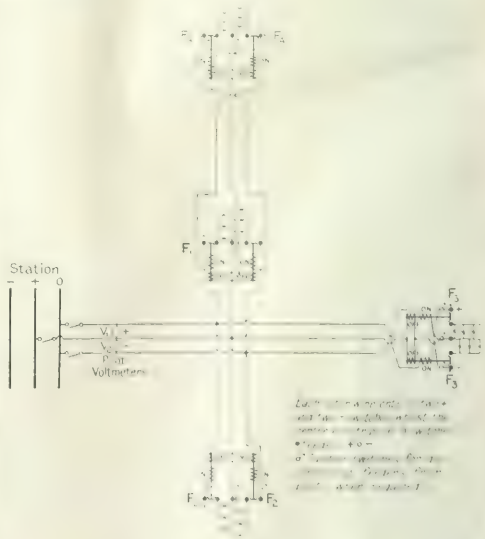


Fig. 4.

The number of pilot wires may be considerably reduced if the average voltage only is required. Such a method is illustrated in Fig. 4, which is self explanatory. Temperature changes are now registered and the pilot wire may be used to switch off the street lamps. In the figure the lamps are arranged that one half of the street lamps may be switched off at a different time from the other half.

Switching of Street Lamps.—When consumers and street lighting feeders are combined, special switching arrangements are wanted for the public lighting. Fig. 5 shows how this is done when three pilot

wires are installed. Where there are none, time switches are usually installed, in which a clock switches in and out the lamps at predetermined times. As feeder pillars have to be erected for the meters registering the consumption of street lamps, the time switches may be placed into the same pillars. Reliable time switches can be obtained for a sum of £4 to £7, so that their installation is not a costly affair. The switching in and out of street lamps may also be accomplished with relays, which are energised by an alternate current temporarily superposed upon the network current. It is questionable whether in South Africa such relays are an advantage over the time switches, because the expenditure of a small alternating-current generator set for superposing currents upon the direct current and of the relays will go a long way towards buying the time switches, and, as the switches have to be set once a month only, the advantage of selective relays disappears.

Methods of Charging.—The prices to be charged for electric current have to be so adjusted that the undertaking becomes a financially sound one. To obtain the necessary consumers these prices must not be too high, otherwise the people will stick to their oil lamps. The greater convenience of electric light is, therefore, not the only quality which will make it attractive, but the price must compare favourably with that of oil. On the whole, one may say that even in this country, where people have a greater buying capacity than in Europe, a scheme of electric lighting is hardly justifiable commercially if the price per unit exceeds 1s. Supposing, however, that a scheme has a fair promise of financial soundness and is being carried out, the people have to be persuaded to commence the wiring of their houses. It is not enough to tell them that the municipality has decided to instal electrical plant for the supply of current and that the price per unit will be so much, whereby a 50 candle electric lamp does not cost any more to burn than a similar oil lamp at the high price of oil in this country, the people want to know exactly how much it will cost to wire their houses. The following were the figures which we were able to obtain for Stellenbosch :—

£1	15s.	0d.	per point for one point installed.
£1	7s.	6d.	„ „ for two points installed.
£1	5s.	0d.	„ „ for three or four points installed.
£1	1s.	0d.	„ „ for five to nine points installed.
£1	0s.	0d.	„ „ for 10 to 19 points installed.
£0	18s.	0d.	„ „ for 20 and more points installed.

These prices include simplex tubing, main switch and distribution board, 2,500 megohm C.M.A.-grade wires and cables, switches, simple pendant, opal shades and the lamp bulb. It is the universal practice in this country to instal a meter in each house and charge according to the units used. For day load often half the night price is charged, and for motive purposes a special flat rate. This method is on the whole fair, and, as meters are cheap nowadays, the outlay for the municipality is not very great and may be regained by a meter rent. From the example given it will, however, be seen that the expenditure as far as the outlay for fuel is concerned, amounts to about 10 per cent. only. Under these circumstances, I do not know whether a fixed charge for a given house, in the form of a rate, would not be better. This would, of course, lead to a certain waste, but it would certainly popularise the use of the current ; the people would know what they would have to pay at the end of the month, and the municipality would be sure of a certain income, and could regulate the price of the current accordingly. Even supposing that 50 per cent. of the light were wasted, it would mean only another £100 in the example quoted and save the salary of the meter reader. The meters might even be installed for such a system, and the rate could include current up to a certain maximum, after which extra payment must be made. Two-rate and flat-rate meters would then be largely superfluous, and the meters installed need not be read more than twice or three times a year.

Example.—As an example, I intend to give you particulars of the electric lighting scheme for Stellenbosch, a town of about 6,500 inhabitants. Diesel and suction gas plants were considered, but the position of the chosen site made Diesel engines essential in order to avoid smoke and smell.

It will be noticed that for this size of plant there is little to choose between Diesel oil engines and suction gas plants as far as the price is concerned, the difference being in favour of the Diesel engine (see following table). It is thus simply a matter of running costs, where other considerations, such as smoke and smell, do not matter.

Erection of Plant. Various constructional difficulties were encountered during erection. The whole of Stellenbosch must have been a lake at one time. The ground throughout the town consists of a layer of fertile soil, followed by one of cobbles about 1½ ft. to 2½ ft. deep, after which a sump of wet clay is encountered. The station site had to be drained by digging an 8 ft. deep trench all round. Considerable trouble was experienced during the erection of the network. Nearly all of Stellenbosch streets are planted with oaks, and an underground system would have been preferable. Unfortunately, the money was not sufficient, except in one street, where the oaks were too low to keep below them and too high to go above. The system has now been running for seven months, and sufficient indication can be given whether the scheme is a commercial success. To pay all expenses, to allow for depreciation and sinking fund (30 years), the annual income has just to exceed £1,900. The units sold during the first seven months were 38,963, bringing in an income of £1,265. 8s. 5d. This is in excess of the estimate of income and of expenditure, and must be considered highly satisfactory. There are few stations which pay the first year. The number of consumers is 234, a number of whom have been connected during the seven months' working. Applications are still coming in, and the municipality will be able to reduce the price for current before long. The number of kilowatts connected is 118, the cost of fuel per kilowatt-hour *sold* 1·18d., for lubricating oil, waste, &c., 0·30.1. These figures compare favourably with those of other stations of similar size in this country. Fuel oil is dear, and may be reckoned at 9½d. per gallon.

Diesel Engine Plant.			
Brick building complete in every respect, including office furniture, underground tank, lavatories .	£1,204	9	6
Two 60 B.H.P. engines, including 2,000-gallon tank for storing oil, erection and foundations, indicator outfit	1,870	0	0
Complete generating plant as per figure 15, including Tudor battery of 216 ampere-hours (3 hours discharge), testing instruments, workshop, motor-driven lathe	1,910	10	0
	£4,984	19	6
Network complete (including 200 house connections)*	4,377	0	0
190 Meters and 380 Corporation fuses, &c., including spares and tools	319	5	0
	£9,681	4	6
In this sum £265 are included which must be paid by the consumers for being joined up. The Municipality thus has to find—reckoning about £200 for emergencies and a small sum for advertising, and adding the consulting engineers' fee—a total amount, to be borrowed, of	£10,000	0	0
Suction Gas Plant.			
Building complete with office furniture	£1,400	0	0
Two complete 60 H.P. generating gas plants, including two 60 H.P. engines, erection, foundations...	1,730	0	0
Generating Plant (as before)	1,910	10	0
	£5,040	10	0
Network	4,377	0	0
Meters, &c.	319	5	0
	£9,736	15	0

* Half to be paid by consumer.

THE ELECTRIC VEHICLE AND THE CENTRAL STATION.

BY J. F. GILCHRIST (*president*) AND A. J. MARSHALL (*secretary*).
(Electric Vehicle Association.)

Introductory.

Investigation seems to warrant the statement that only a comparatively few central stations appreciate the tremendous opportunities attending the further developments of the electric vehicle, and it is only a few that have effectively co-operated and placed their organisations properly behind the exploitation of the electric vehicle. The principal way in which the central station can help to develop the electric vehicle is by using them. Central stations have use for both the passenger and commercial types of vehicle. One of the great obstacles encountered in the general use of the passenger vehicle by central stations is the "joy-riding" element on the part of members of the staff. In certain cases this personal factor results in the purchase of a petrol car where the work of the station can be equally well done by the use of an electric. This, of course, only applies to such cases where the staff are allowed the use of the car for private purposes.

Central stations should support the efforts of the electric vehicle salesmen in every possible manner, if for no other reason than that such salesmen are endeavouring to introduce large and profitable current consuming devices. For this it is essential that central stations should electrify their own entire transportation equipment

Table I.—*General Operating Cost—Electric Vehicles.*

Based upon figures which are as nearly representative as possible with the varying equipments on the market at present.

Capacity. * Assumed price.	700 lb. $1,500.	1,000 lb. $2,200.	2,000 lb. $2,800.	3,000 lb. $3,000.	4,000 lb. $3,400.	7,000 lb. $4,000	10,000 lb. $4,500.
Fixed Charges							
Interest at 6 per cent.	$90	$132	$168	$180	$204	$240	$270
Depreciation at 10 per cent.	150	220	280	300	340	400	450
Fire insurance at 1 per cent.	15	22	28	30	34	40	45
Liability insurance	100	100	100	100	100	100	100
	$355	$474	$542	$610	8678	8780	$865
Maintenance							
Battery upkeep	170	180	200	240	285	365	415
Tyre upkeep	119	156	212	225	306	340	575
Mechanical parts upkeep	50	60	80	90	100	125	150
	339	396	492	555	691	930	1,140
Garaging—							
Electric power	120	140	170	240	300	360	400
Storage and washing	180	180	180	180	180	180	180
Garage labour	100	120	160	180	200	250	300
	400	440	510	600	680	790	880
Annual operating cost	$1,094	$1,310	$1,544	$1,765	$2,049	$2,500	$2,885
Daily cost (312 days)	$3.51	$4.20	$4.85	$5.66	$6.57	$8.01	$9.25
Drivers per day	2.00	2.00	2.50	2.50	2.50	3.00	3.00
Total daily cost	$5.51	$6.20	$7.35	$8.16	$9.07	$11.01	$12.25

* This assumed price includes complete vehicle with the average type of body. Increase or decrease in these prices (if not radical) will not seriously alter the operation charges. ($1=4s. 2d.) [There appear to be some errors in this Table, the figures not checking.—Ed. *E.*]

with the least possible delay, and, in addition, that they should advocate and promote in every way possible the use of electric vehicles. In this respect it is a fact that a great number of central station employés are ignorant of the merits and capabilities of the electric vehicle. Every central station representative should be taught to appreciate the advantages and superiority of the electric Within 10 years the great majority of all transportation, at least in cities and their suburbs, will be driven by means of mechanical power, and it is for the central station to determine whether a large percentage of this shall be electric. If prompt and vigorous co-operative action on the part of the central station is not immediately forthcoming the petrol car will permanently reign supreme, and all chance of the electric vehicle being adopted on a proper scale will be lost. Too much stress cannot be laid on this important fact, and it demands the very serious consideration from the entire central station industry.

The second section of the Paper is devoted entirely to illustrations of electric vehicles in use in a variety of different capacities.

Some Data on the Cost of Operating Electric Vehicles and Notes on Garaging.

The advantages which the electric vehicle can claim for the transportation of merchandise are dealt with in detail. One peculiarity of the electric vehicle which is emphasised is that the consumption of energy, tyres, gears and battery material is in direct proportion to the work performed, and that periodical renewal of such consumed material is as much an essential part of the service rendered as is the renewal of horseshoes, wheel tyres, feed, blankets or any other similar material requiring constant renewal with horse maintenance. This periodical renewal of consumed material has been regarded by those unaccustomed to analysis, as the gradual breakdown or depreciation of the entire machine, whereas the machine proper undergoes very slight wear, the annual depreciation being somewhere between 5 and 10 per cent.

The principal lines upon which central station men can most rationally aid in the introduction of electric vehicles will be: To bring home to the horse vehicle user the very high cost which he pays for animal transportation, independent of the prevailing prices at which horses, feed and other required materials may be purchased. In other words, horse transportation costs very much more for the performance of any particular work than the owner of horse equipment usually appreciates. To analyse the performance of the work at present done by horse vehicles so thoroughly that suitable machines may be consistently recommended in any particular case. To bring out for consideration all the advantages which machine operation carries with it in regard to precision, regularity and reliability. In outlining the subject to avoid as much as possible diverting the prospective machine user's attention from the real issues to the relatively unimportant details of mechanical equipment. To deal with him in terms which will enable him to arrive at a true economic value of machine installation, either as to serviceability or as a time or labour saver. To avoid undertakings of a doubtful or experimental nature with regard to the machine's ability. To induce the prospective user to regard the project in the same manner as he would the installation of a power plant for other purposes. To render such assistance during the preliminary period of use as will prevent the misapplication or abuse of machines.

Report of Operation of The Electric Vehicles of The United

Rated capacity of vehicle in lbs.	700	700	1,000	1,000	1,000	1,000	1,000	1,000	1,000	2,000
Investment per vehicle	1,731·75	1,456·75	2,200·00	2,200·00	2,200·00	2,200·00	2,170·00	3,000·00	2,850·00	3,465·00
United Company's number of vehicle	14	15	2	3	8	9	22	23	24	6
Description of battery { Make	Edison	Exide	Exide	Exide	Exide	Exide	Exide	Edison	Edison	Edison
Description of battery { Type	A 4	Iron-clad	Hycap	Hycap	Hycap	Iron-clad	Hycap	A-6	A-6	A-6
Description of battery { Number of cells	45	44	44	44	44	44	44	60	60	60
Miles travelled	16,733	17,938	13,749	11,524	15,651	21,388	6,550	10,797	9,525	12,632
K.watt hours consumed	12,946	7,202	8,114	6,282	7,423	9 918	3,324	9,610	8,625	12,570
K.watt hours per mile travelled	0·724	0·401	0·590	0·545	0·475	0·465	0·506	0·891	0·906	0·994
Miles travelled per day	18·53	20·20	13·20	10·92	14·92	20·60	16·08	26·40	25·90	10·72
K.watt hours consumed per day	14·32	8·11	7·80	5·95	7·08	9·55	8·15	23·55	23·45	10·68
Operating labour {										
Labour	7·34	6·08	9·53	8·43	9·43	8·50	3·95	6·51	5·74	10·84
	517·84	288·08	324·56	251·28	296·92	396·72	132·96	384·40	345·00	502·80
	7·25	352·34	785·46	519·00	683·20	630·19	194·22	1·77	1·45	6·16
	10·50	110·90	95·44	98·71	237·03	76·94	33·33	58·24	109·07	95·39
Energy {	168 84	69·44	347·79	98·82	91·91	269·74	5·80	126·52	55·12	134·43
Labour {	54 48	17·25	86·84	30·04	47·39	106·53	24·98	48·91	30·76	49·97
	30 88	14·75	44·20	...	...	24·27	6·94	...	...	...
	2,383·09	2,297·20	3,156·83	3,192·83	3,174·83	3,151·33	1,233·48	1,230·61	1,136·36	1,317·35
	1,161 25	1,037·17	1,592·55	1,581·35	1,590·75	1,600·75	576·57	725·15	705·29	2,237·73
Total expense per day operated	5·10	5·10	6·19	5·48	5·86	6·04	5·41	6·32	6·50	6·16
Total expense per mile travelled	0·27	0·252	0·469	0·501	0·392	0·293	0·337	0·239	0·251	0·575

One of the greatest incentives to the favourable consideration of electric vehicle employment will be to direct attention to the present stability of its equipment as compared with that of any other type of motor vehicle. The electric machine has been evolved under the most rigorous and exacting service during the past 15 years, and, as a successful device in quantity installation for commercial purposes, has commanded the endorsement and investment of the merchant community to a greater extent than any other kind of motor vehicle.

Large installations of such vehicles in all the principal cities of the country and their economical operation have instilled such confidence in those conversant with these capabilities as to put the electric vehicle in the class with all other staple industrial apparatus. Some of the underlying considerations which have developed this confidence are as follows: They are made up of the least number of moving parts of any type of motor vehicle, so designed and applied as to be practically fool-proof. Their performance is so predetermined that the operator has little to do but apply power and steer the machine. The working equipment has been so standardised that the renewable wearing parts are readily replaceable at low cost. Wherever they have been installed within the field of rational application they have not only remained, but by the influence of their economy have forced an increase in their number.

There has been considerable demand for reliable information on the cost of operating electric vehicles and as is well understood, the peculiarities of the service in each particular instance may seriously influence the cost, hence, data procured from specific cases may not be applicable elsewhere. It has, therefore, been considered desirable to work up a table covering the various sizes of machines, in which costs would be based upon actual operating experience covering a great variety of installations in normal city service. Table I. is, therefore, intended to give a fair illustration of the cost of operating electric vehicles under normal conditions where the machine service does not exceed the capacity of one battery per day. The figures given in Table I. may be reduced in many cases where special care is exercised in supervising the equipment and the service rendered, and it naturally follows that there will be other cases where the severity of service or operating condition will necessarily increase these figures. They are intended to indicate those likely to exist in the majority of city installations. For particular or individual cases other figures can, of course, be substituted for those in the table.

Depreciation of 10 per cent. should provide one complete equipment renewal in 10 years, which is not figured in maintenance. As depreciation gradually reduces the investment, a 3 per cent. rate of interest may be considered more equitable. With an alkaline battery equipment investment and interest will be higher, depreciation and maintenance lower, and power consumption higher than shown in the table. However, over any extended period the resultant operating cost will not differ radically from that given in the table. Table II., which is given in a slightly abbreviated form, is taken from a Paper by Mr. R. B. Grove, of the United Electric Light & Power Co. It might be pointed out that the vehicles referred to are operated on Manhattan Island, portions of which are extremely hilly, a grade of several of the streets being as high as 12 per cent. The United Company maintains two garages for the care of its vehicles, one in the northern and the other in the southern part of the city. The main garage, at which most of the vehicles are cared for is approximately nine miles from the extreme southern end of Manhattan Island and three miles from the northern end. It occupies three floors, with a total of approximately 10,000 sq. ft. devoted exclusively to garage purposes. In the building is a room 25 ft. by 20 ft., which was especially designed and equipped for all kinds of battery work. The floor is acid proof and the room is generously supplied with basins, water taps and drainage facilities. An expert battery man is in charge of all the work done. The garage is also equipped with an automobile lift having a capacity of 15,000 lb., used to convey the vehicles to the different floors. Thirty-six charging outlets are distributed throughout the three floors, each containing a separate wattmeter. The charging current is supplied from two 125 kw. motor-generator sets (motor, two-phase 1,900-volt 46-ampere 900 revs. per min.; generator, 125-volt 1,000-ampere 900 revs. per min.) which are placed in an adjoining sub-station of the company. One set is sufficient to meet the demands of the garage. The charging current is controlled from a switchboard 10 ft. long and 8 ft. high on a mezzanine of the first floor. The smaller or auxiliary garage, approximately six miles south of the main garage, comprises one floor only, the approximate dimensions being 45 ft. by 95 ft. The charging current is supplied from a 125-kw. motor-generator set (motor, two-phase 1,900-volt 46-ampere 900 revs. per min.; generator, 125-volt 1,000 ampere 900 revs. per min.) located on the premises. All vehicles upon being returned to the garage after a day's operation are, regardless of their condition, thoroughly washed, lubricated and polished. An inspection is made of each vehicle and minor mechanical repairs made if needed. This inspection frequently reveals slight defects which can be repaired during the night, thus returning the vehicle to service the following day. If, however, the necessary repair is of such a nature that it cannot be completed during the night by the inspection force, the vehicle is turned over to the repair department of the company, which keeps it until it is restored to first class operating condition. The batteries are examined each night, new parts, solution or water being added where necessary. They are then charged, after which the vehicles are ready for the next day's operation.

During the operation of charging the batteries, a record of the current and voltage employed for the battery of each vehicle is made by the garage man on a card. Any repairs made on the battery or vehicle are noted on the card, hours of labour, quantity of material and the name of the workman being tabulated.

The card is then placed in the vehicle in a specially provided holder, and at the end of the following day's operation the driver notes thereon the number of miles travelled during the day, together with any remarks he may deem necessary regarding the operation. The card is then delivered to the head of the battery department, who inspects the record of the charging. If, in his opinion, the battery was not charged properly, he apprises the person who did the work of the error made and intructs him as to the proper method. The head of the battery department then forwards the card to the garage superintendent, after noting thereon any remarks he considers necessary regarding the charging of the battery. The garage superintendent at the end of each month summarises the information which has been collected daily on the cards, fills out a monthly report

Remarks with regard to the Table below.—Amortization: 10 per cent. on original cost of vehicle, battery and tyres. Interest on the investment: 6 per cent. per annum on one-half original cost of vehicle, battery and tyres. Driver: The following schedule is used: 700 lb. and 1,000 lb. vehicle $2·00 per day, 2,000 lb. and 4,000 lb. vehicle $2·50 per day, 7,000 lb. and 10,000 lb. vehicle $3·00 per day. All costs are given in dollars.

Electric Light & Power Company, New York City.

2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	4,000	4,000	7,000	7,000	10,000	10,000	2,000
2,650·00	2,650·00	3,000·00	2,650·00	2,650·00	2,650·00	3,000·00	3,020·00	3,950·00	3,950·00	4,550·00	4 270·00	5,100·00	5,100·00	2,920·00
7	13	17	18	19	20	21	27	10	11	5	26	12	16	25
Exide	Exide	Exide	Exide	Exide	Exide	Exide	Exide	Exide	Exide	Exide	Exide	Exide	Exide	Exide
Stnd.MV	Iron-clad	Iron-clad	Stnd.MV	Iron-clad	Iron-clad	Iron-clad	Iron-clad	Stnd.MV	Iron-clad	Stnd.MV	Stnd.MV	Stnd.MV	Stnd.MV	Iron-clad
44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
12·849	18.826	15,574	8,483	10,482	10,473	15,409	9,476	11,062	16,591	10,591	4,820	11,058	7,674	5,893
8,166	15,258	10,638	4,948	5,601	6,524	9,645	4,959	11,451	15,365	12,688	5,536	15,529	11,779	3,883
0·635	0·810	0·684	0·583	0·535	0·623	0·625	0·523	1·035	0·927	1·200	1·148	1·105	1·532	0·660
10·50	16·31	22·61	11·28	13·90	13·70	21·95	23·79	10·15	15·46	9·88	12·43	10·33	10·53	18·09
6·66	13·22	15·48	6·56	7·45	8·55	13·71	12·43	10·50	14·33	11·86	14·29	14·55	0·45	11·91
9·99	8·00	5·90	6·15	6·41	6·15	5·81	6·86	8·65	9·08	9·74	4·44	10·15	7·71	4·27
326·64	640·32	425·52	197·92	224·04	260·96	385·80	198·36	458·04	614·60	507·52	221·44	621·16	471·16	155·32
463·20	1,613·16	1·25	443·22	479·91	447·71	1·51	1·79	861·94	27·55	934·28	3·42	1,105·33	328·39	3·13
176·60	310·84	65·09	117·15	54·30	138·21	69·09	89·88	384·27	627·63	431·01	38·89	568·00	240·56	133·04
107·91	59·44	259·92	48·57	68·72	8·51	193·63	7·00	214·13	107·93	66·59	17·00	73·46	43·94	11·25
28·87	287·47	84·98	30·58	33·71	38·45	32·36	19·94	1·63·96	78·57	47·00	39·25	44·82	5·88	23·26
...	...	...	35·56	...	...	50·95	...	24·15	31·16	...	...	...	33·62	...
3,53·35	4,142·29	2,504·62	2,734·40	2,733·09	2,825·79	2,585·58	1,388·48	4,330·09	1,253·48	5,076·79	1,845·70	5,378·29	3,674·95	1,168·03
8,29·50	1,785·05	1,263·65	1,229·20	1,215·05	1,226·33	1,294·65	702·70	2,545·51	2,499·78	2,788·95	913·27	3,080·46	2,080·40	517·66
5·95	7·65	6·71	6·45	6·41	6·36	6·51	6·20	8·23	7·69	9·21	8·06	10·20	9·52	6·19
0·567	0·469	0·297	0·570	0·460	0·480	0·298	0·262	0·751	0·549	0·933	0·650	0·985	0·904	0·342

sheet for each vehicle and passes it to the purchasing department. Any mechanical repairs are entered on the monthly report sheet in detail, all material and labour being noted. The cost of each item noted on the monthly report sheets is placed opposite that item by the purchasing department, and the sheets are then forwarded to the engineering department, where they are further summarised, the items being finally classified and filed. At the end of each year the information that has been entered is supplemented by such operating costs as amortisation, interests on the investment, administration, &c., and a report is prepared by the engineering department similar in appearance to the one contained in this Paper, showing in detail the complete performance of each individual vehicle.

(*To be concluded.*)

APPARATUS FOR PROTECTING ELECTRICAL MACHINERY AGAINST ABNORMAL ELECTRICAL CONDITIONS.*

BY C. C. GARRARD.

(*Continued from p.* 425.)

Summary.—The author deals first with the conditions which give rise to abnormal electrical conditions of a transient type, such as those due to switching, arcs and sparks. Methods of suppressing arcs to earth are described. The author then passes on to pressure rises between the turns of electrical windings, and those due to causes exterior to the system, such as lightning. Various protective devices are described, such as water jet earthing resistances, the Moscicki and other condensers, Giles' valve and the more ordinary lightning arresters. In conclusion the question of earth plates is considered.

LOCALISED PRESSURE RISES BETWEEN THE TURNS OF ELECTRICAL MACHINERY.

Probably the most frequent pressure rises to be met with, and those which cause the most harm are high-frequency phenomena. In fact, Steinmetz ("Trans." Am.I.E.E., Vol. XXX., 1911, p. 1853) states that in high-voltage systems high

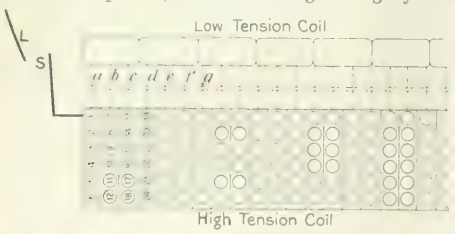


FIG. 9.—STRAIN OR INSULATION OF END TURNS WHEN CONNECTING TRANSFORMER TO LINE.

frequency is an ever-present phenomenon, as much as the waves are ever-present in the ocean. These high-frequency oscillations, however, are generally only of moderate voltage and will not discharge across spark gap arresters. Their danger consists in piling up the voltage in the end-turns of machinery, with consequent eventual short-circuiting of the windings. P. H. Thomas ("Trans." Am.I.E.E., Vol. XIX., 1902, p. 189) has given a very clear picture of this action as follows :—

Fig. 9 represents a portion of a transformer winding. The numbers in the circles (which represent windings) indicate the [illegible] through the turns of the windings. Now the high-tension winding lying adjacent to the low-tension winding will have a certain amount of electrostatic capacity relative thereto. This is represented in the figure by the condensers a b c &c. Now directly the switch S is closed the terminal turn (1) assumes the voltage of the line, the remainder of the transformer winding, however, does not instantly assume the same voltage. In order that it should do so the necessary current to charge the condensers a, b, c, &c., cannot flow. In order that this current may flow through the inductance of the winding a very short but appreciable time is required. It will thus be seen that during this short period the whole of the line voltage is impressed across a larger or less number of the terminal windings. A worse result happens if both poles of the switch do not close simultaneously, as it may happen that before the second pole closes the whole of the winding has assumed the voltage of the one line so that there is a sudden transition at the other end of the winding from the voltage of the one pole to that of the other. Generally, in the case of ordinary switching, this phenomenon is without evil effect. The conditions governing the sensitiveness of machines to such effects are dealt with below. The trouble, however, is very greatly aggravated when we deal with high-frequency oscillations and travelling electric waves of steep wave front. With these the strain on the insulation between turns is very much greater. Thus although the voltage of the high-frequency current or travelling wave may not be sufficient to jump across the arrester gap, it may yet be enough to cause a breakdown between windings.

The fact that with high-frequency oscillations very severe strains can be put across very few turns of an inductive winding can be appreciated by a simple calculation. Let us assume a choke coil having an inductance of 0·03 millihenry. Such a choke coil would be formed by an ironless coil of about 33 turns and 6 in. diameter.

The inductive volt drop across this, with a current of 50 amperes through it at a periodicity of 50, is

$$2\times\pi\times 50\times\frac{0\cdot 03}{10^3}\times 50=0\cdot 47 \text{ volts.}$$

If, however, the frequency of the current be 2,000,000 per second, then the volt drop across this choke coil would be 19,000 volts. This illustrates the great strains which high-frequency currents cause on the end turns of windings. That this is not a fanciful calculation is shown by Faccioli's experiments ("Trans." Am.I.E.E., Vol. XXX., 1911, p. 1840). During ordinary switching operations Faccioli found that the momentary voltage across such a choke coil was sufficient to jump across an $1\frac{1}{4}$ in. spark gap which represents a voltage of upwards of 20,000 volts. It is of interest to note that Steinmetz in the discussion on Faccioli's Paper states that on the system in question, during ordinary switching operations, there are frequencies of oscillations moving around the system of from 20 to 2,000,000 cycles per second.

Degree of Sensitiveness of Electrical Machinery as Regards Pressure Rises.—The view has been put forward by Felix Finckh (*see* "E.T.Z.," 1913, Vol. XXXIV., p. 1450) that while a good many of the breakdowns which have been ascribed in recent years to pressure rises have been really caused by other accidental occurrences, nevertheless the undoubted increase of failures due to pressure rises has been by reason of the greater "sensitiveness" to such rises of modern machinery as compared with earlier types. The pressure rises we are here concerned with are those existing between turns, chiefly between the turns nearest the terminals of the windings. The degree of sensitiveness of a machine to pressure rise is determined by the relation between the distance separating such turns (*i.e.*, metal to metal) and the normal voltage induced under working conditions per turn in the winding. If the distance between turns of the winding be small, then a relatively slight pressure rise between turns will cause a spark to jump across and momentarily short-circuit the turn or turns concerned. If the normal induced voltage per turn is not sufficient to follow up the spark and cause a short circuit, the spark is extinguished without any damage. If, on the other hand, this induced voltage is large enough to follow up the spark, then a burn out of the winding takes place. It is thus possible to arrive at a figure of merit for any particular winding which would be a measure of its "sensitiveness" in this connection. It is obvious that, provided precautions be not taken, improvements in design which generally take the form of a decrease in overall dimensions for a given performance, tend to increase such sensitiveness, and it is to this that Finckh puts down the relatively increased number of breakdowns, due to real pressure rises, which have taken place in recent years. It may be mentioned here that as these dangerous pressure rises occur almost exclusively in the terminal turns and layers, an artificial decrease of the

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sensitiveness is nowadays often arranged for by increasing the insulation and distance between turns and layers of the windings nearest the terminals.

It follows from these considerations that, in the first place, considerable caution should be exercised in assuming that any particular trouble that may be experienced is due to pressure rises, and that before coming to such a conclusion a thorough examination of all the circumstances of the case should be made. Secondly, information of the "sensitiveness" of the machinery to pressure rises, in the above-mentioned sense, should be obtained, as naturally, if a transformer or generator be over-sensitive, it may not be possible to safeguard it by the installation of any kind of protective gear whatsoever. It also follows that the most common form of pressure rise which has to be guarded against is the localised rise between the end turns of windings. Such rises may not be large as compared with the normal working voltage of the system, although very large indeed as compared with the normal voltage between turns. A spark-gap, therefore, would offer no protection, and some other form of safeguard must be used.

It may be added that, although these localised pressure rises between turns generally occur near the terminals, they may also take place, but to a lesser extent, within the windings at points where the value of the self or mutual induction per turn of the winding changes.

PRESSURE RISES DUE TO CAUSES EXTERIOR TO THE SYSTEM.

The phenomena which come under this heading are among the most elusive and, as yet, least understood in the whole domain of electrical science. They owe their origin to the varied electrical conditions of the atmosphere, and therefore, as a rule, are only present in apparatus connected to overhead lines. The following classification of the different phenomena may be made.

Direct Lightning Stroke.—A direct lightning stroke may vary in intensity between very wide limits. In the worst cases no system as yet known will afford adequate protection and prevent a breakdown of the line or a "spill over" of an insulator. Fortunately, such severe strokes, besides being very infrequent, are extremely localised in their effects, and rarely extend far enough to reach the machinery in the stations connected to the lines. Less severe side strokes are of much more frequent occurrence, and these can be dealt with more or less satisfactorily by known appliances. No doubt the best safeguard is a well-earthed wire carried on the poles of the line above the conductors.

Another scheme which affords some protection against severe direct strokes is a horn lightning arrester without any series resistance, this latter being replaced by a fuse connected between the earthed horn and earth.

Direct strokes have been divided into two classes—viz., "A" flashes and "B" flashes. The first take place when a cloud gradually acquires an increasing charge relative to earth until the difference of potential is high enough to cause a discharge to earth. The second kind of flash is a more dangerous one, and is the result primarily of a discharge taking place between two clouds. The result of the discharge is to leave another cloud with a high potential charge which had been previously held by the charge of one of the two clouds which have discharged together. This suddenly released charge goes to earth with such suddenness and violence that it may pass quite near to a well-designed lightning conductor and shatter a brick chimney. It may go straight to earth, while there are trees and people dotted all around. It may avoid striking the flat land even, and go straight to the bottom of a quarry or a sand pit. It may depart, as photographic observation has shown, from a fairly straight course and dart aside to a falling rain drop, then back to another raindrop, in apparent contradiction of the law that electricity takes the line of least resistance. Similarly, it may leave its direct course to strike an insulated metal object, apparently ignorance of the fact that the metal does not present a path to earth.

As regards side strokes, it is considered almost certain that these are of the B variety. It will be quite evident that severe B strokes will be very difficult to be dealt with by any form of lightning arrester. An A stroke is generally preceded by a brush discharge, which tends to relieve the electric stress, and if the lightning discharge eventually takes place it will be at the location of the previous brush discharge. The B strokes are analogous to travelling electric waves in a line with extremely steep wave fronts. To sum up, direct strokes can only be dealt with when they are not severe, and there exists to-day no apparatus which is really effective against the more severe strokes of this character.

Induced Charges and Discharges due to Lightning.—Lightning phenomena being due to the existence or motion of large quantities of electricity, it is natural that all neighbouring metallic conductors should be affected by electrostatic or electromagnetic induction. When the conductor is insulated from earth, such as a transmission line, we get the secondary lightning effects which are so much more numerous than the direct strokes, and with which existing protective gear can deal in a more or less effective manner.

Lightning Effects due to Static Induction.—If a charged cloud comes near to a transmission line, an electric charge of opposite polarity is induced in the conductor in the neighbourhood of the cloud. The charge of like sign to that in the cloud is driven away along the line, and either leaks to earth or banks up at the insulated ends of the line. This is represented by the Fig. 10 (*see* Capart, "Protection des Réseaux et Installations contre les Surtensions," p. 13). Should now the cloud become discharged the line wires are left highly charged, and the charge travels off in both directions in the form of a travelling wave.



Fig. 10. Induced Charge in a Transmission Line due to a Cloud.

Lightning Effects due to Electromagnetic Induction.—It is natural that a lightning discharge which may be of the order of 10,000 amperes (*see* Steinmetz, "Theory and Calculation of Transient Electric Phenomena and Oscillations," 1908), will induce currents in neighbouring lines. These may have a frequency of 1,000,000 a second, and of course can be the cause of considerable trouble. Besides the very high frequency discharges, low frequency ones sometimes occur, or even aperiodic discharges, *i.e.*, discharges which do not reverse in direction. A number of such discharges can follow one another rapidly along a line, and can be of very abrupt wave front, and in consequence extremely destructive when they strike against the winding of an electrical machine. In fact the effect of a lightning flash may be likened to a tank of water situated at a great height over another tank, and which has its bottom suddenly knocked out so that its contents drop into the water contained in the lower tank. This is, of course, a very imperfect simile, but will give one an idea of the extreme electrical confusion which occurs in installations subject to these atmospheric disturbances.

Static Charges.—Overhead lines, and apparatus connected thereto are apt to assume under certain conditions considerable static charges. The electricity forming the charge is not moving but still, and the line becomes charged analogously to a conductor connected to a Wimshurst machine. The causes of this accumulation of electricity are various. For example, clouds, dust or dry snow blowing past a line may gradually charge it. Another cause is the variation in level of the country over which the line passes. It is well known that the electrical state of the atmosphere is different on mountains than in the valleys. An insulated conductor going between the two will tend to equalise such differences, and will become charged highly relatively to earth

at one portion of its length. Whatever be the cause, however, the accumulation goes on until the voltage above earth is sufficiently high to cause a sparking across and perhaps breakdown of insulation to occur. It is obvious that the only way to guard against such trouble is to remove the accumulated electricity from the line as fast as it arrives. This can be done by arranging a leak to earth. If the neutral point of the system be connected to earth it is clear that this will provide a path for such static charges to dissipate themselves. If the system be an insulated one, however, an excellent safeguard is to connect the lines to earth either through a high self induction or a high non-inductive resistance. In both cases the amount of working current which leaks can be kept within very small dimensions, but the accumulation of static charges is effectively prevented.

Travelling Electric Waves of Steep Wave Front.—If an overhead line becomes charged by, for example, electrostatic induction from a charged cloud, or other means, and this charge suddenly becomes released as a result of a lightning discharge, a quantity of electricity suddenly moves along the line with the velocity of light in the form of a travelling wave. Although the voltage of this travelling wave may not be high, nor yet of an oscillating character, yet by reason of the abruptness or steepness of its front it may do damage to any electrical machine it may impinge against, by causing a short circuit across the end windings. By steepness of front is meant that at a point (b) in the line the voltage due to the travelling wave is zero, while at a point (c) a short distance away from (b), the voltage of the wave is a maximum. The wave travels in the direction (c) to (b), and if the distance $b\,c$ is short it very quickly raises b to the maximum wave voltage, exactly as if an alternating current voltage of high frequency were supplied to the point b. Fig. 11 illustrates this. This

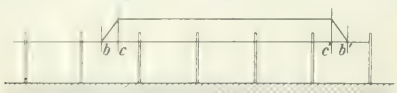


Fig. 11.—Diagrammatic Representation of a Travelling Electric Wave in an Overhead Conductor.

represents a transmission line on poles, and the distance over which the travelling wave stretches is $b\,b'$. The wave, of course, moves in both directions gradually decreasing in voltage as it spreads itself over the length of the line. If we know the distance $c\,b$ it is easy to calculate the frequency this would correspond to. P. H. Thomas ("Trans." Am.I.E.E., 1908, Vol. XXVII., p. 771) finds that this distance, with waves due to lightning disturbances, may be 1,000 ft. Taking this figure by way of illustration, then the time required for the maximum of the wave to travel from c to b would be $\frac{1{,}000}{186{,}000 \times 5{,}280}$ seconds $= \frac{1}{982{,}000}$ seconds. If the rise of voltage at b due to the impinging of the wave be regarded as the first quarter of an alternating wave this would correspond to a frequency of 245,500 per second. Let us assume that the maximum voltage of the wave is 20,000 volts. R. P. Jackson ("Trans." Am.I.E.E., 1906, Vol. XXV., p. 891) shows that the current which would flow due to the wave would be about 50 amperes. If this current then passes through the choke coil, mentioned on page 506, having an inductance of 0·03 millihenry, then the momentary volt drop across the coil would be 2,300 volts. It will thus be seen that the inductance of one or two turns of a transformer winding is sufficient to cause large enough voltages to exist between the turns, to result in breakdown between turns. This calculation, of course, is not a rigidly correct one, as it is based upon the properties of alternating currents, while in the actual case we may have no true alternation. Nevertheless it is sufficiently accurate to illustrate what is an undoubted physical [illegible] the highest importance in determining the destructive [illegible] of an electric machine [illegible] quite apart from the actual voltage of the travelling wave.

(To be continued.)

RADIO FREQUENCY CHANGERS.*

BY ALFRED N. GOLDSMITH.

(*Concluded from p.* 463.)

Summary.—The author deals with the various frequency changers that have been proposed for use in radiotelegraphic stations, including the static method, the Goldschmidt alternator, and methods dependent upon the arc electrolytic rectifier and transformers.

Continuing the consideration of frequency changes without moving parts, we come to a method for tripling the frequency directly by taking advantage of certain characteristics of an ordinary alternating current arc. It is well known that the potential difference at the terminals of an alternating current arc may have the form shown in Fig. 10. So greatly deformed a wave form naturally

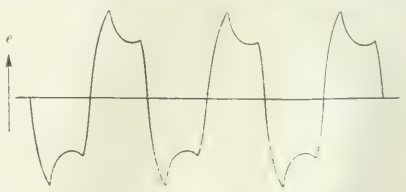


Fig. 10.

suggests the existence of strong upper harmonics. It is in fact found that if we decompose this curve into component waves of the fundamental and other frequencies, the third harmonic is very prominent. In Fig. 11, curve a represents fairly accurately the potential difference at the terminals of the arc. Curve b shows one of its components; namely, that of the fundamental frequency. Curve c shows the

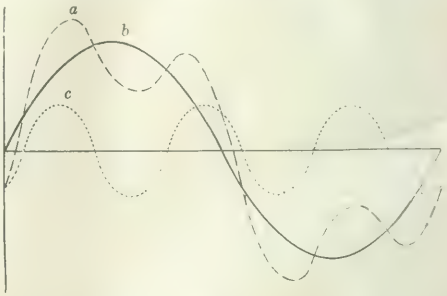


Fig. 11.

component of triple frequency; in fact, curve a is merely the sum of curves b and c. A circuit arrangement which can be employed to advantage under these conditions is given in Fig. 12. The circuit LC is tuned to the triple frequency, and the inductances D prevent to a certain extent the triple frequency current from getting back to the alternator. The arrangement shown further permits obtaining

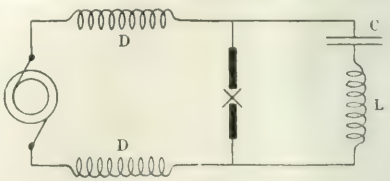


Fig. 12.

the fifth, seventh, ninth and so on, frequencies, provided the circuit LC is tuned to the appropriate frequency. In fact, Rukop and Zenneck have done considerable work for the case where the frequency of the circuit LC was 300 times the fundamental frequency. For details of this investigation, the reader is referred to their article in "Annalen der Physik," 1914, Vol. XLIV., page 97.

* Paper read before the Institute of Radio Engineers, New York, somewhat abbreviated.

We consider now the extremely important cases wherein stationary frequency changers are employed, their operation being dependent on electromagnetic induction and the peculiar properties of iron. In Fig. 13 is shown a typical B-H (magnetising force-induction) curve for iron. Let us suppose that the magnetisation of the iron has been brought to the point c. If now, by means of a superposed alternating magnetising force, equal increments and decrements be added to the magnetising force, the magnetic induction will increase during the positive half of the cycle by the small amount ef. On the other hand, during the negative half of the cycle, the induction will diminish by the considerably larger amount xd. The explanation of this phenomena is to be found in the well known magnetic saturation qualities of iron. In other words, a marked deformation from a sinusoidal variation of magnetic induction will occur when nearly saturated iron cores are employed. Such a deformation always leads to the production of upper harmonics, and it is upon this principle that the entire series of frequency changers employing iron

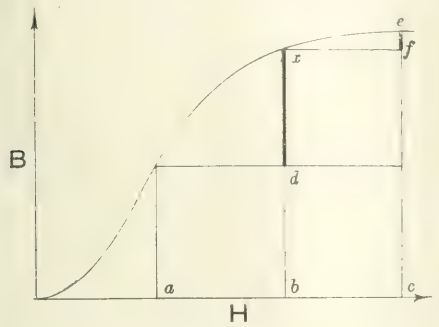


Fig. 13.

is based. A modification of the method just mentioned, and one of a highly ingenious sort, has been devised by Dr. R. Goldschmidt. It will be remembered that Rutherford first showed that remanent magnetism in iron could be destroyed by an alternating current field of high frequency. Furthermore, the hysteresis loop of iron for a magnetic cycle is much diminished in area if the iron is at the same time placed in a weak high frequency field. Consequently it follows that if a piece of iron be magnetised longitudinally by a direct current field and transversely by an alternating current field, any slow variations in the direct current field will show only small hysteresis effect. A rough physical explanation of this phenomena is given by the consideration that the transverse magnetisation keeps the elementary magnets of the iron in a mobile condition and thereby permits the longitudinal field to control them accurately and instantaneously. The large "static friction" between them is replaced by a much smaller "dynamic friction." Furthermore, if a direct

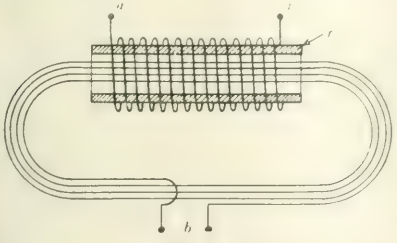


Fig. 14.

current transverse field be employed, the effective permeability of the iron for the longitudinal magnetisation will be diminished, and the hysteresis loop therefore will be changed in shape. We have here the interesting situation that two mutually perpendicular coils may react on each other through the influence of the iron in between them, and in spite of their apparent zero mutual inductance.

The arrangement used by Goldschmidt is given in Fig. 14. The iron tube x is magnetised longitudinally (usually by means of the coil a and is magnetised transversely by means of the coil b. If the longitudinal magnetisation is produced by direct current and the transverse magnetisation by alternating current, the positive and the negative maxima of the alternating transverse field will cause minima in the strength of the longitudinal field. These variations in the longitudinal field have, therefore, a frequency which is twice that of the alternating current supplied to the transverse field. If now we connect across the terminals of coil a a condenser, whereby coil a and the condenser are resonant to the double frequency, and if we simultaneously place large choke coils in the direct current supply lines to the coil a to prevent alternating current getting back to the direct current source, we shall be able to draw considerable amounts of double frequency energy from the terminals of coil a. By a further artifice we may carry the process of frequency transformation forward any desired number of steps. If we have a direct current as well as an alternating current flowing in the transverse magnetising coil b, the double frequency current in coil a will produce a quadruple frequency current in coil b. The next step will give us a current of eight times the fundamental frequency in coil a, and the process may

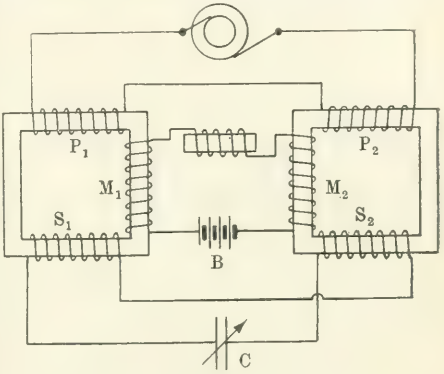


Fig. 15.

be continued through any desired number of steps. Any of the upper frequencies may be brought to resonance and energy absorbed at that frequency by appropriate tuning. The limitations of the process as to energy output are based on the small amount of iron which is available in any arrangement of this sort and the consequent over-loading thereof.

The method next described was shown by Epstein in 1902 (German patent 149,761), and has since been worked out and amplified in detail by Joly in 1910, and by Vallauri in 1911. The circuit arrangement employed is shown in Fig. 15. As will be seen, an alternating current source A sends its current through the primary P_1, P_2 of two

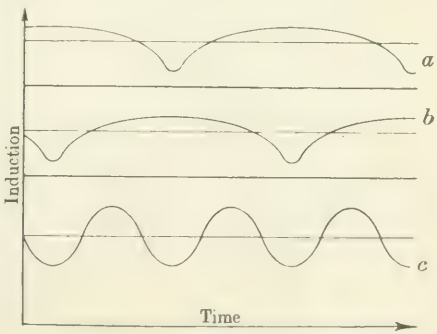


Fig. 16.

transformers. These primaries may be either connected in series or in parallel. They are wound oppositely. A direct current source B supplies two auxiliary coils M_1, M_2, which coils are wound on the transformer cores. These direct current coils are also wound oppositely. The secondaries of the transformer S_1, S_2 are wound in the same direction and connected as shown. The operation of this device is as follows: The direct current magnetisation of each of the transformer cores is such that it is working at the knee of the magnetisation curve. If we consider Fig. 16, curve a, we shall have a representation of the varying magnetic flux or induction in one of the transformers. The fine horizontal line represents the constant direct current induction the full line represents the resulting in-

duction. It will be seen that when the positive half of the alternating current cycle is taking place, there is only a small increase in the magnetic induction, whereas when the negative half cycle is taking place, there is a large diminution in the induction. It will be noticed that the direct current coils and the alternating current coils on the two transformers are wound so that during the positive half cycle they assist each other on one transformer and oppose each other on the other. From this it follows that the induction in the second transformer is given by curve *b*, which lags practically 180 degrees behind curve *a*. The resulting total induction is given by curve *c*, and is seen to have a double frequency. In Fig. 17, oscillograms of the phenomena mentioned are shown. The voltage at the terminals at one of the transformers is given by E_1; that at the terminals of the other transformer by E_2, and there is also shown the resultant

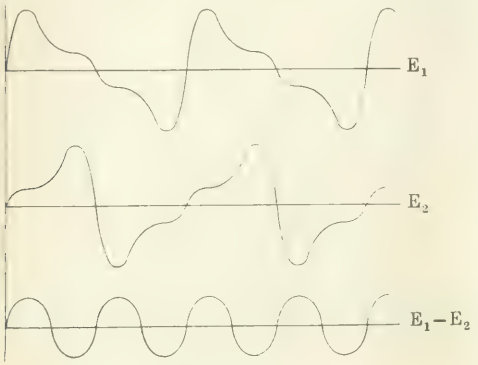


Fig. 17.

voltage, namely $E_1—E_2$. This latter is seen to be of double frequency. A simplified modification of the circuits has been given by Vallauri.*

Joly has described a method for directly tripling the frequency, using iron core transformers. It depends upon the following principles. If we send an alternating current through the primary of a transformer, and arrange that at the maximum current point of the cycle the iron core shall still be working far below saturation, the induction curve will be a peaked curve such as is shown in curve *c* of Fig. 18. On the other hand if we work the iron at saturation value for the maximum current point of the cycle, we shall obtain a very flat-topped induction curve as shown by curve *b* of the same figure. If two such primaries, of the classes mentioned, are connected in series in opposite directions on two transformers, as shown by S_1 S_2 of Fig. 19, the resulting secondary E.M.F. will be of triple frequency.

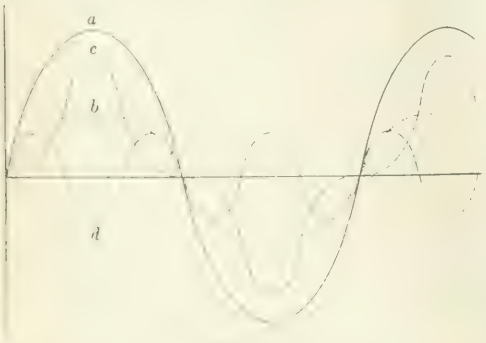


Fig. 18.

The [illegible] curve in Fig. 18, which curve represents the [illegible] of the two induction curves in the separate transformers. [illegible] that the secondaries, S and S', are wound with appropriate numbers of turns, so as to compensate for the inequalities in the curves of them of S and S'. Furthermore the secondary current is sensibly limited to the triple frequency. Needless to say a very rapid multiplication of frequency can be obtained by this method. For example, the frequency can be raised 81 times in only four steps. In the foregoing, the author has utilized among many other sources, discussions on the subject of radio frequency generation and multiplication by Prof. B. Glatzel and Dr. F. Kock.

It is our belief that the most fruitful results in the field of radio-telephony may well be obtainable by the use of one or the other of the frequency changers which have been herein described. One of the difficulties in practical long distance radio-telephony, and it is a very serious difficulty, is the control or modulation to speech form of the outgoing energy by an ordinary microphone transmitter. Up to the present time, it has not been possible to replace the ordinary transmitter by any simple and at the same time reliable device. We are therefore driven to use some method of trigger control whereby small changes in the resistance of the microphone transmitter, such as are caused by speech, will produce proportionate but highly magnified changes in the amount of radiated energy. The various frequency changers described lend themselves admirably to different forms of trigger control of output. For example, many of them are very sensitive to a small change in tuning in one of the intermediate

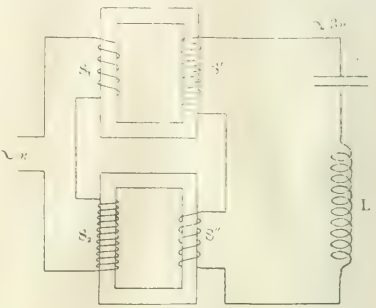


Fig. 19.

steps. If, therefore, we shunt one of the tuning condensers in the iron core type of frequency changer by either one or more microphones, we are given a ready means of controlling the output to a certain extent. Still another possibility is given in some of these types of transformers just described if we cause the microphone to vary the direct current magnetisation which brings the iron cores to the saturation point. Since the proper operation of the Joly frequency transformer is largely dependent on an accurate adjustment of the core magnetisation, it is clear that microphone control thereof should be successful in practice. The Telefunken Company, which has widely experimented with the Joly transformer, has attained considerable success in radio-telephony by some of the above means.

It seems to the writer that the apparent trend of high power radio design is in the direction of the moderately high or even radio frequency alternator, employed in conjunction with one or more of the frequency changers. So far as radio-telephony is concerned, this direction of development should be highly favourable to success.

THE USE OF ELECTRIC MACHINES FOR THE SOLUTION OF EQUATIONS OF ANY DEGREE.*

BY L. BERTHENOD.

Different types of machine have been proposed for the solution of equations: there is the balance due to Bérard, and improved by Lalanne, and there is also the ingenious machine of M. G. Meslin, which is based on the principle of Archimedes. The principle, which the author proposes, has not yet been published, though it has been discussed with various persons who were thought to be likely to be interested in the matter. It is hoped that these lines may meet the eye of someone who may be disposed to put the matter to a practical test.

If we consider a continuous current magneto, it is known that the E.M.F., which it develops, is directly proportional to the speed of rotation, which we will call n, always provided the construction of the machine is suitable. A magneto similar to that used in the OK current meters would be suitable. The same is true of the current sent by the machine into a circuit of constant resistance, if this current is sufficiently weak not to cause any distortion of the field by its reactive effect. Let us suppose that the whole or a portion of this current is used to excite the inductor of a second machine; this

* Abstract of an article in "La Lumiere Electrique."

* See THE ELECTRICIAN, Vol. LXVIII., p. 382. ED. *E.*

machine should be free from iron, and similar to the motor used in the Thomson meters; in any case, if the design is suitable, this second machine will produce an E.M.F. proportional to x^2, and the current discharged into a circuit of constant resistance will be similarly proportional to x^2. This latter current can be used to excite a third machine, which will produce a current proportional to x^3, and if n machines are connected in cascade, the first being, as aforesaid, a continuous-current magneto, we shall get a series of currents proportional to x, x^2, x^3, . . . x^n. Let us add to this system a constant current k, supplied from an accumulator or battery. We can then suppose a galvanometer, submitted to the action of these $n+1$ currents, and let its needle point to zero when the algebraic sum of the ampere-turns of these $n+1$ currents is zero. If such a state of equilibrium is attained, we have then a relation of the form

$$0 = k_0 + k_1 x + k_2 x^2 + k_3 x^3 + \ldots + k_n x^n,$$

which expresses mathematically the conditions of equilibrium, the constants being dependent on the construction of the machines and on the different circuits.

If we translate the equation into ordinary language, we may say that if we start from rest and gradually increase the speed of the machines, the galvanometric system will reach a state of equilibrium every time that the speed x reaches a value equal to one of the roots of the equation. In order to solve an equation of the type

$$0 = k_0 + k_1 x + k_2 x^2 + k_3 x^3 + \ldots + k_n x^n,$$

it is necessary to choose the coefficients k_1, k_2, k_3, . . . k_n so that one can make the roots of the equation the same as that of the system of machines, so to speak. The problem is, therefore, solved theoretically, seeing that it only consists in measuring x each time that the galvanometer shows a state of equilibrium; the negative roots are evidently obtained by reversing the direction of rotation. It will naturally be an advantage so to transform the proposed equation that its roots do not exceed certain numerical values, fixed by the machines. From the practical point of view, the main difficulty consists in devising a method for conveniently adjusting the constants of the different circuits in such a way that the equation which gives the condition of equilibrium for the galvanometer shall be identical with the one which it is proposed to solve. However, this matter ought not to present insuperable difficulties.

MATHEMATICAL RELATIONSHIP BETWEEN FLUX AND MAGNETISING-CURRENT WAVES AT HIGH FLUX DENSITIES.*

BY A. L. TACKLEY, B.Sc.

This Paper originated in an attempt to deduce mathematically the constant experimental result obtained by Mr. J. S. Nicholson, B.Sc., for the shape of the magnetising current wave required to produce an alternating sine wave of flux attaining high flux densities.†

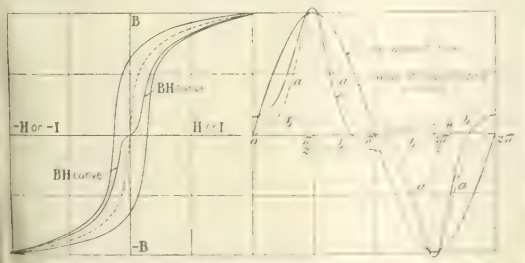


FIG. 1.—STATIC HYSTERESIS LOOP AND B-H [illegible] AND WAVE OF FLUX AND MAGNETISING [illegible]

As an introduction to the mathematical treatment of this subject, it is desirable to consider the relation between flux and magnetising current waves at normal flux densities.

In Fig. 1 the magnetising current wave required to produce a sine wave of flux as given in a [illegible] was obtained graphically from the corresponding static hysteresis loop. The construction could have been carried out [illegible] by replacing the loop by the dotted line which bisects its horizontal width; this gives the current wave [illegible]

* Part of a Paper read before the Institution of Electrical Engineers.

† J. S. Nicholson. "The Magnetic Cycle of Iron in Relation to Work with Alternating Currents." Journal I.E.E., Vol. [illegible], 248, 1915.

to allow for the width of the loop. Wave b is the difference between current wave a and the total magnetising current wave, and it could also have been deduced directly from the hysteresis loop.

Now, harmonic analysis of this static magnetising current wave gives

$$\begin{aligned} &a_1 \sin\theta - a_3 \sin 3\theta + a_5 \sin 5\theta \quad \&c. \\ &- b_1 \cos\theta \quad b_3 \cos 3\theta + b_5 \cos 5\theta - \&c. \end{aligned} \quad \ldots \quad (1)$$

By considerations of symmetry, the sum of the sine terms of equation (1) gives wave a, the maximum value of which, I_M, is given by $a_1 + a_3 + a_5 + \&c.$; the sum of the cosine terms gives wave b, and owing to the convergency of this series and the signs of the terms, the maximum width of the hysteresis loop is of the order of magnitude $2b_1$. One other line is shown in Fig. 1 within each half of the hysteresis loop—namely, the B–H curve as obtained by the method of reversals with a ballistic galvanometer.

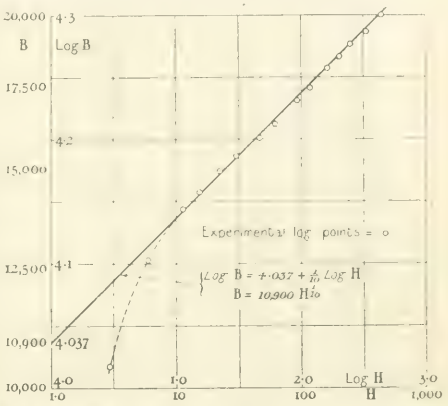


FIG. 2.—ANALYSIS OF B-H CURVE. LOG B PLOTTED AGAINST LOG H.

Now, if the magnetisation reaches high flux densities, the width of the loop becomes so small compared with the maximum value of the magnetising current that its influence on the shape of the magnetising current wave becomes negligible. The latter may, therefore, be derived directly from the line bisecting the loop, and its analysis will yield only sine terms, giving

$$a_1 \sin\theta - a_3 \sin 3\theta + a_5 \sin 5\theta \quad \&c. \quad \ldots \quad (2)$$

Also, since the width of the loop is negligible, this bisecting line may be replaced by the corresponding B–H curves, since both are contained within the loop.

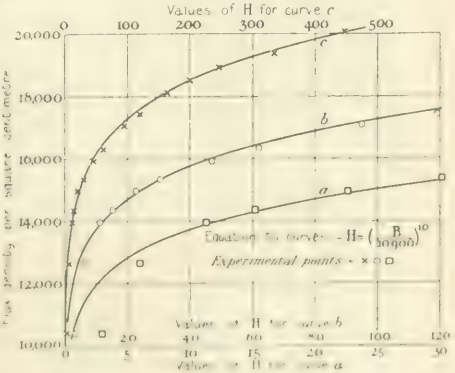


FIG. 3.—EXPERIMENTAL AND CALCULATED B-H CURVES.

Proceeding to the B–H curve for the [illegible] given by Mr. Nicholson's experiments, Fig. 2 shows the curve plotted to B, log H scales. The equation to the straight-line portion of this graph is given by

$$\log B = 1{\cdot}037 + \tfrac{1}{10} \log H,$$

or else

$$B = 10{,}900\, H^{\frac{1}{10}} \text{ or } H = \left(\frac{B}{10{,}900}\right)^{10} \quad \ldots \quad (3)$$

The accuracy of these equations when applied to the B–H curve has been checked in Fig. 3, from which it will be seen that the calculated curve would practically coincide with one drawn from experimental data at high flux densities. For low values of B the curve, although not accurately representing the B–H curve, would lie within the hysteresis loop for the high flux density conditions considered above. For the present purpose equation (3) will, therefore, be used instead of the B–H curve. It is written more generally in equation (4).

$$B = K_1 I^{\frac{1}{n}} \text{ or } I = K B^{n} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Consider, now, an electric circuit consisting of a single-phase alternator maintaining a sine wave of voltage of normal frequency f when connected to the magnetising winding of a laminated iron magnetic circuit. Assume the total resistance of the circuit (including the resistance of the alternator) is negligible, and that, the iron being worked to high flux densities, it is possible to neglect the

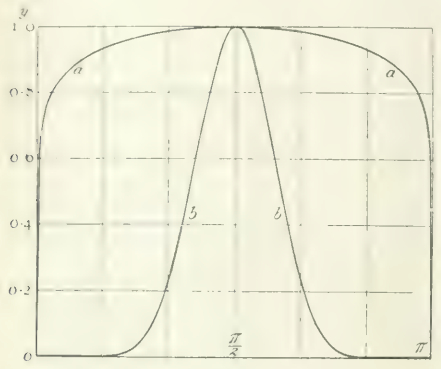


Fig. 4.

$$y = \sin\theta; \quad y = \sin^{n}\theta.$$

influence of hysteresis on the shape of the magnetising current wave. Then if the influence of eddy currents may also be neglected, there are two limiting cases which may be considered mathematically—namely, the effect of producing (1) a sine wave of magnetising current in the electric circuit, or (2) a sine wave of magnetic flux in the iron circuit.

Case 1.—Let $i = I_M \sin\theta$ be the magnetising current, where $\theta = \omega t$, t = time and $\omega = 2\pi f$. Then, by equation (4), the curve of flux density B produced by this current is given by

$$B = K_1 I_M^{\frac{1}{n}} \sin^{\frac{1}{n}}\theta \text{ for values of } \theta \text{ between 0 and } \pi, \text{ and}$$

$$B = -K_1 I_M^{\frac{1}{n}} \sin^{\frac{1}{n}}\theta \text{ for values of } \theta \text{ between } \pi \text{ and } 2\pi \quad . \quad . \quad (5)$$

Owing to similarity, only one-half period need be considered, so, substituting B_M for $K_1 I_M^{\frac{1}{n}}$, equation (5) becomes

$$B = B_M \sin^{\frac{1}{n}}\theta.$$

and since the flux $\Phi = BA$, where A = area of the iron circuit, the current flux is given by

$$\Phi = \Phi_M \sin^{\frac{1}{n}}\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The curve to represent this equation has been plotted in Fig. 1, curve $y = \sin^{\frac{1}{n}}\theta$ being taken for the case of the flux, the analysis of equation (6) may be obtained from Fig. 2 by noting the amplitudes of the fundamental and harmonics for $n = \frac{1}{10}$ giving

$$\Phi = \Phi_M (1{\cdot}22\sin\theta - 0{\cdot}38\sin 3\theta + 0{\cdot}21\sin 5\theta$$
$$- 0{\cdot}13\sin 7\theta + \&c.) \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$= \Phi_1 \sin\theta + \Phi_3 \sin 3\theta + \Phi_5 \sin 5\theta + \Phi_7 \sin 7\theta + \&c.$$

[illegible] $\Phi_1 = 1{\cdot}22\Phi_M$

[illegible] $\Phi_3 = -0{\cdot}38\Phi_M$

[illegible] $\Phi_5 = 0{\cdot}21\Phi_M$

[illegible] $\Phi_7 = -0{\cdot}13\Phi_M$

[illegible] (7)

[illegible] Φ_1

[illegible] Φ_3

[illegible] Φ_5

[illegible] Φ_7

[illegible] Φ_M

[illegible] (6)

[illegible] Φ_M

[illegible] Φ_1

[illegible] Φ_3

[illegible] Φ_5

[illegible] Φ_7

PHYSICAL SOCIETY.

At the Meeting held on June 25th, at the Imperial College of Science, Dr. A. RUSSELL, M.A., Vice-President, in the Chair, a Paper entitled

"Conduction of Electricity through Metals,"

was read by the President, Sir J. J. THOMSON, O.M., F.R.S.

The discovery by Kamerlingh Onnes that at the temperature of liquid helium some metals can exist in a state in which their specific resistance is less than one hundred thousand millionth part of that at 0°C., appears to necessitate the abandonment of the ordinary theory of metallic conduction, as the experimental conditions prohibit the explanation of the phenomenon by an abnormal increase, either in the number or mean free path of the free electrons. The effects observed by Kamerlingh Onnes may, however, be accounted for by a theory of metallic conduction previously given by the author in "The Corpuscular Theory of Matter." On this theory the atoms of some substances contain electrical doublets—*i.e.*, pairs of equal and opposite electrical charges at a small distance apart. The effect of an applied E.M.F. is to alter the heterogeneous distribution of the axes of these doublets by bringing them into partial alignment with the field. The influences preventing complete alignment are considered, and it is shown that if M is the moment of a doublet, N the number per unit volume, w the average kinetic energy of the molecules ($=R\theta$, except at very low temperatures) and I is the resultant of the molecular moments in the direction of X the electric force on the doublets, then

$$I = NM f(XM/w) \quad NM f(\infty) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which $f(x)=0$ when $x=0$, and $f(x)=\infty$ when x is infinite.

X is made up of the applied electric field X_0 plus an internal field due to the polarised doublets, the latter of which is assumed to be proportional to I. Hence, $X=X_0+kI$, and $x=M(X_0+kI)/w$, or

$$I = w/Mk \quad X_0/k. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

For any value of X_0 the value of I can be found from the intercept of the straight line (2) with the curve (1). The effects due to any value of I will be the same as if I doublets per unit volume pointed in the direction of the field, the axes of the rest being uniformly distributed in all directions, and the substance may be pictured as containing a number of chains of polarised atoms whose doublets all point in the direction of the field. The electrons in the atoms will be acted on by forces due to the neighbouring polarised atoms, and the theory supposes that in conductors the electrons are easily abstracted by these forces from the atoms to which they are attached, and pass, under their influence, from atom to atom round the polarised chain. If p electrons pass along each chain per second, and if there are n chains per square centimetre perpendicular to the field, the current density $i=epn$, where e is the electronic charge. It is shown that p is independent of X_0, and so the ratio of i to X_0 will follow the same laws as that of I to X_0.

When w/Mk is large, as at ordinary temperatures, the slope of (2) will be steep and will intersect (1) near the origin where it approximates to a straight line. In these circumstances it is shown that Ohm's law holds. As the temperature falls the slope of (2) also decreases, and may ultimately become less than that of the tangent at the origin of (1). In this case, if we start with an external field producing a polarisation, I, and gradually reduce the field to zero, the point of intersection of (1) and (2) moves along the former, but still gives a finite value of I, when (1) passes through the origin—*i.e.*, when $X_0=0$—and a current continues to flow in the absence of an applied E.M.F. as observed in one of Kamerlingh Onnes' experiments.

On this view, therefore, the function of the applied field is to produce the alignment of the doublets; the actual transference of electricity is effected by the large inter-atomic forces brought into being by the polarisation of the doublets. Thus, if the polarisation remains on withdrawing the applied E.M.F. the current will also remain.

In addition to the disturbing effects on the electronic orbits due to thermal energy, there may be mutually directive action between different atoms such as gives rise to crystallisation. The effect of this is considered, and it is shown that if this factor is large the metal cannot become superconducting.

Prof. S. P. THOMPSON, in proposing a vote of thanks to the President for his Paper, said there were one or two points [illegible] grasped in the course of the lecture, and which he [illegible] cleared up. We were all led to assume a current [illegible] positive and negative ions producing an electric [illegible] transference of electrons from one atom to the [illegible] circuit, this transference constituting the electric current. Although the responsible factor in the transference of the electrons was the internal force, an external force was necessary to produce this, and he did not see why, on withdrawing the applied field, the process should go on instead of stopping after one, or, at most a few, transfers had taken place. Were there any physical grounds for supposing that the forces of restitution were greater in the case of mixed crystals than in homogeneous ones? Lastly, he did not see the physical necessity of introducing the quantity d. Could the total force of restitution from all causes not have been included in a single symbol?

The PRESIDENT, replying to the points raised by Prof. Thompson, said that the energy was not spent in the movements of the electrons, but in creating the initial polarisation and it, in any circumstances, this could be maintained, the current would go on without any loss of energy, except a little by radiation. The formation of mixed crystals of A and B was due to the force between a molecule of A and one of B being greater than that between two of A or two of B. Hence, the force of restitution called into play on displacing a molecule will be greater in the case of the mixture than in that of the pure metals. He had thought it better to denote the force of restitution due to the directive action of neighbouring molecules, which did not depend much on temperature, by a separate symbol d, and keep it clear from the restoring couple due to the gyrostatic action which did depend on the thermal conditions.

A Paper

"On an Unbroken Alternating Current for Cable Telegraphy,"

was read by Lieut.-Col. G. O. SQUIER, Ph.D.

1. The Paper proposes a new angle of view in the method of transmission of signals in the submarine telegraph cable, and describes some apparatus for operating on the general principles involved.

2. An ocean cable is considered as a power line, and starting with the standard form of circuit which would be used in case it were required to operate an electric motor through an ocean cable, experiments are described to determine the minimum possible variations required in such a circuit to permit the alternating current received to be interpreted in dots, dashes, and spaces of the present alphabet. The uninterrupted alternating current used in transmission is operated on synchronously by the ordinary transmitting tape, so as to alter the impedance of the transmitting circuit at the instants when the current is naturally zero. Dots, dashes and spaces are each sent by semi-waves of either sign, but of different amplitudes. The alternating current received may be read directly from the record made by a syphon recorder, or this current may be employed to operate a syphon Morse printer, by means of an adaptation of Muirhead's gold-wire relay, or a Heurtley magnifier and a local wire relay.

3. The voltage stress along an Atlantic cable when an alternator is employed is shown, and the transmitting impedance of such a cable is computed as the frequency varies.

4. A special form of cable dynamo to operate at frequencies from 4 to 10 was used in the experiments described.

5. The fundamental principle is developed of never metallically "breaking" the transmitter circuit, which permits of greater accuracy in balancing the duplex bridge.

Mr. W. DUDDELL said the author and Dr. Crehore some 20 years ago were trying to get rid of the square corners of the waves due to the upper harmonics. The difficulties now appeared to have been entirely surmounted. As pointed out in the Paper, if the current be broken the harmonics are again introduced, and he thought the method of avoiding this by exact synchronism of the transmitter and generator very ingenious.

Prof. S. P. THOMPSON thought the great merit of the method of working was that it reduced everything to the sine curve. Anything else than a sine curve was less economical mechanically and electrically. He admired the author's method of obtaining synchronism, and of making the alterations in amplitude exactly at the zero points.

Mr. A. CAMPBELL said that frequencies of 4 to 10 seemed to be usually employed. What were the limits of frequency practically possible on an Atlantic cable, for example? Was the limit set by the facility with which the signals could be read by the operator?

Dr. H. W. MALCOLM thought that by adopting the principle of never breaking the circuit the author was working on the right lines. The distortion in a long cable was so great that the wave-form of the signal received depended very little on the form transmitted, and so the wave-form could be chosen to produce the least disturbance at the receiving end. For this the use of a series inductance was helpful. Another method was to use a commutator to shut off the recorder while the battery circuit was made or broken.

Prof. G. W. O. HOWE asked why the amplitude of the current which passed between [illegible] was made zero. Was it on account of [illegible] difficulty of working [illegible] cable?

The AUTHOR, in reply, said the [illegible] the amplitude large between signals, so as to depart as little as was practicable from its steady state value. Moreover, the [illegible] to feed the tape. With regard to frequency, 10 was very high from a cable standpoint, but he expected that when the present [illegible] of the receiving instrument much higher frequencies, say, within the aural limit, would be possible.

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SPECIAL NOTICE.

In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY NOON, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Advertisements of all kinds of which no proofs are required before first insertion can be accepted up to FIRST POST THURSDAY MORNING.

THE NATIONAL ORGANISATION OF SCIENCE.

At the annual general meeting of the British Science Guild last week Sir WILLIAM RAMSAY delivered an address on the National Organisation of Science. This is a subject which would be important at any time, but it is of more than usual importance at the present moment, because the methods of war consist largely of applied science, and the question with which we are faced is—Are we making the most of the scientific resources of this country for the prosecution of the war to a successful conclusion ?

The tendency in times of peace is to disregard science, taking this term in its broadest sense. More than half a century ago it was pointed out that whereas other countries send over men to Great Britain to study our methods and conditions, we do not take the same trouble to discover what is done by other nations. The tendency has been towards self-satisfaction, which becomes a national danger. This attitude has now been somewhat rudely shaken, and it is to be hoped that the ultimate result will be all to the good.

For the moment, however, the question before us is the application of science to warfare in particular, and in approaching this subject under present conditions we think it must be realised that the War Office and the Admiralty are necessarily labouring under extreme pressure of military and naval work. It is, therefore, difficult, if not impossible, for them to organise scientific work, more particularly if this does not appeal to them as having an immediate application. That, however, is no reason why scientific societies should not take some action in organising themselves. From a reply to a question asked in Parliament by Sir PHILIP MAGNUS last week, it is evident that Mr LLOYD GEORGE does appreciate the possibilities of an organised scientific effort. At the same time, it is well that the difficulties should be realised. In many matters it is

essential that secrecy should be preserved, and for this reason Government departments very naturally prefer to deal with individuals or with very small committees rather than with large bodies. Further, it is highly desirable not to have duplication of work, or the covering of the same ground by a number of individuals without one section knowing what another section is doing. On the other hand, it should be comparatively easy for societies to act as a source of information, and to carry out certain work which is known to be wanted. In this connection the broadest possible view should be taken, for a certain work may be required for our industries under present conditions, and may be as important for the country generally as work more directly connected with warfare. A very good example of this class of work is that which has been recently carried out by the Institute of Chemistry in providing formulæ for certain classes of glass which had hitherto been imported into this country. There must be a great deal of work to be done of this kind, but we doubt if the position is sufficiently realised. The want is there and the workers are there, but what is necessary is to bring them together so as to obtain a useful result. The suggestion made by Sir William Ramsay is that a central scientific organisation should be formed and that Government departments should be *compelled* to apply to this body for information. It is common knowledge that Government departments have no love for seeking information from outside sources; hence Sir William's desire for compulsion.

At the moment there are certain small committees which have been formed by various members of the Government, but their membership has not been announced, and their existence has somewhat deterred scientific men from organising themselves, as those who are serving on these committees have felt that they might be guilty of a breach of trust in taking part in any such organisation. Sir William is anxious to have a broad scheme embracing all the scientific and engineering societies, and that the Royal Society should act as a sort of intermediary between the Government and the societies. In this connection it may be mentioned that the Chemical Society has already done a good deal in organising its members into a number of sections, some of which are practically delegated to certain other specialised societies. In broad outline this seems to be the proper direction in which to work.

Perhaps the most disquieting feature of all these movements is the national characteristic of slowness to take action. In comparison, we have the fact that so far back as August 4th last (that is, immediately following the outbreak of war), the Académie des Sciences offered all its resources to the French Government, and formed a number of commissions which have since been carrying out valuable work. In this country it has taken us 10 months to think about doing something of the same kind. In conclusion, we would emphasise the fact that it is not merely the conditions of war, but the conditions in peace that we have to consider. It is essential to look forward and to spare no effort in putting our industries into a satisfactory position, so that they will be able to meet the stress of competition in the near future. This can largely be accomplished by a suitable co-operation between science and industry.

REVIEWS.

[Copies of the undermentioned works can be had from The Electrician Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Modern Illuminants and Illuminating Engineering. By L. Gaster and J. S. Dow. (London: Whittaker & Co.) Pp. xiv. + 462. 12s. 6d. net.

Many books have been written during the last few years on lighting, illumination and its allied subjects. Each has dealt with some specific aspect, which, as a rule, has been developed with as much detail as the exclusion of the use of mathematics will permit. The book at present under review differs from others on the same subject in that it surveys the whole realm of illuminating engineering, including many of its more physical and physiological aspects; but the authors have successfully resisted the temptation to enter into very much detail in any section of it. To make up for what would otherwise be a defect, many references are given throughout the volume to Papers and books, which may be referred to when more detailed information is required. Such a plan as this, well and methodically carried out, has the effect of converting what in any case is a most interesting survey of the subject into a book of no little value for reference purposes.

Complete as the references already are, in a future edition one hopes that they will be still further extended. With the unrivalled acquaintance which the authors have with current literature, there is no reason why their book should not form a complete bibliography of the subject, which would constitute it an unrivalled reference work for all time.

Those who are familiar, as the present writer is, with the labours of the authors in connection with the work of the Illumination Engineering Society, will expect great things from this book, and they will not be disappointed. If a criticism may be offered, it is that the references to the various authorities and investigators, which now appear in the text, might with advantage be consigned to footnotes. In their anxiety to give proper credit to all who have done original work, the text has in parts become overloaded with personal references. Furthermore, parts of the book may give the impression to some of being too much in the nature of a résumé of other people's opinions, and the reader would like to know more often what the authors themselves think and recommend.

The book with its 460 pages may be divided into three sections. The first, extending to Chapter IV., after giving an historical résumé of the subject, deals with the different systems of lighting used at the present day from an engineering point of view. The second section (Chapters V., VI. and VII.) treats of the more physical and physiological aspects of the subject, including the measurement of illumination, whilst the last three chapters are concerned with the design of lighting installations from the point of view of the illuminating engineer. Each of these sections will appeal in turn to different readers, but none are so specialised as to lack interest for all. Turning to the individual chapters, Chapter I., on the history of the subject, is remarkable as showing the great impetus which has been given to the development of good lighting along scientific lines by the advent of illuminating engineering societies in different countries. Chapter II. deals with gas lighting from a practical standpoint and all the accessory questions connected with it, such as the composition and testing of mantles, remote control and automatic ignition, &c. In Chapter III. all types of electric lamps are described in a way which will be acceptable to those who have not a profound electrical knowledge, but yet desire to be informed regarding the outstanding features of the various lamps dealt with. Unfortunately, the most important development of all, the gas filled tungsten lamp has appeared too recently to receive any but a brief passing mention.

Chapter IV. deals in the same way with other illuminants, such as oil, petrol, air gas and acetylene.

The next two chapters, entitled "Illumination and the Eye" and "Colour and the Eye," are most valuable and well repay careful perusal. They may be said to contain those facts in the physics and physiology of vision which should be within

the knowledge of everyone who desires to have an intelligent appreciation of the principles underlying our power to see.

The following chapter is on the measurement of light, and is accurate and well worked out. Considering, however, that they are undoubted authorities on this branch of the subject, the attitude of the authors is somewhat neutral, and the reader will find more information than guidance. In this section of the book, which deals with the physics of the subject, the absence of a chapter on radiation is a defect which one hopes will be corrected in a future edition. It is to be feared that there is much general ignorance of the principles of radiation, and yet they are most intimately bound up with the physical production of light.

The final three chapters on the design of internal and exterior lighting installations leave little to be desired, and contain many valuable hints and maxims, together with not a little useful advice. Until now every man has felt himself competent to arrange the details of a lighting installation, and the result has often been waste, discomfort and ugliness. A little attention to these concluding chapters can hardly fail to convince the amateur that there are both good and bad ways of lighting, and the latter are at present much more usually met with than the former. It is to be hoped that this excellent book will do much to promote what its authors have laboured for for so many years—the following of scientific principles in the installation and use of artificial light. The book is excellently illustrated, and the exceptionally matt paper used adds to the comfort of reading, and does not appear to interfere in any way with the reproduction of the many splendid half-tone illustrations

NOTES ON THE USES OF MERCURY TYPE ELECTROLYTIC METERS.

BY R. BOSSOM.

Summary.—The author refers to the ease with which electrolytic meters can be used for checking others *in situ* and their advantages in certain kinds of work, such as the testing of primary cells for ampere-hour output. Some notes are given on the testing of such meters in quantities.

The mercury electrolytic meter is now so largely used that these notes concerning them need no apology. Their great accuracy at all loads, their ability to register very small currents and the fact that their upkeep is practically nil, are features which cannot be ignored, and, at the present time, when meter room staffs are depleted owing to so large a number of men joining the fighting forces of our country, the electrolytic meter, which is so easily read and requires no periodic overhauling to keep it in order, presents great advantages to the supply engineer.

Testing in Situ.—Instead of removing the meter for testing purposes, after say, three years, it is much more convenient to connect in series with it one of the "miniature" type which has been previously checked in the test room. Simultaneous readings are taken of both meters when the check meter is installed, and at convenient intervals, until sufficient registration of units has taken place to enable the accuracy of the older meter to be checked, when the "miniature" meter may be removed. This method is much better than removing the original meter, as the customer is able to see the whole thing for himself (and a satisfied customer is the best form of advertisement), whereas if the meter is removed the customer feels that he has no check on what is being done and concludes that he is at the mercy of the supply authority. Of course, motor-type meters can be tested on the customer's premises by similar means, but there are several drawbacks.

(*a*) Load must be varied at "low" and "full" loads to obtain the necessary information as to their actual condition, [illegible] trouble they may be considerably in excess at the lower loads. This necessitates the use of portable testing apparatus.

(*b*) Checking in situ with a portable load and apparatus needs two men—the inspector and a labourer with the truck or van to move the apparatus from place to place.

(*c*) The men are on the premises some considerable time, which is rather a nuisance to the customer, who may not have a lot of faith in the result if unsatisfactory.

(*d*) The customer must be assured that the testing current is not charged in his bill.

(*e*) The whole thing is a mystery to him and he naturally has not the same confidence as he would have if he could see at a glance how things were going.

(*f*) The cost of current, time and labour of this method is considerable and not to be compared with the cost of temporarily installing a check meter weighing about 3 lb. which can be put in one's pocket. Further, electrical energy is to have such a large domestic use in the reasonably near future, that everything should be done to simplify matters to the customer, as by such means new business is much more readily obtained.

Disputed Accounts.—In order to obviate trouble with an occasional awkward customer, who tries to dispute his account after the meter has been reset, it is a good plan to instal a check meter at the commencement of the last period before the meter is to be reset. At the end of the period only the customer's meter is reset and the other meter continues the reading. Then, should there be any question as to the amount registered, as charged in the account, the check meter remains as a record which is easily consulted. After the occasion for its use has passed it can be removed.

Consider the case of a customer with the equivalent of, say, 16 20-watt lamps. These will take about 0·09 ampere each, giving a total of 1·44 amperes at, say, 230 volts=330 watts=0·33 units per hour when they are all on at once. Such a customer might consume about 0·5 unit per day on the average, which amounts to 183 units per year. The heaviest quarter of the year would not amount to 100 units and so a "miniature" meter having a capacity of 200 units is a suitable size for a check meter. With a dozen small meters used in this way any trouble with customers after resetting the meter soon disappears, as the meter usually fitted to such an installation would register at least 1,100 units and would only require resetting once in five years.

Testing in Quantities.—The best and most direct way of testing these meters in quantities at a time is to connect a carefully standardised meter of the same type, in series with those to be tested. Current is then passed through the circuit until, say, 40 units are registered, and the readings of those under test are compared with the standard meter. The size most used is of 10 amperes capacity and taking the pressure as 200 volts we have 10 amperes at 200 volts=2 units per hour, therefore, if a batch of meters are started off at 10 a.m. on one day, they will be ready to read by about 10 a.m. the next day. Or if started at 5 p.m. they will have registered 32 units by 9 a.m. the next day, thus causing the minimum delay in testing. This method is very simple and gives very reliable results. The best form of standard is the "laboratory" type, which has a very open scale and with which the makers are always prepared to supply a Board of Trade certificate—the meter then becomes a real standard. If there are not many meters to be tested it is economical to furnish the current from accumulators giving the required voltage instead of using the mains. It does not matter if the cells have to be recharged during the test, the current not needing to be on continuously.

Where the number of units registered is small, say, between 10 and 20, it is not easy to read correctly to within 1 per cent. a scale where 1 unit=about 1 mm. In such cases the writer's method may be of interest. An ordinary mercury-type motor meter has its gearing altered so that the dials read "revolutions of the armature spindle" instead of Board of Trade units. The gear wheels right back to the armature spindle are also altered and figured to agree, so that the reading is continuous from the highest front dial to the first wheel engaging with the armature spindle. In the average meter there are four front dials and three gear wheels between the lowest front dial and the armature spindle, thus enabling a seven-figure reading to be taken very accurately. Now assume the armature to make 10

revolutions per ampere per minute and a supply voltage of 200, the test being run at 5 amperes to register 1 unit per hour. The meter armature will make $10\times5\times60=3{,}000$ revolutions per hour=60,000 revolutions for 20 units. The meter constant for that particular load is very carefully determined by running it continuously and taking half-hourly readings with the aid of a potentiometer. It is also tested with currents 10 per cent. above and below 5 amperes to see that the constant is steady. The constant should be known to one-tenth of 1 per cent. The writer uses a batch of three motor-type meters adjusted in this manner connected in series with the electrolytic meters under test. All the dials are read at the beginning and end of the test and the number of revolutions divided by the meter constant gives the number of ampere-minutes, from which the number of Board of Trade units corresponding to the voltage of supply is easily found. The electrolytic meters are then compared with this reading with much better results than are obtained by reading the units directly off the standard electrolytic meter when only a few units have been registered. Another method is to use a copper voltameter, but the mess, trouble and liability to errors due to lumpy and loose deposits which sometimes drop off in small pieces during drying and weighing, led to the above method being tried, with a great improvement in accuracy, reliability and saving of time.

Miscellaneous Uses.—When one gets used to the advantages of mercury electrolytic meters, particularly in the direction of accuracy at all loads, freedom from breakdown, and especially the ease of reading, various other uses suggest themselves. For instance, it was desired to test the performance of different makes of dry cells when working intermittent contact apparatus in which the duration and frequency of contact depended somewhat on the condition of the cells. After trying various tests to show the ampere hours taken from the cells, mercury electrolytic meters were used. A number of the "miniature" type were ordered with "ampere-hour" scales and suitable shunts so that the scale should be as open as possible, and one was connected in series with each separate test consisting of an intermittent contact apparatus, ampere-hour meter and the dry cell under test. The scales of all the meters were similar and the height of the deposited mercury was an obvious record of the cells' performance.

When scaled in ampere-hours they are also very handy to connect in series with motor car accumulators brought in to be recharged. The input can be seen at a glance and their use does away with all uncertainty. The whole lot of various sizes and types, each with its own meter can be connected in series with a regulating switch and resistance, ammeter, &c., and as each size of battery gets fully charged it can be cut out, the meters of each lot showing their total input. Thus the cost of charging each different capacity is easily arrived at and the use of these meters renders obsolete such methods as charging so much per pound weight of cell! Another advantage is that after each run the meter can be reset, thus enabling each run to start from zero on the scale—there is no back reading to take into account.

THE VAPORISATION OF CARBON AND THE PRODUCTION OF THE SOLAR TEMPERATURE.*

BY DR. O. LUMMER.

The questions which the author sought to answer were: Does the positive crater have a constant normal temperature? Is the temperature of the negative crater under all circumstances lower? and What is the true temperature of the positive crater? For measuring the temperature of the crater he used his interference photometer (see "Verh. d. Deutsch. Phys. Ges., Vol. III. (1901), pp. 131-147), the photometric criterion in which is the disappearance of interference bands when the object viewed has wholly or in any single part the same brilliancy as the source with which it is compared. To convert this into a pyrometer, it only needs to be calibrated against a black body. Dr. Lummer first found that the glowing arc lamp carbon radiates like a grey body, and after determining the true temperatures of carbon filament incandescent lamps, which also radiate like a grey body, he used a carbon filament lamp as a standard to measure the black temperatures of arc lamp carbons, assuming that the radiation of arc lamp carbon and that of the carbon filament of an incandescent lamp have the same properties. The temperature determinations were based on the Lummer-Kurlbaum equation $H_1/H_2=(T_1/T_2)^x$, where H_1 and H_2 are the intrinsic brilliancies at the absolute temperatures T_1 and T_2 respectively. In the present experiments, which extend up to incandescent lamp temperatures of 2,900°C., it was found that the coefficient x approaches asymptotically the value 8·5, and this value is employed in calculating the temperatures above 2,900° C. The carbons used for the experiments were specially made of the purest material by the Plania Works and only contained an average of 0·07 per cent. of ash. The temperatures were measured at intervals between the pressures of 0·1 to 26 atmospheres, in order to determine the relation between the temperature of the crater and pressure. The results are as follows:—

Pressure in atmospheres.	Intrinsic brilliancy taking the normally burning lamp as unity.	Absolute temperature.
1·0	1·0	4,200
0·9	0·99	4,195
0·8	0·975	4,185
0·7	0·955	4,175
0·6	0·925	4,160
0·5	0·885	4,145
0·4	0·835	4,110
0·3	0·72	4,070
0·2	0·70	4,025
0·1	0·59	3,940

The following values for higher pressures are given provisionally as being the best obtainable at present:—

Pressure in atmospheres.	Intrinsic brilliancy taking the normally burning lamp as unity.	Absolute temperature.
1	1·0	4,200
2	2·5	4,690
4	4·4	5,000
6	6·0	5,190
8	7·8	5,350
10	9·5	5,470
12	11·0	5,560
14	12·7	5,650
16	14·2	5,740
18	15·6	5,800
20	16·8	5,840
22	18·0	5,890

The most recent observations give at only 22 atmospheres a brilliancy 23 times the normal, and a temperature of 6,090 deg. absolute. It will thus be seen that the solar temperature, which has been estimated at 5,900 deg. absolute, if the sun radiates as a black body, has been reached.

The uncertainty in the temperature determinations at supernormal pressures is mainly due to the fact that, when using pure carbon, no true arc forms when the pressure rises above 1 atmosphere, and also to the fact that it is very difficult to keep the arc stationary. Dr. Lummer describes the normal arc as follows:—

"In order that the arc shall produce its greatest heating effect at the positive crater, in my opinion, the whole kinetic energy of the electrons coming at a high velocity from the negative crater must come fully into play. If the momentum of the electrons is reduced by any impediment, the arc no longer exerts its maximum heating effect, it is then no longer a normal arc."

It is only possible by means of carbons impregnated with salts to obtain a true arc at supernormal pressures. Information as to the nature of the salts and details of the experiments are given in the book. Further investigation is also required in order to determine whether the salted carbons radiate as grey bodies or whether they radiate selectively.

The temperature of the negative crater is several hundred degrees lower than that of the positive. If, however, the negative carbon be made very thin, so that it becomes white hot over its whole length, and at the same time the arc be made so short that the high temperature of the positive crater prevents any considerable radiation of heat from the negative crater, the negative crater can be brought to the same temperature as the positive.

The following peculiar phenomenon occurs most readily at the critical pressure of 0·5 atmosphere and with a current which is less than the normal, but does not much differ therefrom. Dr. Lummer

* From a review by Dr. H. Lux of a book with the above title, by Dr. Lummer, published by Vieweg & Sohn, Braunschweig. Price 5 M. The Elektrotechnische Zeitschrift, Jahr. 35, pp. 1110-1118.

also produced it at pressures between 0·5 and 2 atmospheres. It is as follows :—

From a dark background having angular boundaries so as to give it a network appearance, there stand out bright particles which likewise have angular boundaries and move in the liquid, like fish. These particles appear to come out of one mesh or cell of the netlike background, which Dr. Lummer terms a honeycomb (Waben), pass rapidly into another cell, fix themselves there, first become darker in the middle and finally disappear entirely in the cell. He considers that they are graphite crystals produced by the melting of the carbon.

CORRESPONDENCE.

THE USE OF THE ELECTROSCOPE FOR HIGH VOLTAGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : In a recent issue you describe the high-potential electroscope devised by Prof. Fleming. It may interest some readers to know of a method of utilising an ordinary gold-leaf electroscope in demonstrations involving high static potentials.

Let a conductor A be charged to the required high potential, say, of positive sign ; then let an insulated conductor B connected by a wire to the electroscope be brought near. As B approaches A the potential of B rises, its value being, of course, measured by the deflection of the leaf (or leaves) of the attached electroscope. For given relative positions of A and B the potential of B is a constant fraction of the potential of A ; the readings of the deflections of the leaf are thus a measure of the corresponding potentials of A, and can be determined if desirable in actual volts by the ordinary process of calibration. The potential of A is thus "stepped down" in any suitable proportion.

As an example of application the discharging action of points can thus be readily studied. An earthed needle-point will not discharge a conductor at a potential so low that it may be connected directly to a gold-leaf electroscope. When the point of the needle is brought towards a polished conducting sphere charged to a potential of, say, 50,000 volts, discharge occurs where the point is inches away. It is interesting to examine the effect of coating the point with a dielectric, say paraffin wax. The high dielectric strength of the wax is easily demonstrated. A small bead of wax surrounding the point is sufficient to arrest its discharging power, especially if the wax be allowed to get quite cold first. If a smooth earthed metal sphere, say, $\frac{1}{2}$ in in diameter, is very thinly coated with paraffin wax, then on bringing it near the charged conductor a spark passes which pierces the wax and causes complete discharge of the conductor. But with a somewhat thicker coating of wax it is seen that though sparks pass to the ball the conductor is by no means completely discharged. It is the air that has broken down and not the paraffin ; testing by the electroscope shows the surface of the wax to be highly charged.—I am, &c.,

[illegible] July 5 D. OWEN.

THE GYROSCOPIC COMPASS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Gyro-compasses are at present so important that I ask you to permit me to write again concerning the Sea-Star compass. I am driven to ask this permission because Mr. Denton claims to have discovered that my description given on May 28th differs from that given by Mr. Kilburn Scott in the Paper to which the amendment in question was originally [illegible]. Mr. Denton also claims that the Sea-Star as first [illegible] has no degree of freedom about the horizontal [illegible]. I [illegible] to show that there is no [illegible] in the [illegible].

A gyroscope has three degrees of freedom when it can rotate freely [illegible] about three axes which intersect at its [illegible]. If from the Sea-Star compass the meridian motor and the gear wheels which connect it to the vertical axis be removed that which is left is a gyroscope having three degrees of freedom ; but the meridian motor, together with the gear wheels, are essential parts of the Sea-Star, and when these are in place the freedom about the vertical axis disappears, for the gyroscope cannot turn unrestrainedly about this axis. Indeed, it is only when the meridian motor is running that any effective motion can take place about the vertical axis. This is a brief description of that part of the Sea-Star concerning which, according to Mr. Denton, Mr. Kilburn Scott and I do not agree. Mr. Denton writes as follows : "He (Mr. Scott) states that 'three freedoms are provided,' though this seems to be contradicted by his description and sketches. Mr. Longland says that his own description 'is not that of a gyroscope having three degrees of freedom.'" Mr. Kilburn Scott is correct when he states that three degrees of freedom are provided ; his description goes on to show, as has been done above, that the freedom about the vertical axis disappears, although the possibility of rotation about that axis does not. Under the heading "Method of Working" he writes : "The action, therefore, is simply that the movements of the gyro-wheel about a vertical axis are constrained ones." From this it will be seen that Mr. Kilburn Scott does not contradict his own statement, but simply states that, although three degrees of freedom are provided, two only are used. In other words, the Sea-Star is not a gyroscope having three degrees of freedom ; but this is also my statement about the compass. Indeed, except that my description of the Sea-Star is briefer than Mr. Kilburn Scott's, there is no difference between these descriptions.

To complete the brief description given above of the Sea-Star the method of starting the meridian motor must be added. It is as follows : A pendulum hangs from the horizontal diametral axle of the gyroscope, being free to swing about that axle. The pendulum carries two strips of metal insulated from one another, and with a narrow gap between them. A roller is indirectly attached to the gyro wheel in such a way that it shares the motion of the gyro wheel about the horizontal diametral axis. If the pendulum be vertical and the axle of the gyro wheel horizontal, the roller is in the gap between the strips of metal ; if the pendulum remain vertical, but the axle of the gyro wheel turn out of the horizontal, then contact will take place with one or the other of the strips of metal. The contact with either strip closes the circuit of the meridian motor ; with one the rotation about the vertical axis is clockwise, and with the other anti-clockwise. The width of the gap depends upon the design of the compass. For obvious reasons, it would be made as narrow as would be consistent with the proper working of the compass. I fail to discover anything that I have written which would support Mr. Denton's statement that the compass described by me "demands considerable freedom of movement of the contact roller between the two segments."

Referring to Mr. Kilburn Scott's Paper, Mr. Denton writes : "The gyro-compass there described is so arranged that, in principle, the least tendency to turn about the horizontal diametral axis causes the meridian motor to prevent such turning." It has been shown that the meridian motor causes the freedom about the vertical axis to disappear, but evidently it does not disturb the freedom about the horizontal diametral axis, so that if the motor be rotated by hand the rotation of the gyro wheel caused by the motor about the vertical axis sets up an accelerated precessional rotation about the horizontal diametral axis. When the current is supplied to the motor the behaviour of the gyroscope is somewhat different, for if the roller is in contact with one of the strips the direction of the current is such that the precessional motion set up by the motor causes the roller to move across the gap to the other strip. On contact being made with this strip the motor is reversed, and the precessional motion also. Thus, precessional motion can only take place across the gap (this is not strictly correct, for there must be a slight precessional movement along the strips). Hence, if the meridian motor is to turn the gyroscope about the vertical axis, there must be a certain amount of movement about the horizontal diametral axis. This, however, must be as small as possible. To make the gap so narrow that there can be no appreciable movement

about the horizontal diametral axis in the setting the valve of a steam engine so that it will not admit steam and then triumphantly declaring the engine will not work, or it is like tying a man's legs togther and then jeering at him because he cannot run. Yet this is what Mr. Denton states is his "understanding of Mr. Scott's description." In support of this he refers to Fig. 25 of Mr. Scott's Paper. This figure shows in diagrammatic form two views of the Sea Star. That these views are only diagrams can clearly be seen by anyone who can understand a drawing; but, even if they were drawn to scale their size is of necessity so small that no accurate information can be obtained as to the extent of any clearances. The left-hand view, to which Mr. Denton evidently refers, shows the roller in contact with both strips, a state of things which would prevent the meridian motor working. Its title is "Normal horizontal position with contact roller between segments. Meridian motor standing." One of the notes referring to this view states that the axle of the gyro wheel is horizontal; but a note referring to the other view states that the axle of the gyro wheel is out of the horizontal: while still another note states that the fin (or pendulum) hangs vertically. For this to be the case the gyro wheel must have turned about the horizontal diametral axis. The title of this view confirms this, for it is as follows: "Tilted position of gyro wheel with contact roller on left-hand segment. Meridian motor running." This, then, is the evidence advanced by Mr. Denton in proof of his statement that the Sea-Star as described by Mr. Kilburn Scott is dead-beat. The text of Mr Scott's Paper gives no support to Mr. Denton's contention, as the following quotation will show: "Clearly, therefore, a couple is set up, and as the gyro wheel cannot go one way it goes another—that is to say, the axle tilts in a vertical plane. In thus tilting it brings the contact roller on to one of the segments." If this does not mean that there is some movement about the horizontal diametral axis it means nothing. Here once more Mr. Scott and myself are in agreement. Indeed, it would seem that there is not any difference in principle between Mr. Longland's and Mr. Scott's Sea-Star," but that there is a great difference between the Sea-Star as described by Mr. Scott and Mr. Denton's understanding of that description. It is Mr. Denton who has, and not I who have, invented a pseudo Sea-Star.

I regret that I cannot understand the few arguments advanced to show that the Sea-Star has a latitude error, and that I cannot agree that the Sea-Star has the errors common to the other types of gyro compasses. However seeing that Mr. Denton has confounded the Sea-Star with a gyroscope whose freedom about its horizontal diametral axis is suppressed, it is just possible—although, of course, it does not follow that he is wrong when he advances these propositions—I am, &c.,

London, July 6. WALTER LONGLAND.

ALTERNATING-CURRENT CABLE TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The abstracts published in THE ELECTRICIAN of July 2nd—of Lieut.-Col. Squier's Paper "On an Unbroken Alternating Current for Cable Telegraphy" must be most welcome to those of your readers who, like myself, had not the advantage of hearing the Paper read.

The Paper itself, however, I have learnt, is of special interest to me in view of my own work in this direction, the main features of which I will—with your permission—briefly describe.

Apart from two forms of electrolytic cable [illegible] devised by me* for the transmission of two-power alternating current impulses as advocated by the late Mr. Gott,† I have directed my attention mainly to two problems.

Firstly, how to cause two-power alternating-current signals to be registered in the usual manner on a cable.

Secondly, how automatically to re-transmit two-power alternating current from one cable into another.

* Application of E. R. B.'s British Patent No. 5,822, 1912, for a long-wave cable.

† Gott's British Patent No. 22,364, 1912.

Not only has *rectification* proved feasible in the sense of perfect siphon-recorder signals being produced from received two-power alternating currents, but automatic re-transmission of these same impulses has become a simple matter.

Although, in all my work, the cable receiver controlling the *rectifier* has been an Orling jet relay, my system of *rectification** is equally adaptable to the gold-wire relay of Muirhead.

It is interesting to observe that the recording method shown by Lieut.-Col. Squier develops on lines parallel to my own, but I go a step further, as shown by the accompanying signal records and diagrams.



FIG. 1.

The *rectifier* consists of four simple co-related electromagnetic relays, namely S_1, S_2, S_3, S_4 (in Fig. 6).

S_1 and S_2 are compatable with *h h'* in Col. Squier's Fig. 5, as shown on page 467 of THE ELECTRICIAN of July 2, the main difference being that S_1, S_2 are controlled by an Orling jet instead of by a Muirhead gold wire.

A weak *dot* alternation works S_1, whereas a stronger *dash* alternation actuates—with practical simultaneity—S_1 and S_2, as in the case of Col. Squier's *h* and *h'*.

Fig. 1 shows what the record would be like, were the armatures of S_1 and S_2 to carry recording siphons, and alternations were to be received as shown in Col. Squier's Fig. 1 (Fig. 2 herewith).

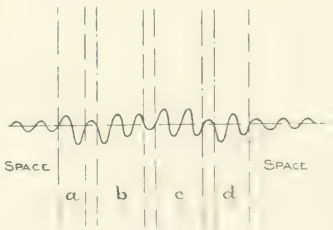


FIG. 2.

Fig. 3 shows the same signals as recorded by Col. Squier, the beautifully symmetrical appearance being got by the pretty mechanical device described in his Paper.

But one need not rest satisfied with these dot marks when it is easy to obtain the customary recorder-code signals preferred by all cable men.

As will be seen in Fig. 6, S_1 worked by a *dot* (*i.e.*, a weak impulse) in its turn actuates S_3, but it does this through the armature of S_2, which is included in this particular local circuit.

It has been seen that a *dash* signal (or stronger impulse) causes S_1 and S_2 to work simultaneously. S_2 works S_1 but, in

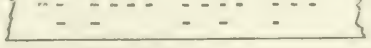


FIG. 3.

doing so, breaks the local circuit $S_1 \ldots S_3$, thus preventing S_3 from being affected by a *dash*.

It comes to this, then: Weaker *dot* signals actuate S_1 and stronger or *dash* signals affect S_2.

The armature levers of S_1 and S_2, therefore, constituting two independent keys worked [illegible] to act upon a local recorder, [illegible] Fig. 4 (a_2, b_2, &c.). Or, again, S_1, S_2 may be used to control [illegible] cable, of

† E. R. B.'s British Patent No. 2,225, 1913.

common reversals, or of two-power alternating currents, as desired, all the time, by means of extra contacts, as in Fig. 6, retaining a siphon-recorder register at the repeating station.

Fig. 4 shows comparative records of actual two-power alternating signals, first of all as received, from an artificial line (a_1, b_1, c_1) and secondly as received and simultaneously *rectified* on a local siphon-recorder (a_2, b_2, c_2).

All these signals were "sent" by the transmitter shown in Fig. 5, designed by the writer to transmit Gott two-power alternating currents.

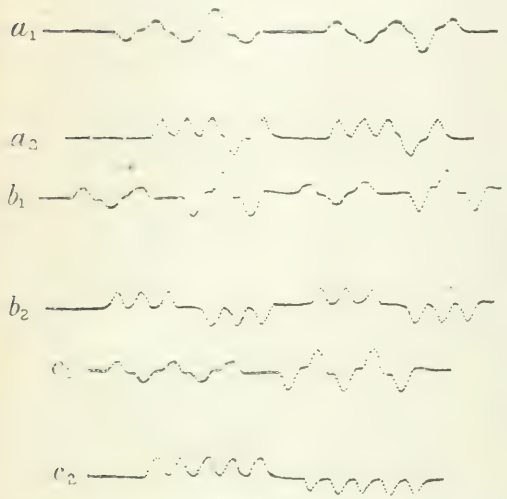


Fig. 4.

said impulses being weak or strong according as *dot* or *dash* key is pressed.

Fig. 6 is comprehensive, inasmuch as it shows a triple series of operations.

1. Reception—on an Orling jet relay—of Gott two-power alternating currents from cable C_1.

2. The writer's conversion of these alternating currents into a *rectified* register of recorder-code signals on the local instrument LR.

3. The writer's automatic re-transmission, into cable C_2, of fresh Gott two-power alternating currents (using, in this particular instance, Gott's cable-discharge method of obtaining battery reversals and consequent alternating-current transmission.)*

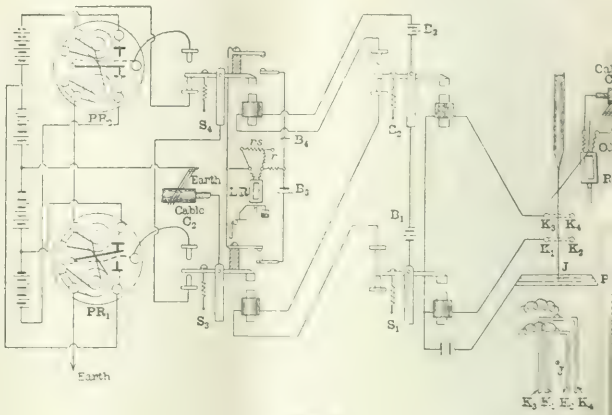


Fig. 6.

TK is a twin key for recorder code.

PC is a pole-changer* which always responds which ever key (TK) is pressed.

IS is an increment switch which brings the higher battery-power into play whenever the dash key is pressed.

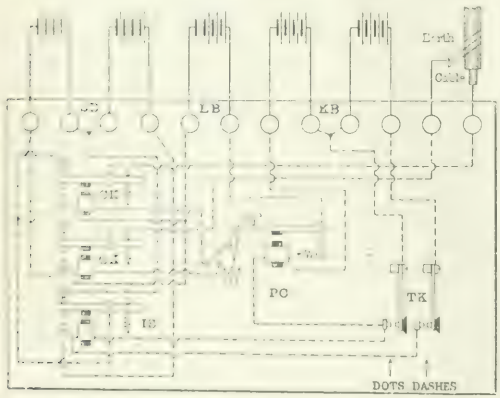


Fig. 5.

In these the dot key works PC; the dash key work PC—IS. C1, C2, are ordinary electro-magnetic cable keys, each key working alternately under the control of the pole changer PC sending to the + and — in pulses alternately, the

* The idea of Mr. Axel Orling, communicated by Albert Turpain to "La Nature," Paris, 1st June, 1907, "Sur une Nouvelle Disposition des Cables Télégraphiques." (C. Naud, Editeur, Paris.)

If, in one small, though highly important feature at the receiving end of the line, I shall be found to have contributed a good idea as apex to the scheme of unbroken alternating-current reception devised by Lieut.-Col. Squier amid the helpful surroundings of Messrs. Muirheads' laboratories, I may be justified in having encroached to this extent, Sir, on your valuable space.—I am, &c.,

London, July 5. EDWARD RAYMOND-BARKER.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Just a word to explain that "vain shadow" that inadvertently crossed your pages on June 25th, concerning Prof. Blondel's experiment on the induced E.M.F.

Prof. Robertson is, of course, quite right as to the meaning intended to be conveyed by the symbols I used in my letter.

In reading the Blondel experiment very hurriedly I made a mental note of his results. But later, on the appearance of Prof. Robertson's letter, I lost sight of Blondel's symbols. When I scribbled my note to you, Sir, I stupidly assumed that Prof. Robertson's N was intended for the flux and $d\Phi/dt$ an angular velocity. I did not quarrel with the rest of his letter. I heartily apologise for this confusion of symbols.

I was interested in the Blondel experiment, for I was myself 15 years ago on an experiment relating to it, and all I wished to convey in my letter was the simple argument that $d\Phi/dt$ was preferable to $\Phi\, d\theta/dt$ as a fundamental form common to all practical cases of induced E.M.F.s, Φ being the flux and $d\theta/dt$ the angular velocity. The same argument has been dealt with more fully in Mr. Jakeman's letter.

Blondel's experiment can be performed in other ways. An elastic metallic helix of n turns in a uniform field with axis

* Fig. 5 and Fig. 6 are taken from an extensive series of diagrams arranged by the writer in connection with a work on "Alternating-Current Cable Telegraphy" he has in course of preparation for the Press.

parallel to the lines would give the Blondel result if suddenly opened and closed. It is a coil whose turns can be changed from n to 1.

The experiment could also be made by using two or more motionless coils in a field; the coils to be provided with means of connecting them in series or in parallel. No one would dream that any observable phenomenon would result from such operations; but they are precisely similar in character to that of Blondel and prove the same thing, viz., no work done, no E.M.F. induced. These forms of the experiment tend to render the whole quest a feeble thing, but in the absence of knowledge of the law of conservation of energy I'm not sure that anyone could predict exactly what the effect of varying N would be.—I am, &c.,

Enfield, July 6. BENJAMIN DAVIES.

TRANSIENT PHENOMENA IN A CIRCUIT OF CAPACITY AND INDUCTANCE IN PARALLEL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In a letter by Mr. O. E. Grigsby appearing in last week's issue of THE ELECTRICIAN the following statement occurs: ". . . if we had a parallel tuned circuit of inductance and capacity only (no resistance), we would, on closing the circuit on the zero point of the E.M.F. wave, obtain an unidirectional pulsating current from an alternating-current source." This statement is not quite correct. Assuming a sinusoidal wave of applied P.D. the current drawn from the alternating current source under the conditions postulated, would be not only unidirectional, but also of constant magnitude—that is to say, it would be a true continuous current. This result appears by putting the value of the resistance R equal to zero in the equation given by Mr. Grigsby.

A somewhat simpler way of arriving at this curious result is as follows: If a P.D. $e=E\sin\omega t$ be applied to the terminals of an inductive circuit of which the coefficient of self-induction is L henrys and the resistance zero, and if the circuit be closed at the instant at which $e=o$, it is well known that the current will be represented by the expression $i_l=\frac{E}{\omega L}(1-\cos\omega t)$, that is to say, the current will be unidirectional and pulsating

If the P.D. $e=E\sin\omega t$ be applied to the terminals of a condenser of which the capacity is C farads and the resistance zero, and if the circuit be closed at the instant at which $e=o$, the current in the condenser will be $i_c=E\omega C\cos\omega t$. (In the resistanceless condenser the current will immediately attain its normal value and there will be no transient component.)

If the condenser and inductive coil be arranged in parallel and the P.D. $e=E\sin\omega t$ be applied to the terminals, and if the circuit be closed at the instant at which $e=o$, the current drawn from the alternating-current source will be $\frac{E}{\omega L}(1-\cos\omega t)+E\omega C\cos\omega t$. If the condenser and inductive coil are in resonance—*i.e.*, $1/\omega L=\omega C$, the current from the mains will have the constant value $E/\omega L$. I am, &c.,

Birmingham, July 5. T. F. WALL.

NEW RESEARCHES ON THE DIRIGIBILITY OF ELECTRIC WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to make a remark on Prof. Artom's article, published in your issue of June 25th, under the above title. The second paragraph of this article refers to a particular kind of directive aerial which, according to Prof. Artom, can give very different shapes of diagrams, depending upon the angles that one of the branches of the aerial would ideally describe around a vertical axis. The aerial is shown in Fig. 4 and the alleged diagram in Fig. 5.

From the theory and from my personal experiments, it follows that the diagram of the aerial of Fig. 4 is that of Fig. 2. This is natural, as this aerial does not differ from the aerials of Figs. 1 and 3, except in the point that the plane, instead of being vertical, is inclined to the vertical; and this condition cannot modify the form of the diagram.

Moreover, let us admit for a moment that the diagram of the aerial of Fig. 4 is that shown in Fig. 5. How could we explain then that the shape of the diagram could change according to an ideal rotation of half the aerials of Figs. 1 and 3 around their vertical axis, which operation always gives as the result an aerial of the shape of Fig. 4?

Prof. Artom affirms that his experiments confirmed the alleged properties of the aerial of Fig. 4. This is another point which it is difficult to explain.—I am, &c.,

Enghien-les-Bains, June 29. E. BELLINI, D.Sc., Electrical Engineer.

REPORT OF THE BRITISH SCIENCE GUILD.

The Ninth Annual Report of the Executive Committee of the British Science Guild was presented to the members at the general meeting held on Thursday, the 1st inst. The chair was taken by Sir William Mather, P.C., and the adoption of the report was moved by Sir Boverton Redwood, who gave a précis of its contents.

In the report it is mentioned that though the secretary has been serving his country at the front, and other difficulties have been caused by the War, the Society has continued to do useful work. The present membership is 758, besides which the South Australian Branch has 210 members and the Canadian Branch 61.

The Report severely criticises the National Dye Scheme, pointing out that not a single chemist is on the board of directors of British Dyes (Ltd.), so that the company is not very well qualified to compete with the highly organised coal-tar colour industry of Germany. The appointment of various Royal Commissions, Departmental and other Committees, by the Government is welcomed, however, the Royal Commission on the Sugar Supply and the Committee on the Supply of Drugs being mentioned in this connection.

No information has been available to the Executive Committee as to the appointment by the War Office or the Foreign Office of any Committees on scientific matters, and with regard to those appointed by the Admiralty no information can be published.

An account is given of the appointment by other Government Departments of committees to inquire into various scientific subjects.

With regard to the work of the Guild itself the Agricultural Committee has been considering the question of facilities for veterinary research, and now a special committee has been appointed to deal with this subject. The Conservation of National Sources of Energy Committee hopes to report in due course on the utilisation of peat, and on tide and wave energy.

A Science and State Committee has been formed specially to consider the adequate financial support of scientific workers, and this has obtained from the principal Government Departments and public bodies information concerning the remuneration of scientific workers serving on Royal Commissions or other Public Committees or as expert advisers and witnesses in Government inquiries. The Committee drafted a general letter asking the authorities in question to recognise the principle that no expert advice be taken without the payment of a fee in addition to expenses. This letter was issued by the Executive Committee with the signature of the President.

The Synchronisation of Clocks Committee has made inquiries into the non-participation of the British Government in the International Wireless Time Service, from which it appears that at the Paris Conference in 1912 the British delegates recommended the establishment of wireless stations in certain parts of the British Empire, which would in their opinion, greatly assist the scheme. The Committee, however, is awaiting the publication of the Report of the 1913 Conference.

The Technical Optics Committee had been inquiring into the facilities for training in technical optics, which they found to be very inadequate for the needs of the industry; but the outbreak of war caused them to leave this subject to discuss the possibilities of increasing the manufacture of optical glass in this country. The British Science Guild was asked to help the Board of Trade in this inquiry, and the Report issued was sent to the department as well as to members of the Optical Convention and other societies and public bodies. The Technical Optics Committee is also helping in the co-operation of British makers of microscopes now that the German supply has ceased, and the Education and Technical Education Joint Committee have been endeavouring to forward the British manufacture of glass and porcelain scientific apparatus of all kinds.

After the report had been adopted, and the Executive Committee, with the Lord Mayor as Vice-President, had been elected, an address was given by Sir William Ramsay on "The National Organisation of Science." We refer to this address in our leading article.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following [illegible] specifications [illegible] Patent Agents, 70 [illegible]

[illegible] which the application was lodged at the [illegible] Office.

1913 SPECIFICATIONS.

[illegible]

19,732 MOLLER. Process and apparatus for electrically separating sus pended bodies [illegible]

1914 SPECIFICATIONS.

3,701 OWNBEY. Rotary electric switches.
4,237 ELEKTRIZITATS AKT.-GES. HYDRAWERK. Operation of low-pressure electrical installations from high-pressure circuits. (19,2,13.)

[illegible] circuits having at any time to be in direct electrical connection with each other.
5,040 VARLEY. Electric ignition apparatus for internal-combustion engines.

[illegible]

5,345 MOUL. (Korting & Mathiesen Akt.-Ges.) Reflector for arc lamps.
5,467 ALLGEMEINE ELEKTRICITATS-GES. Electric switch arrangement for a plurality of conductors, machines or apparatus to be connected with the same bus bar and [illegible] (4,3,13.)

A switching arrangement in which a single safety resistance is utilised in connection [illegible] switches controlling the resistance circuit and the respective main switches are [illegible] switching on or off a conductor or the like the several switching operations follow each other in definite order; the safety resistance being also utilised for automatic switch ing off in the case of an excess current or a short-circuit.
5,841 SIEMENS BROS' & CO. (Siemens & Halske Akt.-Ges.). Circuit arrangements for [illegible] semi-automatic telephone systems.
6,182 JANSSEN. Electric-current collectors.
6,341 SIEMENS SCHUCKERTWERKE GES. Electricity meters. (12,3,13.)

[illegible] other signals.
7,746 FOX. Combined dynamo-electric generator and electric motor.
8,683 ELECTRIC UTILITY CO. & LONG. Method of repairing electric incandescent lamps. [illegible]

10,930 HOWARD. Electrical liquid heater. (11/7/14.)
11,097 WILLIAMS. Electric burglar-alarm systems.

[illegible] circuits.
12,059 ADAMS. Incandescent eelctric lampholders. (14/11/14.)
13,022 KETTERING & CHRYST. Dynamo-electric machines, particularly applicable for engine-starting systems. (14/7/13.)
13,057 KETTERING & CHRYST. Dynamo-electric machines, particularly applicable for engine-starting systems. (13/9/13. Addition to 13,022/14.)
13,076 BRITISH THOMSON-HOUSTON Co. (General Electric Co.) Manufacture of tungsten. [illegible]

[illegible] Telephone Co., Bryant & Ward.) Automatic telephone exchange connexions.
13,231 BRITISH THOMSON-HOUSTON Co. (General Electric Co.) Systems of control for electric motors.

Means for controlling a plurality of pairs of electric motors comprising series contactors responding to a weakened current only, shunt contactors, resistances adapted to be short-circuited by said series contactors, and interlocks so arranged and [illegible] having three working positions only.
13,232 BRITISH THOMSON-HOUSTON Co. (General Electric Co.) Liquid rheostats.

A liquid rheostat for electric circuits comprising main and auxiliary electrodes arranged to be successively immersed in a liquid, the auxiliary electrodes being normally disconnected from the circuit and arranged to be automatically connected in circuit independently of their immersion.
13,310 BURROWS. System of electric signals for main and tail haulage in mines and like places.
13,410 CONNER & ROBINSON. Telephone systems.
13,549 BRITISH THOMSON-HOUSTON Co. (General Electric Co.) Manufacture of metal wire. [illegible]

Comprises mesh connected resistances for the rotor phase windings, and a controller or switching device adapted to successively short circuit portions of the resistance in each of two of the phases alternately, no portion of the resistance in the third phase being short circuited.
13,715 CADENHEL. Electro-magnetic locking-devices. (10/6/13.)
13,854 THORNBLAD, WARFVINGE & WERNER. Means for telephonic communication between moving trains and railway stations or other stationary places. (Convention date not granted).
14,022 SIEMENS-SCHUCKERT WERKE GES. Cooling of electric portable drilling machines. (19/6/13.)
14,024 O'DONNELL & GLENN. Railway signalling. [illegible]

14,156 WILLIAMS. Sparking-plugs for internal-combustion engines.
14,229 BRITISH THOMSON-HOUSTON Co. (General Electric Co.) Shaping filaments for [illegible]

15,464 [illegible]

17,732
18,477 [illegible] which each signal, whether a dot or [illegible] the transmission of [illegible] longer in the trans-

24,646 CHELL.

APPLICATIONS FOR PATENTS

*NOTE.—The undermentioned Applications [illegible] those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published [illegible] in the ordinary course. Names and addresses [illegible] communications [illegible] inventions. When complete Specification [illegible] an asterisk is affixed.*

June 1. 1915.

[illegible]
8,090 BROOKE. Apparatus (portable) for field and army use combined telephonic and telegraphic.
8,099 TAFFINDER. Electric light adjuster.
8,100 QUAIN. Electric radiators.
[illegible]
8,107 BRITISH ELECTRIC TRANSFORMER Co. & MCWILLIAM. Oil-cooled transformers.

June 2. 1915.

[illegible]
8,163 SCLATER. Connectors for electrical signalling wires and cables.
8,169 B.T.-H. Co. (G.E. Co., U.S.) Electric hoisting equipment.
[illegible] 11/7/14 (U.S.)*
[illegible]
[illegible]

June 3. 1915.

8,227 HEYS. (Neuland Magnets, Ltd., U.S.) Electrical generators.*
8,238 SHARMAN. Discontinuous wire telegraph system.
8,248 B.T.-H. Co. (G.E. Co., U.S.) Electric welding and apparatus therefor.
8,268 DALEN. Multiple diaphragms.*
8,272 ALLGEMEINE ELEKTRICITATS-GES. Arc lamp with electrodes of highly refractory metals, tungsten in particular. (3,6/14, Germany.)*

June 4. 1915.

8,294 DYSON. Fittings for conduits for electric wiring and the like.
8,303 MCRAE & RUSSELL. Insulation division piece or partition for a controller arc deflector, circuit-breaker and the like.*
8,305 WALKER. Separating metals by electrolysis.
8,318 MURRAY. Mechanism for operating electrically-worked tramway and railway [illegible]
8,319 BOOTHROYD & CALLENDER'S CABLE & CONSTRUCTION Co. Electric wiring systems.
8,321 SUETER, GROVES & BINYON. Apparatus for use in wireless telegraphy and the like.
8,326 B.T.-H. Co. (G.E. Co., U.S.) Electric welding and apparatus therefor.
8,327 B.T.-H. Co. (G.E. Co., U.S.) Composite metal bodies.
8,332 MIDGLEY & VANDERVELL. Holders for electric incandescent lamps.*
8,333 KREMENEZKY. Electric heating devices. (9/6/14, Austria.)*
8,334 BRESLAUER. Dynamo-electric driving mechanisms of the unipolar system. (4,6/14, Germany.)*

June 5. 1915.

8,358 NORTH. Field telephone and telegraph apparatus.
8,367 POGNON. Sparking plugs. (Addition to 6,593/15. 16/6/14, France.)*
8,376 TURNER. Safety device for use with electrically-driven vehicles. (24/10/14, U.S.)*

June 7. 1915.

8,409 STEPHENS. Electric alarm.
8,412 BURTON. (Siemens-Schuckertwerke G.m.b.H., Germany.) Electrical safety-[illegible] devices.
8,417 MASCHINENFABRIK OERLIKON. Casing for the stators of electrical machines. (30/6/14, Switzerland.)*

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of [illegible] adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Dielectric Phenomena in [illegible]." By F. W. Peek, jun. (London: Hill Publishing Co.) Pp. xv + 200. 12s. 6d. net.

"Tramway Track Construction and Equipment." By R. Buckstaffe Holt. (London: Technical Publishing Co.) Pp. xv. + 249. 10s. 6d.

"Heart," edited by Thomas Lewis, M.D. (London: Shaw & Sons.) Vol. VI., No. 1. Pp. 104. 5s. 6d.

"Alternating Current Work." By W. Perren Maycock. (London: Whittaker & Co.) Pp. xxiii + 414. 6s. 6d.

"Transactions of the North East Coast Institution of Engineers and Shipbuilders." Edited by E. W. Wood Smith. (Newcastle-on-Tyne: The Institution). Vol. XXXI., Part 3. [illegible]

"Journal of the Institution of Electrical Engineers." Edited by P. F. Rowell. (London: E. & F. N. Spon.) Vol. 53, No. 250. 3s. 6d.

"Arithmetic of Alternating Currents." By E. H. Crapper. (London: Whittaker & Co.) Pp. viii + 208. 2s. 6d. net.

"Proceedings" of the Royal Society. (London: Harrison & Sons). Series A. Vol. 91, No. A 631. 2s. 6d.

"Proceedings" of the Cambridge Philosophical Society. (Cambridge: University Press). Vol. XVIII., Part 3. 2s. 6d. net.

"Science Abstracts." Publication of Electrical Engineers. London: E. & F. N. Spon. No. 240, Vol. 18, Part 6, Section A.: Physics. Section B.: Electrical Engineering. 1s. 6d.

Aluminium Charts. By Francis Andrews. (London: Chapman & Hall.) Pp. iv. 32. 1s. 6d. net.

Recherches sur la Conductibilité [illegible]. By J. Rezelman. (Brussels: Fuchs, Successeur Emile Bruylant.) Pp. 36. 1.0

Journal of the Royal Artillery. (Woolwich: Coast Artillery School Press.) Vol. XLIII., No. 5. Pp. 126. 80 c.

Journal of the Washington Academy of Sciences. (Baltimore: The Waverly Press.) Vol. V., No. 12. 80 c.

Proceedings of the American Institute of Electrical Engineers. New York. American Institute of Electrical Engineers. Vol. XXXIV., Nos. 6 and 7. $1.00 each.

The Physical Review. [illegible] Publication of American Physical Society. Vol. V., Second Series, No. 6. 80 c.

Mitteilungen der Physikalischen Gesellschaft Zürich. (Zurich: Druck von Gebr. Leemann & Co.) No. 17. Pp. xxiv + 30.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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HALF-WATT LAMP DEVELOPMENT.

The announcements made by a number of lamp manufacturers regarding the new sizes and prices of half-watt lamps will, doubtless, have excited considerable interest amongst our trade and installation readers. This pattern of lamp has been on the market but little more than 18 months. During that period it has been applied in those fields of practical illumination which require a lighting unit of high candle-power, and of simple construction. Judging by the records of progress with this type of lamp, which have been furnished by lamp manufacturers and contractors from time to time, we gather that many of the older types of arc lamp, particularly those of the open type, have been displaced by half-watts with highly satisfactory results. We anticipated at the time of the introduction of the half-watt lamp that by patient research and experiment, lamp manufacturers would gradually reduce the size of the half-watt unit so as to bring it into competition with the higher candle-power lamps previously made in what was commonly known as the "one-watt" type. Slowly, but surely, this anticipation is being realised, and in the announcements which the lamp makers are now sending out to the trade it is evident that they are within reasonable reach of a domestic size of this highly efficient form of lighting unit.

It will be observed from the particulars which we publish in our supplement pages this week, that the half-watt lamp is now available in the low voltage ranges in sizes as low as 15 watts. This rather suggests that in towns where an alternating-current supply is available, and in installations in which the 25-volt transformer is still in use, half-watt lamps of a highly economical pattern may be advantageously employed by the consumer. It is true that the initial cost of the lamps is still high, but the economy in energy consumption is such that it will justify their use where units of 30 c.p. and upwards are required. We realise that such a step would be somewhat in the nature of a temporary expedient, but the case would be almost an exact parallel with that which obtained at the time of the introduction of the metal filament lamp some 10 years ago.

The 25-volt half-watt lamp also presents possibilities to the railway companies for effecting considerable economy in the lighting of trains. Train lighting dynamos are at present operated at this voltage, and with an early prospect of the introduction of electric cooking in the buffet cars, those railway companies which have persistently developed electric lighting, at any rate on their main lines, will probably welcome the introduction of the size of lighting unit which should reflect favourably on the coal consumption per train-mile, so far as the locomotive is concerned for lighting purposes.

For the time being the 100- to 130-volt range of lamps is of considerable interest, particularly as the lowest size lamp is now brought down to the 60-watt limit. A lamp giving over 100 c.p. with so low an energy consumption will, we feel sure, be welcomed by installation contractors who will have numerous opportunities of introducing electric lighting with direct or semi-indirect light fittings for the interior of commercial and industrial establishments. Much the same may be said of the 100- to 150-watt size of lamps which are offered for 200- to 260-volt circuits. It is not unusual for advantage to be taken of the fact that lamps of the lower voltage can be run in series on 200- to 260-volt circuits, even though this is in the nature of a temporary expedient. The light user is able to make use of economical light units which are available at a low initial price, and which furnish a high degree of illumination at a comparatively moderate cost. In the literature which various lamp makers are distributing, putting forward the merits of these lamps, it is apparent that finality has not yet been reached, but, for the time being, the installation trade may feel a considerable gratification in the fact that they are offered high efficiency electric lamps at reduced prices.

Gift to Oxford University. According to "The Times," Mr. C. W. Dyson Perrins has offered to present the sum of £25,000 for the furtherance of instruction and research in chemistry at the University of Oxford. The sum is in addition to £5,000 which he gave two years ago to assist the erection of a new chemical laboratory.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From [illegible] 28, 1915, *to July* 3, 1915.

In view of the interest which is being taken in the subject of the importation and the exportation of Electrical Manufactures from the United Kingdom, we reproduce our weekly lists. *See also* note at foot of Exports.)

IMPORTS.

[illegible] £1,578; unenumerated, £2,093—237 pkgs. *Switzerland:* Elec. carbons, £370. *Holland:* Elec. lamps, £2,693; lamp parts, £229; unenumerated, £52. *Sweden:* Elec. machinery, £784; telephone materials, £235; lamp parts, £167. *France:* Elec. carbons, £836; lamp parts, £70. *Denmark:* Dry cells, 33 pkgs.; unenumerated, £101. *Norway:* [illegible] £1,510 [illegible] 40 [illegible]

EXPORTS.

To Australasia.—*Auckland:* Wire and cable, £55; unenumerated, £120. *Melbourne:* Elec. machinery, £46; wire and cable, £2,073; unenumerated, £901. *Sydney:* Wire and cable, £152; unenumerated, £1,098. *Wellington:* Wire and cable, £1,719; unenumerated, £594. *Brisbane:* Elec. machinery, £203; unenumerated, £119. *Dunedin:* Unenumerated, £31. *Christchurch:* Unenumerated, £48. *Perth:* Unenumerated, £91. *New Plymouth:* Unenumerated, £32. *Lyttelton:* Unenumerated, £158. *Fremantle:* Wire and cable, £82; unenumerated £1,065. *Adelaide:* Elec. machinery, [illegible] £181. *Geelong:* Elec. motors, £144. *Patea:* Unenumerated, £41. *Maryborough:* Telegraph material, £464. *Townsville:* Wire and cable, £130.

Africa. *Durban:* Wire and cable, £319; elec. machinery, £523; unenumerated, £593. *Port Elizabeth:* Wire and cable, £290; unenumerated, £119. *Cape* [illegible] £275. *Beira:* Elec. machinery, £42. *Mauritius:* Elec. machinery, £74; wire and cable, £12; unenumerated, £361. *Madeira:* Telegraph material, £112. *Delagoa Bay:* Elec. machinery, £392; unenumerated, £18. *St. Helena:* Unenumerated, £88.

Egypt.—*Aden:* Elec. machinery, £27, *Port Said:* Unenumerated, £11.

Malta.—Wire and cable, £6,031; unenumerated, £24.

Spain.—*Gibraltar:* Unenumerated, £52.

Portugal.—*Lisbon:* Telegraph material, £97; unenumerated, £93.

South and Central America.—*Buenos Ayres:* Wire and cable, £1,876; elec. machinery, £101; unenumerated, £1,893. *Rio de Janerio:* Unenumerated, £678. *Demrara:* Unenumerated, £120. *Batavia:* Wire and cable, £88; unenumerated, £123. *Guayaquil:* Unenumerated, £141. *Colon:* Unenumerated, £58. *Vera Cruz:* Elec. cable, £71.

Fiji.—Unenumerated, £14.

Holland.—*Amsterdam:* Wire and cable, £1,308; unenumerated, £100. *Rotterdam:* Wire and cable, £470; unenumerated, £41.

West Indies.—*Jamaica:* Elec. machinery, £100.

Italy.—*Naples:* Unenumerated, £19. *Genoa:* Unenumerated, £21.

Japan. *Yokohama:* Unenumerated, £41. *Kobe:* Unenumerated, £280.

China.—*Hongkong:* Elec. machinery, £298; unenumerated, £91. *Shanghai:* Elec. machinery, £423.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Wire and cable, £150; elec. machinery, £302; unenumerated, £257. *Calcutta:* Wire and cable, £413; unenumerated, £925. *Colombo:* Elec. machinery, £31; unenumerated, £35. *Madras:* Wire and cable, £14; elec. machinery, £40; unenumerated, £429. *Singapore:* Elec. machinery, £140; unenumerated, £369. *Kilindini:* Wire and cable, £26. *Karachi:* Elec. machinery, £140; unenumerated, £171. *Sourabaya:* Wire and cable, £473; unenumerated, £22. *Bangkok:* Wire and cable, £298. *Penang:* Wire and cable, £58; unenumerated, £22.

Canada.—*Toronto:* Unenumerated, £15. *Montreal:* Unenumerated, £76. *Halifax:* Submarine cable, £600. *St. John's:* Unenumerated, £62.

France. *Paris:* Elec. machinery, £40; unenumerated, £217. *Dieppe:* Elec. machinery, £90; unenumerated, £208. *Havre:* Unenumerated, £50. *Calais:* Telegraph material, £77. *St. Nazaire:* Elec. machinery, £19.

Greece.—*Piraeus:* Unenumerated, £31.

U.S.A.—*New York:* Unenumerated, £63.

Baltic Papers: Unenumerated, £25.

FOREIGN GOODS (duty paid and free).

[illegible] Unenumerated, £215. *Cape Town:* Unenumerated, £23. *Dieppe:* Unenumerated, [illegible] Unenumerated, £80. *Madras:* Unenumerated, £19.

FOREIGN FREE GOODS, entered in transit on through Bills of Lading.

Brisbane: Telephone apparatus, £60. *Melbourne:* Telephone apparatus, £158. *Wellington:* Telephone apparatus, £28

Note.—The large number of items in these official returns under the [illegible] unenumerated relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Osram Lamp Works (Ltd.) v. Pope's Electric Lamp Co. (Ltd.)

[illegible] was tried by Mr. Justice Joyce [illegible] and had nothing to add [illegible] of defendant's process. Having seen the [illegible] experiments on that process he said that [illegible] chemical compounds could be [illegible] and [illegible] that in [illegible] 1904 the carbon [illegible] to have included tungsten, [illegible] with reference to the nature of carbide [illegible] They well appreciated both [illegible] but that was developed in the electrical furnace, the temperature being at 2,000 deg. There he got a definite molecule compound of two atoms of wolfram or tungsten, and one of carbon, but any form of so-called tungsten containing carbon was always produced at the highest temperature of each furnace where the tungsten was reduced direct. It was in a black powder, and therefore under conditions which would have a very high temperature. He said it was quite impossible that at a temperature of 950° C. any carbide of tungsten could be formed by the interaction of carbon and tungsten or carbide and tungsten. From knowledge of tungsten compounds he said all those carbides that had been revealed were high temperature electric furnace products.

Dr. Otto Oberlander said that he had been approached by Mr. Hirst, chairman of the General Electric Co. (sole selling agents under the Just & Hanaman patent) with a view to making enquiries to enable them to make filaments similar to the filaments in the Osram lamps. At that time the General Electric Co. had no interest in the Just & Hanaman specification. In 1907 he put the Just & Hanaman specification into practice and made filaments from it. It was not necessary to submit them to any equalising process because they were sufficiently uniform when made.

Mr. Hughes, in opening the defence, said there was nothing novel in the mixture of a finely divided metal with an organic binding material when Just and Hanaman published their specification in 1904. That idea was quite well known in connection with osmium filaments. Of the mixture of tungsten and binder material Just and Hanaman said that filaments were to be formed "in the usual manner." In defendants' view the usual manner in 1904 was what was called by way of distinction the "soft paste" process, a process by which a relatively small quantity of metal mixed with a relatively large quantity of binder was squirted through a die at a pressure of a few pounds to the square inch. The process by which a paste so hard that it was to the touch almost like metal was squirted through a die at [illegible] than 1,250 tn. at a pressure of 20 tons to the square inch was subsequent to 1904. Again, for the purpose of carbonising the filament Just and Hanaman prescribed that electric current should be passed through it. That was an essential part of the specification. In fact, the only way of heating the filament for that purpose known at that time was by the passage of current through it. It was said on behalf of the plaintiffs that the only object of passing the current through the filament was to raise it to a high temperature. But the language of the specification would indicate that it must be done in that way. At any rate no one could tell in 1904, and he doubted if anyone could tell now, whether the results of passing a current of electricity through the filament and the results of external heating would be the same. It was obvious that the results might be totally different. The patentee had said do it by the passage of current. If he knew at that time it could be done in another way he was bound to say so. If he did not know and a new process had arisen since then it was not within the patent. If the patentee knew that that process could be carried out by external heating he had carefully excluded it from the patent. At any rate he knew that it was claimed that it could be done by external heating and it turned out that it could not the validity of the patent would be jeopardised. Moreover, the passage of current through the filament was essential to the equalising process, necessary when dealing with the soft paste filaments of 1904 but unnecessary when dealing with the harder filaments it was now possible to turn out. Such as it was the patentee had obtained the advantage of limiting the patent. With that he must also take the disadvantages. Defendants did not use the passage of current through the filaments at all. The filaments were taken in bundles of some hundreds at a time and heated in a furnace which was electrically heated, but that was a mere method of getting the heat and was immaterial. Defendants used a furnace heat instead of the direct current; the difference was enormous, and in truth the two systems were hardly capable of being compared. On that point he submitted there was clearly no infringement. The next point was the atmosphere in which the removal of the carbonised binder was to be carried out. On that point Just and Hanaman were clear. According to the specification sued upon that was to be done in an atmosphere of hydrogen and water vapour introduced for the purpose. Plaintiffs now said it did not mean that at all; but that if hydrogen were introduced and if in the process water was formed that was using an atmosphere of steam and hydrogen. In his submission that was an entirely extravagant proposition. According to that specification at any rate no one could doubt that steam was meant to be introduced. If plaintiffs' view were right and sufficient moisture were necessarily generated in the process why was steam mentioned at all? It would have been sufficient to say [illegible] in an atmosphere of hydrogen which in the course of the process will produce water and that will perform the process of oxidation. But the specification did not say that. Nor if the Z case showed anything, had it been the view of plaintiffs [illegible] Presumably the work was carried without knowing how [illegible] But by inspection granted in Aug., 1914 [illegible] (1). That declaration did not produce the result by the passage of an electric current through the filaments but by external heating. It [illegible] that the hydrogen introduced was dry and therefore plaintiffs' process carried on were knocked on the head at once. It [illegible] that the defendants had an alternative process which was carried out in a vacuum. That must also have been a great surprise to them. In fact they found that the production was carried out without any of the things on which plaintiffs had relied throughout as constituting the invention. The [illegible] that it was necessary to produce a new thing which was necessarily carried on the production of some water in the process. How that could be done [illegible] the mixed atmosphere of steam and hydrogen he failed to see. Moreover, the hydrogen defendants used was not only dry but

it was used in a rapid stream which immediately removed whatever products were formed in the process. So that instead of using water vapour, if in fact it were produced, that water vapour was being carried away as rapidly as possible. It was not wanted for the allowed reaction. What defendants said happened was this: There was some oxygen in the filament in the form of oxide of tungsten and that combined direct with the carbon of carbide and passed off in the form of carbonic oxide. Doubtless it was difficult to say with any certainty what really happened. Scientists appeared to differ considerably. But as the onus was on plaintiffs it might not be necessary to decide that point absolutely. Plaintiffs' theory that in the vacuum process hydrogen and water were produced although the process was commenced with either steam or hydrogen was more extravagant still. But whether they were right or wrong one cardinal fact remained. The process was not carried out in an atmosphere of steam and hydrogen but in a vacuum. Therefore, in the process of carbonisation, to be performed by direct current according to Just and Hanaman, there was no infringement by defendants; and in the removal of the carbon there was no infringement. The third essential in the process described by Just and Hanaman was the equalising process which modern developments had rendered unnecessary; and in that respect also there had been no infringement. On the issues of anticipation and want of subject matter, it was clear that the idea of using tungsten for electric lamp filaments was not new at the date of the specification. It was mentioned in Just and Hanaman's own German specification as nothing new. It was also referred to by Bottome, by Lodyguine, and in Siemens & Halske. The only point was how it was to be used. The process of building up a filament by taking metals or carbon and mixing them with an agglutinant and squirting the mixture through an orifice and burning away the binder was also well known. In fact it was described by Welsbach in 1898 with reference to osmium and other metals of the platinum group. It was also well known that tungsten was a most suitable metal for filaments and perhaps the most suitable. All Just and Hanaman did was to say: Try a known process suitable to some metals on other metals, or rather, another metal which is the most suitable for the purpose for which you want it. There was very little invention, if any, in that.

His LORDSHIP: There was no reason to suppose it would not work.

Mr. HUGHES: Apparently not and when it was applied it was found it would work. Proceeding, Counsel said that everything else in the specification was known. The only thing which could possibly be described as novel was the direction: Try tungsten. No one had thought it worth while to put "try tungsten" under a special heading, possibly because most people thought there was no subject matter in it. Besides this specification did not contain a satisfactory method of carrying out the process.

The case was not concluded when we went to press.

New Phonopore Co. v. Electrical Supplies Co.

Before Judge Woodhall, in the Westminster County Court on Tuesday, plaintiffs sought to recover £95 damages for the detention of a portable telephone.

Mr. KINGSBURY (for plaintiffs) said his clients manufactured (among other things) portable telephones for use by armies in the field. At the beginning of the year they were in treaty for the supply (through an agent in France) of a new form of telephone they had invented, and a sample of the invention had been handed to couriers awaiting the necessary permit for its being introduced across the Channel. On Feb. 26 the plaintiffs were rung up by defendants, asking if they had a good field telephone for sale, and saying they could [illegible] Mr. Isaac, managing director of plaintiff company, consented to lend a sample from the couriers, and on its being forwarded he had an interview on the telephone with Mr. Roden, one of the directors of defendant company, in which he stipulated that the telephone must be returned the following day. That was not done, and in consequence plaintiffs suffered considerable loss through failing to obtain orders.

Mr. ISAAC gave evidence in support of counsel's opening, and in cross-examination denied that Mr. Roden informed him that the sample telephone had been sent to France for approval by the French Government, and that it could not be returned for a week.

For the defence, Mr. Roden admitted that he promised to return the sample telephone on the following day. On the contrary he said he required a week would be the shortest period in which it could be returned.

His HONOUR said he must find for plaintiffs. [illegible] difficult case to decide. It was understood that a week's [illegible] would be necessary, and as much as three days over the week without any [illegible] beyond hope. The simple telephone had been returned to plaintiffs to be detached, and that being so he thought the damages in the case would be met by some payment for plaintiffs' time and trouble.

Dundee Tramway Arbitration.

The Board of Trade arbitrator (Mr. W. A. Cadell, K.C.) has issued his award in the proceedings for taking over the undertaking of the Dundee, Broughty Ferry, & District Tramways Co., Ltd. The amount of the award is £9,275, and it is provided that the purchase price shall be paid to the Corporation with [illegible] £2,000. The details of the award are as follows: Tramway lines, £6,527 [illegible] of negligible, £1,816; overhead equipment, £640. Parliamentary expenses, £750 [illegible] agreed £432. The company claimed £14,400.

PARLIAMENTARY INTELLIGENCE.

EMPLOYEES OF ELECTRICITY SUPPLY WORKS AND WAR BADGES.

In the House of Commons on Friday, Mr. Touche asked the Under-Secretary of State for War whether he was aware that the manager of the Heston and Isleworth Electricity Works, in response to an application for war badges for certain skilled employees on his staff, made on June 4, and containing names of firms engaged on Government work to which power was being supplied by his works, was informed that the issue of official badges could not be authorised on the ground that no power was being supplied to any factory manufacturing munitions of war; that his application was made as the result of a communication from the War Office to the Secretary of the Associated Municipal Electrical Engineers (Greater London), in which it was stated that a system had been instituted by which badges for skilled employees of suitable age and willing to enlist if called upon to do so could be obtained on application to the War Office; and that the application of the system was suggested by the military authorities as a means of retaining their skilled employees; was he aware that the attitude of the War Office towards applications for badges did not seem in accord with the official statement to the effect that several electrical companies had been offered such badges for issue to men of recruitable age who would be willing to enlist in the event of an emergency; would he say why there was this inequality of treatment in regard to the issue of badges to skilled employees of electrical services; and, if it represented a change of attitude, would he consider the advisability of its modification, with a view to granting badges to the skilled employees of the Heston and Isleworth Electricity Works, and to the employees of other companies similarly situated.

Mr. H. W. FORSTER: There has, as yet, been no change in the procedure as regards the issue of badges to employees at electricity power stations. The position is as stated in the first part of the question of the hon. member, but the power stations must be supplying power for the manufacture of munitions of war.

On Monday Mr. Touche asked why the issue of war badges to employés at electric power stations was limited to stations supplying power for the manufacture of munitions of war and was refused to other power stations, although many of them were supplying power to private firms engaged on Government work, and, even when not doing so, have been asked by the military authorities to prevent skilled employés from enlisting, so as to preserve the efficiency of [illegible] war. It now [illegible] to preserve efficiency only in cases where the station supply power for the manufacture of munitions or was it the wish of the Government to have all power stations sufficiently manned; why the military authorities asked them to retain their skilled men while refusing to issue badges to make it easier for them to do so, even where the men were willing to give an undertaking to enlist if called upon; and was any change in this procedure contemplated.

Mr. Forster said he had nothing to add to the answer he gave last week, except that under the new Munitions of War Act the making of regulations with regard to the issue of war badges to persons engaged on munitions or other war work had now been transferred to the Ministry of Munitions.

SOUTHAMPTON PROVISIONAL ORDER.

A Committee of the House of Commons recently considered the Electric Lighting Provisional Orders (No. 3) Bill, which confirms the East Grinstead, Connah's Quay and Southampton Provisional Orders. The latter order authorises Southampton Corporation to supply electric current in the parish of Bitterne, &c. The Southampton Gaslight & Coke Co. had asked the Board of Trade to insert the "Northumberland clause" in the order, but the Board declined to do so, and the company therefore petitioned against the Bill.

For the Corporation, Mr. VESEY KNOX, K.C., pointed out that the Corporation already had powers to supply electricity in two parishes outside the borough area—viz., North and South Stoneham, in the area of the South Stoneham Rural District Council, as was the parish of Bitterne, to which it was proposed to further extend the supply. The only opposition was from the gas company. Although Bitterne was a small place, electricity supply was required there, and it would produce a return upon the small capital expenditure required to provide the supply. The object was to secure the inclusion in the order of the "Northumberland clause," which would require the undertakers to revise their charges every three years, not merely as regarded the supply in that small parish of Bitterne, but throughout their area. The clause had been inserted in the East Grinstead and Connah's Quay Orders, and required the undertakers on the expiration of every third complete financial year after the commencement of the supply of electrical energy under the order, and on the expiration of each third succeeding year to consider and if necessary revise and thereafter maintain the scales of prices charged for electrical energy under the order so that so far as is reasonably practicable no contribution from the rates of the urban district will be required for the purpose of defraying the [illegible] expenses of the undertaking during the next three years. Provided nevertheless that [illegible] shall not exceed the maximum prices which may be charged under the order. On the [illegible] of prices so revised and recommended to be [illegible] to time in like manner as aforesaid and [illegible] to the undertakers. Counsel argued that to put that clause in the Southampton order would be to prevent the [illegible] from making [illegible] to the supplied power [illegible] a great power for the gas company, with which they were competitors, and who

wished to prevent the [illegible] business. When the Corporation applied for a previous order in 1908 the gas company petitioned for the application to it of the "Northumberland clause," but after correspondence their solicitors and the Corporation they said that, on the explanations as to the financial position of the electricity undertaking, showing that it was unlikely that it would become a charge on the rates, they would withdraw their objection, it not being their intention to act in any way hostile to the municipality or disturb the harmonious relationship between the company and the Corporation. The Corporation, [illegible] "fringe orders," enabling them to supply houses just beyond their borders, but not applying to more than six houses. One of those "fringe orders" operated in the case of Bitterne Grove. There was a further demand for electricity in the parish of Bitterne, notably in the case of the Garden Suburb, where there were some very attractive houses, some of which had been actually wired in readiness for the supply. To link up that area with the Corporation mains would not cost more than £400. It was quite a small matter, and to imagine that the gas company would be injuriously affected by it was ridiculous. Since 1908 the Corporation had so developed their undertaking that they had become formidable competitors, and the company wanted to hamper competitors in power supply—that was the whole origin of their opposition. In 1908 the Corporation sold 2,892,000 units; in 1914 7,164,000. It was because the Corporation were able to provide a very cheap electricity supply that the company came to Parliament to ask for the clause. There was no justification for their application on the score of the financial position of the undertaking, for in the six years that had elapsed since the company first asked for the clause the combined surpluses on the undertaking had amounted to £27,000, in spite of the high prices of coal in recent times and the reduction of charges for electricity. The Corporation's main object was to supply electricity at a cheap price rather than to make large profits for the relief of the rates. So low were the charges for heating and lighting that there had been a great controversy in the Council as to whether they were actually remunerative. The low charges for electric power had been an inducement to Messrs. Pirelli to erect large works on re-claimed land belonging to the Corporation on the western shore, and it was hoped by degrees to attract other manufacturers. At present Southampton was almost entirely dependent upon the docks, and it was not a healthy thing for any town to have to depend so much upon a single industry. Without cheap facilities for obtaining power it was impossible to get big manufactories established so far from the coalfields.

Sir John Snell said that Bitterne was a parish in which there was scope for the extension of the Corporation's electricity supply at a remunerative rate. At first there had been a loss on the extension to North and South Stoneham, but that was not so now. As to the "Northumberland clause," he was recently called in by a gas company to advise as to the enforcement of its provisions in the case of a local authority which was not making its electrical undertaking pay, and he had to advise that the position of the undertaking would be worse if the prices were raised. He had come to the conclusion that the clause could not be applied in practice. Anything which hampered the making of long-term contracts was a great impediment to the prosperity of an undertaking. The Southampton Corporation electricity department was extremely well managed, and its position was most sound; there was, therefore, no just cause for the insertion of this clause, which would be inimical to its development.

After hearing Mr. Paddon for the company, the Committee refused to insert the clause.

STALYBRIDGE, HYDE, &c., TRAMWAYS & ELECTRICITY BILL.

Last week a Select Committee of the House of Commons commenced the consideration of the Bill to authorise the Stalybridge, Hyde, Mossley and Dukinfield Joint Tramways and Electricity Board to construct additional tramways, to extend their area for the supply of electricity, &c.

Mr. Balfour Browne, K.C., for the promoters, explained that the Joint Board was composed of 24 members, giving six representatives to each district. The only opponents were Dukinfield Corporation, and they had really no right to appear against it, because they were part of the promoters of the Bill by their representatives on the Joint Board. It had been provided that in the event of any difference of opinion between the Joint Board and one of the constituent authorities it should be decided by arbitration, but that had not been accepted. The opposition of Dukinfield was on account of the fact that Stalybridge had been decided upon as the place where the generating station should be erected. In order to make the tramway undertaking a success it was necessary to provide other lines to bring in the populations outside, and the new routes that were proposed would be feeders to the existing system. The promoters asked for powers to borrow £12,000.

Mr. Wedderburn, K.C. (for Dukinfield Corporation) argued that the proposed tramway undertaking would be a disastrous one, and that the Board [illegible] to proceed with the enterprise [illegible] without [illegible] them.

Mr. [illegible] contended that [illegible] and that the cost [illegible] He urged that the Board ought to be compelled to [illegible] before it could [illegible]; and that [illegible].

Similar evidence was given by Mr. J. M. McElroy, manager of the Manchester Corporation tramways; Mr. J. B. Hamilton, manager of [illegible]; Mr. E. Bradshaw, engineer in charge at Stalybridge; and by Mr. S. L. Pearce, chief electrical engineer to Manchester Corporation.

Mr. Wedderburn [illegible] the case for Dukinfield Council, who opposed the [illegible] on the ground that [illegible] by the Board. He urged that the new tramways would not pay, and that there was no urgency for the electricity supply extensions.

Local evidence was given in opposition, and the Committee unanimously decided to allow the Bill to proceed. The clauses were adjusted on Wednesday, and the Bill was ordered to be reported for third reading.

Royal Assent.—On June 24 the Royal Assent was read to the following Acts of Parliament: Ormskirk Gas and Electricity, Metropolitan District Railway, Bristol Tramways, Halifax Corporation, Sheffield Corporation (Tramways).

On July 6 the Royal Assent was read to the following Acts of Parliament: Munitions of War, Electric Lighting Orders Confirmation (No. 1), Tramways Orders Confirmation.

London Electric Railway Companies' Facilities Bill.—In the House of Commons on Monday this Bill was read a second time.

Subsequently the Bill came before a Select Committee of the House of Commons, the only opponents being the London County Council who asked (1) that the agreements under the Bill should be submitted to the Board of Trade, and that the Council should have a right to be heard on them; (2) that a special form of accounts should be settled with particular reference to the Omnibus Company and its contributions to the common fund; (3) that there should be a time limit for the operation of the Bill. The Committee, however, refused to insert these provisions, and the Bill was passed.

South Shields Corporation Bill.—On Tuesday the Local Legislation Committee of the House of Commons passed this Bill, which confers additional powers for the tramway and electric supply undertakings, &c. The Bill has already been passed by the House of Lords.

BUSINESS NOTICES.

At a meeting on June 29 the resolution to wind up voluntarily the Electric Power Storage Co. (Ltd.), for the purpose of amalgamation with Pritchetts & Gold (Ltd.), was confirmed. The title of the combined undertaking is Pritchett & Gold & Electrical Power Storage Co. (Ltd.) Mr. G. E. B. Pritchett will be chairman and Mr. James Gray deputy-chairman of the new company. The other directors will be: Sir James Pender, and Messrs. A. G. Gold, F. C. Graham Menzies, T. W. Pritchett, C. R. D. Pritchett and David Willock. Messrs. G. E. B., T. W., and C. R. D. Pritchett will continue to act as managing directors. Particulars of the amalgamation were given in our issue of June 11 (p. 370).

The Westminster Tool & Electric Co., Suffolk House, Laurence Pountney Hill, London, E.C., inform us that they have discontinued the use of the name "Vulcan" in connection with their electric tools. In future these portable electric drills, blowers and lifting magnets will be known by the registered trade mark "Westool."

The partnership between Arthur A. Kay, Geo. H. S. Carter and Chas. E. Carter (trading as Kay & Co.), electrical and mechanical engineers, Ecclesfield Works, Ecclesfield, Yorks, has been dissolved. Debts by Mr. Kay, who continues as Kay & Co.

Patent Development.—The proprietors of patent No. 13,991 of 1910, relating to "Method of and means for controlling from a distance electric apparatus, and especially telegraph apparatus and the like," desire to dispose of the patent or to grant licences thereunder. Applications to Messrs. Cruikshank & Fairweather (Ltd.), 65-66, Chancery-lane, London, W.C.

Annual Holidays.—The works and offices of the Falkirk Iron Co. are closed from the 2nd to the 12th inst. inclusive, but a small staff will remain on duty to attend to urgent orders.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barking. The L.C. Board have given their decision on the Council's recent application for sanction to borrow £18,000 for the electric supply undertaking.

The Board stated that as to [illegible] the excess expenditure on the undertaking, amounting to £1,728, they had decided to sanction loans of £1,376 in respect of mains and services, and £117 in respect of an alternator and transformers and of certain loan costs. The Board were not prepared, however, to sanction loans in respect of the items of £204, 3s. 11d. for expenditure in connection with the abandoned extension scheme of 1911, or of £20. 15s. 1d. for miscellaneous expenses. The small item of £10.8s.6d. excess on meters should also be defrayed out of income. As regards the proposed additional plant and works the Board were advised that the proposals, while generally satisfactory, should in existing circumstances be somewhat reduced and revised. In particular, the Board were advised that the following reductions and omissions should be made:—

Fixed and Buildings. New pump, omit, £60; recorders, omit, £91; one chain grab stoker instead of two, saving £150; one superheater instead of two saving £130; reduction in boiler brickwork, £400; crane (£80); rail mains, &c. (£275); superheater (£140); cooling tower (£1,000), tools (£100), air filter, &c., (£212) to be omitted, or a total of £2,338.

Mains and Services, &c.—Feeder to Longbridge-road Estate, omit, £1,126; terminate Creeksmouth cable at Dampers Dock, saving £800; prospective expenditure during next three years, omit, £1,000; total, £2,926. Proportion of items for loan costs, clerk of works' salary, £71.

With regard to the remainder of the proposed works the Board would defer their further consideration until they had before them revised estimates based upon accepted tenders for the works and plant now contemplated.

The Council are advertising for tenders for the plant, &c., under the revised scheme.

Erith.—The Council recently approved a scheme for the extension of the electricity generating station at an estimated cost of £15,300. Tenders are being invited for a 2,000 kw. turbo-alternator, boiler, &c.

Maidstone.—The Council has been authorised to borrow £4,800 for new plant for the electricity works.

The sum sanctioned represents the estimated cost of the plant, less £2,150 received from the sale of three small generating sets, and £500 to be transferred from revenue.

The contract of the Brush Electrical Engineering Co. for the new generating set will be increased by £22 owing to the rise in prices of material caused by the war.

Manchester.—On Wednesday the Electricity Committee reported that they had obtained the sanction from the L.G. Board to borrow £424,220 for establishing an electricity generating station at Barton.

Of the sum sanctioned £121,770 is repayable in 30 years, £49,500 in 20 years, £126,850 in 17 years, £105,780 in 15 years, £15,480 in 10 years, and £4,840 in eight years.

Sutton Coldfield.—Last week the new refuse destructor, adjoining the electricity works in Ryland-road, was opened by the Chairman of the Health Committee, Mr. G. F. Pearson.

Woolwich.—The Borough Council have appealed to the L.G. Board against the decision of the London County Council not to sanction a loan of £2,172 required for laying electric supply mains to and for wiring certain of the Wellhall-road Government houses.

GENERAL.

Batley.—The charge for electric current for lighting has been increased by 7½ per cent., and for power 15 per cent.

Belfast.—The cost of electric current has been increased by ½d. per unit for lighting and ¼d. per unit for power.

Croydon.—The borough electrical engineer (Mr. A. C. Cramb) has been nominated by the Board of Management of the Metropolitan Munitions Committee to serve as honorary district manager of the Croydon area.

Darwen.—The Electricity Committee has decided to endorse the following clause on all statements of accounts for the electricity department:—

The Corporation will not supply or fix internal fittings (except meter and main fuse) on consumer's premises, and at the meter their responsibility ends. The responsibility for all wiring, fittings and apparatus on the consumer's side of the Corporation main fuse, whether tested or not by the Corporation, rests solely with him.

Edinburgh.—At a meeting of the Electric Lighting Committee last week the engineer and manager (Mr. F. A. Newington) reported that the staff for general work could not be reduced further. The only work that could be delayed was the laying of new mains, but he did not think it would be advisable to refuse to connect new consumers, as that would tend to check the development of the undertaking.

Finchley.—Last week the Council adopted the recommendation of the Electricity Committee to increase the price of current for private lighting and street lighting by 10 per cent.

The Chairman of the Committee (Mr. Boggon), in moving the adoption of the recommendation, pointed out that as a result of the increased cost of generating and distributing owing to the war, due to the war, the Committee estimated that next year they would have a deficit of £2,000, and only about £1,300 to meet it with. They had, therefore, decided to increase the price of current.

Gloucester.—At the meeting of the City Council last week, the Electricity & Light Railways Committee reported further on the negotiations with the Gloucester Railway Carriage & Waggon Co. as to the supply of electric current for power.

The company proposes to instal in the new part of the Madleaze extension 350 h.p. of motors and on the completion of that extension they will have 800 h.p. installed. The company is ready to enter into an agreement to take the whole of the supply of electricity for that portion of their works from the Corporation for 10 years, the supply in the first instance to be at the ordinary rates and thereafter by arrangement, the larger scheme comes into being an equitable arrangement will be made between the parties. The Council have also been asked to give consent for laying the necessary cables, &c., and to give a supply to Messrs. J. M. Collett & Co. for special purposes for at least three years.

Marylebone (London).—The Council have authorised the general manager of the electric supply department (Mr. A. H. Newton) to act as chairman of an operating sub-committee on the case of war, and also to act as district supervisor of various works in the district of London. Mr. Seabrook proposes to give practically all his time to the work, but he will remain in touch with his present duties and will be within easy reach.

Nottingham.—Owing to the advance in the price of coal and other commodities the Corporation decided on Monday to increase the price to be charged for all electric current by 12½ per cent.

Shoreditch (London).—The Borough Council have been authorised by the London County Council to borrow £500 for the purchase of 204 electricity meters, provided the meters are only obtained for consumers engaged on war work.

Twickenham.—The Council have authorised the Twickenham and Teddington Electric Supply Co. to commence laying a supply cable to the Pelabon Works (which are engaged on munitions of war) before the expiration of the statutory notice.

West Bromwich.—The Electricity Committee recommends an agreement being entered into with the Wellington Tube Co. for a minimum quantity of 80,000 units of electric current per annum for five years.

Wrexham.—The Rural Council have notified the Corporation that they do not object to the parishes of Acton, Broughton and Stansty being included in a provisional electric lighting order to be applied for by the Corporation.

LIGHTING, POWER & HEATING NOTES.

Electric Signalling in Mines.—At the recent meeting of the Lake View & Star, Ltd., the Chairman (Mr. F. A. Govett) said that during the year they had made various additions to their plant and mine equipment, but instead of charging the items to capital, they had charged the entire cost out to working expenses. The heaviest item completed during the year was the electric bell signalling under ground, which had been installed from the surface down to 2,100 ft. level. That system was working very satisfactorily, and they proposed installing the same system on the Star as soon as opportunity permitted.

Hendon.—The Hendon Electric Supply Co. (Ltd.) have just finished a series of five demonstrations on electric cooking at St. Albans Hall, Golders Green.

Admission was by cards issued by the company, the district being taken in sections and roughly according to rental value. The lines adopted were somewhat novel, the hall being invitingly laid out with small tables provided with electric kettles, teaball teapots and toasters, at which during the interval the guests made their own tea. Various useful domestic appliances were also displayed on the tables for inspection, and as the guests arrived the use of them was explained by the company's staff in attendance. Floral decorations were plentifully used, and the effect was most attractive.

Mrs. Lewis, F.C.A. and gold medallist, gave most interesting practical cookery lectures, and explained the use of the various cookers in operation, and also prepared the bread, cakes, pastries, &c., for afternoon tea. Mrs. Maud Lancaster (authoress of "Electricity in the Service of the Home") ably explained the use of various domestic electrical apparatus, and lectured on the economy, cleanliness and comfort of an electric home.

The whole was very completely organised by the engineer and manager (Mr. B. G. Drummond), and the cookers used were made and supplied by the General Electric Co., the Brompton & Kensington Accessories Co., Messrs. Ferranti Ltd., and the Belling Co.

TRACTION NOTES.

Hull.—A special committee, which has been inquiring into the working of the various trading departments of the Corporation, has recently issued a report.

The committee is of opinion that the present system of dual control of the tramways department is not conducive to the best interests of the undertaking. The actual effect of the traffic and engineering sides being under separate management is that the individual [illegible] for the speed up, general consumption and staff [illegible] control over the speed at which the cars run, the loads they carry, or the [illegible] the general [illegible] Committee [illegible] the [illegible] [illegible] [illegible]

[illegible] by tramway [illegible] by which the recommendation the committee [illegible] to be understood that it has no intention of suggesting that the present officials in charge of the tramways are not doing their best under existing conditions.

London County Council.—On Tuesday it was agreed that the appointments of inspectors and conductors in the tramways department be [illegible] hours of labour relative to rates of wages, [illegible] payment in respect of broken parts, rate of pay for overtime, hours of labour on Bank holidays and Sundays, annual holidays, [illegible]

[illegible] to question as to the [illegible] services [illegible] the chairman of the Highways Committee replied that the time was coming when the committee would have to consider what steps could be taken to avoid wastage both [illegible] in connection with street services for passenger traffic.

L.C.C. Tramways.—At the meeting of the City of London Corporation it was agreed to give the London County Council permission to lay a third line of tramways over Blackfriars Bridge.

Maidstone.—The salary of the tramways manager (Mr. A. T. [illegible]) has been increased by £25 per annum.

Plymouth.—The Board of Trade have sanctioned a loan of £5,000 for the purchase of six new trailcars, but subject to the consent of the Treasury being obtained before any portion of the money is raised by the issue of stock, bonds or bills.

Women Tramcar Conductors.—Hull and Belfast Corporations have decided to employ women tramcar conductors.

[illegible] to the proposal on medical grounds but it was approved by a large majority and 10 women have already started work on the Spring Bank route. They will be on duty for 52½ hours per week at a wage of 27s.

TELEGRAPH AND TELEPHONE NOTES.

Telegraph and Telephone Journal.—We have received from the [illegible], O.H.M.S., the "Telegraph and Telephone Journal" for July, which announces that a new scale of telephone charge has been introduced (as from July 1) in New York. The most notable changes are as follows:—

[illegible] Manhattan and The Bronx (the business districts of New York). The old rates ran from an annual charge of £10 for 600 calls, £11. 17s. 6d. for 800 calls, and so on up to £47. 10s. for 5,700 calls. The new rates run from £8. 6s. 8d. for 800 calls up to £36. 5s. for 4,800 calls. Above this number additional calls may be purchased in blocks of 300 at 1½d. each. Under the new rates, therefore, 5,700 calls would cost £40 [illegible] as compared with the old rates. A subscriber [illegible] 12s. 6d. instead of 10s. 5s. as formerly. Similarly 2,400 will be 24. instead of 2½d., [illegible] 3,000 [illegible] 22.

[illegible] Manhattan and The Bronx were divided into three [illegible] 1 and 3 cents each. Now the fee for a local call covers all calls in those districts.

[illegible] continued to residences only, and are [illegible] The Bronx. The measured-charge rate is now £7. 10s. for 720 [illegible] 1,200 calls.

[illegible] were formerly available in a few places [illegible] Manhattan, Lower Bronx and Brooklyn. [illegible] Now rate 20s. as for 600 calls instead of £7. 10s. as formerly.

[illegible] the postal service, except for the [illegible] 5,000 calls and 3 cents each. [illegible] service [illegible] Government [illegible] the postal [illegible] a memorandum by Mr. [illegible] entitled "Wireless National Trouble." There is [illegible] opposing particularly assigning to the assorted telephone [illegible] Mr. Aylesworth [illegible].

EMPIRE NOTES.

Australasia.—[illegible] Melbourne and District [illegible] M. J. [illegible] Bayswater (Victoria) Shire Council that he is [illegible] for the [illegible] Council accepts electric light for the town area. The Council has postponed consideration of the matter in [illegible]

Canada.—The [illegible] Bay Railway is being [illegible] equipping it with [illegible] Mr. Mansfield.

[illegible] Sydney and Glace Bay are both available [illegible] The estimated [illegible] water [illegible] 1,000 [illegible] 1,000 [illegible] 1,000

Electro Harmonic Society. The annual general meeting of this society will be held on Wednesday next, July 14, at 4.30 p.m., at the Institution of Electrical Engineers, Victoria Embankment, London, W.C., to receive the statement of account for the 29th season, to elect officers for the 30th season, and to transact the ordinary general business of the Society. The Committee are asked to meet at 4 p.m.

During the past season 55 new members were elected, nine members were lost by death, 52 resigned and 26 were removed from the register for non-compliance with Rule 11. There are now 682 names on the register. The accounts show receipts amounting to £390 17s. 8d., of which £331. 10s. 9d. is from subscriptions, £13. 13s. from entrance fees and £28 10s. 5d. brought forward. There is a balance at bank and in hand of £19. 7s., and subscriptions due are estimated to be worth £20. The surplus assets amount to £31. 14s. 6d.

Mica Supplies. The "Journal of the Swedish Chamber of Commerce in London" reprints a partial list of the uses of mica in the electrical industry given by Mr. Howells Frechette in a Canadian Department of Mines report, and a statement that the approximate prices of Canadian sheet mica are: 1 in. by 1 in., 7c. per lb.; 5 in. by 8 in., $2 per lb. It is also stated that members of the Chamber are in a position to offer Swedish raw mica in sheets, and that further particulars are obtainable from the secretary (Ref. *A* 895 15).

TENDERS INVITED.

Telephone and Telegraph Material, Wire, Instruments, &c.

The Deputy Postmaster-General, Adelaide (South Australia) will receive tenders until 2 p.m. Aug. 18 for Battery Material (schedule 385); Magneto and Trembling Bells (schedule 386); and until 2 p.m. Aug. 25 for Ammeter, Lightning Arresters, Testing Sets, Resistances, Voltmeters, &c. (schedule 383); and Dry Cells, Earth Clips, Switches, Telephones, &c. (schedule 389), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *Further particulars are given in an advertisement.*

The Deputy Postmaster-General, Perth (W. Australia) requires tenders by 3 p.m. July 21 for 40 Trembling Bells, 3 lb. Gran. Carbon, 1,000 Earth Clips, 33,000 Fuses in tubes and 6 Galvanometers (Schedule 423 W.A.) and until 3 p.m., Aug. 11, for Telegraph Instruments and parts (Lightning Arresters and Mica Discs, Resistance Boxes, Condensers, Galvanometers, Morse Sounders and Switches (Schedule No. 422 W.A.), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specifications from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Adelaide, will receive tenders until 2 p.m. July 14 for the supply of Galvanised Iron Wire, and until 2 p.m. Aug. 18 for 4,850 yds. Silk and Cotton Insulated Switchboard Cable, 6,140 yds. Lead-covered Paper-insulated Cable (schedule 387) and 3,080 yds. Silk and Cotton insulated Switchboard Cable and 250 yds. Three-conductor Cord (schedule 388) for the AUSTRALIAN COMMONWEALTH Postmaster General's Dept. Specifications from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Turbo-Alternators, Motor Generators, Boilers, &c.

BARKING Urban Council require tenders by 7 p.m. July 16 for supply and erection of 1,000 kw. Turbo-alternator, Cooling Tower, Chain-grate Stoker, Economiser, Rotary Converter, Switchgear, h.t. Main, &c. Specification, &c., from the Acting Engineer and Manager, electricity works, Barking.

The Electricity Committee of HULL Corporation invite tenders for the supply, erection and setting to work of one 5,000 kw. Turbo-alternator, with Exciter, and one Condenser Outfit. Forms of tender and specification from the city treasurer, Mr. T. G. Milner, and tenders, to the chairman of the Electricity Committee, Guildhall, Hull, by first post Thursday, July 22.

EDINBURGH Corporation invite tenders for the supply and erection of One 1,000 kw. Motor Converter and Transformer Sub-station, &c., from the engineer, Mr. F. A. Newington, Sports-road, general condition and drawings may be seen at, but not obtained from, the office of the consulting engineer, Sir A. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders to the town clerk (Sir Thomas Hunter, W.S.), City chambers, Edinburgh, by 10 a.m. July 12.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. July 19, for supply and erection of a 12,000 kw. turbo-alternator. Specification from the Electric Light Department, Town Hall, Sydney.

Tenders are invited for the supply and delivery in Melbourne of one 1,000 kw. direct-current Generator with Field Regulator and accessories, one Liquid Starter with accessories, &c. Tender forms, &c., from the agents for the Council, Messrs. McHaffie, McEacharn & Co. Pty., Ltd., Bilbster-square-buildings, London E.C. Tenders to Chairman of Electric Supply Committee, Town Hall, Melbourne, by 10 a.m. Aug. 11.

Carbons.

The Electricity Supply Committee of DUBLIN Corporation invite tenders for the supply of various types of Carbons. Particulars and forms of tender from the city Electrical Engineer, and tenders to the chairman of the Committee, Lord Edward-street, Dublin, by noon July 12. *See also an advertisement.*

Machinery Oils.

HULL Corporation want tenders by first post July 22 for supply of Machinery Oils for their electricity department. Forms of tender from the acting City Electrical Engineer.

Wiring and Fittings.

EDINBURGH Corporation require tenders by July 14 for an Electric Lighting Installation for the public workhouse, McLeod-street, Edinburgh. Specifications from the Engineer, Dover-place, Edinburgh.

Fuses and Fuse Boxes.

SYDNEY (N.S.W.) Council want tenders by 3 p.m. July 19 for Fuses and Fuse Boxes (contract 397). Specification from the City Electrical Engineer.

Meters and Maximum Demand Indicators.

Tenders are invited for the supply of a.c. and d.c. Meters and md. Indicators to the City of MELBOURNE. Copies of specification, &c., from the agents for the City Council, Messrs. McHaffie, McEacharn & Co. Propy. (Ltd.), Bilbster-square-buildings, London, E.C., to whom tenders by noon July 27.

SYDNEY Municipal Council require tenders by 3 p.m. July 19 for supply of Electric Meters and Maximum Demand Indicators. Specifications from the City Electrical Engineer. (The Council will grant 10 per cent. preference on British made goods and 5 per cent. preference on those of the allied countries during war.)

Tramway Construction.

The DIRECTOR-GENERAL OF PUBLIC WORKS, MADRID, will receive tenders until noon July 31 for the construction and working (for 60 years) of an Electric Tramway between Mongat and Tiana, Province of Barcelona. The minimum rolling stock required to commence working is three motor tramcars. An option on the concession is held by Don Juan Gari.

The Director General of Public Works, Madrid, requires tenders by noon Aug. 3 for the construction and working of an Electric Tramway between DENSTO and IBARRECOLANDA (Province of Viscaya), Spain. An option on the concession is held by the Cia Vizcaina de Electricidad.

Armature Winding Machines, Instruments, Converter, Cables, &c.

The VICTORIAN RAILWAY COMMISSIONERS, Spencer-street, Melbourne, require tenders by 11 a.m. July 14 for supply of two Armature Winding Machines and Voltmeter, Ammeters and Wattmeters. Specifications, &c., from Contract Office, Railway Stores, Melbourne.

EDINBURGH Corporation will receive tenders by 4 p.m., July 26, for converter, switchgear, under-ground feeder cables, &c. Specifications, &c., from the City Electrical Engineer.

Electric Light Wire, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Aug. 11 for supply, of 600 lineal ft. Strip Copper, No. 28,924), 20 miles v.r. Electric Light Wire (No. 28,925), and 250 lengths of Stranded Copper Tubes No. 28,926. Specifications from the Contract Office, Spencer-street, Melbourne.

Fire Alarms.

PAKENHAM Rural Municipality require tenders by Aug. 11 for the installation of a system of Fire Alarms for the town of Pakenham. Specification, &c., from Messrs. Ogilvy, Gillespie & Co., 67, Cornhill, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

[illegible] County Council.—For wiring the County Secondary School at Hadleigh, the order of the Alpha Mfg. Co. (at £562) has been accepted.

Eastbourne.—The Council have accepted the tender of the Stanton Ironworks Co. for the supply of 160 ft. of 14 in. c.i. circulating water piping and valves at £226.

Belfast.—The Guardians have accepted the tender of R. Patterson & Co. for wiring the offices, board room, &c., at £488.

Winchester.—Ferranti (Ltd.) have been awarded the contract for the supply of prepayment electricity meters to the Corporation for the year ending May 31, 1916.

West Ham.—The Electricity Committee recommends the acceptance of the tenders of the British Insulated & Helsby Cables for e.h.t. mains and switchgear extensions; and that of Ferranti (Ltd.) for the extra high-tension cubicle in connection with the additional supply of current to J. Brookhouse & Co.

Melbourne (Victoria).—The Council have accepted the following tenders:—

Australian General Electric Co., 3,000 metal filament lamps, £125; W. T. Henley's Telegraph Works Co., trifurcating boxes, £43. 16s.; British Westinghouse Co., oil switches, £459. 4s.; Noyes Bros., isolating switches, £66.

Fabroil Pinions.—The British Thomson-Houston Co., of Rugby, have received an order (through B. & S. Massey, of Manchester) for 93 special Fabroil pinions for power hammers for the French Government to be used in a French munition works.

Fabroil pinions are very satisfactory in operation, being silent, strong and durable, and reducing vibration to the lowest limits. We learn that the Fabroil pinion department of the B.T.-H. Co. is at present occupied with over 75 per cent. of Government work directly, and 95 per cent. directly and indirectly.

New Zealand Government Contracts.—The following tenders have been accepted by the N.Z. Public Stores Tender Board:—

Rubber-insulated Twin-twisted Wire.—P. R. Baillie & Co., 60 miles, £758. 15s.

Air-space Lead-covered Cable.—Lawrence & Hanson, 3 miles £312, 8 miles £1,168, 6 miles £1,134; Turnbull & Jones, 7 miles £1,694, 9 miles £11,790; P. R. Baillie & Co., ½ mile £173, 1½ miles £623. 5s., 7 miles £5,516. 14s. 6d., ½ mile £115. 10s., 2 miles £1,182, ½ mile £515; Richardson, McCabe & Co., 6 miles £6,493. 4s. 6d.; A. D. Riley & Co., 6 miles £7,042. 7s. 6d., 6½ miles £8,125. 7 miles £10,641. 15s., 1,320 yds. £263. 1s. 3d.

Switchboard Cable.—P. R. Baillie & Co., ½ mile £263. 15s.; A. D. Riley & Co., 1 mile £1,335; Turnbull & Jones, 1 mile £2,617.

The following tenders have also been accepted: B. L. Donne, 1,000 bells, £316. 13s. 4d.; Lawrence & Hanson, 35,000 yds. jumper wire £134. 15s.; Canterbury Engineering Co., 6,000,000 lead seals, £1,739; P. R. Baillie & Co., 5 tons bronze wire, £597. 0s. 10d., 100,000 insulator cups, including bolts, £3,174. 11s. 8d., and 1,000,000 insulator bolts, including cups, £3,174. 11s. 8d.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Barnstaple.—The accounts of the electricity supply department for the year ended March 31 show total capital expenditure £34,275, of which £21,125 is outstanding.

Income was £5,232 (against £5,770 in previous year), working expenses were £3,199 (£3,569), leaving gross £2,033 (£2,201). Interest required £855 (£903) and instalments of loans £1,285 (£1,244) and revenue contribution to capital £282 (£509) and, of the deficiency, £404 is to be met from local rate, and £389 carried forward. Units generated were 426,361 (370,060) and sold 370,060 (364,225). Total maximum supply demanded was 248 kw. (264·5 kw.).

Brighton.—The report and accounts of the tramways department for the year to March 31 were adopted by the Corporation last week.

The expenditure on capital account amounts to £280,392 (increase £1,925), and the total amount provided for redemption of loans is £69,124. Revenue was £56,526 (compared with £56,838 in previous year), working expenses were £41,148 (£42,440) and war allowances absorbed £1,836, leaving gross profit £13,541 (£14,398). Interest required £7,661 (£7,895), and sinking fund £5,917 (£5,783), leaving an unappropriated balance of £18 (£842). Passengers carried were 11,837,828 (11,839,515), car-miles run 1,108,352 (1,156,584) and units [illegible] (1,650,770 1,722,481).

The manager and manager (Mr. Wm. Marsh) says in his report the surplus would have been about £2,500, but for the war, dependents' allowances and capital charges on cost of Rail-less Traction Acts. A profit of £47 was made on the parcel traffic, compared with a slight loss in 1913-14, the revenue being £150, parcels carried being 25,585 (against 15,841). In eight months £1,837 was paid to dependents of employés on military service. By March 31 114 men had been called up or enlisted [illegible] of the total number employed). Income per car-mile was 12·24d. (11·70d.) and working expenses were 8·91d. (8·80d.) plus 0·398d. [illegible]. The cost of maintaining the cars was £107. 13s. 8d. [illegible] £91 14. Experience now that the useful life of the greater part of the rolling stock of the cars is only about 10 years. Only a few of the old tip-up seats on the top decks of the cars remain, and these are being [illegible] as the opportunity occurs. The three new cars [illegible] are more powerful and the cost of maintaining the equipment is likely to be less. The increase in cost of materials caused [illegible] largely felt in connection with the maintenance [illegible] generally.

Burnley.—The [illegible] accounts for the year ended March 31 [illegible] expenditure £2,480 [illegible] £796, of which [illegible] paid out of revenue. Land amounts to £26,690. [illegible] £3,36[illegible] and working expenses were £36,834 [illegible] Interest charges £9,[illegible] and sinking fund £8,284 [illegible] £50,[illegible] £60,[illegible] of which £1,664 is to be [illegible] Passengers carried were 15,867,699 [illegible] and car-miles run 1,944,712 (1,764,811). Traffic receipts were 11·42d. (12·04d.) per car mile, and working expenses were 8·15d. (8·62d.).

In the report of Mr. H. Mozley (general manager) it is stated that about 50 per cent. of the normal staff are serving with H.M. Forces, and the amount of the allowances to March 31 was £2,483. 3s. 1d. Car meters have been purchased to check consumption of energy, and the first results set out in a table. The average difference in the consumption of energy per car-mile between regular and check drivers was found to be 0·13 units on 26 cars on the main line and the Harlesyke-Rosegrove branches and 0·9 unit on four cars on the Manchester-road Townelly branches. The mileage per annum of one car is about 35,000, therefore, at 0·12 unit per mile the total units are 4,200 which (at 1·15d. per unit) equals £20. 3s., or, on the full service, about £1,000 per annum. In his last report Mr. Mozley stated iron axles were being tried and that they were so far satisfactory, but further experience has shown that their life is after all too short, and steel axles are again being purchased.

Canterbury.—The capital expended on the electricity department at March 31 was £73,338 (increase £1,482), of which £29,474 has been repaid. There is also £7,718 of unapplied sinking fund, and revenue contributions to capital amount to £7,718.

Revenue was £12,053 (compared with £11,151 in previous year), working expenses were £6,136 (£5,735), leaving gross profit £5,918 (£5,416). Interest required £1,228 (£1,298) and loan repayment and sinking fund £2,630 (£2,585), the net profit being £1,891 (£1,436). Units generated were 1,041,922 and sold 872,322. Total maximum supply demanded was 585 kw.

Chester.—The accounts of the hydro-electric works for the year 1914-15 have been issued.

During the 12 months 1,459,500 units were generated, of which 15,679 were used for pumping the sewage, 1,659 for lighting the works, 63,232 by excitation and feeder booster, 117,209 in the distribution cables and 1,261,721 sold to consumers. The cost of operating the works is as follows: Oil and stores, £39. 8s. 5d.; wages, £249. 4s. 4d.; repairs and maintenance, £21. 10s. 7d.; rent, £100; rates, £135. 14s. 7d.; insurance, £1. 5s. 6d.; and part of general establishment charges, £100; a total of £647. 3s. 5d.=0·123d. per unit sold. The capital charges were £944. 15s. 1d., interest on loans £460. 12s., and sinking fund charges £484. 3s. 1d., or 0·179d. per unit sold. The total expenditure (£1,591. 18s. 6d.) was, therefore, 0·302d. per unit sold. By taking the income at 1d. per unit sold, as in the original estimates, the undertaking shows a surplus of £3,665. 4s. 11d. on the year's working.

Colchester. The accounts of the tramways department for the year to March 31 show capital expenditure £69,472 (increase £71), of which £21,195 has been redeemed.

Revenue was £13,822 against £10,966 in 1913-4), working expenses were £9,570 (£8,812), and after providing for interest £1,986 (£2,081), instalment of loans £2,496 (£2,406), and allowance to wives and dependents £172, the net deficit was £402 (£2,333). Average total revenue per car mile was 9·963d. (8·107d.) and working expenses, including power, were 6·898d. (6·515d.); average fare per mile was 0·96d. Tickets issued were 2,434,786, including 458,656 returns (against 1,757,794, including

380,994 returns), car-miles run 332,963 (324,622), units used 445,214 (410,555).

Mr. R. C. Bullough (general manager and engineer) reports that the large increase in revenue was due to the extraordinary number of troops in the town. Within two months of the declaration of war 60 per cent. of the outside staff enlisted, and difficulty was experienced in replacing them, the difficulty at present being more acute. New motormen and conductors have been trained, and after working a few weeks have left to enlist or take up other work at better wages, and no doubt the question of employing women as conductors will have to be considered.

The gross capital of the electricity undertaking is £89,814, of which £34,946 has been redeemed. The past year's income was £18,111 (increase of £301 over 1913-14), and total expenditure was £17,293, leaving a surplus of £813 (against £650). Units sold were 1,658,596 (1,623,526).

Heywood. The accounts of the electricity department for the year ended March 31 show total capital expenditure £36,281 (increase £723), of which £14,187 is redeemed or in sinking fund.

Revenue was £7,122 (compared with £6,426 in previous year), working expenses were £5,400, leaving £1,705 gross profit. After providing for capital charges, the net deficit was £927.

Mr. R. B. Leach (borough electrical engineer) states in his report that the L.G. Board have sanctioned the borrowing of £6,355 for the bulk supply scheme, making a total of £42,655 sanctioned. Average price obtained was 1·33d. per unit (1·32d.), and total costs, including capital charges (0·50d.), were 1·57d. Coal costs 0·51d. (0·63d.). Total working costs were 1·07d. (1·22d.), and coal used per unit was 6·25 lb. (8·45 lb.).

Capital expenditure on the tramways is £68,099 (increase £172), of which £16,962 has been repaid. Revenue was £11,626 (£11,839), working expenses were £7,936 (£7,068), leaving £3,681 (£4,771) gross profit, and after providing for capital charges the net deficit was £1,042 (compared with a profit of £85). Passengers carried were 2,268,331 (2,322,007), car-miles run 269,088 (269,426), and units used 376,726 (426,792) = 1·40 (1·58) per car-mile.

Kirkcaldy.—The capital expenditure on the electric light department at May 15 was £80,891 (increase £2,047), of which £19,820 has been repaid.

Past year's revenue was £12,296 (against £12,852 in 1913-14), working and general expenses were £7,430 (£8,600), leaving gross profit £4,866 (£4,251). Interest required £2,158 (£2,313), and redemption £2,176 (£2,112), the net profit being £532 (against a deficit of £174. Coal cost 0·320d. per unit sold, and total costs (other than capital charges) were 0·911d. (1·1013d.), 0·948d. (1·055d.). Units sold were 1,880,193 (1,955,868).

Capital expenditure on the tramways is £97,869 (increase £1,120), of which £21,402 has been repaid. Revenue was £16,977 (£17,949), working expenses were £11,451 (£11,454), leaving gross profit £5,526 (£6,495). Interest required £2,630 (£2,779), redemption £2,521 (£2,466) and depreciation £409 (£409), leaving net profit £33 (£841). Average total revenue per car-mile was 9·085d. (9·162d.), and working expenses, including power, were 6·128d. (5·84d.). Passengers carried were 5,492,120 (5,781,895) and car-miles run 448,469 (470,162). Units used per car-mile were 1·558d. (1·573d.).

Oldham. The accounts of the electricity supply department for the year ended March 25 show total capital expenditure £356,998 (increase £21,745) of which £213,225 is outstanding.

Revenue was £52,293 (compared with £49,472 in previous year), and total costs were £27,006 (£26,398), leaving gross profit £25,287 (£23,074). Interest required £11,366 (£10,627) and sinking fund £9,337 (£9,237) and expenditure on meters was £1,034 (£1,215), the net profit being £3,550 (£1,995). Fuel cost 0·347d. (0·423d.) per unit, and total revenue costs were 0·812d. (0·898d.) Maximum load was 4,591 kw. (3,854 kw.) and load factor 19·85 per cent. (20·91 per cent.). Units sold were 7,985,859 (7,058,801). There were 2,564 consumers on March 25 (increase 297), and the number of (equivalent) 32 watt lamps connected was 342,254 (increase 55,832). The total length of l.t. distributing mains laid was 78,274 yd. and of e.h.t. feeders 11,650 yd.

The report of the joint engineers and managers, Mr. F. L. Ogden and Mr. W. Chamberlain, says the 2,000 kw. Howden-Serpollet turbine set was completed and put in commission on Sept. 2. The new h.t. switch room and switchboard were completed early in the financial year. Seven consumer-sub-stations have been erected on manufacturers' premises. Sanction was given on Dec. 24 last to borrow £40,000, having been made for additional plant at Greenhill Works, and tenders have been accepted for two 3,000-kw. British Westinghouse turbo-generators; three Babcock water tube boilers with chain grate stokers, foundations and pipework, feed pumps, Green's economisers and induced draught plant; two water-cooling towers; an extension to the Ferranti e.h.t. switchboard; and new battery house and battery.

Reigate. The accounts of the electricity undertaking for the year ended March 31st were adopted by the Council [illegible]

The Chairman of the Lighting Committee (Mr. J. Priest) stated that the net profit was £266 and exceeded the estimate by £80. Had it not been for the restricted lighting, &c., due to the war which had lost them over £350 in revenue, the profit would have been considerably greater. Arc lighting had suffered severely, and their output was 43 per cent. less than in 1913-14. Heating and power had increased by 32 per cent. and the total output increased by more than 21,000 units, this being due to the action taken in offering reduced rates for power, &c. The engineer was experimenting with a cheaper grade of coal for banking up the fires during the period the steam plant was not actually running, which would (he hoped) enable them to effect economies.

Stoke-on-Trent. The accounts of the Electricity Supply Committee were submitted to the Corporation last week.

The chairman of the committee (Ald. Leese) said the L.G. Board had granted a loan which would pay the off overdraft at the bank, so far as capital account was concerned, and allow a small sum to go on making small extensions. For further extensions of an extensive character they would have to apply to the Board again. They would also notice that the committee were asking the Council to increase the price of electricity by a further 10 per cent. The committee reluctantly had to come to that decision, but when they came to make their coal contracts they found they would have to pay this year about £6,000 more for coal, &c., than they had paid in the previous year. They were paying an additional 5s. per ton, and they used 20,000 tons per annum. Besides that, they were paying £400 war allowances, and £300 bonuses to men of the department in his Majesty's Forces. They estimated that £8,000 would be required to meet these increased charges, and they estimated that the 20 per cent. increase on the price of electricity would bring in £7,000, so that they would require economies to the extent of £1,000 to preserve the financial position they were in at present. The first 10 per cent. increase in the charge for current came into force on the next reading next quarter, but the second could not come into force until the September quarter. The accounts had been supplied to every member of the Council. There were one or two items he would like to mention. The total revenue was £55,159, and the total works expenditure was £32,418: the gross profit being £22,741. Loans repaid and interest required £21,565, and after paying £1,076 for meters—he would like to point out that in the old days at Hanley that was paid out of the depreciation fund—and £29 for the removal of a spoil heap at Hanley, the net profit was about £71. The total capital expenditure on the five works amounted to £336,704, but the outstanding liability was only £217,504. In connection with the generation of electricity at the new works, the Council would recollect that when the committee asked for sanction to the scheme a statement was made that for the first year of working the new power-house they would be able to pay their way, and it was further stated that in the next two years they would be able to pay off the loss which occurred in the first, an incomplete, year. Up to the end of March they had worked it nine months and two weeks, and they had been able to present accounts on the right side. If they had had the same increase this year in the number of units sold as in the previous year, they would have had, instead of £71, a profit of just under £6,000. If they went on at the same rate as at present, they would show a substantial profit at the end of next year. Last year they generated nearly 9,000,000 units of electricity, and this year they had generated more than 10,500,000 units, and they had generated these extra units with a reduction of coal of over 4,000 tons, or a saving of £2,800. The total units sold was 7,432,910, and the gross revenue was £55,117, against £52,561 in the previous year. The total expenses were £58,723 in 1913-14, and only £55,046 during the past year, or a reduction of more than £3,600. Their net profit was £71, against a loss of £6,162 in the previous year. He would point out that they had not attained that position by heavy charges for power and light, for their charges to manufacturers who desired power were on just the same terms as in all the big centres of the country. He thought they would agree that that was a satisfactory statement.

The minutes were approved after a brief discussion.

Yarmouth.—The tramway accounts for the year ended March 31 show capital expenditure £126,453 (increase £90), of which £116,150 is out standing.

Revenue was £22,367 (compared with £26,240 in previous year), and working expenses were £16,660 (£17,608). Interest required £4,158 (£4,065), and sinking fund £2,883 (£2,826), and the net result was a deficit of £1,294 (against a profit of £1,816). Average total revenue per car-mile was 7·927d. (8·738d.), and working expenses, including power, were 5·905d. (5·864d.). Passengers carried were 4,236,424 (4,930,728), car-miles run 677,153 (720,702), and units used 708,756 (758,296) = 1·046 (1·052) per car-mile.

COMPANIES' MEETINGS AND REPORTS.

CAPE TOWN CONSOLIDATED TRAMWAYS AND LAND CO. (LTD.)—The report for 1914 states that there was debit balance for the year of £1,894. 6s. 9d. The operation of the Camps Bay tramways during the year resulted in a profit of £1,521. 5s. 1d., against a profit of £1,599. 2s. 3d. in 1913. The number of passengers carried shows a decrease of 7,052.

CHILI TELEPHONE CO. (LTD.)—The directors' report for the year ended March 31 states that the aggregate number of subscribers at all centres at the end of the year was 13,095, compared with 13,975 at the beginning, a decrease of 880. The gross revenue in Chili from all sources was $1,667,759, against $1,670,606 in 1913-14. The expenditure in Chili was $1,647,933, against $1,620,821. The net income in Chili from all sources was $19,825, against $49,785 a decrease of $29,585. The average rate of exchange for the year was 8·46d., compared with 9·00d. Converted into sterling at these rates the income given are £3,124 against £6,141 in 1913-14. The balance to credit of revenue account including £3,048 brought in £31,921, of which £3,848 has been expended on replacements, &c., of plant. An interim dividend of 3 per share (tax free) was paid in January last, and after carrying £12,344 to

general reserve and setting aside £5,000 as a special reserve against loss on investments, the directors now recommend a final dividend of 5s. per share (tax free), leaving £4,339 to be carried forward.

CROMPTON & CO. (LTD.) At the meeting on Monday the chairman (Mr. Carleton F. Tabor) said he thought the shareholders would agree that the figures had been themselves satisfactory, and but for the war the results would have been even better. The net profit for the year was £28,479, compared with £14,550 for the previous year, and, with the amount brought forward, the available total was £38,018. The directors proposed to place £6,500 to general reserve (against £2,500 last year), £3,500 to special depreciation account, to write £1,608 off preliminary expenses, and to declare the full 7 per cent. on the preference shares, carrying forward £7,091, against £2,189. So far as the current year was concerned, he said that contracts were favourable, and, providing nothing unforeseen happened to interrupt their working, the directors were looking forward to a successful year. They had a very large amount of work in hand for the Government, to whose requirements everything at Chelmsford was subordinated. The board were making special allowances to the dependents of those employees who had joined the colours. Wages generally had been raised, and in the minor staff a bonus was being paid in view of the increased cost of living.

GENERAL ELECTRIC CO. (LTD.) The report of the directors states that the net trading profits and income from investments, &c., for the year ended March 31 amount to £164,877. 10s. 4d., and with balance brought forward (£36,739. 16s. 10d.) the total available profit was £201,617. 7s. 3d. Deducting debenture interest (£8,000), depreciation and provision for renewal reserves (£18,855), and dividend on the preference shares at the rate of 6 per cent. for the year (£38,681), the available balance is £136,081. 7s. 3d. The directors recommend the following appropriations: Provision for managing directors' and employees' bonus (£9,934. 3s.), balance of expenses of new issue of capital (£3,821. 11s. 3d.), dividend on ordinary shares at rate of 10 per cent. for the year (£48,142. 9s. 2d.), to reserve account (£20,000), war grants (£7,481. 14s. 4d.), leaving to be carried forward £36,701. 9s. 6d.

In the report of the chairman (Mr. H. Hirst) it is stated that the war has interfered with the company's plans for extension, but so far has not affected the volume of business, as the great increase in orders from Government departments and Government contractors has fully compensated for the decrease in general business. Although the great majority of the company's products are essential for war purposes, the outlook for the coming year is one of some uncertainty owing to the absence with H.M. Forces of nearly 1,000 of the company's most skilled staff and workpeople, and owing to the unsettled state of the labour and raw material markets. Extensions at the Witton works are being carried out for the purpose of giving more assistance in the supply of munitions and other war materials. The Pirelli-General Cable Works at Southampton have been completed during the year, and have started manufacturing. The re-building of the Rugeway factory is proceeding, but the board have decided to defer completion of the building to a more suitable time.

GREENWOOD & BATLEY (LTD.) At the meeting last week the Chairman (Col. O. C. Armytage) said that their main and legitimate business had hitherto been confined to that of engineers and machine makers. Shortly after the commencement of war the directors were pressed by the Government to devote greater attention to the production of small arms ammunition and to the machine making and engineering side, to supply a considerable amount of plant required by Government or other firms holding Government contracts. As time went on the Government demands steadily increased, until at present every suitable machine and every available man was employed on machines and tools directly or indirectly for Government work. The cartridge factory had grown into a huge one, and the output would shortly be 1,000 per cent. greater than the average output before the war. They were forced to abandon the ordinary business and to refuse all invitations to quote for machines, &c., required by firms unconnected with Government work. The directors gladly and readily undertook these responsibilities, but at the same time there was no doubt that that abnormal diversion of their trade from one channel to another would affect their legitimate business more or less prejudicially at the conclusion of hostilities. The financial position of the company was a very strong one, and the orders on hand were likely to keep them all fully employed for a considerable time.

SINGAPORE ELECTRIC TRAMWAYS (LTD.) At the meeting on Tuesday, the Chairman (Mr. Frank A. Swettenham, C.M.G.) said that the past year's trade showed a net profit of $66,918, and showed a decrease of $4,520 compared with the previous year. The capital (£192,000 preference and £96,000 ordinary) was unchanged. The debenture debt was reduced by £10,000 during the year, and stood at £100,000 at the end of the year. The gross receipts showed a decrease of £2,000, and the working expenses were 51·3 per cent. of the gross receipts (49·5 per cent.). Until the outbreak of the war the traffic receipts continued favourably with the corresponding period of 1913; but since the end of December showed a decrease of 16 per cent. From the figures received, ended March, 1915, it was 14 per cent., and the traffic for April and May had progressed considerably the decrease being only 5 per cent. The sale of electric energy had continued to increase, the figures for that item being 4,800 units more than in 1913. The directors had been advised that the life of the track and rails might be estimated at about 40 and 16½ years respectively. They had considered it necessary not only to place to depreciation a larger sum annually, but they had decided to create a special reserve to meet those charges, and to take £7,000 from the available balance brought forward, and to place it to depreciation reserve. One result of the renewal of the track and rails would be a reduction in the power and maintenance expenses. They hoped that the Municipal Commissioners would see their way to lay their mains in the residential district of Tanglin, and so commence to take from the company a supply of energy for lighting that district. Two of the Diesel engines which they had shipped were designed specially to deal with that demand, but until the Tanglin supply had commenced the expenditure would not be remunerative.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

BACHELET FRENCH SYND. (LTD.) (140,823). Reg. June 30, capital £50,000 in £1 shares, to adopt an agreement with H. C. Barrett, to acquire and turn to account patents, licenses and rights, to carry on the business of manufacturers of and dealers in any articles capable of being manufactured thereunder and that of founders, metal workers, electricians, electrical, mechanical and general engineers, generators of electricity, &c. Private company. First directors (to number not less than two nor more than seven) are C. Vane (chairman), W. H. G. Barrett, D. S. Crowther, T. B. Barnham, A. Dent and E. Alderton. Reg. office: 166, Piccadilly, W.

CAHIRCIVEEN ELECTRIC LIGHT & POWER CO. (LTD.) (4,259). Reg. in Dublin on June 29, capital £1,800 in £1 shares, to carry on at Cahirciveen (Co. Kerry) the business of an electric light supply company. First directors are T. B. Morley, J. Brennan, T. C. Fitzgerald, M. J. Hedley, P. J. Reardon and E. L. Cantwell. Reg. office: Power House, Cahirciveen.

J. F. & G. HARRIS (LTD.) (140,745). Reg. June 22, capital £16,000 in 13,000 cumulative preference shares of £1 each and 24,000 ordinary shares of 2s. 6d. each, to take over the business of timber merchants, importers and exporters, builders, &c., carried on as J. F. & G. Harris. First directors: P. L. Mott, H. G. Notman and W. Goff. Reg. office: 58, Wilson street, E.C.

NEW QUEBEC GRAPHITE CO. (LTD.) (140,819).—Reg. June 29, capital £7,000 in £1 shares, to take over certain graphite properties in the Province of Quebec, Canada, to carry on the business of miners, prospectors, owners, lessees of mines or of graphite and other mines, &c. Private company. Reg. office: 8, Old Jewry, E.C.

SILUMINITE INSULATOR CO. (LTD.) (140,804).—Reg. June 28, capital £1,500 in £1 shares, to acquire and turn to account any invention relating to the manufacture, production, treatment, application and use of electric insulating materials of all kinds, &c., and to adopt an agreement with W. E. W. Richards. Private company.

WHOLESALE ELECTRICAL CO. (LTD.) (140,845).—Reg. July 1, capital £2,000 in £1 shares (1,000 preferred), to take over the business of manufacturers of and dealers in electrical supplies carried on as the Wholesale Electrical Co. and to adopt an agreement with T. W. Greaves. Private company. First directors are T. W. Greaves and F. W. Evans (both permanent). E. H. Beynes may retain office as secretary while holding 200 shares.

STATUTORY RETURNS.

ATLAS CARBON & BATTERY CO. (LTD.) Capital at Dec. 29, 1914, was £2,000 in £1 shares. All shares taken up. £8 paid. £1,992 considered as paid. Mortgages and charges: £3,000.

BASTIAN METER CO. (LTD.) Return to March 11 gives capital as £20,235. 10s. in 3,000 preference shares of £1 each and 68,942 ordinary shares of 5s. each. 2,011 preference and 39,673 ordinary shares taken up. 5s. per share called up on 1,272 ordinary and £1 per share on 2,011 preference. £3,082. 10s. paid. £8,850 considered as paid on 35,400 ordinary shares. Mortgages and charges: £1,150.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.) According to return to April 2 capital is £200,000 in £1 shares (100,000 preference). 61,988 preference and 86,198 ordinary shares taken up. £1 per share called up on 52,764 preference and 9,750 ordinary shares and 7s. 6d. per share on ordinary. £62,298 is paid thereon. £1,142 10s. paid on 25 shares forfeited. £85,179 considered as paid on the remainder. Mortgages and charges: Nil.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The return to April 5 gives capital as £1,000,000 in 100,000 preference and 100,000 ordinary shares of £5 each. All shares taken up. £5 per share called up on 74,170 preference and 19,065 ordinary. £372,675 paid. £427,325 considered as paid on 25,530 preference and 39,935 ordinary. Mortgages and charges: £700,000.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.) The capital in return to April 1 is £300,000 in £5 shares (20,000 preference), 6,007 preference and 33,993 ordinary shares taken up. £5 per share called up on 6,007 preference and 1,993 ordinary shares. £40,000 paid. £5,000 considered as paid on 1,000 ordinary shares. Mortgages and charges: Nil.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—According to return to March 25, capital is £400,000 in 74,000 ordinary and 6,000 preference shares of £5 each. 49,436 ordinary and 6,000 preference shares taken up. £5 per share called up on 37,750 of latter and 6,000 preference: £218,850 paid; £58,330 considered as paid on 11,666 ordinary. Mortgages and charges, £175,000 debenture stock.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—According to return to March 29 capital is £2,000,000 in 80,000 preference and 80,0000 ordinary shares of £10 each. 65,000 preference and 65,000 ordinary shares taken up. £1,300,000 paid. Mortgages and charges: £1,000,000.

EASTERN & SOUTH AFRICAN TELEGRAPH CO. (LTD.)—In return to May 26 capital is £600,000 in £10 shares. All shares taken up. £600,000 paid. Mortgages and charges: Nil.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The capital in return to March 30 is £1,500,000 in 200,000 ordinary and 100,000 preference shares of £5 each. 200,000 ordinary and 76,121 preference shares taken up. £5 per share called up on 195,936 ordinary and 76,121 preference. £1,360,285 paid. £20,320 considered as paid on 4,064 ordinary. Mortgages and charges: £628,000.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—According to return to March 11, capital is £150,000 in 10 "A" and 149,990 "B" shares of £1 each. 10 "A," 78,500 "B" ordinary and 31,490 "B" preference shares taken up; £110,000 paid. Mortgages and charges, £58,165.

NORTHWOOD ELECTRIC LIGHT & POWER CO. (LTD.)—According to return to March 18 capital is £30,000 in £1 shares (15,000 preference) 12,507 ordinary and 6,880 preference shares taken up. £1 per share called up on 8,282 ordinary and 6,880 preference shares. 15,162 paid. £4,225 considered as paid on 4,225 ordinary shares. Mortgages and charges: £4,625.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—According to return to April 5 capital is £100,000 in £1 shares (50,000 preference). All shares taken up. £100,000 paid. Mortgages and charges: £17,000.

OXFORD ELECTRIC CO. (LTD.)—In return to March 29, capital is £175,000 in £5 shares (15,000 preference). 20,000 ordinary and 11,000 preference shares taken up. £5 per share called up on 13,200 ordinary and 10,000 preference and £1 per share on 1,000 preference shares. £118,550 paid (including £1,550 paid on 310 ordinary shares forfeited). £34,000 considered as paid on 6,800 ordinary shares. Mortgages and charges: £50,000.

SIMPLEX CONDUITS (LTD.)—The capital in return to March 23 is £100,000 in 10,000 preference shares of £5 each and 50,000 ordinary shares of £1 each. 10,000 preference and 40,000 ordinary shares taken up. £5 per share called up on the preference. £50,000 paid. £40,000 considered as paid on the ordinary. Mortgages and charges: Nil.

MORTGAGES AND CHARGES.

BRITISH SHERARDISERS (LTD.)—Debenture dated June 10, 1915, to secure £600, charged on company's property, present and future, including uncalled capital. Holder: W. J. Halsey.

CARVILLE SITE & POWER CO. (LTD.)—Issue on June 18, 1915, of £10,000 debentures, part of series of which parts have been allotted.

GENERAL CABLE MFG. CO. (LTD.)—Debenture dated June 24, 1915 to secure £1,000, charged on company's undertaking and property, present and future. Holders: Ambert, Grenier & Co.

RECEIVERSHIPS.

BUENOS AIRES PORT & CITY TRAMWAYS (LTD.)—Notice of appointment of Sir Wm. Plender, 5, London Wall-buildings, E.C., receiver and manager by order of Court dated June 18, 1915, has been filed.

NORTH EASTERN ELECTRIC SMELTING CO. (LTD.) (118,843).—E. H. Clegg, 107, Wood Exchange, E.C., ceased to act as receiver or manager on April 21, 1915.

CITY NOTES.

MEMORANDA (July 7).—Bank rate 5 per cent. (since Aug. 8, 1914. Consols 65. Consols Pay Day Aug. 5. Stocks and Shares Ticket Days July 13 and 28. Pay Days July 14 and 29. Price of silver 22 7/16d.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold to consumers during the four weeks ended 4 July 28 was 1,901,820 compared with 1,420,595 units in the corresponding period of 1914.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The interim dividend on the ordinary shares of this company for the half-year ending July 31, due on the 1st proximo, will be payable on Aug. 3 next. The transfer books will be closed from July 28th to the 31st inst., inclusive.

EDGAR ALLEN & CO. (LTD.)—The directors recommend a dividend on the ordinary shares of 10 per cent. per annum and a bonus of 2½ per cent. for the year ended March [illegible].

ELECTRICAL & INDUSTRIAL INVESTMENT CO. (LTD. & REDUCED).—On July 9 Mr. Justice Younger will hear a petition for an order to reduce the capital of the company from £100,000 to £80,000.

ELECTRICAL FINANCE.—In the Journal of the Institution of Electrical Engineers for July the Institution's Committee on Finance has issued the annual report on the financial position of the leading electrical undertakings of this country as determined by writers expert in the dissection and criticism of directors' financial statements. The companies which come under review are:—

(1) Marconi's International Marine Communication Co., Ltd.
(2) General Electric Co., Ltd.
(3) Consolidated Electrical Co., Ltd.
(4) Crompton & Co., Ltd.
(5) J. G. White & Co., Ltd.

The Investors' Guardian is an old-established publication which makes a special feature of dealing fully and critically week by week with the financial results of joint-stock undertakings. The excellent field of investment which, in normal times, the electrical joint-stock companies offer makes such ample reviews of their financial position a useful guide to investors.

KAMINISTIQUIA POWER CO. (LTD.)—The directors have declared a dividend of 1½ per cent. on the common stock for the quarter ending July 31.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors have decided to pay an interim dividend of 2½ per cent. on the preference shares, but the question of an interim dividend on the ordinary share capital has been postponed.

RAILWAYS AND THE NEW WAR LOAN.—The Great Central and Great Western Railway Companies have made arrangements to facilitate subscriptions by their employees to the new 4½ per cent. War Loan, and thus enable the smallest investor to acquire this excellent Government Stock upon the same terms as the capitalist. Upon the subscriptions reaching £5, or multiples of £5 the sum can be converted into War Loan Stock, and the necessary stock certificate will then be issued. This effort on the part of these two leading Railway Companies to encourage thrift, and directly benefit the Country is very commendable, especially when it is borne in mind the number of trained men who have already been released for active service.

ST. JAMES & PALL MALL ELECTRIC LIGHT CO. (LTD.)—An interim dividend at the rate of 7 per cent. per annum on both preference and ordinary shares has been declared for the half-year ended June 30, payable Aug. 7. The transfer books will be closed from July 24 to Aug. 6 inclusive.

SOUTH AMERICAN LIGHT & POWER CO. (LTD.)—The directors recommend a dividend of 5 per cent. (less tax) for the past year, after writing off £1,400 for debenture issue expenses and carrying forward £898.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The directors have declared the usual interim dividend of 1/2s. per share or 5 per cent. per annum. The transfer books of the company are closed from the 5th to the 15th inst., inclusive.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, July 7. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shares	Last Dividend	NAME.	Price, Wed. July 7.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7½	Brompton & Prince's E.L. Ord.	9¾	7 .. 8	Mar, Sept
1	4½	Do. 4½ per cent. Pref.	9	4 15 0	Feb, Aug
1	5	Do. 5 per cent. Pref.	10½	5 17 1	Feb, Aug
5	5½	Brompton & Kens. Ord.	9⅝	6 .. 0	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St.	99¾	4 8 5	..
St.	4	City & West End & City Debs.	83½	4 15 10	Jan, July
5	3	Do. 4½ per cent. Pref.	4¾	5 13 ..	..
..	..	Do. 5 per cent. Pref.	5	6 5 0	Aug, Feb
1	7½	City of London Elec. Lt. Ord.	13⅝	6 9 1	Feb, Aug
1	7	Do. 6 per cent. Pref.	12¼	4 17 9	Mar, Jly
St.	..	Do. Deb. Stock	110½	4 10 11	Jun, Dec
10	..	County of London Elec.	11	6 7 3	Mar, Sept
1	5	Do. 5% Pref.	11	5 9 1	Feb, Aug
St.	..	Do. 4% Deb.	97	4 12 7	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	99½	5 12 3	July
..	..	Kensington and Knightsbridge Ord.	7⅛	6 4 2	Feb, Aug
St.	..	Do. 4% Deb.	85	4 14 ..	Jan, Jly
..	..	London Elec. Supp. 6% Pref.	5½	5 19 3	..
St.	..	Do. 4% Deb.	89¾	4 11 11	Jan, Jly
..	..	Metropolitan E. Supp. Ord.	3..	6 13 7	Mar, Aug.
St.	4½	Do. 1st Mort. Deb.	103	4 14 3	Jan, Jly
..	..	Midland Elec. Corpn. 1st Mort. Deb. St	97	6 1 ..	Jan, Jly
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs.	99½	6 1 1	Mar, Sept
St.	..	Notting Hill Elec. Deb. St.	100	.. .. ..	May, Oct
1	6%	North Metropolitan E. P. Supp. 6% Pref	1..	6 11 ..	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs.	8..	6 5 3	Jan, Jly.
St.	4½	Do. 4½ per cent. Deb.	9..	5 .. 3	Apl, Oct
..	..	Do. 4½ per cent. Pref.	1..	6 .. 7	May, Aug
5	9%	Westminster E.S. Corp. Ord.	1..	9	Mar, Sept
5	9½	Do. 5% Pref.	14½	6 11 ..	Jan, Jly.
		Electric Railways & Tramways.			
St.	..	Central London Rly.	1..	.. .. ..	Apl, Oct
1	..	Do. Pref.	1..	.. .. ..	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	7..	5 7 ..	..
St.	4%	Do. do. Assented Def. Ord.	5..	5 14 3	..
..	..	Do. 5% Pref. 1876	9..	5 11 ..	May. Nov
St.	5%	Do. Pref. 1876	9..	5	Jan, July
1	4	Do. Pref.	1..	4	Feb, Aug
1	4	London Electric Ry. Ord.	1..	.. .. ..	Jan, July
1	4	Do. Pref.	1..	6 7 ..	Mar, Sept
..	..	Do. Def.	1..	4 11 ..	Jan, Jly.
1	4	Metropolitan Ry. Con. Ord.	7..	5 14 ..	Feb, Aug
..	..	Do. 4½ per cent. Pref.	7..	4	Jan, Apr
..	..	Do. 4½ per cent. Deb.	7..	5 14 3	Feb, Aug
..	..	Do. 4½ per cent. Deb.	7..	4 4 7	Jan, July
..	..	Do. 4½ per cent. Deb.	7..	4 4 1	Jan, July
..	..	Metropolitan Dist. Ry. Ord.	1..	.. .. ..	Feb, Aug
2	4½	Do. 4½ per cent. Pref.	9..	4 7 0	May, Nov

†Ex Dividend or Interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name.	Price, Wed., July 7.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*	£ s. d.		
St.	4½%	[illegible] Pref.	90	5 0 7	Feb, Aug
St.	6%	Do. [illegible]	120½	4 12 8	Jan, July
St.	4%	Do. [illegible]	[illegible]	4 10 8	Jan, July
St.	4%	Do. [illegible]	[illegible]	4 11 7	Jan, July
St.	4%	Do. [illegible]	[illegible]	5 0 0	Mar, Sept
10	..	Underground Electric Railways	14	..	..
1/0	..	Do. [illegible]	..	..	..
St.	6%	Do. [illegible]	..	5 12 1	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup.	15	8 4 5	Mar, Sept
..	4½%	Do. 4½% Bds.	[illegible]	4 13 9	Jan, July
		Yorkshire [illegible]	[illegible]	..	March
		[illegible]	4½	4 11 0	Jan, July
		Electric Manufacturing, &c.			
1	1/9	[illegible]	23	5 17 1	Apl, Oct
1	[illegible]	Brit. Aluminium Ord.	1½	4 14 9	Mar
100	5%	Do. Prior Lien Debs.	93½	5 8 3	Jan, July.
1	[illegible]	Do. [illegible] Pref.	[illegible]	6 15 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	11½	6 14 10	Aug, Feb
5	5/0	Do. 4½% Pref.	[illegible]	4 15 5	Mar, Sept
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	1½	5 12 11	Mar, Sep
2	7½	Brit. Westinghouse Pref.	11	8 5 [illegible]	Apl
100	6%	Do. [illegible] Debs.	100½	5 19 8	Apl, Oct
St.	4%	Do. [illegible] St.	73	5 9 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11	6 16 4	Jan, July
5	2%	Do. 5% Pref.	5½	5 0 0	Feb, Aug
1	15%	Castner Kellner [illegible]	2½	5 3 3	May, Nov
1	[illegible]	Do. [illegible] Pref.	[illegible]	12 13 4	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	..	..	Feb, Aug
1	6%	Elec. Construction Ord.	..	9 2 10	May
1	[illegible]	Do. 7% Cum. Pref.	[illegible]	7 0 0	Jan, July
St.	4%	Do. 4% Debs.	69½	5 15 4	Jan, July
10	6	General Electric 6% Pref.	[illegible]	5 17 2	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	14½	7 0 4	Feb, Aug
5	2/3	Do. 4½% Pref.	4½	5 0 0	..
St.	4½%	Do. 4½% Deb.	98	4 11 10	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	[illegible]	5 17 3	Feb, Aug
10	5%	Do. Pref.	8½	5 15 11	Apl, Oct
100	4%	Do. [illegible] Debs.	98	4 1 8	Apl, Oct
12	3%	Telegh. Con. & Main. Co.	35½	7 8 11	Mar, July
100	4%	Do. 4% Debs.	95½	4 4 3	Jan, July
1	[illegible]	Vickers Ord.	11½	4 10 7	May, Aug
1	6%	Do. [illegible] Pref.	[illegible]	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	93	4 6 0	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99½	4 10 6	Jan, Dec
		Telegraphs.			
100	5%	Anglo-[illegible] Tel. Co. Pref.	95†	5 5 3	Jan, July
St.	3½%	Anglo American 6% Pref. Ord.	101	5 18 10	Feb,My,Aug.N
St.	30/0	Do. Def. Ord.	21½	6 19 6	Feb,My,Aug.N
St.	4%	Commercial Cable 4% Debs.	72½†	5 10 9	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	8½	5 13 6	May, Nov.
12	10%	Do. 10% Pref.	15½	6 9 0	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	[illegible]	6 13 6	Ja,Ap,Jly,O
St.	[illegible]	Eastern Tel. Co.	123	5 9 5	Ja,My,Jly,O
St.	12%	Do. [illegible]	174	4 17 7	Ja,My,Jly,O
St.	4%	Do. [illegible]	85	5 0 0	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	84½	4 14 8	Feb, Aug
12	4%	[illegible]	11½	5 19 2	Ja, Ap, Jly,O
10	22½%	Gt. Northern Tel. Co. Ex Coup. 7	33½	6 12 4	Ja, My, Jly
25	12½	[illegible]	51	5 0 4	May, Nov
[illegible]	..	Marconi's Wireless Tel. Co.	1½	11 17 0	April
1	1/4½	[illegible]	1½	11 2 0	July
12	7½	West India & Panama Ord.	1½	8 13 11	May, Nov
10	6%	Do. 1st Pref.	6½	7 3 4	May, Nov
10	3/0	Western Telegh. Co.	12½	5 12 7	Mr, Jly,O,Dec
St.	4%	Do. 4% Deb. St.	83†	4 16 5	Jun, Dec
..	4½	Western Union 50 yr. Bds.	96½	4 14 7	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	126½†	6 6 9	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	80	6 5 0	Jan, Jly
1	7½	[illegible]	[illegible]	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	99½	4 15 1	May, Nov
1	10%	Oriental Telephone Ord. (ex bonus)	11½	8 13 7	Apl, Oct
St.	4½	[illegible]	94½	4 12 6	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St.	86†	5 2 3	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	6 17 [illegible]	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4½†	5 3 3	Jan, July
St.	4	Do. Deb. Stk.	[illegible]	[illegible]	Jan, July
		Financial and Investment.			
1	..	[illegible]	7½	[illegible]	Sp,Dc,Mr,Jn
1	..	[illegible]	11½	5 5 1	Sp,Dc,Mr,Jn
10	..	[illegible]	30	6 6 0	Ja, Apl, Jly,O
..	..	[illegible]	30	6 14 0	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	125½	4 15 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	[illegible] Deb.	[illegible]	5 0 0	Jun, Dec
St.	4½%	[illegible]	[illegible]	5 9 1	Jan, July
St.	4%	[illegible]	78½†	5 1 9	Jan, July
..	..	[illegible]	41†	6 13 3	Jan, July
..	..	[illegible]	..	7 7 2	Jan, July
5	2/9	[illegible]	[illegible]	11 15 4	Jan, July
100	[illegible]	Brazilian Traction Ord.	[illegible]	11 15 4	Fb,M,Aug,N
10	[illegible]	[illegible]	[illegible]	6 16 6	Ja,Apl,Jly,O
..	..	[illegible]	[illegible]	5 14 3	May, Nov
..	..	Do. 5% Cum. Pref.	[illegible]	5 2 3	[illegible]
St.	4½	[illegible]	[illegible]	5 13 4	..
..	[illegible]	[illegible]	[illegible]	6 17 6	Mar, Sep
..	..	Havana Elec. Ry. 5% Bds.	[illegible]	5 13 3	Feb, Aug
..	..	Madras Elec. Trams 6% Cum. Pref.	[illegible]	6 0 0	..
100	5%	[illegible]	[illegible]	7 4 11	Jan, July
..	..	[illegible]	34½	..	Fb,M,Aug,N,
..	..	Do. [illegible]	..	8 15 5	May, Nov
St.	4½	Montreal Street Ry. 4½% Debs. (1922)	[illegible]	4 [illegible]	Feb, Aug
100	..	Rio de Janeiro Tram, L. & P. 50 yr. Bds	[illegible]	[illegible]	Jun, Dec
100	4½	[illegible]	[illegible]	4 14 3	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
..	..	[illegible]	[illegible]	13 7	Mar, Sept
St.	..	[illegible]	[illegible]	[illegible]	Jan, Dec
..	..	[illegible]	[illegible]	14 3	..
5	9½	Calcutta E. S. Corp. Ord.	[illegible]	[illegible]	May, Nov
..	..	[illegible]	[illegible]	[illegible]	Mar, Sept
..	..	[illegible]	[illegible]	7 1	Ja, Apl, Jly,O
St.	..	[illegible]	[illegible]	4 17	June, Dec
St.	..	[illegible]	[illegible]	4 11	Apl, Oct
..	..	[illegible]	[illegible]	4 11	Jan, July
..	..	[illegible]	[illegible]	4 11	Ja,Apl,Jly,O
St.	4½	[illegible]	[illegible]	4 [illegible]	Jan, July
St.	4½	[illegible]	[illegible]	[illegible]	May, Nov
..	..	[illegible]	[illegible]	[illegible]	Jan, July

† Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date July 7, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	14½d.	Antimony	£122 0 0
Solid Drawn Copper Tubes	14½d.	English Lead	£25 5 0
Brazed Copper Tubes	14½d.		
Brazed Brass Tubes	16d.		
Brass Wire	14½d.	Old Metals.	per ton.
Copper Wire	14½d.	Clean Scrap Copper	£76 0 0
Rolled Brass	14½d.	Brazlery Copper Scrap	£71 0 0
Brass Sheets	15d.	Clean Scrap Brass	£59 0 0
		Old Lead	£22 0 0
		Old Zinc	£65 0 0
	per ton.	Hollow Pewter	£120 0 0
Copper Sheets	£110 0 0	Black Pewter	£85 0 0
Spelter	£105 0 0	Gun Metal	£64 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date [illegible], the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£90 0 0	Old Lead	£20 10 0
Clean Mixed Brass	£68 0 0	Tea Lead	£18 10 0
Clean Copper	£68 0 0	Hollow Pewter	£120 0 0
Brazlery Copper	£62 0 0	Shaped Black Pewter	£85 0 0
Gun Metal	£62 0 0		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or dec. (d)	Aggregate. No. of weeks.	Aggregate. Amount	Inc. or dec (d)
		£	£		£	£
Aberdeen Corporation	June 30	1,733	— 145	4	7,908	
Anglo-Argentine	July 1	48,158	— 3,601	26	1,332,691	— 125,048
Ashton-under-Lyne	.. 3	486	.. 21	14	6,791	+ 122
Ayr Corporation	.. 3	414	.. 13	7	2,620	— 195
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	.. 4	1,452	+ 101	14	18,443	+ 627
† Birmingham Corporation.	..	..	..	..	..	..
Blackburn Corporation	June 30	1,319	— 46	14	18,401	— 870
Blackpool Corporation	July 1	2,190	— 895	13	17,601	— 4,778
Blackpool and Fleetwood	.. 3	1,236	— 466	26	12,842	— 2,713
Bolton Corporation	.. 4	2,955	+ 287	14	36,338	— 3,486
Bournemouth { Trams	June 30	1,922	— 251	13	27,280	— 274
Bournemouth { Buses	.. 30	31	.. 22	13	305	— 18
Bradford Corporation	.. 30	6,381	+ 252	13	83,190	+ 1,548
Brighton Corporation	July 4	1,201	— 183	14	14,467	— 1,217
Bristol Trams { Trams	.. 2	4,945	— 265	26	119,585	— 1,842
Bristol Trams { Buses, &c.	.. 2	5,426	— 147	26	120,868	+ 22,327
Burmah E. Trams & Ltg.	.. 3	R4,037	— R1,841	26	..	— R45,859
Burnley Corporation	.. 4	1,758	.. 6	14	36,409	— 1,717
Burton Corporation	.. ..	..	..	..	..	..
Bury Corporation	.. 4	1,494	— 50	14	19,007	— 624
Calcutta Tramways Co.	.. 3	109,648	+ R1,852	26	R1,717,806	+ R86,809
Camborne-Redruth	.. 3	147	.. 14	26	3,522	.. 12
Cardiff Corporation	.. ..	..	..	..	..	..
Cork Electric Trams Co.	.. 1	500	.. 48	26	12,633	— 214
Coventry Corporation	.. 4	962	+ 92	14	13,102	+ 1,184
Croydon Corporation	June 25	1,987	+ 96	12	23,034	+ 24
* Derby Corporation	July 3	1,107	.. 10	13	14,240	— 14
Dover Corporation	.. ..	..	..	..	..	..
Dublin & Blessington Railway	June 30	317	+ 5	26	3,718	+ 13
Dublin United	July 2	[illegible]	— 884	26	156,726	+ 6,056
Dundee Corporation	June 30	1,379	.. 4	13	8,902	— 2
East Ham Council	J.. 3	1,326	+ 171	13	17,908	+ 3,344
Exeter Corporation	.. 3	339	.. 19	13	5,067	+ 1
Glasgow Corporation	.. 3	22,566	.. 95	..	107,500	+ 4,220
Glossop Trams	.. 3	134	.. 1	27	3,195	— 14
Gloucester Corpn.	.. ..	..	..	..	..	..
Halifax Corpn. { Trams	June 30	[illegible]	— 136	13	29,625	— 2
Halifax Corpn. { Buses	.. ..	..	— 2	13	660	—
Hastings Elec. Trams Co.	J.. 1	1,024	— 244	26	21,922	— 1,202
Huddersfield Corpn.	.. 3	..	+ 168	14	36,788	+ 3,516
Hull Corporation	.. 3	3,048	.. 361	13	41,363	+ 2,900
Ilford District Council	.. 3	702	+ 41	13	8,894	+ 1,606
Ilkeston Corporation	J.. 4	136	.. 6	13	1,681	— 24
Ipswich Corporation	June 30	635	— 71	13	6,965	+ 53
Isle of Thanet Co.	.. ..	473	.. 301	13	12,900	— 5,330
Kilmarnock Corporation	.. 3	179	.. 9	7	1,192	..
Lanarkshire Trams Co.	.. 1	2,009	.. 26	26	48,171	— 1,150
Lancashire United	June 30	2,041	+ 248	26	43,375	+ 5,000
Leeds Corporation	.. 3	9,253	+ 128	14	121,670	+ 5,000
Leicester Corporation	.. 3	3,238	.. 4	26	78,095	+ 1,000
Leith Corporation	.. 3	..	.. 7	7	5,580	+ 1
Lincoln Corporation	.. 3	136	.. 4	14	1,868	— 1
Liverpool Corporation	J.. 3	13,776	+ 367	26	328,629	+ 2,000
Llandudno&Colwyn Bay R	.. 3	416	.. 81	5	8,065	+ 1
London County Council	June 23	44,897	+ 171	12	485,863	+ 40,000
Lowestoft Corporation	.. 3	..	.. 26	..	6,560	— 1
Maidstone Corporation	July 1	..	.. 13	13	2,878	— 1
Manchester Corporation	.. 3	11,000	.. 400	13	244,724	— 1
Neath Corporation	.. 3	117	.. 27	13	2,408	— 1
Newcastle-upon-Tyne Corpn	J.. 3	1,112	— 1,186	13	84,066	+ 9,000
Newport (Mon.) Corpn.	.. ..	..	..	..	..	..
Northampton Corporation	.. 3	825	+ 179	13	10,163	+ 1,000
Nottingham Corporation	.. 3	4,581	.. 85	13	48,936	+ 1
Oldham Corporation	.. 3	2,236	.. 136	13	33,723	— 1
Portsmouth Corporation	.. ..	..	..	..	..	..
Preston Corporation	J.. 3	977	+ 64	13**	12,395	— 1
Rochdale Corporation	J.. 3	1,772	+ 43	13‡	23,668	+ 1
Rotherham Corporation	J.. 3	1,136	+ 108	13	14,502	— 1
Salford Corporation	J.. 3	5,332	— 1,400	14‡	72,480	— 1
† Sheffield Corporation	J.. 3	8,655	+ 288	14	124,067	+ 8,000
Southampton Corpn.	J.. 3	1,473	.. 58	13	18,870	+ 1
Southend Corporation	.. 3	737	.. 90	13	10,528	+ 3,000
Southport Corporation	.. 3	884	+ 134	14‡	9,858	— 1
St. Helens, Lowton, Hyde, &c., Jt. Bd.	.. ..	..	..	..	..	..
Sunderland Corporation	July 1	1,900	— 117	14	19,993	— 1
Swansea District	June 30	[illegible]	.. 30	13	19,235	— 1
Swindon Corporation	July 1	1,000	+ 41	13	2,584	+ 1
Taff Vale Trams Co.	.. 1	828	.. 26	26	14,343	— 1
Wallasey Corporation	July 1	1,392	+ 138	13	17,199	— 1
Walsall Corporation	.. 3	781	+ 116	13‡	18,520	+ 1
Wigan Corporation	.. 3	950	.. 2	13	12,544	+ 1
Warrington Corporation	.. ..	400	.. 13	13	5,888	+ 1
West Ham Corporation	.. 3	3,080	+ 90	13	41,075	+ 1
Wigan Corporation	.. 1	1,552	.. 85	13	20,182	— 1
Wolverhampton Corpn.	J.. 3	1,090	.. 50	13	13,918	— 1
Yorkshire W.K. Trams	July 1	1,541	.. 60	13	41,544	+ 1

(*a*) These comparisons are with the corresponding period last year. * Partly electri
† Including [illegible] &c. ‡ Minus 2 days. § Minus 3 days ¶ Plus 3 d
¶ [illegible] days. ** Compared with one week more last year.

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NOTES.

The Testing of Electrical Porcelain.

To the testing of electrical porcelain every attention must be given by those responsible for the design, construction and maintenance of extra-high-tension transmission lines. The revenue of a power supply company depends upon continuity of supply, and the latter is determined by the proper performance of the line. A breakdown of the line is generally a much more serious matter than the failure of a generator, and as a rule it is more difficult to protect the transmission line than other parts of the system. In order to minimise the risk of breakdown, it is necessary to test the insulators under the same conditions which cause them to fail in actual operation, and to test them in position under these conditions at regular intervals. In this way, and in no other, is it possible to [illegible] the initial factor-of-safety, and to maintain the factor-of-safety. It is the common experience of engineers in charge of extra-high-tension lines to find that when insulators have passed the customary tests the only breakdowns due to electrical causes are traceable to high-frequency discharges. These discharges are due to lightning, or to the abnormal conditions brought about by the opening and closing of circuit breakers, the blowing of fuses, or other causes. In the case of lightning, the only limit to the rise of potential is that which causes a discharge to earth, and in the case of switching, the voltage on the line nearly always reaches double value. With partial resonance the potential may rise to a considerably higher value.

IMPACT in mechanical and structural engineering is a fairly close analogy, and research on the subject has been practically continuous for nearly half-a-century. As a result, less importance is now attached to the static breaking strength of a material than to the behaviour of the material under suddenly applied and rapidly varying loads, and various methods of impact testing have been proposed. On another page of this issue we publish an abstract of an informative article, by Messrs. CHERNYSHOFF and BUTMAN, in which the different methods of testing electrical porcelain are compared. Several of the methods dealt with by the authors have already been fully discussed by IMLAY and THOMAS, by CREIGHTON and others. To duplicate as nearly as possible the effects of a lightning stroke IMLAY and THOMAS were led to try a high-frequency impulse test. This work was followed by that of CREIGHTON, who called attention to the availability of the Tesla coil for the high-frequency testing of insulators. CHERNYSHOFF and BUTMAN claim that the direct-current single-impact method which they have developed resembles more closely than any of the other methods the effects of a lightning stroke. It is important to distinguish between the results obtained by high-frequency wave trains, such as those generated by an oscillator, and continuous high-frequency, as generated by a 200,000-cycle alternator. In practice there is no known strain on insulators corresponding to those induced by continuous high-frequency, and, as pointed out by CREIGHTON, there is no reason for using the high-frequency alternator in a standard test, much less so in fact than using low-frequency as a standard test for insulators.

Electric Heating Elements.

In the construction of electric heaters the tendency has been to increase the temperature of the wire that is used, partly because it is necessary to get the element into a comparatively confined space in many cases, and partly because it is desirable to use the radiant form of heat. From every point of view it would be preferable to run the resistance wires at a considerably higher temperature than is commonly employed even now, were it not for the diffi-

culty introduced by the gradual oxidation of the wire. This remark applies, of course, only to those cases in which the wire is exposed to the atmosphere, but more often than not this is the case. An attempt to overcome this difficulty is described by Mr. C. P. RANDOLPH in a recent issue of the "General Electric Review." We give the substance of his article in another column of our present issue. This new type of wire, which has been developed by the General Electric Co. of America, is encased in a thin steel tube, and the space between the resistance wire and the inside of the tube is filled with a special heat resisting material, which is packed in so that it is very hard; consequently, the wire can be run at a high temperature and is not affected by the atmosphere.

FROM the point of view of mechanical construction and protection, such a method has obvious advantages, but it is clear that the steel sheath must be at a temperature very much lower than that of the wire, and that, if unprotected steel were at a rådiant temperature, oxidation would set in; for this reason the surface is protected by a coating of aluminium steel alloy if the temperature is to be above 400°C. From the point of view of the ordinary black hotplate, the construction that is here outlined may be a considerable advance, as it is robust, and the wire can simply be embedded by pouring cast-iron upon it when suitably made up. On the other hand, most of the applications of electric heating tend to be of the radiant type. Even in the case of the hotplate there are many engineers who consider that the radiant type will displace the black type before so very long. In the case of ovens, opinion is probably in favour of the radiant type of element rather than the black type. Also in grills this type is generally used, and in electric fires it becomes almost imperative. Moreover, the new style of wire is necessarily more bulky, and although this may not present a difficulty in the case of 110 volts, which is the pressure more or less general in America, the thickness of the wire is a matter of much greater importance when we have to deal with pressures up to 200 and 250 volts. Consequently, although we think there may be a distinct future for this particular wire in certain limited directions, we hold the view that what is required still more is an alloy which will not oxidise when running at a bright red heat.

Electricity in Farming.

IN this country there is often a great lack of elasticity in the way in which things may be done, the object being no doubt to preserve the rights of corporations and individuals by means of restrictive clauses in regulations and Acts of Parliament. In the United States it is otherwise, and thus the "Electrical World" is able to give an interesting instance of how four farmers within four miles of the small town of Candy, in Minnesota, combined to obtain a supply of electrical energy for lighting and power. It seems to have been necessary at first to come to some sort of understanding with the supply company, the Citizens' Light, Heat & Power Co., in order to obtain what was required. Part of the Company's transmission is at 13 200 volts and part at 2 300 volts. The desired service was obtained by running a four-mile line, costing approximately £80 each. Copper-clad wire is used for the line, and this is strung on 30 ft. poles spaced 40 to the mile. The farmers each agreed to pay the supply company £7. 5s. per annum for the service, plus £1. 16s. per month per rated horse-power of the motors and a further 6½d. per unit. The average energy bill per consumer per month is £1. 6s. Simplicity is one of the features, for each farmer reads his own meter and reports to the company by post-card, but an inspector checks the meter readings and inspects the line at irregular intervals. There is no doubt something to be said in favour of hard and fast rules, but, on the other hand, we probably lose quite a considerable amount of business in this country through not adopting a more flexible attitude at times.

Telephonic Carbon Contacts.

MR. A. L. CLARKE has made some interesting observations, the most important of which we reproduce in another column, on the resistance of carbon contacts in the solid back transmitter. Mr. CLARKE has dealt with steady electric pressures as distinct from currents of telephonic frequency, and he finds that when a pressure is applied the resistance always rises first, in some cases as much as 100 per cent., and then usually falls, but more slowly. The general tendency is for an increase in current to be met by an increase in resistance which proceeds to cut down the current; similarly a decrease in current causes a diminution of resistance. On the other hand, if the transmitter is filled with oxygen instead of air the resistance first falls and then rises. We doubt whether these phenomena, which are doubtless due to a large extent to the heating of the contacts and possibly to oxidation, play an important part in actual telephonic transmission, because changes under speech conditions vary so rapidly. It may also very well be that all these matters are thoroughly understood by those organisations, somewhat limited in number, which are concerned with the telephone in all its branches; but even so, the investigation of these phenomena on fundamental lines is an advantage to those who wish to understand what really takes place, and who may be seeking to increase the range of the present transmitters and receivers.

German-American Radio Stations.—Since the Emden cable was cut the United States have been relying on radio-telegraphy for most of their telegraphic intercourse with Germany. The system between Nauen and Sayville, and that from Hanover to Tuckerton, have worked successfully both by day and night until about six weeks ago, since when the warmer weather has given rise to so much "static" interference that messages cannot be received for most of the period of daylight. Though writers in the daily press declare that the atmospherics, being due to the aurora borealis, will pass off in a few weeks, experts say that such conditions are normal for the summer, and that, consequently, uninterrupted communication will not be regained till the autumn. This is giving some concern to Americans, who wish for German War Office reports direct from their source, instead of through the hands of the British censor; and efforts are being made to render the receiving apparatus at Tuckerton and Sayville less sensitive to atmospheric interference.

United States Navy Inventions Board.—It is announced that Mr. T. Alva Edison has accepted a seat on the Inventions Board organised by the Secretary of the United States Navy.

Royal Engineers (T.F.)—The following appointments have been made :—

London Electrical Engineers : Thos. C. Mann to be Second-Lieutenant.
Tyne Electrical Engineers : Noel G. Hollebone to be Second-Lieutenant.
Tyne Electrical Engineers : Major E. Robinson to be temporary Lieutenant-Colonel.

Coal Supplies.—The text of the Bill limiting the price of coal has now been published. It is proposed to limit the increase in the price of coal at the pit's mouth to 4s. per ton beyond the price at corresponding times of year before the outbreak of war. The comparative year ends with June 30, 1914. The Board of Trade is to have power to vary this advance.

West of England Industrial Reserve.—The University of Bristol is now following the example of others in co-operating with the local Munitions Committee to swell the ranks of the Industrial Reserve. The faculty of engineering is opening a register of the names of all who are willing to devote the whole or part of their time to such service, and is also providing classes in the workshops of the college for instruction in the work. Information can be obtained from the Registrar, Merchant Venturers' Technical College, Bristol.

Organised Research by British Dyes (Ltd.)—The board of directors of British Dyes (Ltd.) are establishing a research department, and have invited Dr. G. T. Morgan, F.R.S., to become the head of the department. They have resolved to appoint a Technical Committee, which will consist of the following :—

Dr. M. O. Forster, F.R.S. (chairman), Dr. G. T. Morgan, F.R.S., Dr. J. C. Cain and Mr. J. Turner.

They have also resolved to appoint an Advisory Council, under the chairmanship of Prof. Meldola, F.R.S., and the following professors have been invited to join the Council :—

J. N. Collie, F.R.S. (London), A. W. Crossley, F.R.S. (London), Percy F. Frankland, F.R.S. (Birmingham), A. G. Green, F.R.S. (Leeds), G. G. Henderson, L.Sc. (Glasgow), J. T. Hewitt F.R.S. (London), F. S. Kipping F.R.S. (Nottingham), A. Lapworth, F.R.S. (Manchester), A. G. Perkin, F.R.S. (Leeds), W. H. Perkin, F.R.S. (Oxford), W. J. Pope, F.R.S. (Cambridge), J. F. Thorpe, F.R.S. (South Kensington), W. P. Wynne, F.R.S. (Sheffield).

Prof. Silvanus P. Thompson, in a letter to "The Times" calls attention to the fact that Prof. Meldola has for 30 years been the head of the chemical department at the Technical College, Finsbury, and that Dr. Morgan, Prof. Pope and Dr. Forster were all trained at Finsbury by Prof. Meldola.

Protective Action of Condensers and Choking Coils.—In a letter in the "Elektrotechnische Zeitschrift," Dr. G. Benischke expresses the opinion that condensers are not capable of protecting the windings of transformers, &c., against excess pressure, for the reason that the condenser only reflects a part of a wave with a too-steep front, whereas a choking coil with an iron core flattens the front of the part of the wave passing through it, in addition to reflecting the other part of the wave. He further objects to the use of condensers on the ground that a condenser, in combination with the self-induction of the apparatus to be protected, forms an oscillating circuit, in which oscillatory currents of high pressure are liable to be set up. He does not consider choking coils without iron to be any more efficient than condensers, since the self-induction per unit length is too small to produce sufficient reflection of the pressure wave. He considers that, in installations working in the neighbourhood of 100,000 volts and over, the conductors should be protected by coarse and fine spark-gap protectors with satisfactory damping resistances (or water-jet earths or other resistances as a fine grade protection) and choking coils with iron cores, and in all cases an earthed guard wire should be arranged above the conductor. If it be found that the wave is reflected too strongly, the other end of the conductor should have a choking coil if there be any apparatus liable to be injured by it there.

Fixation of Atmospheric Nitrogen.—In a recent Paper before the American Institute of Electrical Engineers, Mr. I. L. Summers deals very fully with the problem of the commercial fixation of nitrogen. The author discusses the sources of supply of nitrogen products and the form in which the nitrogen is actually required. The vast natural deposits of sodium nitrate place a very definite limit on the cost of production of any artificial nitrogen compound. There are also certain theoretical limitations to the fixation of nitrogen imposed by the laws of physical chemistry, and these must be taken into consideration in reviewing the subject. There are three processes, which have been applied on a commercial scale, for preparing directly nitric acid from atmospheric nitrogen—namely, the Birckland-Eyde, the Schonherr and the Pauling; and the author describes the outstanding features of each of these. The processes have a very low efficiency, due to the fact that they utilised thermal energy only. Combinations of chemical and electrical methods promise better results. The Serpek and the Haber processes possess considerable interest. In the Serpek process a revolving barrel furnace of the resistance type is used, the resistance being in the form of a squirrel-cage, which continually agitates the material as it passes through. Bauxite and coal are fed from a producer type furnace into the electric furnace, and the sensible heat is thus utilised to heat the material as it travels to the electric furnace. The product is discharged as aluminium nitride with a content of 26 to 34 per cent. nitrogen. The reaction was represented by the equation $Al_2O_3+3C+N_2=2AlN+3CO$. The Haber catalytic process for the synthesis of ammonia directly from its components depends, of course, upon there being a supply of these elements available at a low price. The success of the Haber furnace is principally due to the ingenuity of its construction and the use of uranium as a catalyser. The process is carried out at a pressure of 200 atmospheres and a temperature of 500°C. in retorts which are heated internally by electric resistors. In conclusion, the author takes the view that the future of nitrogen fixation is full of promise under proper conditions.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Dr. C. C. Garrard deals further with apparatus for protecting electrical machinery against abnormal electrical conditions (p. 542).

Mr. Kenelm Edgcumbe contributes an article on the predetermination of the residual flux in magnets (p. 546).

We conclude an article on "The Electric Vehicle and the Central Station," by Messrs. J. F. Gilchrist and A. J. Marshall (p. 539).

Abstracts are given of Papers on electrical precipitation, recently read by Mr. F. G. Cottrell and Mr. A. F. Nesbit before the American Institute of Electrical Engineers (pp. 544 and 545). Our leading article also deals with this subject (p. 552).

We give an abstract of an article on the testing of porcelain, by Dr. A. Chernyshoff and Mr. C. A. Butman, appearing recently in the "Electrical Journal" (p. 554).

We publish a description of a new form of resistance thermometer, by Mr. S. Leroy Brown (p. 549).

An account is given of investigations by Mr. A. L. Clarke into the resistance of carbon contacts in the solid back transmitter (p. 557).

Companies' Meetings, &c. Meetings of the Club Telephone Co., General Electric Co. and Marconi's International Marine Communication Co. are reported, and an abstract is given of the scheme for the rearrangement of the capital of the British Electric Traction Co. (pp. 568-569).

OBITUARY.

KILLED IN ACTION. We regret to record the death of Second-Lieutenant Theodore E. Williams, who was killed at Ypres on the 1st inst. The deceased officer was for six years on the staff of the Hendon Electric Supply Co. at Golder's Green; he was the youngest son of the Rev. E. Williams, M.A., Vicar of Hunstspill, Somersetshire, and received his commission in the 1st Somerset Light Infantry only a few weeks since. He was originally attached to the Artists' Rifles, members of which have done yeoman service in France.

We also regret to record the death of Lieut. W. J. C. Budd, of the 2nd Battalion South Wales Borderers, who was killed in action on June 28 last near Achi Baba, in the Dardanelles. Deceased was chief clerk of the Shanghai Municipal Council electricity works. At the outbreak of war he volunteered and was granted a commission in Shanghai on Dec. 14.

PERSONAL.

The latest officer recruit from the General Electric Co.'s staff is Sub-Lieut. A. R. Courtenay, late acting manager of the publication department. He was gazetted on May 20th sub-lieutenant in the Royal Naval Air Service, Armoured Car Aeroplane Support (Royal Naval Volunteer Reserve), and is now undergoing a course of gunnery.

APPOINTMENTS VACANT AND FILLED.

An energetic man is wanted to act as works manager to company manufacturing dry batteries. *See advertisement.*

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply department. Applicants must have had thorough training as an engineer, experience in design and operation of large electric supply systems, of distribution of e.h.t. current over large areas, &c. Salary £650, rising to £700 per annum. Applications to the town clerk (Mr. Thos. H. Nesbitt), Town Hall, Sydney, N.S.W., by Sept. 13.

An experienced man with good commercial and technical knowledge is required to take charge of electrical instrument department in Glasgow.

A resident engineer is required to take charge of pumps, electric lighting, &c., at Bucks County Asylum. Commencing salary £165 (less £45 for house, &c.). Applications to the Clerk of the Asylums Committee, Aylesbury, by noon July 17.

West Hartlepool Electricity Committee received 92 applications for the position of borough electrical engineer, in succession to the late Mr. W. H. Friederichs, and the following were selected for interview :—

Messrs. D. H. Davies, assistant electrical engineer, Stockton-on-Tees; E. B. Grange, chief assistant and deputy electrical engineer, Paisley; J. W. Spark, electrical engineer and manager, Plymouth; Ernest Stubbs, chief assistant electrical engineer, Wolverhampton; J. H. Thompson, chief assistant and deputy city electrical engineer, Carlisle; A. E. Wilson, chief assistant electrical engineer, Bristol; and S. R. Windle, chief assistant electrical engineer, Sunderland. The Committee ultimately selected Mr. J. W. Spark, M.I.E.E., of the Devonport station of Plymouth Corporation, and the Council have now confirmed the appointment. The commencing salary is £400 per annum.

Mr. E. E. Stockens, district manager of the Post Office telephones for Aberdeen and the North of Scotland, has been promoted to be district manager for Blackburn and Bolton. Mr. J. T. Whitelaw, of Lincoln, succeeds Mr. Stockens.

INSTITUTIONS AND SOCIETIES.

Tramways and Light Railways Association.—In the "Journal" of [illegible] before the Expert Committee of the Local Government Board on the [illegible] On June 2nd, a deputation attended at the Local Government Board offices, consisting of Mr. E. H. Edwardes and Mr. T. B. Goodyer, general managers of the Lancashire Tramways Co. and the Croydon Corporation Tramways [illegible] Motor Car Order of 1904 to travel at over 5 miles per hour; and in

EDUCATIONAL NOTES.

University of Manchester.—The new session commences on Oct. 7. In the Faculty of Science complete theoretical and practical training is given to students preparing for the higher positions in the electrical engineering profession. At the end of a three years' course students may obtain either the ordinary or an honours degree of B.Sc. in electrical engineering. There is also a special course extending over three years in preparation for the certificate in electrical engineering. The John Hopkinson laboratories have been recently extended, and the equipment added to. The laboratories are fitted up with modern electrical machinery and testing appliances, and excellent facilities are given for educational and research work.

City & Guilds Technical College, Finsbury.—The day courses at this college are adapted to the needs of various students, including pupils from secondary schools above the age of 15 who desire to receive a practical and scientific training, and young men who, having previously served a pupilage or apprenticeship, desire to go through a more systematic training. The laboratories and workshops are equipped for instructional purposes, and include engineering and hydraulic laboratories, drawing offices, mechanics, physics, electrical and magnetic laboratories, dynamo and generating rooms, chemical laboratories, &c. Programmes may be obtained from the Registrar of the College.

Bradford Technical College.—At this college there are diploma courses in civil, mechanical and electrical engineering, power generation and transmission, &c. Full courses are also offered in all branches of the textile industries, including dyeing. There are well-equipped laboratories and good facilities for practical and research work. The terms commence September, January and April. Prospectuses, giving full particulars of courses, &c., will be sent post free on application.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, July 16th (to-day).

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

10:30 a.m. Annual Congress at the Institution of Civil Engineers, Great George-street, Westminster. Agenda: Annual General Meeting and Papers on "Glimpses into the Obvious," by A. V. Mason, on "Tramways During War Time," by J. W. Dingdale; and on "Electric Battery Vehicles as Adjuncts to Tramways," by W. H. L. Watson.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week ending 24th July, 1915:

Monday, 6:30 and 7:30: No. 1 Platoon, Technical Instruction and Squad Drill; No. 3 Squad, Squad Drill without arms; No. 4 Squad, Squad Drill with arms.

Wednesday, 6:30 and 7:30: Platoon and Company Drill.

Friday, 6:30 and 7:30: No. 1 Platoon, Technical Instruction and Squad Drill; No. 3 Squad, Squad Drill with arms; No. 4 Squad, Squad Drill without arms.

Munition Work: Owing to shortage of material, it has been impossible to arrange work for Saturday, July 17.

Camp at Thames Ditton: The Architects will welcome any Member of the E.I.V.T.C. who wishes to spend the week-end in Camp. Names must be given to the undersigned by Wednesday morning, and members going to camp must take with them blankets, knife, fork, spoon, cup and soup plate. Expenses about 7s. 6d.

THE NATIONAL RELIEF FUND.

(Treasurer, H.R.H. The Prince of Wales.)

This great National Fund, for the relief of those amongst the needier classes who are widowed, orphaned and otherwise affected by the fighting in which our troops and ships are now taking part, urgently seeks contributions however small. These can be sent with the following note, which can be cut out, filled in, put in an envelope and sent *unstamped*, addressed H.R.H. The Prince of Wales, Buckingham Palace, London.

Post . . . . . .

I enclose £ . . . . . *and remind the Prince of Wales*

NATIONAL RELIEF FUND.

Name . . . . . .

Address . . . . . .

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THE ELECTRIC VEHICLE AND THE CENTRAL STATION.

BY J. F. GILCHRIST (*president*) and A. J. MARSHALL (*secretary*).
Electric Vehicle Association.

(*Concluded from p. 500*).

VALUE OF THE ELECTRIC VEHICLE CHARGING LOAD.

No other load that the central station can secure is so essentially off-peak in character as an electric vehicle battery-charging load. When the electric vehicle first made its appearance central station men were quick to perceive how much they would benefit by the development of the electric vehicle industry. With an excess of enthusiasm, many of them and their friends invested in electric vehicles, while the whole combination of motors, vehicles and batteries was still in an experimental state and at a time when there was no one to show them how to operate the vehicles, even if the vehicles themselves had been sufficiently developed. Before the reputation of the electric vehicle had time to recover from the effect of these early failures, the petrol car made its appearance, and soon gained public favour. After years of experience, however, in operating different kinds of vehicles, those who are best qualified to form an opinion of their relative merits are now strongly in favour of the "electric," more especially for use in city streets. We now know from actual experience that electric vehicles are capable of doing good work even under conditions not particularly favourable to the use of electricity, and also that conditions in none of our cities are yet as favourable as they should be to allow electric vehicles to be used to the best advantage. There is need of better garaging facilities, and there is need of more men who know how to operate electric vehicles properly.

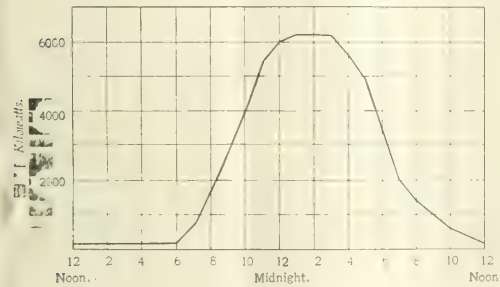


FIG. 1.—LOAD DIAGRAM VEHICLE BATTERY CHARGING.

The central stations should not hesitate to make a reasonable outlay to improve conditions for the electric vehicle, as the money so spent is sure to return in the form of a valuable off-peak load. Some of us have been inclined to defer taking action in this matter while waiting for a fool-proof vehicle to make its appearance, thereby depriving ourselves of the most valuable class of business that a central station can obtain, and the public of the benefits to be derived from the use of the least objectionable type of vehicle that has been produced up to this time. Already some of our central stations have a large income from power supplied from electric vehicle charging. The battery-charging load curve of one of these is shown in Fig. 1. From this curve it will be seen that during the small hours after midnight, over 6,000 kw. are used for charging vehicle batteries. This load is entirely off-peak, and would be practically constant for every month in the year if it were not for the fact that it is constantly getting larger. We may have a better idea of the importance of this load if we stop to think that the combined light, power and railway load of many of our cities, even those of considerable size, does not amount to much more than 6,000 kw.

A load diagram from a large central station [illegible] from six o'clock in the afternoon, where the curve [illegible] to have the appearance of a toboggan slide, until two o'clock in the morning, the engineers at the central station are kept busy shutting down dynamos and banking fires. During this time and until five o'clock, energy, representing in some cases hundreds of horse-power, escapes in the form of heat from the boilers standing idle with banked fires. The power generating equipment is not only kept [illegible] while idle to keep it in readiness to meet the next [illegible]. In addition, when the dynamos are again started energy is lost in putting the machinery up to speed and [illegible]. It is evident therefore that any kind of business that helps to fill up the valley of the load curve is desirable for several reasons. How much the electric vehicle charging load helped in one instance to fill up this valley is shown in the crossed line part of the diagram in Fig. 2, while the part marked with cross hatching represents the estimated load that will result when all the electric vehicle charging load that is now in sight has been secured. Curves in Fig. 3 are presented of a passenger vehicle garage, where about 125 vehicles are charged.

A study of the distribution of the electric commercial vehicles in this country will show that in the great majority of cases the trucks are operated in fleets of comparatively large size. From data gathered in one of our large cities it is shown that of the total haulage done in the city, 45 per cent. was for small establishments. One of the facts which has held back development for this class of business

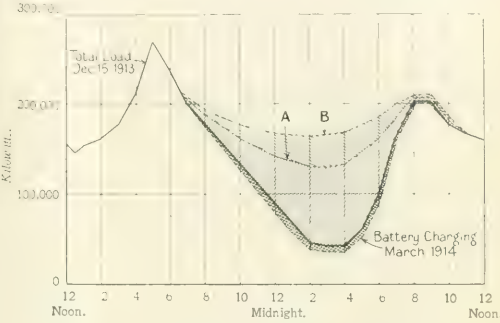


FIG. 2.—LOAD DIAGRAM CENTRAL STATION CO. PRESENT AND PROSPECTIVE VEHICLE BATTERY CHARGING.

A = Estimated load to displace 90,000 horses, 6 kw.-hour per horse, 1 kw. max. per horse.
B = Estimated load for 20,000 trucks and 15,000 pleasure cars.

is that the small user cannot afford to hire competent men to take care of the batteries. To meet this situation a considerable amount of attention has been given of late to the development of a battery-maintenance system whereby the owners can buy trucks without batteries, and so be relieved of all responsibility in the matter of battery maintenance. The plans thus far considered include the furnishing of such battery service by outside parties, customers to be charged a fixed price per month per truck, depending upon the size of the truck, plus a mileage charge. There is no doubt at all that the adoption of some such system will be necessary in order to cover the field occupied by the small user. The most practicable way would be to operate in conjunction with some large public garage. By this plan the overhead expenses would be borne in part by the garage,

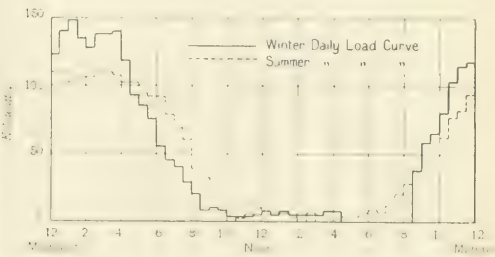


FIG. 3.—DAILY LOAD CURVES, ELECTRIC GARAGE (PLEASURE CARS), PLANT A.

and then, too, the labour required for exchange of batteries could, during the balance of the day, be used to advantage in general garage work.

RELATIVE IMPORTANCE OF ELECTRIC VEHICLE CHARGING AS COMPARED WITH OTHER CLASSES OF CENTRAL STATION BUSINESS.

To-day, however, there is such a variety of electrical devices and so many branches of central station business that need attention, that it becomes interesting to analyse the relative importance of the more prominent classes, and to show why one class differs from another class in character and in importance. It was the long-hour business which first attracted central stations to the industrial motor load. It was long-hour business which led to such effective organization among the central station men in connection with power [illegible]

and industrial power stations. It is now a rare occurrence to visit a light and power company that has not vigorously promoted the motor business.

The National Electric Light Association has recently (about 1913) sent out some very interesting data relating to 114 motor installations. It is interesting to note that out of the 44 installations, the 29 which show load-factor indicate that it is not over 10 per cent. Thus we see that it is not over three hours per day that the 29 installations are in service. It is common knowledge that electric vehicles are on charge six to eight hours each and every night, and surely we are warranted in claiming a marked advantage for the electric vehicle on account of such long-hour business. The load-factor up to 30 to 35 per cent. is uniform. It does not vary with the size of the vehicle nor with the number of batteries on charge, except, as has been forcibly brought out, that in a garage of large size one-half of the installation can be charged the fore part of the night and the balance the latter part. By this practice the central station secures a 12 to 16-hour load of uniform character. Next your attention is drawn to the low demand of the electric vehicle. For the same amount of plant equipment needed to operate it, the electric vehicle has 8½ times the earning capacity of the electric flat-iron. While it takes 86 irons to equal the annual income from one 2-ton electric commercial vehicle the irons demand 51·6 kw., against 6 kw. for the truck. Again, 50 electric trucks would produce the same annual income that is derived from 1,350 houses. The time will come when house lighting, cooking and baking, and innumerable electrical fields will be thrown open for active exploitation, but to-day the path of least resistance leads to the electric vehicle class of business, and of all branches with which the central stations

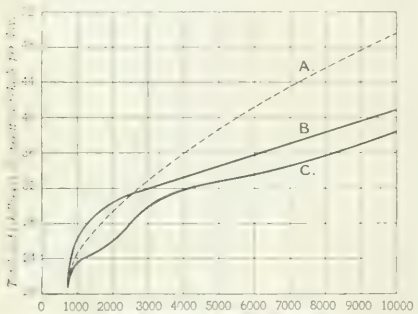


Fig. 4.—Curves showing Comparison of the United Co.'s Operating Costs per Day, with "General Average Operating Costs," Estimated by the Electric Vehicle Association of America.

C—The United Electric Light & Power Co. (minimum).

deals there is no other of equal importance. It needs more attention, however, from the sales manager of the central station. It is a selling proposition. Current in abundance is available. Along with it, electric vehicles are thoroughly developed and successful as a commercial product. What the business needs is the benefit of the sales manager's experience, his judgment, his approval, his influence with the public, his influence with his own organisation. Wherever

output (1913) for electric lighting plants of this country is about

Fig. 4

cities, where the vehicle development has extended over a period sufficiently long to establish these machines, shows that the ratio of electric passenger vehicles used to the population is materially greater in the smaller community. In Chicago, with a population of approximately 2,200,000, there exists one machine for every 750 inhabitants, while in Cleveland, with but 25 per cent. of that population there is one machine for every 340 inhabitants. One explanation for this condition is that in the larger city apartment house dwellers predominate, who through force of circumstances must depend upon public garages for the care of their machines, while in the smaller cities private garaging is more generally possible. As a matter of fact, the real business in the electric passenger vehicle is to be found among that class of buyers with whom depreciation and economy of operation are important considerations, and it is just that difference between public garage charges and the expense of maintaining a car "on the premises" which deters a majority from purchasing. The value of an electric passenger vehicle to the central station from

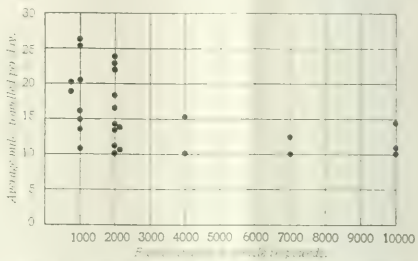


Fig. 5.—Average Miles Travelled per Day Operated.

the point of revenue equals that of an average residence; £20 per year per machine is a fair estimate of the amount of money to be derived from this class of business, while the load is particularly valuable as being of an off-peak character and requiring no additional investment for power-house equipment and line extensions.

Electric Commercial Vehicle.

It may be stated broadly that the field of application for the electric commercial vehicle is *the service wherein horses are now employed*. Naturally, a large volume of business in this direction is to be obtained from the largest cities. However, in communities of from 200,000 to 300,000 inhabitants the possible vehicle market is considerably greater than is generally realised, particularly as the development of low-priced machines designed to replace the single-horse unit is opening up an extensive market among those who may be classed as doing "a neighbourhood business." As indicating the possible market in small cities, a tabulation has been taken from the census of two cities of approximately 350,000 and 260,000 inhabi-

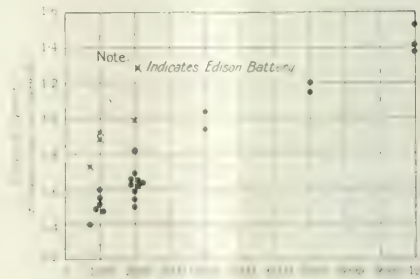


Fig. 6.—Kilowatt-hours per Ton-mile Energy used for Charging Batteries per Mile Travelled. Value of Energy before Entering Rheostat).

tants. In compiling this record all trade men and business houses of low commercial rating whose house vehicle equipment was not sufficient to warrant its replacement by electric machines were eliminated so that the results may be taken as a fair indication of the probable market in communities of the above sizes. For the first town 1,097 vehicles would be required by 153 firms, the ratio of

Table III.—*Current Consumption Characteristics for Power Wagons.*

Capacity of vehicle (in pounds)	700	...	1,000	...	2,000	...	4,000	...	7,000	...	10,000
Kilowatt capacity input *	11·3	...	15·1	...	17·7	...	23·7	...	30·5	...	35·6
Annual kilowatt-hour input (312 days) ..	3,526	...	4,711	...	5,522	...	7,394	...	9,516	...	11,107
Annual income at 3 cents per kw.-hour ..	$105·78	...	$141.33	...	$165.66	...	$221.82	...	$285.48	...	$333.21
Horse-power connected	4·4	...	4·4	...	5·3	...	5·3	...	7·2	...	7·2
Income per horse-power of connected load	$24.00	...	$32.00	...	$31.30	...	$41.90	...	$39.70	...	$46.30

Average kilowatt-hour input for all sizes of vehicles, 6,963. Average annual income for all sizes of vehicles, $208.88.

* Based on standard lead battery equipment.

vehicles to population being 1 to 319. In the second, or smaller town, 137 firms would require 911 vehicles, or the ratio of vehicles to population would be 1 to 285.

Considering the cities for which this census was compiled, the value of the power vehicle load based on the average current consumption for all sizes of vehicles would be as follows:—

Population.	Kilowatt-hour consumption.	Income at 3 cents per kilowatt-hour.
260,000	6,343,293	$190,298.79
350,000	7,638,411	229,152.33

In Table III. are shown the kilowatt-hour consumption for the various sizes of commercial vehicles, connected load and income per horse-power of connected load, which latter it will be observed, compares very favourably with other branches of power business.

Solicitation—Electric Vehicle Bureaus.

The central station can help promote the sale and use of electric vehicles in a number of ways. If the field justifies it an experienced man can be secured to conduct an aggressive campaign, but in a small city, at least to start with, the work could be delegated to the most logical member of the staff, and he could devote certain days or parts thereof to the work, until results or the outlook warrant the giving of more time. When the electric vehicle representative possesses some general knowledge as to the application of "Electrics," he should approach prospects much in the same manner as if he were endeavouring to get a man interested in a sign, or any other power-consuming device. If, in the judgment of the representative, the prospect could use electric vehicles, and could in some way finance their purchase, the representative could communicate with one or more manufacturers (many central stations issue such "leads" simultaneously to all manufacturers) who would arrange for one of their salesmen or engineers to call. Upon the arrival of the manufacturer's salesman, the central station representative would introduce him and stand by prepared to render any assistance that might be required. By carefully noting the methods employed by the manufacturer's salesman, the central station representative will find his stock of information liberally increased. In the event that the central station sells electric vehicles directly, the representative selected should spend at least a week or two at the manufacturer's plant. Even then he should unhesitatingly call for help if the problem appears too difficult for him to solve. As indicating methods which central stations might employ in a development of this nature, extracts are given below of reports from the Commonwealth Edison Co. (Chicago) and the New York Edison Company.

Report of the Commonwealth Edison Company.

The company has always looked with great favour on the electric vehicle as a very valuable field for central station service and has [illegible] to build up the [illegible] load being done by it may be classified under the following general heads: General publicity; favourable rates for electricity for charging batteries; personal service and solicitation [illegible] electric vehicles; inspection of garages and equipment; maintenance of emergency charging and boosting stations.

General Publicity.—This work has been carried on through insertions in trade papers and journals, bill-board advertising, issue of [illegible] pamphlets and folders [illegible] of electric vehicles and photographs.

Favourable Rates for Electricity.—We have [illegible] that the best interests of the company [illegible] by the adoption of the following rates which are based on the [illegible] per kilowatt-hour for all current used for charging electric vehicles, [illegible] per kilowatt-hour for all current used for charging electric vehicles, [illegible] per kilowatt-hour for all current used for charging electric vehicles,

APPARATUS FOR PROTECTING ELECTRICAL MACHINERY AGAINST ABNORMAL ELECTRICAL CONDITIONS.*

BY C. C. GARRARD.

(*Continued from p. 508.*)

Summary.—The author deals first with the conditions which give rise to abnormal electrical conditions of a transient type, such as those due to switching, arcs and sparks. Methods of suppressing arcs to earth are described. The author then passes on to pressure rises between the turns of electrical windings, and those due to causes exterior to the system, such as lightning. Various protective devices are described, such as water jet earthing resistances, the Moscicki and other condensers, Giles' valve and the more ordinary lightning arresters. In conclusion the question of earth plates is considered.

WATER JET EARTHING RESISTANCES.

As mentioned on p. 508, an efficient means of relieving overhead transmission lines of dangerous charges of static electricity is to provide a leakage path to earth from each conductor. Where a plentiful supply of water is available, as in water-power stations, this can be done very conveniently by means of jets of water issuing from earthed nozzles and impinging upon metallic inverted cups which are in direct connection with the lines. An earthing resistance constructed on this plan is illustrated in Fig. 12. It will be noticed that the three cocks controlling the flow of water are connected together so that the size of the jet on each phase is the same. Adjustments are provided so that the length of the jets may be chosen to suit the local conditions. It is advisable to instal an ammeter in series with one of the phases to check the waste of current which necessarily always goes on with such an apparatus. This is shown in Fig. 12. The hook just below the ammeter operates a short-circuiting link, as the instrument is normally short-circuited, and is only thrown into circuit when it is desired to make a measurement of the leakage current. A suitable leakage current on a 10,000 volt system would be 0·4 amperes, corresponding to a continuous waste of 6,920 watts. The resistance between each phase and earth would be, under these circumstances, 14,450 ohms. It is obvious that such a high resistance may prevent the rapid enough dissipation of quickly formed into charges of considerable amount. For large systems therefore water jet earthing resistances are not so good as earthing choking coils. Of course the very best

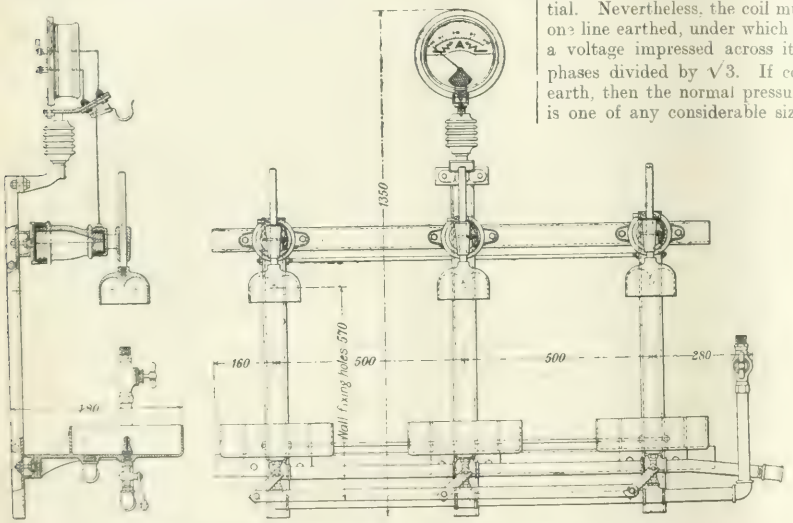


FIG. 12.—WATER JET EARTHING RESISTANCE, THREE-PHASE, 18,000 VOLTS.

preventative of static charges is to earth the neutral point of the high voltage system. It is, however, not always possible to do this.

Earthing Choke Coils.—For large systems, where it is necessary to provide means to dissipate static charges, the water jet has often too high a resistance, and the earthing choking coil has to be resorted to. This consists of a highly-insulated winding wound on an iron core and connected either between line and earth or between the neutral point and earth. With the water jet or other non-inductive leak the only thing that prevents useful current leaking to earth is the ohmic resistance. In order to keep this waste as small as possible, the resistance must be large, which is the direct contrary to what is required for a rapid dissipation of static electricity. It must be remembered that the current which passes due to this dissipation of static electricity is a continuous one. With the choke coil, on the other hand, leakage of useful current is limited by the inductance of the coil, and the ohmic resistance may be kept as low as the design allows. This is an advantage in favour of the choking coil. The losses in the latter are the iron loss and the copper loss due to the magnetising current of the choker. If the choking coil be connected to the neutral point, the losses in the choker in the ordinary way will be very little, as the neutral point is generally at or near earth potential. Nevertheless, the coil must be suitable for working with one line earthed, under which circumstances the coil will have a voltage impressed across it equal to the voltage between phases divided by $\sqrt{3}$. If connected between one line and earth, then the normal pressure across the coil, if the system is one of any considerable size, will be equal to the voltage between phases divided by $\sqrt{3}$; it must be capable, however, of standing up to the full voltage between phases which it would have to bear if one of the other phases became earthed. The efficiency of the coil for its purpose is inversely proportional to the ohmic resistance of the winding; this value should, therefore, always be asked for by the purchaser. In addition, the total losses in the coil should be specified when a voltage equal to the voltage between phases divided by $\sqrt{3}$ is applied across its terminals. The detail design of the coil is, of course, very similar to that of an ordinary transformer of the same voltage. It is desirable that the insulation of the high voltage end turns should be specially reinforced.

USE OF CONDENSERS FOR PROTECTION PURPOSES.

The faculty that an electrostatic condenser possesses o offering a relatively free passage to currents of high frequenc while presenting a high resistance in the path of a current o normal periodicity, has caused its use as a protective devic against lightning and other pressure rises to be often suggested Thus, Percy H. Thomas (see Trans." Am.I.E.E., Vol. XIX 1902, pp. 213-264) used a condenser combined with a choke co in his so-called "static interrupter." This apparatus consiste of an ironless choke coil connected in series with the line, and condenser connected between the junction between the chok coil and the apparatus to be protected and earth. Both chok coil and condenser were contained in a tank filled with oil, an it will be seen that, contrary to present-day practice, the co denser was connected on the apparatus, instead of the li side of the choke coil. The condensers used seldom exceede a few hundredths of a microfarad. The static interrupte

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probably on account of difficulties in the construction of the condenser, never came very much into use; American practice soon after its introduction inclined strongly to the electrolytic type of arrester.

Current Passed through a Condenser if the Discharge be of High Frequency.—If an alternating current of voltage E volts and of frequency f periods per second be applied to a condenser of capacity C microfarads, then the current which will pass through the condenser will be

$$I = \frac{2\pi fCV}{10^6} \text{ amperes.}$$

Let us assume a system operating at 20,000 volts, 50 periods three-phase, having protecting condensers installed between each phase and earth of 0·05 mfds. Assuming the earth connections were of negligible impedance, the current normally flowing through each condenser would be 0·18 amperes, each condenser having an apparent resistance to the path of the 50 period current of 63,500 ohms. If, now, the frequency of the discharge be, say, 3,000 cycles per second (due, for example, to a surge in the transmission line), this apparent resistance would be reduced to 1,058 ohms, which would still be too high to allow any large quantity of energy to pass quickly through to earth. If, on the other hand, the periodicity of the discharge were of the order of 100,000 per second, as would be the minimum in the case of atmospheric discharges, the apparent resistance of the condenser battery comes down to 32 ohms, and will, therefore, pass large quantities of electricity to earth at a comparatively low voltage. From these considerations it will be seen that the connection point to the line of the condenser battery is a point of nearly zero potential for very high frequency discharges. It is almost the same, as far as these very high frequency discharges are concerned, as if the line were connected to earth at this point. It is this property of the condenser of presenting a very small obstacle in the path of the very high frequency current, while allowing practically no current to pass at normal frequency, which makes it so valuable as a protective device against atmospheric discharges. On the other hand, it is of very little service as a protection against line surges (of the order of 3,000 periods per second). To protect against these some form of spark-gap is necessary. As shown on p. 508, however, many forms of electrical disturbance, such as travelling waves, have the characteristics of very high frequency currents, and their evil effects are guarded against efficiently by means of condensers.

The Moscicki Condenser.

The Moscicki condenser (British patent 1,308/1904) is illustrated in Fig. 13. It consists of a glass tube, A, coated on the inside and outside with chemically deposited silver, which is afterwards electroplated. This method of forming the coating obviates any danger of air bubbles being enclosed between the coating and the glass, which would be a source of danger. The thickness of the glass tube is kept as small as possible in order to get a high capacity. It is found that the most likely places for a breakdown of the dielectric to occur is at the edges of the coatings. This is due to the concentration of the electric stress at this spot. To guard against this danger the glass tubes are thickened at the upper end, and thus possess a great resistance to puncture at this dangerous region. In order to obviate surface discharges taking place from the edges of the coating, the neck of the condenser is fixed inside a porcelain insulator, and the whole space filled with insulating compound, so that the edge of the coating is buried in the same. The condenser proper is mounted in the outer metallic tube B, the annular space between the two being filled with a low freezing point mixture of water and glycerine. By this means local heating is avoided. Moscicki condensers can be constructed to withstand peak voltages of 60,000 volts, and a single tubular condenser 3 in. in diameter (over all) and 14·9 in. long (over all) will have a capacity of about 0·005 mfd.

It is claimed that in spite of the use of glass as dielectric that Moscicki condensers are very robust and strong articles. Naturally, from an electrical point of view, nothing better than glass for making a high-voltage condenser could be used. It may be mentioned that the glass tube is elastically supported inside the outer metallic tube by means of a rubber sleeve. The outside coatings of the condenser tube end just by this rubber sleeve, but are continued over the rubber by means of graphite paint, thus ensuring metallic continuity between the silver coating of the glass tube and the outer metal tube. The inside silver coating of the condenser tube extends practically right up to the end of the tube.

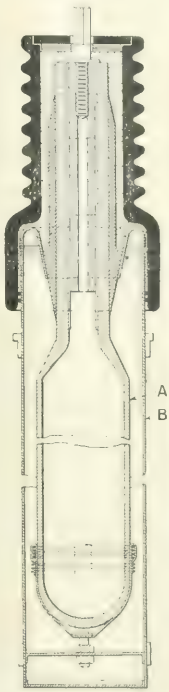


Fig. 13. Cross-section of Moscicki Condenser.

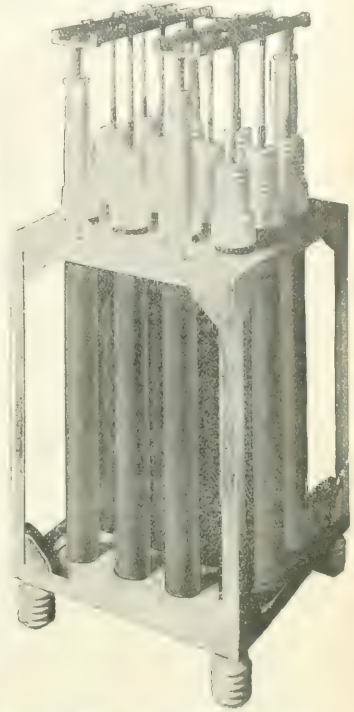


Fig. 14.—Battery of Moscicki Condensers.

The tubes are assembled in metallic frames in the form of batteries, a sufficient number being connected in parallel to give the requisite capacity.

An illustration of a complete battery is shown in Fig. 14.

The Meirowsky Condenser.

The Meirowsky condenser (*see* Fig. 15) as made for protective purposes is somewhat similar in external appearance to the "Moscicki" condenser. As dielectric, a fibrous material known as "pertinax" is used, the condenser plates being of tinfoil pressed into the pertinax. The chief advantage claimed for the Meirowsky type is that it is unbreakable. On the other hand, the dimensions are higher with the glass tube type, and, of course, the chief point of the Moscicki patent—viz., the thickening of the dielectric at the edges of the coating—is absent. It may be added that "pertinax" consists of paper treated with "Bakelite" insulation.



Fig. 15. Battery of Meirowsky Condensers.

Switches for Disconnecting Condenser Batteries.—If an ordinary air-break switch be used for connecting and disconnecting condenser batteries, the condition may arise of an arc in an existing in series with the high capacity. The c-

apt to be a source of danger when pressure rises. An oil disconnecting switch could be used with safety, but this would be expensive. A simple and cheap method is to connect the condenser through a high resistance, gradually short-circuiting same when closing, and gradually introducing same into circuit when opening. Such a resistance is formed conveniently by a mixture of distilled water 20 per cent., and chemically pure glycerine 80 per cent., contained in a glass tube. Such a resistance charging switch as used with batteries of Moscicki condensers is illustrated in Figs. 16 and 17. These switches are only necessary for voltages above 8,000 volts. It will be seen the

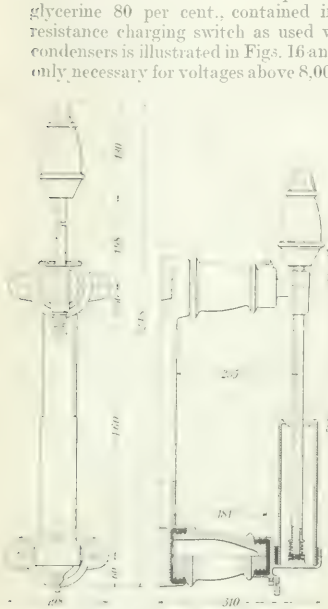


Fig. 16.—Switch for Gradually Charging Moscicki Condensers Indoor Type.

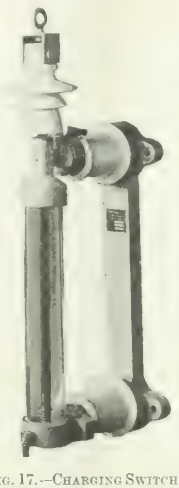


Fig. 17.—Charging Switch for Moscicki Condensers Outdoor Pattern.

arrangement consists of two porcelain insulators. The lower one carries the one terminal and the tube of glycerine solution, and the upper one the movable electrode which is raised and lowered by means of a string or similar method.

(*To be continued.*)

ELECTRICAL PRECIPITATION.*

BY [illegible] COTTRELL.

The author gives a review of the development of the work on electrical precipitation and outlines its future progress.

The earliest reference to the application of electrical forces to [illegible] of Halle in 1824, who was the first to point [illegible] as a practical matter. Nothing further [illegible] 1850, when C. F. Gottard mentioned a similar [illegible] to be observed incidentally on tobacco smoke in a [illegible]. Beyond [illegible] no further notice seems to have been taken of the subject till 1884, when there is a record of a patent [illegible] to A. L. Weber, superintendent of a large lead [illegible] dated August 9, 1884. There is also a [illegible] dated October 2, 1884, issued to Dr. Carl [illegible] Weber [illegible] Oliver Lodge about that time, [illegible] of these appear except in a Paper read before the Royal Institution in May, 1886. Following Lodge's work, [illegible] for the Bank Lead Works, for [illegible] machines, 64 in [illegible] connected in series to a single [illegible] ends

* Abridged from a Paper read before the American Institute of Electrical [illegible]

placed in the flues of the lead smelter. Nothing further is heard of this installation, and it is evident that it proved entirely impracticable to maintain in continuous operation.

About 1905 experiments were undertaken, on the clearing of fumes from acid works in California, by the University of California to determine the practicability of these general methods, using more modern apparatus, or substituting the modern high-tension transformer with the auxiliary apparatus necessary, for the friction machine, and working out a more efficient system of electrical distribution. Out of that grew some interesting laboratory experiments which looked promising, and these attracted the attention of some of the local manufacturing concerns who were willing to carry the work further. It was very soon found that the work would have to be put on a more stable basis than it was possible for the author and others to do at the University, as members of the staff, and carry the thing to a practical issue.

That led eventually to the organisation of the present institution which is handling the work. It was realised that it would be difficult for the University itself to undertake this work, and there was a distinct prejudice against purely commercialising the matter in the hands of any one commercial organisation. A scheme was worked out to develop the patents under the guidance and backing of local capital, with the understanding that when the money invested had been returned, and a reasonable profit secured, that the patents should go over to some holding organisation to be used for the benefit of scientific research. It was expected then that that organisation would be the University of California, but as the work developed it took more time and money than was anticipated, and had spread over such a large territory that it seemed impracticable to administer it from a single institution. This would also tend towards the commercialising of educational laboratories. After coniderable search for the best means of carrying this out, the patents were turned over to the Smithsonian Institution, and by it transferred to a corporation which was formed under its auspices—its guidance at least—called the Research Corporation, organised as a business organisation with directors and a charter, to conduct the business of the research work, and to turn over the property to the Smithsonian Institution and other national institutions.

Simultaneously with this development in the East there came a development in the West. At the universities of Kansas and Pittsburgh, under the direction of Prof. R. K. Duncan, the work dealt more particularly with black smoke, which was the specific problem in the city of Pittsburgh. This work was financed by Mr. R. B. Mellon, of Pittsburgh, and out of it grew the Mellon Institute of Industrial Research and School of Specific Industries. The work of the Mellon Institute not only covered electrical precipitation but other fields. The electrical precipitation, however, formed a prominent part of this work, and co-operation in this direction between the two institutions has come about to the advantage of each. What has been actually done by these institutions is told in other Papers, but as to how far this work will go beyond its present state is an interesting problem.

In Lodge's original plans there were two distinctly separate conceptions, two separate lines of attack, one was directed at the precipitation or collection of industrial fumes and smoke, house smoke and volatile matter, or at least man-made fumes. The other was directed to the question of fog precipitation in the open, the clearing of route for navigation, the clearing up, particularly (as the idea existed in Lodge's mind) of the fogs of London. That, in one sense, looks like a greater task, like a more hopeless task, than those we have undertaken. In another sense, perhaps it is in some ways the easier of the two. The commercial developments of fume precipitation were matters in connection with which direct financial support could be got from individual firms, but the clearing of fog in the open is a thing in which it will be harder to interest business interests. It is a matter of public interest, and it was felt that it was best attacked after the other work had been established. Also it is a matter which will require probably more powerful apparatus, and the small installations that have grown up to the present time have been a forerunner of that.

The possibilities of experiments in this direction are growing rife along among the shipping and other interests, to whom the fog question is a vital one, and it is entirely probable that within the next few months a direct start may be made in experiments along this line. Lodge has carried out some very startling experiments in this direction already. On the top of the building in his old headquarters at the Physics Laboratory at Liverpool, before he left there to go to Birmingham, he erected a mast, practically a flagpole, carried a wire up that to the top, and charged that simply from a series of large electrostatic machines available at the laboratory, and was able to gradually dissipate the fog for several hundred feet around the wire. That at least represents what may be hoped for. The line of attack

taken up would probably be somewhat different from that. The method would probably lie more in finding a means of carrying an electrode system, slightly modified, but in general not so different from those at present in use in the flue systems, in front of the vessel that was to be protected from fog dangers. Aerial problems are coming fairly and distinctly in the field of the engineer, and in talking with aeronautic people they do not see why there should be any question of carrying at a couple of boat lengths ahead of the vessel, from each side, an apparatus, such as the electrode system. By connecting that to high-tension apparatus, such as you will see operating here, on shipboard through the cable that is supporting this motor, you would have a broom, so to speak, sweeping a path clear in front of that vessel, that would give you room enough to stop if you were about to run into anything. If you wreck the helicopter, that does not amount to much, and that can be deflected in a shorter time than that in which you can stop a large vessel. This is offered purely as a suggestion as to the line of work that may be taken up, but it is not half as big a jump into the dark as it would, perhaps, seem at first sight. Some of the steamship people in New York have indicated their willingness to go forward with the work and supply the necessary means to carry on preliminary tests to see what may be done in the matter, and it is hoped some such development may take place in the near future.

THE THEORETICAL AND EXPERIMENTAL CONSIDERATION OF ELECTRICAL PRECIPITATION.*

BY A. F. NESBIT.

Summary.—Laboratory apparatus for electrical precipitation is described and a practical precipitator, designed by the author and Dr. Strong, is illustrated. Details of its working are given.

Consideration is first of all given to the phenomena of ionisation and the laws of electrically charged bodies upon which the theory of electrical precipitation of suspended matter in gases is based. The author then outlines the general theory of electrical precipitation.

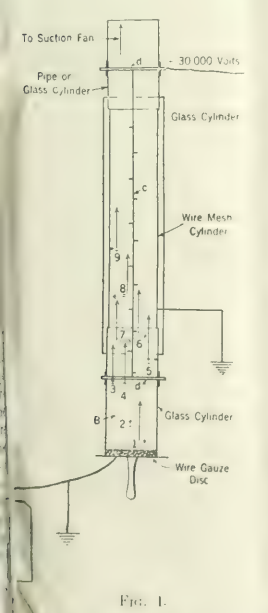


Fig. 1.

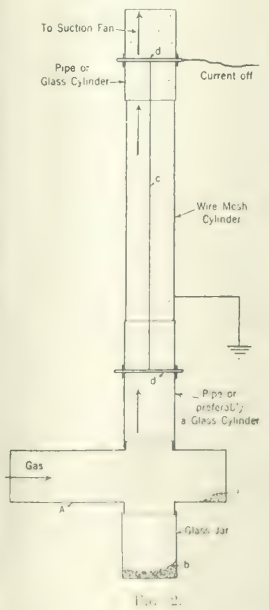


Fig. 2.

Research Work on Electrical Precipitation.—Some idea of the phenomena attending the precipitation of suspended particles in gases by the electrical process was obtained by means of special apparatus as shown by Figs. 1 and 2. The glass cylinder, Fig. 1, 6 in. inside diameter, completely enclosing the 4 in. wire-mesh cylinder 5 in. in diameter, was sealed to the brass plate and also to the upper glass jar or pipe leading to the suction fan. Thus was thus eliminated any possibility of an in-draught of air through the wire mesh cylinder which constituted the grounded electrode. The wire *c* in Figs. 1 and 2 represents the active electrode of the system, and was placed axially within the wire-mesh cylinder, being supported at either end by means of heavy walled glass tubes *dd*. Connection to the high-voltage electrical circuit was made through the upper glass tube *d*.

In the experiments to be described, all cylindrical parts of the apparatus were of glass, except the wire-mesh cylinder and the cross A of stove pipe in Fig. 2. Ample insulation was thus provided against any leakage of electricity from the active electrode *c* to any part of the apparatus, except corona discharge between the wire *c* and the grounded wire-mesh cylinder. The electrical circuit consisted of a high-voltage transformer capable of stepping up from 220 volts to as high as 80,000. The high-voltage side of this transformer was connected through a mechanical rectifier of the Lempe type, and one side of the circuit was taken to the upper end of the active electrode *c*, the other side going to ground. A potential of about 30,000 volts was needed to get a strong negative corona discharge from the wire *c* towards the wire gauze.

Referring now to Fig. 1, very fine pieces of thin tissue paper, tin foil and gold leaf, fine shreds of silk fibre and other light substances were placed on the wire gauze disc. Every precaution was taken to insure that these particles of paper, &c., were free from any electrical charges, the disc being first connected to a delicate gold leaf electroscope, which gave no indication of charges, and then earthed. When the electrical circuit was open, and a gentle suction applied by means of a fan connected to the top of the apparatus, the light pieces of paper, tin foil, &c., were lifted off the wire gauze disc, and floated lazily along through the wire gauze cylinder without any definite or prescribed course. Some of these particles jostled against their companions and aimlessly wandered along with the gentle current of air.

Upon closing the electrical circuit, however, the particles almost invariably flocked very quickly toward the wire *c*, only to be hurled, as it were, away from it an instant later and start on their journey toward the wire-mesh cylinder, where the electric field was very much less intense. When such particles have once reached the earthed electrode, they sink more or less aimlessly down the inner wall of this electrode.

In Fig. 2 the glass cylinder surrounding the wire gauze cylinder of Fig. 1 was removed, and simultaneously with the application of a strong suction action at the top of the apparatus, a current of air laden with finely suspended particles was forced into the left end of the cross pipe A, as indicated by the arrow. The slight in-draught of air through the wire mesh prevents any appreciable passage of the suspended particles out through the mesh. Upon closing the circuit a change quickly took place. The particles, which in Fig. 2 had been moving aimlessly along with the gaseous stream, were now acted upon by the electrical forces, so that they were hurled bodily out through the wire mesh with considerable velocity, and to a distance of several feet.

Lastly, taking the case where the 6 in. glass cylinder encloses the wire-mesh cylinder in the manner described in connection with Fig. 1, on closing the circuit the space between the wire-mesh cylinder and the enclosing glass cylinder soon became filled with the particles which have experienced a motion radially out from the wire *c*, under the action of the electrical field.

Precipitation of Smoke, Cement Dust, Alumina Dust, Ashes, &c.—In the non-conducting type of particles or at least those only slightly conducting, is included a large number, of which these are prominent examples. In the presence of intense electric fields, and apart from possible initial ionisation due to high temperatures of the gases, or chemical action taking place at high temperatures, the ionisation, which takes place between the electrodes due to electronic and ionic streams, would sweep the particles to that part of the field which is the weakest, or strongest, depending upon their specific inductive capacitances. This weakest part of the field is located at that electrode which has the larger surface, such as is the case of a cylindrical pipe within which is placed coaxially a wire of small diameter. For a given length of such a cylindrical pipe, the suspended charged matter in the gaseous stream which is made to pass through the pipe, in order to reach the inner wall of the pipe before it passes out of the electric field between the wire and pipe, must move with such a velocity lengthwise of the pipe as will allow it to move in the same time a maximum distance equal to the radius of the pipe. Under these conditions, heavy aggregates, which move more slowly than finer ones, require a longer pipe of the same diameter for the same pipe velocities.

A precipitator based on these principles was designed by Dr. Strong and the writer, and Figs. 3 and 4 give the general appearance of the top of the outfit, when 900 cubic ft. of coal smoke was moving

* Abstract of a Paper read before the American Institute of Electrical Engineers.

through it, at a velocity of about 5 ft. per second. Two circular groups of eight and 17 pipes respectively, each pipe 4 ft. long, and 5 in. in diameter, are firmly jointed to two end headers, to which the fine wires are attached, to keep them in rigid position.

While it is understood that ionic streams may be produced in varying degrees of intensity by point, brush and corona discharges, it is with the last-named type of discharge that this precipitator operates. Comparing the cleaning action of the positive and negative corona discharges with that due to an alternating corona, the following values give an idea of the relative efficiencies of the three kinds of discharges:

1. The alternating corona precipitates about 50 per cent. of the suspended matter.

2. The positive corona precipitates about 70 to 80 per cent. of the suspended matter.

3. The negative corona precipitates about 95 to 98 per cent. of the suspended matter.

The unfitness of the alternating-current corona discharges arises from the fact that the reversal of the polarity of the active electrode,



Fig. 3.—Precipitator out of action.

at which the field is very intense, results in a greater or less reversal of the direction of motion of the electrons and ions which are already on their journey toward the walls of the pipes. By this action many of the ions are more or less partially pulled back into the central region of the pipe, and before they ever reach the walls or an equivalent distance from the wire, the smoke or dust particles thus charged may have been carried out of the pipe and thus do not suffer precipitation. With hot air passing through the precipitator, and with a negative corona the breakdown voltage is somewhere near 32,000.

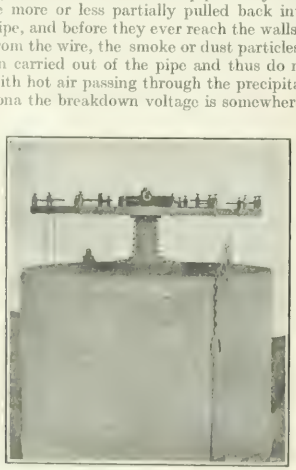


Fig. 4.—Precipitator in action.

Current with the negative corona is slightly greater. With a positive corona the results are lower with both hot and cold air. Very little difference in the voltage, from those given for cold air, were detected in the case of cold smoke. With smoke so hot that tar trickles down the central line or active electrode, and also down the pipe wall, the voltage had to be increased from 33,000 to about 28,000, in order to prevent violent disruptive discharges. Unless there is much moisture present, or the ingredients in the gaseous streams are sticky in nature due to their high temperature, there will be but little deposit on the electrodes. In any event, such a deposit suffers a tendency to be dislodged due to the slight vibration of the wire or the occurrence of a disruptive discharge of short duration. This variation in voltage must be brought about by a hand or automatic regulation in a very short time in order to avoid the establishment of an arc. If the impressed voltage is not too near the breakdown value, a disruptive discharge may continue for several seconds and then break, giving way again to the silent discharge. The presence of fine points or irregularities on the inner walls of the pipes tends slightly to localise the discharge. Fine points due to hardened deposits, kinks in the wire, or rough spots on its surface very materially localises the discharge from the active electrode; and even though there may be many such local discharges, the cleaning action of such discharges is much below that of the perfectly uniform field about a smooth wire although it may have considerable deposit on it.

Smoke, or other suspended particles contained in the gaseous streams passes with considerable freedom from being precipitated through the positive corona, the alternating corona, or the localised type of discharge. With the cylindrical pipe type of precipitator described, about the same efficiency of cleaning was obtained for a number of materials, such as ashes, alumina and cement dusts, fine powdered clay, sand, and hot and cold smoke.

Applications of Electrical Precipitation.

A study of electrical precipitation processes and apparatus, applied to the cleaning of producer and blast furnace gases, is a field in itself of immense value to all interested in the steel industry. We must admit that proper methods of firing furnaces whether in power plants, mills, factories, or our homes, and either by hand or mechanical devices, will do a great deal to eliminate a large amount of our inexcusable smoke nuisance. However, there are many instances where, through limitations of furnace room space, equipment, &c., the furnace, fired by hand or by a stoker, is called upon to do a duty two or three times its normal rating. Under such conditions an electrical precipitation outfit might be of service either continually or at intervals, because it will precipitate the ash as well as the carbon particles. The mechanical stoker, when properly used, eliminates very largely the carbon constituents of smoke by providing conditions of more perfect combustion, but it gives no aid in eliminating the discharge of ashes from the stacks of our mills and factories, or the chimneys of our homes. This item is one greatly in favour of the electrical precipitating processes when cleanliness as well as recovery of finely divided particles is the issue.

PREDETERMINATION OF THE RESIDUAL FLUX IN MAGNETS.

BY KENELM EDGCUMBE, M.INST.C.E.

The importance of the magnet, whether permanent or electromagnetic, in the construction of electrical measuring and controlling apparatus is so great that it is curious how little has been published on the subject of its design. Nearly three years ago Prof. S. P. Thompson delivered a most instructive address on the subject of permanent magnets,* in which the choice and treatment of the steel for this particular purpose was very fully dealt with. Nevertheless, the application of the principles involved in the design of magnets for use with instruments and the like does not seem to be so fully understood as should be the case.

The work which has been done in connection with the magnetic circuits of generators and motors is of little use in this connection, since the fundamental requirement in that case is maximum flux compatible with moderate weight, whereas for instrument magnets it is the value of the hysteresis which is the determining factor, a maximum being required for permanent magnets and a minimum for electromagnets.

Dealing first with the electromagnet, curve I, Fig. 1, represents, to an exaggerated scale, the B, H curve for a closed ring of soft iron. The ordinates give the magnetic density in the iron, and the abscissæ the corresponding magnetising force per centimetre length of path, both quantities being expressed

* "Journal" I.E.E., Vol. L., p. 80. See also The Electrician, Vol. LXIX., p. 452, June 24, 1912.

in C.G.S. units.* Curve II. is a similar curve for an air-gap, in which case the permeability is unity at all densities (*i.e.*, $\frac{B}{H}=1$), so that the " curve " is a straight line at an angle of 45 deg.

If the magnetic circuit, instead of being entirely of iron (curve I.), or entirely of air (curve II.), consists partly of each, the total magnetising force will, clearly, be the sum of those required for the iron and air paths respectively. On the assumption that the length of these two portions is the same, the B/H curve will be as shown in curve III., in which each point (such as b') is obtained by setting off from curve II. a horizontal distance equal to that of the corresponding point (b) from the vertical line; that is to say, the total magnetising force for a density b' is $Oh_i=Oh_i+Oh_a$.

When applying this construction to an actual case, it must be borne in mind that :—

1. It is assumed that the lengths of iron and air paths are equal, so that Oh_i is the magnetising force for each 2 cm. of combined path (*i.e.*, 1 cm. of iron, together with 1 cm. of air).

2. The cross-sectional areas of the two paths are assumed to be the same, so that the flux densities in air and iron are the same.

3. The scale chosen for B must be the same as that chosen for H.

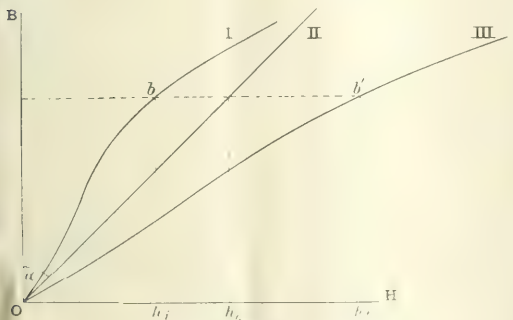


Fig. 1.

In practice these assumptions are seldom applicable, and the following corrections are necessary, B having reference, throughout, to the flux density in the iron :—

1. If the length of air path, instead of being equal to that of the iron, is $1/l$ of it, then the magnetising force required for the air will be Oh_a/l, so that :—

$$\tan\alpha=\frac{\text{length of air path}}{\text{length of iron path}}$$

2. Similarly, if the cross-sectional area of the air path differs from that of the iron, then :—

$$\tan\alpha=\frac{\text{length of air path}}{\text{length of iron path}}\times\frac{\text{sectional area of iron path}}{\text{sectional area of air path}}$$

As already stated the magnetic flux density obtained in this way from curve III. is that in the iron. To obtain the density in the air, the value of B for the iron must be multiplied by the ratio

$$\frac{\text{sectional area of iron}}{\text{sectional area of air}}.$$

3. If the scales chosen for B and H differ, so that equal divisions on the sectional paper used represent a flux density of b and a magnetising force of h, then, finally, we get

$$\tan\alpha=\frac{\text{length of air path}}{\text{length of iron path}}\times\frac{\text{sectional area of iron path}}{\text{sectional area of air path}}\times\frac{b}{h}$$

In the work from a knowledge of the B/H curve of the particular quality of iron used and the dimensions of the iron and air paths it is easy to draw the corresponding B/H curves for [illegible]

[illegible]

any simple magnetic circuit, and from it to determine the magnetising force (*e.g.*, in ampere-turns) necessary to produce the desired flux density in the iron, neglecting leakage.

For our present purpose, however, namely, the design of an electro-magnet for a measuring instrument, such, for example, as an iron-cored moving-coil wattmeter, it is the hysteresis which concerns us most, and a precisely similar construction can be applied to the hysteresis loop. Curve I. in Fig. 2 represents such a loop for an iron ring, plotted to an exaggerated scale. Curve II., as before, is the B/H curve for an air-gap, and since air exhibits no hysteresis, this curve may be regarded as the corresponding hysteresis loop for air. Next, that for the entire magnetic circuit (curve III.) is obtained from curves I. and II. in the way already described ; points on that part of curve I. which lies to the right of the vertical line being set off to the right of curve II., and *vice versa*. The slope of curve II. is obtained as before, namely, by making

$$\tan\alpha=\frac{\text{length of air path}}{\text{length of iron path}}\times\frac{\text{sectional area of iron path}}{\text{sectional area of air path}}\times\frac{b}{h}$$

The residual flux density for a complete iron ring is shown by the point (b) at which the descending branch of loop I. cuts the vertical, and in the case of the combined iron-air circuit this residual magnetic density is reduced to b_1—namely, the point at which loop III. cuts the vertical. This point can be determined from the hysteresis curve (I.) without the necessity of plotting curve III. at all. If a straight line, OP (Fig. 2) be drawn to the left at an angle α, with the vertical, it is easy to show that the point p, at which it cuts the descending curve of

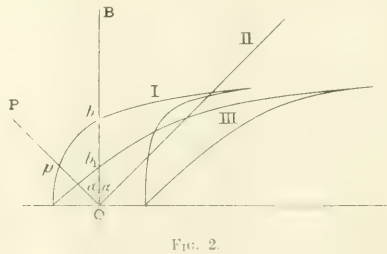


Fig. 2.

the hysteresis loop corresponds to the point b_1, and represents the residual density in the iron.

In any given magnetic circuit, therefore, if the respective dimensions of the iron core and air-gap are known and also the shape of the hysteresis curve, the residual magnetic density to be expected can readily be determined. An inspection of Fig. 2, moreover, shows how effective is the introduction of an air-gap in reducing the hysteresis error in an instrument, such as a direct-current wattmeter, the accuracy of which depends upon the absence of hysteresis. It may be mentioned that, even if the actual hysteresis curve is not available, it can safely be assumed that if the ampere-turns required for the iron (h_i) are $1/n$ of the total ampere-turns (h_t), then b_1 will be not more than b/n and will, probably, be less. Fig. 1, again, shows that the longer the air-gap the more nearly does the B/H [illegible] becomes proportional to the magnetising force, which is another essential in the magnetic circuit of a wattmeter.

Turning, now, to the other extreme—namely, the permanent magnet—Fig. 3 represents the descending branch of the hysteresis loop of a hardened steel ring. The coercive force is [illegible] If an air-gap is introduced into the circuit, the line OP can be [illegible]

[illegible]

[illegible]

[

remanent flux density is reduced. In fact, tan α is often spoken of as the "coefficient of self-demagnetisation," and, although not then so readily calculated, can be applied to bar magnets as well as to the horse-shoe magnets now under consideration.

As is well known, the remanent magnetisation, whether it be b or b_1, is unstable, and liable to be reduced either by mechanical, thermal or magnetic influences. It is usual, therefore, artificially to "age" magnets which are intended to retain their strength and, either by repeated blows, submission to a comparatively high temperature or to demagnetisation by an alternating current, to reduce the remanent magnetic density to a lower value, say, b_2. In practice, b_2 is usually about 80 per cent. of b_1.

A convenient, although possibly somewhat unorthodox, way of looking at the matter is to assume that a permanent magnet is the seat of a magnetising or magneto-motive force of its own, equal to Oh_1. If the magnetic density in the iron and in the air-gap is b_2, in each case, the magnetising force per centimetre required for the latter will be Oh_2, leaving $h_1 h_2$ still available for the steel. Of this, only $h_1 h_3$ is essential for maintaining a density b_2 in the steel, so that the remainder—namely, $h_3 h_2$, forms a protection against further demagnetisation. It is evident that the lower b_2, the greater does $h_3 h_2$ become, and the less liable is the magnet to be demagnetised.

Reverting, now, to the determination of the remanent magnetic density (b_1) from the hysteresis loop, by the method shown in Fig. 3, an actual example may be of interest. Fig. 4

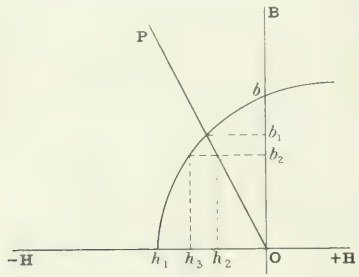


Fig. 3.

represents, to scale, a portion of the B/H curve of a fairly good sample of hardened magnet steel, the scale chosen being such that a B of 100 corresponds to an H of 1.

In a recent Paper, Messrs. Fitch and Huber * give particulars of the magnetic circuits of a number of moving-coil instruments. Taking a typical case from this Paper, one of them had a total length of air-gap of 1·73 mm. and a magnet length of 224 mm. The sectional areas were 910 sq. mm. and 390 sq. mm. respectively. In this case, then:—

$$\tan\alpha = \frac{1{\cdot}73}{224} \times \frac{390}{910} = 0{\cdot}0033.$$

In order to apply this value to Fig. 4, it must be multiplied by the scale ratio, namely, 100, so that we have:

$$\tan\alpha = 0{\cdot}33.$$

In Fig. 4, a line has been drawn at this angle, and is seen to cut the curve at the point B=8,800, showing that with this particular brand of steel a magnetic circuit of these dimensions might have a remanent flux density of 8,800 lines per square centimetre. This would in practice, probably, be reduced by some 25 per cent. through "ageing," &c., so that the net remanent flux density would be about 6,600. As a matter of fact, the density found by Messrs. Fitch and Huber in this particular instrument was 6,500, so that the agreement is close.

It must be admitted, however, that such a result is largely accidental, since neither the nature of the steel, the heat treatment received, the degree of magnetisation given to it, the amount of "ageing," nor the leakage coefficient is known. It is sufficient, however, to indicate that when the hysteresis curve is given it is a comparatively easy matter to predetermine the flux density in the way described.

In a number of cases the actual shape of the hysteresis curve is not known, but only the magnetic constants for the steel, namely, the remanent magnetic density (B_r) and the coercive force (H_c). A rough approximation can be made in such

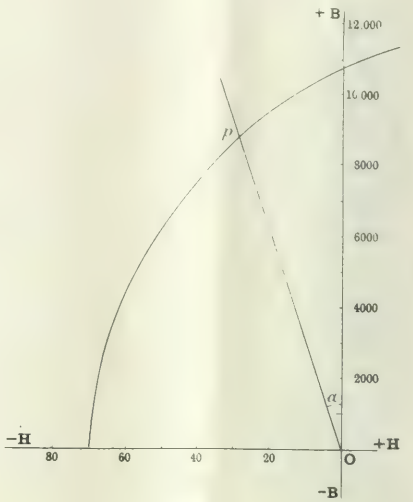


Fig. 4.

cases on the assumption that the descending portion of the curve (*see* Fig. 4) has the form of an ellipse, the axes of which are OB and OH. If this is the case, by choosing such a scale for B and H that $B_r = H_c$, the curve becomes a circle (*see* Fig. 5) and the length Op is the same for all values of tan α.

After calculating tan α as before, put:

$$k = \tan\alpha \times \frac{B_r}{H_r}.$$

Let B be the flux density, which is to be determined, and H be

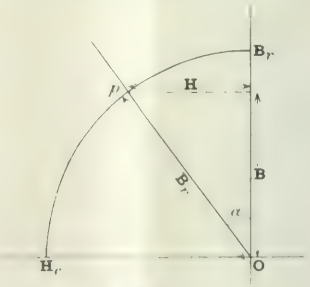


Fig. 5.

the corresponding magnetising force. Then, under the conditions assumed:

$$H : B = k, \text{ or } H = Bk;$$

but $B^2 + H^2 = B_r^2$,

therefore, $B^2 + (Bk)^2 = B_r^2$,

so that $B^2 = \frac{B_r^2}{1 + k^2}$, or $B = \frac{B_r}{\sqrt{1 + k^2}}$.

Applying this to the instrument cited above as taken from Messrs. Fitch and Huber's Paper, and assuming the magnet

* Bulletin of Bureau of Standards (Washington, U.S.A.), Vol. VII., No. 1[illegible]

be constructed of the steel, of Fig. 4, and for which it will be seen that $B_r=1{,}070$ and $H_c=70$, we have :—

$$k=0{\cdot}0033\cdot\frac{1{,}070}{70}=0{\cdot}505,\ \text{or}\ k^2=0{\cdot}254\ ;$$

therefore $$B\sqrt{1-0{\cdot}254}=\frac{1{,}070}{1{\cdot}12}=9{,}550.$$

Allowing 25 per cent. loss, as before, B becomes 7,170, and it will be remembered that the figure obtained direct from the curve was 6,600, while the measured value was 6,500, so that the discrepancy is not large.

In many cases it is the effect on the flux of a change in the dimensions of the magnet or the air-gap which is required ; in fact, this is usually of greater importance than the determination of the absolute flux density. In this case the assumption made above of a hysteresis curve corresponding to part of an ellipse can be made with still greater assurance, since the change of angle is comparatively small.

Let $\tan\alpha$ and k be calculated, as before, from the existing dimensions of magnet and air-gap (k_1) and also for the proposed dimensions (k_2), then :—

$$\frac{B_1}{B_2}=\sqrt{\frac{1-k_2^2}{1-k_1^2}}$$

As a concrete example, the effect of doubling the air-gap in the case of the same moving-coil instrument may be considered. In this case we have :—

$$k_1=0{\cdot}505,\ \text{or}\ k_1^2=0{\cdot}254.$$
$$k_2=0{\cdot}505\cdot 2=1{\cdot}01,\ \text{or}\ k_2^2=1{\cdot}02\ ;$$

therefore, $$\frac{B_1}{B_2}=\sqrt{\frac{2{\cdot}02}{1{\cdot}254}}=1{\cdot}27.$$

B_1 was found to be 6,500, so that B_2 would become 5,120. That is to say, doubling the length of air-gap has only reduced the flux by about 20 per cent., showing that apart from questions of damping, weight on pivots, &c., this particular instrument could be considerably improved by employing a longer air-gap and winding more turns on the moving coil. However, a discussion of these questions would be beyond the scope of the present article, the object of which is only to show how the principles outlined can be applied to concrete cases.

A NEW FORM OF RESISTANCE THERMOMETER.*

BY S. LEROY BROWN.

Summary.—The oxides of certain metals, when melted and moulded into rods, have a very large variation of resistance with the temperature. The author describes thermometers made from these rods and gives the results obtained.

The metallic oxides are generally considered to be non-conductors of an electric current. At room temperature or lower they are very poor conductors, but at higher temperatures most oxides can be considered as conductors. Mr. A. A. Somerville† has shown that a specimen of copper, iron or zinc oxide may reduce its resistance from several million ohms at room temperature to a few hundred ohms at 1,000° C. The determination of the resistance of a powdered specimen or a solid form which has been obtained by baking the powdered specimen, must necessarily give results which are only applicable to the particular sample under test, since much must depend on the completeness obtained in each case. The object of this Paper is to give the results of the determination of the resistance of oxides which have been melted and moulded into solid rods, and to show the application of their resistance-variation with temperature as resistance thermometers.

Solid rods were obtained by filling porcelain tubes with powdered or solid forms of the oxides and melting the oxide by placing the tubes in a tubular electric furnace. By packing a porcelain tube which was 12 in. or 15 in. long with powdered copper oxide, melting the oxide and allowing it to cool and harden, a solid rod can be obtained 5 in. or 6 in. long and $\frac{3}{8}$ in. in diameter. The sample can be used encased in the porcelain, which affords some protection, or the porcelain may be ground away on an emery wheel and the bare solid oxide obtained. The results show that a resistance thermometer can be made with a metallic oxide as the element which will withstand very rough heat treatment and any reasonable mechanical treatment, and still retain the same electrical resistance at a particular temperature. Several months' use of such a thermometer with iron oxide as the element showed that many reheatings to temperatures ranging from 100° C. to 500° C. failed to cause any measurable change in its resistance. The principal difficulty in the resistance measurements is caused by poor and variable contact resistance where the metal leads are connected to the oxide. Satisfactory connections were made by clamping two pairs of leads against the ends of the oxide element, and the potentiometer method of measuring its resistance was used connected as indicated in Fig. 1. The variable contact resistance between the

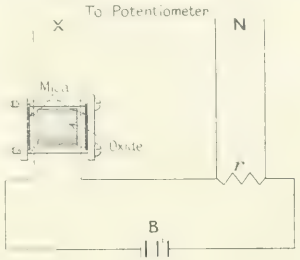


Fig. 1.

oxide and the exciting-current leads is thereby eliminated if a potentiometer balance is made with the standard resistance immediately after each balance is obtained with the oxide element.

The solid copper oxide elements, with which the following data were obtained, were formed by filling a porcelain tube with cupric oxide and heating to about 1,400° C. in an electric furnace. At this temperature the CuO reduces to Cu_2O. The melted cuprous oxide was withdrawn from the furnace and quickly cooled. Chemical analysis of the solid formed showed it to be about 98·7 per cent. cuprous oxide. If cuprous oxide is maintained at about 800° C., it will decompose into cupric oxide and free copper. This means that the upper limit of the cuprous oxide resistance thermometer is certainly under 800° C.

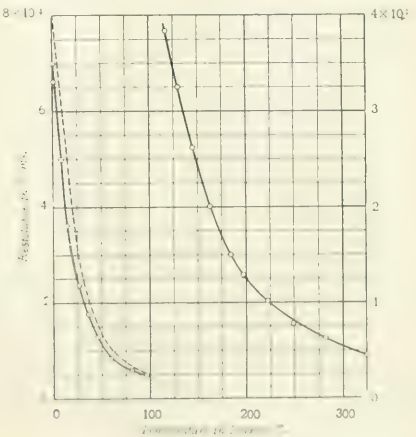


Fig. 2.

The solid iron oxide elements were made by filling a porcelain tube with ferric oxide, heating to about 1,550° C. and then allowing to cool. The melting of the ferric oxide caused a reduction to magnetite (Fe_3O_4), and therefore the solid elements which were used as iron oxide resistance elements are solid magnetite. Chemical analysis showed the solid to be magnetite. The solid lead oxide was obtained by melting the powdered lead oxide in an electric furnace in the same manner as described for the copper and iron oxide.

Short elements with comparatively large cross-sections can be made which have only a moderate resistance at room temperature,

* Abstract of an article in the Physical Review.

† "Metallurgical and Chemical Engineering," Vol. X., No. 7, p. 422, July, 1912.

and small heat capacity. Iron oxide (Fe_3O_4) and cuprous oxide (Cu_2O) gave the most satisfactory results (as far as the author's investigation was extended) for temperatures ranging from a few degrees below zero to 400°C. or 500°C., although lead oxide (PbO) can be used very satisfactorily between 100°C. and 600°C. The lead oxide is more brittle than either iron or copper oxide, and, therefore, is easily cracked or chipped. The extremely high resistance of lead oxide at room temperatures necessitates a very thin element in order that its resistance be not prohibitive. The accompanying data and curves show the temperature variation of resistance for the three oxides and the sensibility of an iron oxide resistance thermometer

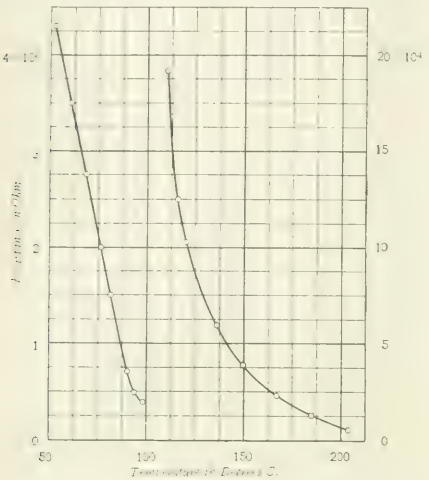
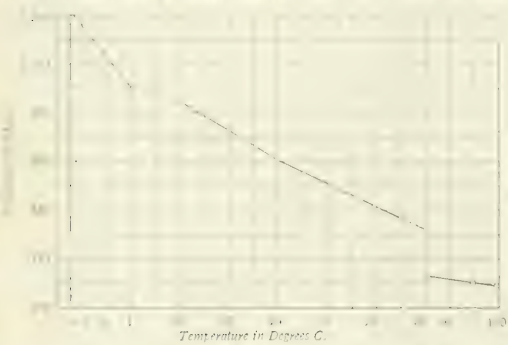


FIG. 3.

at several temperatures. The sensibility at a particular temperature is expressed as the change in resistance per degree per unit of resistance at the particular temperature; that is, the sensibility at a particular temperature is the slope of the temperature-resistance curve at that temperature, divided by the resistance at that temperature. The sensibility of these thermometers is very much higher at low temperatures, but they are sufficiently sensitive at high temperatures to warrant their use.

Oxide Resistance Thermometer No. 1.—The resistance element of this thermometer consists of a cylindrical piece of cuprous oxide



on the right margin refers to the curve which pertains to temperatures higher than 100°C.

Another oxide resistance thermometer (No. 2), similar to No. 1, except it is 9·35 cm. long, has a temperature resistance curve given by the dotted line in Fig. 2 if the scale at the left margin is multiplied by 100.

Oxide Resistance Thermometer No. 3.—The element of this thermometer consists of a solid piece of lead oxide (PbO) which is 0·7 cm. long and about 0·75 cm. in diameter. The cross-section is not quite uniform.

The curves in Fig. 3 show the resistance variation with temperature for lead oxide. The scale at the right margin refers to the curve which pertains to temperatures higher than 100°C.

Oxide Thermometer No. 4.—The resistance element of this thermometer consists of a cylindrical piece of solid magnetite (Fe_3O_4) which was obtained by melting powdered iron oxide (Fe_2O_3). The length of this element is 0·85 cm. and its diameter is 0·65 cm. The resistance range was measured from —3°C. when it had a resistance of 1,377 ohms to 365°C. when it was only 18·5°C. Fig. 4 shows the resistance variation of thermometer No. 4 on an enlarged scale at room temperature, near zero, and near 100°C. The resistance of the magnetite between 10°C. and 30°C. can be expressed in terms of the resistance at 20°C. by

$$R_t = R_{20}(1{\cdot}82 - 0{\cdot}0524t + 0{\cdot}000577t^2)$$

with an error of less than 0·2 of 1 per cent., where t is the temperature of the oxide in degrees centigrade. If the resistance of an iron oxide

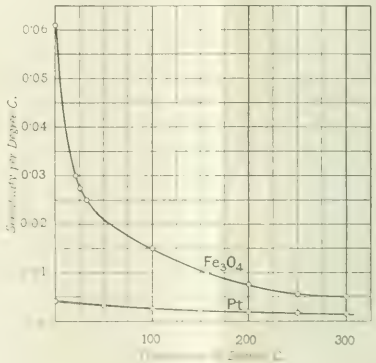


FIG. 5.

thermometer is accurately determined at a known temperature which is near 20°C., an unknown temperature which is greater than 10°C. and less than 30°C. can be determined by the aid of the above parabolic equation with an error of less than 0·1°C. The sensibility of a magnetite thermometer and of the platinum resistance thermometer are shown graphically in Fig. 5. A comparison of the two curves shows that the magnetite thermometer is about 16 times as sensitive as the platinum thermometer at ice temperature, and about eight times as sensitive at room temperatures.

DO THE WAVES OF WIRELESS TELEGRAPHY AFFECT ORGANIC LIFE?*

Dr. C. Abel-Musgrave has put the following questions to a number of well-known German scientists:—

1. Is it proved that electric forces are able to affect the life of plants and animals?
2. Is the influence injurious or beneficial?
3. Is it possible that the electric forces produced in wireless telegraphy affect organic life? And to what extent? Does any proof of such effects exist?
4. Is the biological effect of the various systems different?
5. Would it be desirable, from biological considerations to make international regulations controlling wireless communications?
6. Do you recommend that any steps should be taken to protect human life against such influences?
7. Are the forces necessary to produce a possible influence great or small?

* Abstract of an article in the "Elektrotechnische Zeitschrift," Vol. XXXVI., pp. 7, 8.

8. Can these forces be made answerable for apparent change of the climate or the pleasantness of the weather during recent years ?

Question 1.—All answered this in the affirmative so far as it related to the direct application of electricity to organic life. Some experiments made with four kinds of crops (strawberries, carrots, cucumbers and radishes) by Max Friedmann in 1907, near Vienna, gave mostly negative results, only one kind of crop—viz., carrots—showing an increased rate of growth under electric influence. The electric influence (earth currents and also a high-tension electric field acting through the surrounding air) was only applied for about two hours a day.

Question 2.—The detrimental or beneficial effect of the electricity depends on the magnitude or power of the forces acting.

Question 3.—Profs. R. M. Weber (Rostock) and Bredig (Karlsruhe) answered this in the negative, Prof. H. Boruttau (Berlin-Grunewald) adding that even the operators in sending stations had not experienced any noticeable effects. This also disposes of questions 4, 5 and 6.

As regards questions 7 and 8, Prof. R. N. Weber stated that, although certain electric stresses were capable of accelerating an impending rainfall, yet he was of opinion that the waves used in wireless telegraphy would have no such effect.

Wireless is thus discharged by the German professors without a stain on its character.

ELECTRIC HEATING APPLIANCES.*

BY C. P. RANDOLPH.

The General Electric Company (of America) has developed in the last few years an entirely new method of constructing electric heating units. Fig. 1 shows the construction and dimensions of a typical unit. The core, or electrical resistor, is made of a metal or alloy, chosen according to the resistivity desired. Air cannot penetrate the walls of the sheathing, so the ease of oxidation of the core is not important. The operating temperature of the core may be 800°C.

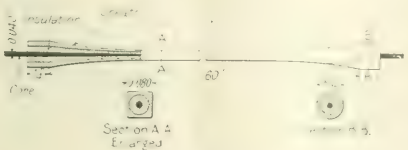


FIG. 1.—SHEATHED WIRE.

to 1,000°C. The insulation is a heat resisting material, so tightly packed that it is as hard as ordinary moulded compounds. Depending on the properties desired the sheath may be steel, copper or other metal or alloy. The sheathed wire is enlarged at the ends of terminals so that the core is cool where it enters the air, although, as mentioned above, the temperature may be 1,000°C. over the small section. Fig. 2 is a photograph of sections of two terminals. In the small cross-section, AA, Fig. 1, the core may be 0·006 in. diameter or larger. It is evident that the dimensions of the sheathed wire can be varied to suit the requirements of each heating unit. For example, a length of wire for a large boiler may have a terminal 1 in. outside diameter, the core where it enters the air may be $\frac{1}{8}$ in. diameter; the outside dimension on AA, Fig. 1, may be $\frac{1}{2}$ in.; and the total length 15 ft. Or, a unit for a large oven may have a terminal $\frac{3}{4}$ in. outside diameter, the core in the terminal may be $\frac{1}{8}$ in. diameter, the outside dimension on AA $\frac{3}{32}$ in., and the length 25 ft.

The piece of sheathed wire is formed into any required shape, either open or closed. In the "open-coil" unit the coils are directly exposed to the air, and this is the correct design for ovens and the like, where it is important that most of the heat be transmitted from the unit by convection or air circulation. When the operating temperature of the steel sheath is above 400°C., the unit and frame receive a coating of aluminium steel alloy on the surface to prevent oxidation. Except at the terminals there are no porcelains, mica pieces, or other insulators, as the sheathed wire can be supported directly on metal. The construction is just as rugged and simple as though the electrical resistor did not have to be insulated.

A hot-plate is made by pouring molten cast-iron directly around a coil of sheathed wire. As a result, we have a hot-plate which is as strong and rugged as the old-time stove-lid; in fact, it is even more rugged, as the casting is reinforced with the wire, it does not warp or crack.

The advantages of sheathed wire heating units over other constructions may be summarised as follows: (1) No fragile porcelain or mica is required to insulate the hot resistor from ground. This



FIG. 2. CROSS SECTION OF SHEATHED-WIRE TERMINALS.

allows a simple, rugged construction with minimum number of parts. (2) The open-coil unit is insulated and the operator cannot get a shock. (3) The resistor cannot be displaced. (4) The core-temperature is definite, depending only on the thermal resistance of the electrical insulation in the wire and on the temperature of the sheath.

GERMAN EXPORTS OF ELECTROTECHNICAL GOODS

An interesting table, which we reproduce below, was published in the "Elektrotechnische Zeitschrift," Jahrgang 35, p. 967, giving the exports of electrotechnical goods to the European countries at war with Germany during 1912 and 1913 in units of £50. The total export of electrotechnical apparatus in 1913 was 330,568 million marks, and in 1912 272,621 million marks. The figures for Russia include Finland, to which electrotechnical goods to the value of 3,983 million marks were sent in 1913 and 3,332 in 1912. Under the heading of switchgear and other fittings, the figures for Belgium, France and Great Britain include the electrical parts of internal combustion engines for automobiles. Also the figures given for the export of carbons include carbons for non-electrical purposes.

Goods.	Austro-Hungary.		Belgium.		France.		Gt. Britain.		Russia.		Serbia.	
	1913.	1912.	1913.	1912.	1913.	1912.	1913.	1912.	1913.	1912.	1913.	1912.
Dynamos, motors, transformers, armatures, &c....	4,952	5,494	4,484	4,118	2,994	2,665	4,852	3,468	8,530	5,623	31	127
Accumulators, batteries, &c.	216	320	191	170	46	52	184	106	85	88	—	5
Cables.....	26	347	4,250	3,357	199	76	1,060	1,122	628	754	24	56
Arc lamps, projectors.....	143	555	172	142	198	322	538	480	1,264	775	1	5
Incandescence lamps	4,532	4,044	2,377	2,156	2,624	2,607	4,458	6,467	8,810	10,061	45	54
Telegraphs, telephones, signalling apparatus, safety devices	1,021	958	1,110	735	723	585	1,870	1,263	2,078	1,893	54	18
Switchgear and other fittings	6,009	4,790	4,656	3,001	7,600	1,909	9,752	2,743	9,720	5,991	20	71
Measuring instruments and registering apparatus....	2,888	3,221	1,028	928	1,209	791	1,474	905	4,645	3,546	25	60
Insulated wires.....	266	208	1,718	1,431	299	179	6,160	1,440	886	829	70	5
Carbons.....	885	908	923	725	943	980	2,008	1,813	656	512	1	11
TOTAL.....	20,329	22,663	21,543	17,510	18,391	11,549	34,421	24,381	39,601	31,792	292	446
Percentage of whole export.	7·06	8·31	6·58	6·42	5·56	4·23	10·41	8·94	11·98	11·66	0·09	0·16

* Abstract from "The General Electric Review" (U.S.A.).

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SPECIAL NOTICE.

In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY NOON, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Advertisements of all kinds of which no proofs are required before first insertion can be accepted up to FIRST POST THURSDAY MORNING.

ELECTRICAL PRECIPITATION.

By slow degrees the electrical method of precipitating fumes, dust and fog is assuming a commercial value. To those who have followed this method from its inception it will, perhaps, seem that progress might have been somewhat less slow than it has been, for it is now many years since the matter was taken up by Sir OLIVER LODGE, and was demonstrated on a considerable scale with a view to the dissipation of fog. In those days the fog problem doubtless appeared to be more important than any other in this particular direction. At the present day, however, we are somewhat less troubled with fog than was the case 20 or 30 years ago, probably owing to the greater centralisation of power in its generation. Consequently, except at sea, the occurrence of fog is now less of an affliction. On the other hand, the precipitation, or the prevention of the emission, of smoke from factory chimneys is still a question of the highest importance from the point of view of public health, and therefore it is well worth while to pay attention to the individual case of smoke emission, as distinct from the general case of the dissipation or precipitation of smoke when once this is in the atmosphere. From this point of view a practical method becomes rather a question of working out details than anything else, and does not involve the very heavy capital expenditure which would be necessitated by any scheme for the wholesale dissipation of fog. Apart from this change from the somewhat general to the particular case, it must be remembered that the highest success can only be achieved by means of high-tension continuous currents, and the rectification of alternating currents for such a purpose has only been satisfactorily attained during comparatively recent years. Quite recently a new device suitable for such a purpose has found its way into the hands of the experimenter—namely, the Kenotron, which is due to the patient researches of Dr. LANGMUIR and others, and which was recently described in

these columns. If such a device had been available some years ago, progress might have been more rapid.

During the last few years the problem of smoke precipitation has been studied energetically at several of the universities in the United States, and as a result of these investigations apparatus has now been evolved which appears to be very effective for the purpose. We give an account of some of these developments in the present issue of THE ELECTRICIAN. As is usually the case, the commercial device has been evolved by considering the subject experimentally in the simplest form, and then passing on to the more complicated practical case. In its final form the apparatus for a chimney stack consists of a number of pipes, 4 ft. long, with axial electrodes, placed near the top of the stack, so that the electrified smoke particles are thrown against the pipe walls. Quite a number of applications have been made at important works in the United States, and we do not think there is much doubt that the method is worth serious consideration in this country.

Perhaps it may be said that the commercial features of the development are even more interesting than the technical. As already mentioned, the work has been carried out at some of the universities, notably California and Pittsburg. It will readily be understood that a point was soon reached when the question of finance became all important, and it was realised that it would be difficult for the universities to complete the work; yet there was a distinct prejudice against purely commercialising the matter. Consequently a scheme was worked out to develop the patents under the guidance and backing of local capital, with the understanding that when the money invested had been returned and a reasonable profit had been secured, the patents covering the method would be handed over to some organisation to be used for the benefit of scientific research. The University of California was largely interested in the matter, but as the work went on it appeared to be impracticable to administer work from a single institution, and it naturally tended towards the commercialising of educational laboratories—a very undesirable result. Finally, the patents were handed over to the Smithsonian Institution, and by that society were transferred to a corporation, formed under its auspices, called the Research Corporation. This Corporation was organised on business lines with a view eventually to handing back the property to the Smithsonian Institution or some other national institution. The chief difficulty in this method seems to have been to obtain sufficient capital; consequently, the progress of the work has depended to a large extent upon the orders received for apparatus.

We think those concerned with this particular movement are to be congratulated on the way in which they have been able to carry it through. It is by no means easy to obtain capital on uncommercial terms for carrying out researches of the kind that were necessary, and for this reason, in all probability, the work would never have been carried through in this country. On the other hand, we are not altogether sure that the idea of working on commercial problems for science instead of for commerce is one that is likely to be satisfactory in the long run. Whether the profits of an undertaking are to go to the benefit of science or to be paid as dividends, the fact remains that a considerable amount of capital is necessary in such cases. Generally speaking, human nature being what it is, such capital is more easily obtained when there is a chance of a fair dividend attached to it, than where the final result is to be moulded by an ideal. Moreover, in all probability commercial conditions are likely to give a more efficient result in the long run. Be this as it may, we must congratulate our American cousins in carrying through this development on lines which would almost certainly have failed in this country.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

High Power Gas Engines. By H. Dubbel. Translated from the German by F. Wemitch. [London: Constable & Co., Ltd.] Pp. xii.+197. 18s. net.

The purpose of this work is to deal with the theory, principles of operation and most important constructional features of large four- and two-cycle gas engines.

The reputation of English makers in the manufacture of small gas engines for industrial purposes is second to none, but it has to be admitted that gas power on a large scale owes its position to the enterprise of Continental engineers.

The utilisation of the energy in blast furnace, coke oven, and producer gas was made possible by the success which attended the attempts towards the cleaning and purifying of these gases, and in the great improvements which have been made in gas producers. These are not dealt with in the volume under consideration, but they have been determining factors which have brought the gas engine into rivalry with the steam engine for large power, particularly in electrical work. The exigencies of cyclical regularity have been satisfied by an increase in the number of impulses, using double-acting or multiple cylinder single acting types, and by special consideration of the methods of governing. The large gas engine has become a special branch of engineering, and, as stated by the author, a book dealing only with this type of prime mover is justified.

On looking through the treatise our attention is immediately drawn to the excellence of the sectional drawings, photographs and folding plates, and we are not surprised to read that this was the main reason which influenced the translator in writing an English copy.

The opening chapter is devoted to theory, and deals with the influences of compression and mixture ratios on thermal efficiency. A comparison between the standard ideal cycles shows that where the final compression pressure is limited by the possibility of pre-ignition the constant volume cycle is best as regards thermal efficiency.

Much attention has been given in recent years to the specific heats of gases which are known to increase with temperature. The author without unduly burdening his book with mathematical analysis, based on results which have not received definite confirmation, proceeds to show that the general effect of this increase in specific heats is to decrease the efficiency of the ideal cycle, and to increase the efficiency of the practical engine. Evidently, in the latter case, what is referred to is the "efficiency" ratio which is designated in the treatise as "indicated efficiency." Considered from a purely thermodynamical point of view it would appear that high ignition velocities with correspondingly high temperatures of combustion are beneficial. In practice this is not so, since as the author clearly shows lower ignition velocities lead to a decrease in cooling water losses and to smoother running, and a compromise has to be effected between the two factors—loss to cooling water and reduction of diagram area.

Subsequent chapters in the book deal with output and

cylinder dimensions, governing, and valve gears for four and two-cycle engines.

Quality, or mixture, governing leads to constant compression and, as regards the efficiency of the cycle, is preferred to quantity governing. To keep up the maximum output and to provide for economical working at the lower powers a combination of the two systems is necessary. Valve gears are dealt with very exhaustively in the next three chapters, including an analysis of the motion of gears worked by cams and eccentrics. Scavenging, stratification of the charge and precautions against the sticking of the mixing valve receive complete treatment where necessary.

The treatise is eminently practical, and it hardly seems possible to do justice to the very comprehensive manner in which the details of construction are explained and illustrated. Immense difficulties have been encountered in the design of large gas engines as regards distribution of metal, cooling arrangements, &c. Considerable departures have been made from older designs, with a view to simplification without any great sacrifice of theoretical advantages, and it is pleasing to observe that this development has been due to the influence of British designers.

The author very clearly points out the manner in which the newer designs differ from the older, and several chapters are devoted to cylinders, pistons, valves, stuffing boxes and general design. The design of framings is most interesting as showing the attempts by various makers to avoid eccentric loadings, and hence large bending stresses, by the judicious use of tie bolts and by symmetry of construction.

There is a chapter on ignition, and the concluding chapters deal with flywheel effect (in relation to speed regulation and oscillating displacements), starting arrangements, piping and the use of the indicator diagram in the location of cylinder troubles.

The translator repeats the assertion that the success of the large gas engine on the Continent is largely due to the free exchange of ideas and publication of opinions and designs, and he is to be congratulated on having obtained from British manufacturers support "exceeding expectations," which has enabled him to expand the original treatise to include British practice. E. C. M.

Consumers' Accounts and Meter Department Routine. By A. C. GLOVER. London: Electrical Press, Ltd. Pp. 49. 5s. net.

This book is a collection of printed sheets suitable for an electricity department to use for the issuing of accounts and specimen pages of books to be kept by the mains and meter departments for the use of the general office in the issuing of accounts for energy, the hiring of any apparatus or special charges. There is a short description of what each sheet is for at the top of the sheet. The book starts very abruptly, and if the diagram of routine had been at the beginning of the book instead of the end it would have made the scheme much clearer. The reviewer would recommend any reader to start with this diagram before studying the different sheets. As the author is recommending the adoption of a system of books for account and record keeping he should have given fuller explanations and made matters clearer, so that a reader could judge more easily if the system would be advisable for him to adopt. Another fault is that abbreviations are carried to such an extent that it is difficult to understand what is meant. As an example, on the quarterly account sheet Form IV. there appears the following:—"H.P. of Fttgs. No. of A/t....." One assumes that fittings are referred to and that H.P. stands for horse-power, but what it is all about would puzzle the average reader. These abbreviations may be all right in an office where the system is in use, but are not advisable in a book advocating such a system.

The meter reading sheet, Form III., seems to contain some good ideas. Many supply authorities, however, use different coloured sheets or cards already for power, lighting or heating supplies. Entering up meter readings from the bottom of the page instead of starting from the top is certainly novel. The advantage would be great subtracting, as the meter readings grow bigger as they continue being written upwards.

It is difficult for anyone to criticise any particular system of account keeping without an actual trial. To make alterations in a given system of book-keeping may be costly, and one needs to be cautious before deciding the matter. Although the system advocated may be first-rate, it has the disadvantage that it would undoubtedly need a good staff of clerks to keep it going. The book concludes with extracts from the Electric Lighting Acts which are useful for reference. W. A. T.

A COMPARISON OF DIFFERENT METHODS OF TESTING ELECTRICAL PORCELAIN.*

BY DR. A. CHERNYSHOFF AND C. A. BUTMAN.

In order to make a comparison between all present methods of testing insulators, a series of tests was run following a method outlined by Messrs. Imlay and Thomas. A diagram of connections for this test is shown in Fig. 1. The contact-maker consisted of a lever on the end of which was a strip of copper which made contact for an instant with a fixed strip, when the lever was allowed to fall, thus completing the circuit; in this way the contact was always of the same duration. A choke coil limited the current when a spark

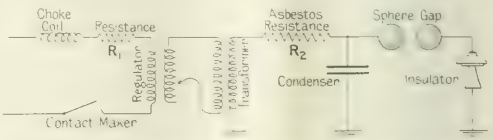


FIG. 1.—DIAGRAM OF CONNECTIONS FOR IMLAY AND THOMAS TEST.
The short impulse method.

passed through the gap, and a resistance, R_1, regulated the amount of energy in the primary of the 300,000-volt 10 k.v.a. transformer. A sheet of asbestos, R_2, was used to limit the energy in the secondary of the transformer. The condenser consisted of a suspended iron plate hung parallel to the wall, which was covered with a grounded wire netting. The diameter of the spark-gap spheres was almost 8 in., and the voltage across the gap was measured by short-circuiting R_2 and thus adjusting the spark-gap so that a spark would just occur at the required voltage as indicated by a voltmeter across the primary of the transformer. To avoid corona loss, the high-tension connections were made with $\frac{5}{16}$ in. brass tubing, and the edges of the condenser plate were curved away from the wall. The insulator on which most of the tests were made was supported on a grounded iron pin.



FIG. 2. DISCHARGE WITH IMLAY AND THOMAS CONTINUOUS TEST WITH THE VOLTAGE NEAR FLASH-OVER.



FIG. 3. DISCHARGE WITH VOLTAGE MUCH IN EXCESS OF FLASH-OVER.

The effect of the condenser shunted across the spark-gap is to superimpose a high-frequency discharge on the ordinary 60-cycle discharge. In making the test, ten insulators were chosen at random, and each was subjected to 50 impulses at the same voltage. The

* Abstract of an article in the "Electric Journal."

voltage was then raised by steps until the insulators failed, the test being made in air.

A continuous series of impulses was obtained by keeping the primary circuit closed. The condition of the discharge under these circumstances is shown in Figs. 2 and 3. An oscillogram of the voltage curve of the primary shows no flash-over with 150,000 volts maximum, although a flash-over is obtained at this voltage with 60 cycles. An ordinary 60-cycle discharge was obtained with these same connections by merely short-circuiting the spark-gap. Fig. 4 illustrates the character of the discharge, and shows that the discharge takes the shortest air-path to ground. The test at 60 cycles was first made in air, but as few insulators broke down, and difficulty was experienced due to heating, the insulator was immersed in oil and the test repeated.



Fig. 4.—Discharge with 60-Cycle Voltage greatly in excess of flashover.



Fig. 6.—Negative Discharge of Direct-current High-frequency Test.*



Fig. 7.—Positive Discharge of Direct-current High-frequency Test.†



Fig. 8.—Positive and Negative Discharges of Direct-current High-frequency Test.‡

The Continuous-current Single-impact Method.—With the short-impulse test described above, a train of waves is set up which is of indefinite length, and there is no way of telling how many impacts are given the insulator. Furthermore, each successive train of waves may be different, as contact may be made at different values of the voltage. Hence, to make the investigation more exact and to duplicate more closely the conditions during a lightning discharge, a method was developed whereby only one impact is given to the insulator. This was accomplished by using direct current on the transformer. Inasmuch as the impact at the making of the circuit is definite, while owing to the rest of the [illegible] is indefinite both in steep wave front, it was necessary [illegible] when the contact was made. This was effected by slowly cutting down the current after the circuit was closed by introducing resistance so that no spark passed between the terminals of the series-gap when the current was interrupted. Another condition which must be fulfilled is that the current through the transformer must be alternately reversed in order that the core will remain in the same magnetic [illegible]. In addition to the foregoing [illegible] desirable to be able to control the nature of the impact, so that it should always be positive or negative, as desired. These conditions were all fulfilled by the rotating device shown in Fig. 5. A positive or negative impact was obtained by [illegible] the primary of the transformer. Hence, when the current flowed in one direction the [illegible] series resistance, and there was not sufficient flux to make an impact, while with the current in the other direction the flux was as usual, and an impact resulted. By [illegible] the operation of the [illegible] be positive. When the brush [illegible] open circuit; as the arm [illegible] circuit is closed; as the arm is moved to G the resistances are introduced until the circuit is broken beyond G. When the black end of the arm is at B, the current flows from B through the resistances r_1, r_2, r_3, &c., then through the arm itself to the centre, then through an ammeter and switch to the primary of the transformer, thence through the other side of the switch through a variable resistance to the inner ring. The brush contact E touches the inner ring, which is connected to the outer brush F, which makes contact with C, thus completing the circuit. When the black end of the arm is at C the current is reversed through the transformer, the same resistances, r_1, r_2, r_3, &c., being introduced in the circuit before the circuit is broken. An electromagnetic counting device is placed across the resistances r_1 and r_4 in series with a lamp, so that every time the current is made it operates. When the rectifier is working the number of impacts will be one-half the number shown by the indicator. A motor drives the arm of the contact maker at such a rate that when the rectifier is working there is about one impact per second. The rectifier is constantly excited by applying about 5 amperes direct current to maintain the arc. Resistance R_2 regulates the amount of current flowing through the branch circuit, R_3 the amount of direct current supplied to the rectifier, and R_1 the amount of current flowing through the contact maker. The resistance R_4 was short-circuited during this test.

Whether the impulse was positive or negative was determined initially as follows: Sphere 2 of the series gap was insulated from ground, a spark was allowed to pass, thus charging the sphere. The nature of the charge on the sphere was examined by bringing up a positively charged pith ball, and with a given connection of the rectifier the charge was always positive or negative, as the case might be.

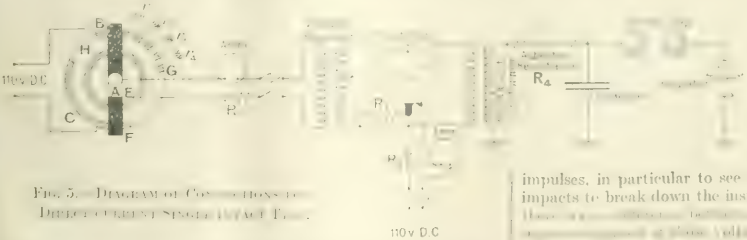


Fig. 5.—Diagram of Connections for Direct-current Single-impact Test.

Tests were made by the direct-current impact method to see if there was any difference between the effect of a positive or negative impact on the insulator. The character of discharge obtained under these conditions is shown in Figs. 6 to 8. [illegible] was developed to investigate the fatigue of insulators with positive and negative impulses, in particular to see whether it took a smaller number of impacts to break down the insulator at higher voltages and whether [illegible] 2,000 impacts unless it broke down with a less number. The results of these tests are summarised in the curves given in Fig. 9. Each [illegible] that the curves represent typical conditions. Further tests were [illegible] negative charges under different conditions.

shortest path.

volts between the primary and secondary under oil, and the voltage was regulated by varying the distance between the zinc plates. The character of the discharge obtained with high frequency is shown in Figs. 11 and 12.

Relation of the Theory of Ionisation to the Test Results.—The time of ionisation plays a very important part in the breakdown strength of

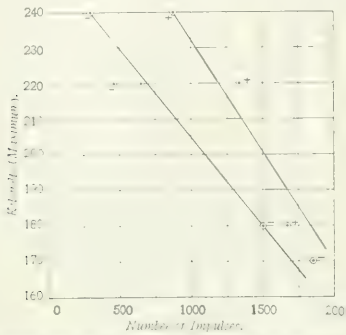


Fig. 9. Comparison of Breakdown Strength of Porcelain with Positive and Negative Impulse.

insulators. It had previously been thought that it was possible to design an insulator so that it would flash-over rather than punctuate. However, the experiments show that it is possible to have a breakdown before flash-over. This result was probably due to poor character of porcelain, although the samples tested were of average

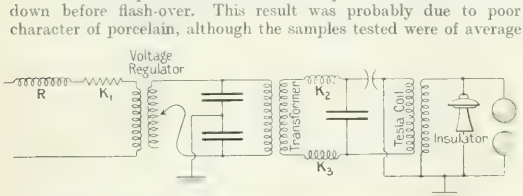


Fig. 10.—Diagram of Connections for testing with High Frequency from a Tesla Coil.

strength. A very important result is that it is possible to raise the voltage on the insulator above the normal 60-cycle flash-over value if high-frequency is used. The results indicate that with a frequency of 60 cycles, no matter how high the applied voltage is, the voltage or the insulator is never much above the ordinary flash-over value,



Fig. 11.—Discharge from Tesla Coil with Voltage just above Flash-over.



Fig. 12.—Discharge from Tesla Coil with Voltage much in Excess of Flash-over.

is the insulator is practically short circuited, hence few breakdowns occur. This is clearly shown in Fig. 4, where the discharge takes the shortest air path. However, the character of the discharge is entirely different at high frequency, as it clings to the surface, and the voltage on the insulator can be raised a sufficient amount to cause a breakdown. The reason is that with high frequency there is not sufficient time to ionise the air, so that the discharge flows over the surface as shown in Figs. 11 and 12. The higher the voltage the less is the time for ionisation, and the greater is the stress on the insulator.

Figs. 6 and 7 indicate clearly that the negative potential ionises the air better when on the pin than when on the insulator head. As it is difficult to ionise the air with the negative impulse on the insulator head and thus relieve the pressure, it is possible with negative impulses to raise the voltage above the flash-over value obtained for positive discharges. The explanation of this is similar to that for the discharge between a point and a plane; if the point is negative a spark will pass at a lower voltage than if it is positive. The Imlay and Thomas impulse consists in part of 60 cycles and in part of high-frequency discharges. This is shown in Fig. 3, where part of the discharge follows the shortest air path and part follows the surface. At voltages near flash-overs the discharge is all on the surface, as shown in Fig. 2, and Fig. 8 shows the alternative positive and negative discharge.

Comparison of Different Methods of Test.

1. *The 60-cycle Test* is fairly satisfactory below the flash-over voltage. Still, it is not searching enough, as quite a number of insulators were found which had been tested by this method which punctured through the lower part of the lower petticoat when tested at high frequency with a slightly greater voltage. It would seem of little value to test with 60 cycles under oil, as the stresses are applied differently than in air. A test in oil might be of advantage in a design test of insulators to determine the dielectric strength of the material.

2. *The Continuous-impulse Test* is better than the 60-cycles test, as the impulse has a high frequency discharge in addition to the 60 cycles. This method could be easily set up in a factory by simply adding a large condenser and spark-gap to the ordinary equipment. This method has the disadvantage that only a few insulators can be tested at one time, as the capacity of the condenser must be much larger than the capacity of the insulator tested. Fig. 2 shows that with this test near the flash-over value the discharge clings to the surface, which means that the strain is on the insulator. Fig. 3 shows the form of discharge at a much higher voltage. Here it is shown that some of the discharge still clings to the surface, although the air has been ionised and part of the discharge is passing through the air. It has been proved that by this method the voltage of the insulator can be increased much above the ordinary flash-over voltage measured at 60 cycles. Hence, this is a much better test than 60 cycles alone.

3. *The Imlay and Thomas Impulse Test* has the disadvantage that some mechanical device is necessary to make and break the primary current. A difference exists between the short impulse and continuous test in that the short impulse has to ionise the air anew each time. Hence, as strains are set up and puncture sometimes takes place before there is time to ionise the air, the short impulse is probably more severe. In addition to the foregoing, if there are any surges set up on opening or closing of the circuit these also will make the test more severe. The Imlay and Thomas test as at present set up has the disadvantage that the circuit of the primary of the transformer is made at different parts of the cycle of the alternating-current wave and with the core at different states of magnetisation. Hence, the nature of the impulses is somewhat indefinite. The number of insulators which can be tested at one time is limited, as with all the other high-frequency methods. With this method the number of impulses in a wave train is different at different times.

4. *The Direct-current Impact Method* was devised to overcome the objections to the Imlay and Thomas method and to make the test more definite. The oscillograph curves show that the voltage is applied very abruptly, and hence reproduces the conditions of a lightning stroke. The charge can also be made positive or negative as occurs in Nature in a thunderstorm. With this method the voltage can be applied so quickly that there will not be sufficient time to ionise the air of the spark-gap. This occurred in the course of the experiments, and it was found necessary to introduce a choke coil into the primary of the transformer. In this way the steepness of the wave was reduced and the time for ionisation increased, causing the spark-gap to work. By this method a voltage may be impressed on the insulator in excess of the 60-cycle flash-over voltage, and by means of the oscillograph and counter it is possible to find out the number of impacts given the insulator.

5. *The Tesla Coil* method has the advantage of portability and can be used for testing insulators on the poles. The severity of the test depends on the coupling of the Tesla transformer.

For factory use, the best single test is probably the direct-current impact method. If this method is to be used, 10 impulses could be given at about 5 per cent. higher voltage than the flash over voltage at 60 cycles. It would seem to be of little advantage to test insulators below their flash-over voltages. If the Tesla test is to be used the voltage should be at least 5 per cent. higher than the flash over voltage on 60 cycles. It is much better to test insulators for a brief time at a high voltage than for a longer time at a lower voltage. By using a high voltage test one is sure that the insulators will stand that voltage, also there is an economy of time.

CONCLUSIONS.

These tests were made on a limited number of insulators, and while the results that are of a laboratory nature are entitled to considerable confidence, it would require the testing of a much greater number of insulators to determine just what kind or method of test would be most suitable for commercial purposes. The tests indicate that the following conclusions are warranted :—

1. By means of high-frequency it is possible to raise the voltage on an insulator in air above the 60-cycle flash-over voltage.

2. Inasmuch as the same breakdown voltage was obtained with the Tesla coil, the Imlay and Thomas test and 60 cycles under oil it is concluded that the frequency of itself has little effect on the breakdown strength. The effect of high-frequency is to raise the voltage which can be applied to the insulator in air. Hence, the breakdown is due to the voltage, primarily and not the frequency.

3. The breakdown of porcelain is due to the electrostatic stress and not to heating.

4. The character of the breakdown at high-frequency and 60 cycles was different.

5. It would seem of little use to apply a high-frequency test of any kind to insulators below the 60-cycle flash-over value.

6. Porcelain appears to be fatigued by the application of potentials above a certain unit stress.

RESISTANCE OF CARBON CONTACTS IN THE SOLID BACK TRANSMITTER.*

BY A. L. CLARK.

That the resistance of ordinary solid back telephone transmitters varies with the time and applied E.M.F. has been known ever since such transmitters have been used, but the cause of these variations as well as their astonishing regularity have not been adequately discussed—at least not to the knowledge of the writer. They are generally regarded as of a more or less erratic and uncertain character.

The essentials of a transmitter of the so-called solid back type consist of a cylindrical brass capsule, having one end closed and the other open. The cylindrical wall is covered inside with a thin layer

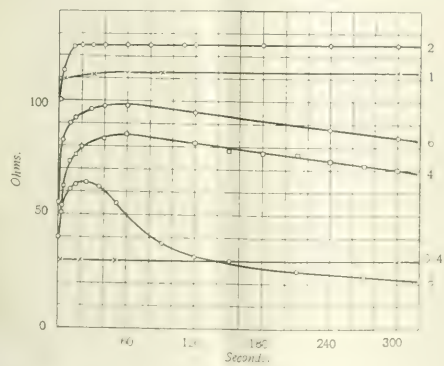


FIG. 1.

of insulating material (usually paper), and the bottom is covered with a disc of carbon securely attached to the brass end of the capsule. The other end of the capsule is covered with a second carbon disc, mounted on a thin mica plate and held in place by a brass ring. The capsule is nearly full of carbon grains, which close the electrical circuit between the two carbon discs. The mica mounted disc is attached to the diaphragm of the transmitter and vibrates with it, when it is acted upon by sound waves. If a solid back transmitter whose front disc is given sufficient elastic freedom of motion, is placed in an electrical circuit where the P.D. between its plates is a few volts, the following phenomena are observed. The resistance rises at first in some cases as much as 100 per cent. of its initial value and then falls off more slowly. The rapidity of the rise in the earlier part of the experiment as well as the amount of rise, and later, the rapidity of the fall in resistance depend on the current density through the apparatus, being greater for large currents than for small. Fig. 1 shows the changes in resistance with time. It will be seen that the initial value of the resistance is largely a matter of accident, depending on the arrangement of the grains and the pressure with which they are held together. The time is given in seconds and the resistance in ohms. This is true for all the curves showing time relations.

The explanation of the phenomena observed above is as follows: In the upper part of the transmitter the current passes between points in loose contact, while in the lower part the contacts are tight. According to the results of previous experiments the resistance of the contacts in the upper part of the capsule is increased when the current passes, while in the lower part there is very little change. Consequently, when the current is first turned on, the resistance rises; but after a certain time the heating of the granules causes increased pressure and shifting of points of contact which reduces the resistance again. No doubt a part of this later decrease is due to the fact that the temperature coefficient of carbon is negative. Thus we have two causes operating together, viz., the increase due to the loose contact effect and the increase of pressure due to expansion. The former predominates at first, but is overtaken by the latter. If the transmitter be jarred during the observation, the resistance drops back to nearly its initial value and the changes in resistance occur over again. The phenomena have an additional complication when the carbon granules are enclosed in a capsule all

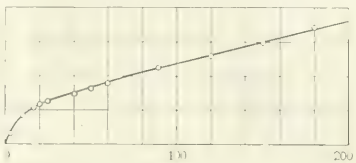


FIG. 2.

of whose walls are rigid. This rigidity may be effected by clamping so that the front mica disc is held firmly, or this disc may be held with wax. In this case the points of contact which are suddenly heated by the current, expand, causing an increase in pressure between the grains, giving rise to a rapid decrease in resistance. This initial rise is soon overtaken by the increase of loose contact resistance which in turn is overtaken by the expansion due to the general rise in temperature. The initial decrease in resistance which appears when the ends of the capsules are rigidly held is seldom noticed in the ordinary use of the transmitter, because the elasticity of the mica plate holding the front carbon disc does not allow the pressure to increase so rapidly. In other words, in the ordinary use of the transmitter, the loose contact resistance *increases* so much more rapidly than the *decrease* due to the expansion of the points, that the resistance rises instead of falls.

The method employed in the measurement of the resistance was a simple ammeter-voltmeter method, with dead-beat instruments which were read at short intervals. The transmitter was connected directly to a storage battery so that the applied E.M.F. remained constant.

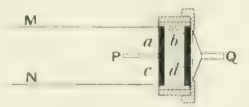


FIG. 3.

That the sudden expansion of the grains mentioned above actually occurs was shown by the following experiment. The capsule was rigidly mounted in a clamp so that as a whole it was immovable and an optical lever with a very short arm was attached to the front disc. The current was turned on and the expansion noted with a telescope and scale. The system was arranged so that the magnification was about 1,000. Fig. 2 shows the expansion with the time. The ordinates are thousandths of millimeters. It will be noticed that the expansion is most rapid at the beginning and appears soon enough to make the explanation of the initial drop referred to previously acceptable. The curves vary greatly according to the rigidity of the carbon disc and the size of grains used.

That the explanation of the initial rise in resistance in the curve of Fig. 1 is correct was shown with the arrangement shown in Fig. 3, consisting of a hollow brass cylinder with a carbon disc stuck on to the back with sealing wax insulating it from the brass. The front was covered with the ordinary mica mounted disc. A stiff copper wire P, was soldered to the middle of this disc to convey the current and small wires M and N soldered to its top and bottom. These last

* Abstract of an article in the "Physical Review."

wires were connected to a galvanometer through a resistance box. This box was placed in the circuit to control the deflection of the galvanometer. Thus the galvanometer may be used to measure the P.D. between top and bottom of the disc to which they are connected. A battery and ammeter were connected to P and Q. It will be seen from the diagram of connections that we have virtually a Wheatstone bridge arrangement, the letters *a b c d* referring to the various parts of the net representing in each case the resistance of the part on which the letter is found. If a constant E.M.F. be applied between P and Q, and I represents the total current measured by the ammeter, and V the P.D. between the top and bottom of the fixed carbon disc, shown by the galvanometer, it can be shown that an increase in the value of *b* causes an increase in I/V, and an increase in *d* causes a decrease in the value of I/V. Fig. 4 shows the way in which I/V changes with the time. It will be noticed that I/V increases to a maximum and then diminishes. The initial rise in the value of I/V is due to either an increase in *b* or a decrease in *d*. If due to the latter I should increase also, which is not the case. So the first change in I/V must be due to an increase in *b* or the loose contact effect in the upper half of the transmitter. The decline in I/V after the maximum value is due to either a decrease in *b* or an increase in *d*, if due to the former it is caused no doubt by crowding of the grains with shifting, thus presenting new points of contact. If the decrease in I/V is due to an increase in *d*, it is caused by the loose contact effect extending into the lower part of the transmitter. Probably the latter cause operates first as the current does not begin to rise until after the maximum in I/V. The inequality of *a* and *c* are brought out in the two curves of Fig. 4. They represent the value of I/V for the two positions of the transmitter.

Two curves are given showing the effect on the resistance due to changing the E.M.F. from 2 to 4 volts and back again. From these

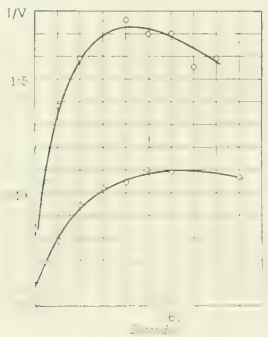


Fig. 4.

[illegible] increase in current is always followed by a decrease in resistance and a decrease in current by decrease in resistance. The reason for the decrease in resistance is probably due to the shifting of the grains with the falling temperature. It has been proved beyond all question that a very slight change only in the position of contacts on the grains is necessary for restoration of the initial conductivity after the loose contact effect has occurred. The recovery of the transmitter after a run was also investigated. In the case of a system of carbon grains, enclosed in a capsule with rigid walls or in an ordinary transmitter capsule where the front disc is clamped or fastened in any other way, the resistance rises rapidly at first and then falls off. No doubt this is due to the release of the pressure due to contraction attending the rapid cooling of the points of contact. If the pressure on the grains be increased in any way, such as by pressing on the mica-mounted disc, the resistance of the transmitter falls but quickly begins to rise again owing to the increased current. If the pressure be released, the resistance always rises but falls again [illegible]

So we see that an ordinary solid back transmitter as commonly [illegible] concerned. Anything which causes an increase in current is met by an increase in resistance which cuts down the current; while if the [illegible] increase of the current. The question whether or not the changes [illegible]

transmitter is used continuously over a long interval of time. On the contrary, an experiment carried out for several days showed no sure change in resistance. A circuit breaker was arranged to make the current for 10 seconds once every minute and at the end of 48 hours the resistance curve was almost identical with the curve at the beginning of the experiment.

That the gas in which the transmitter grains are placed exercises a marked effect on their contact resistance is shown by the following experiment. A transmitter capsule with a number of small orifices in the brass back and grooves in the back of the carbon disc to allow circulation of the gas, was placed in a receiver from which the gas could be removed by pump. With air in the receiver the resistance curves were those of Fig. 1. (Also *see* curve 1, Fig. 6.) When the air was pumped out the curves became like those of curve 2, Fig. 6. When the air is removed so that the pressure is about 3 mm. the rise in resistance due to the loose contact effect is very small and the droop in the curve due to the sudden expansion becomes noticeable. As soon as the air was re-admitted the curve went back to the curve 1 class. In some of the trials the apparatus stood for several hours before measurements were taken in order that there should be no doubt that the air pressure inside the capsule was the same as the pressure in the receiver. Fig. 5 shows the relation between the resistance of a transmitter and the air pressure. One thing that should be noticed is that at any given pressure the resistance is decreased by the passage of current which indicates that the escape of the air is facilitated by the heat generated at the points of contact. This effect was noticed in the previous experiments on carbon resistance. The effect of filling the receiver with oxygen is suggestive. When the transmitter is filled with oxygen the resistance curve rises with much greater rapidity and much higher than when it is filled with air and there is no trace of the drop in the curve shown in curve 2, Fig. 6. Here the resistance increases so rapidly that the inclination is much

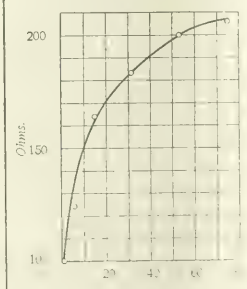


Fig. 5.

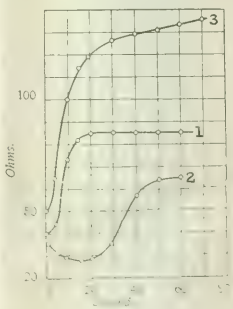


Fig. 6.

sharper than with air. This supports the suggestion made in the previous paper that the rise in resistance, in part at least, may be due to actual combustion with the formation of an ash or other material of permanently high resistance. Curve 3, Fig. 6 shows the resistance of an oxygen-filled transmitter. These experiments indicate that the gas at points of contact exercises more influence than is usually believed.

Thus far the work described has been on a transmitter which is kept perfectly quiet. The effect of a sound on the resistance of the transmitter is interesting. An ordinary central station instrument whose capsule is exactly like those employed in the previous experiments, was used. This was suspended on spiral spring leading wires so that it was free from jar. The sound was produced by an organ pipe (256 vibrations) near the mouth piece of the transmitter. The phenomena exhibited by this instrument differ very little from those already described with a quiet transmitter, except that the changes in resistance are much less [illegible] result was noted which shows again the conservative action of the transmitter. When the sound is turned on, the resistance of the transmitter is increased, due [illegible] to the loosening effect of the vibration, but the resistance [illegible] as to decrease immediately. If the [illegible] of the pipe is covered to stop the sound, but to leave other conditions unchanged, the [illegible] falls immediately but presently [illegible] to the [illegible] The [illegible] of the foregoing experiments indicate that the theory of the [illegible] of the transmitter is not complete [illegible] that some other [illegible] must be taken into account to explain the [illegible] The [illegible] of gas is certainly of importance. A [illegible] of the effect of [illegible] conditions [illegible] above on the [illegible] has been [illegible] This [illegible] will be published in a future paper.

CORRESPONDENCE.

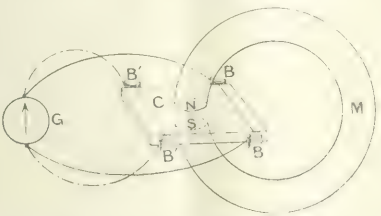
THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of June 11th, p. 344, you published an abstract of a French Academy communication by Prof. Blondel on "The Laws of Induction."

In my opinion his experiments and deductions are very important, and should be brought to the attention of all physicists, teachers, theorists, book-writers and engineers who are in any way concerned with teaching or applying the law of the induction of an E.M.F. in a circuit by magnetic flux, in view of the fact that this law, as originally formulated by Maxwell and copied into practically every text book, is wrong if stated, as is usually the case, as a universal law. This is proved by the readily demonstrable fact that in certain cases the actual results are the exact reverse of what they should be in accordance with this law, as it is usually stated. Hence the law should either be clearly stated to apply only to certain definite limited conditions, and therefore is not a universal one, or it must be corrected or reformulated to make it universal.

Prof. Blondel now confirms, by means of his interesting experiments, what I stated in a Paper,* quite a number of years ago, the publication of which aroused the ire of many professors, book-writers and theorists in Europe and America, as exemplified in their numerous communications to the technical press at that time. Their undisguisable anger was evidently due to the fact that I had said in effect: "Ask the students or readers for whose instruction your teachings or writings are responsible whether or not there would be induction under such and such conditions (describing my experiment)



and you will find that their reply will be the contrary to what actually takes place." They could not deny this, and they vented their anger on me, as though I had been responsible for the laws that Nature had made! Your esteemed contemporary was one of the few which at that time upheld prominently and fearlessly the general principle that our statements of the laws of Nature should be corrected if they are found to be incorrect. Some of your contributors also expressed similar views. From my experience, England is ahead of America as far as being ready to correct in this progressive spirit, and in showing a willingness to be corrected when wrong.

Briefly stated, my simple little experiment, which is easy to repeat, showed that an electric circuit could be linked and unlinked with a magnetic circuit without producing the slightest induction of an E.M.F., the electric circuit being, of course, closed all the time. In other words, the flux enclosed by a permanently closed electric circuit could be cancelled at will and to any amount without producing any induction. It is thus that contradict Maxwell's law.

For instance, in the adjoining figure, M is a heavy C copper block clamped immovably between its poles, G a galvanometer connected in the electric circuit closed through the block C by means of the brushes BB'. The magnetic and the electric circuits are now linked completely with each other. If, now, the brushes are rapidly slid across the edges to the positions B'B', the circuits will be unlinked completely, and the electric circuit has not been opened, yet there will have been no induction, except, perhaps, from some slight stray flux. According to Maxwell's law, as usually stated, there should have been induction. The electric circuit has cut the flux, but its conductor did not.

The original experiment is, perhaps, too well known now to be re-described here. The conclusion was that, to produce induction, the *material of the conductor itself* must cut the flux; it is not sufficient to have the circuit alone do so. There is, therefore, a marked distinction between the circuit itself and the conductor which forms it, as was shown very clearly in my experiment, and was apparently not recognised before.

Prof. Blondel's interesting experiments now confirm this in another way. His results could have been correctly and positively predicted from the statements in my Paper, to which, however, he makes no reference whatsoever—at least, not in the abstract which you publish.

In his experiment No. 2, which is the important one, the electric circuit at the sliding brush is in effect as though the brush were replaced by an imaginary connecting rod (like that of a steam engine), with one end pivoted to the end of the wire and the other end sliding over a plate connected to the galvanometer terminal; hence, for every revolution of the coil, this rod (hence the circuit) would cut once through the total flux. An E.M.F. should, therefore, have been induced by unwinding the coil, in accordance with Maxwell's law. His suggested explanation that the failure of induction may have been due to a neutralising effect of "two different paths" on each other, I cannot agree with, as in my experiment, which involved the same general principle, there was only one path. The correct explanation, in my opinion, is that nowhere in that experiment (No. 2) is any flux cut by the conductor itself (although it is cut by the theoretical circuit).

While his experiments confirm the statements in my much earlier Paper, and while he is in agreement with me in concluding that the "cutting of lines of force" is the more correct and more reliable way of explaining induction, yet he does not point out the importance of the distinction between the circuit and its conductor, and still uses the word "circuit" several times where to be correct he should have used the word "conductor" instead (as he did in one case). I am here referring to your translation, as I have not at hand now the original in French. As he does not refer to my Paper, it is not apparent whether he intentionally differs with me or whether the use of the word "circuit" was inadvertence.

After describing my experiment, I asked Dr. Steinmetz to formulate a law which was really universal, in view of this experiment; this will be found in his discussion of my Paper. It is, presumably, the first time that a truly universal law of induction was formulated.

Important new departures and developments in the science and industry of electricity are now more likely to be found by leaving the beaten tracks than by following them; hence it is important that our laws of Nature should be stated so as to be universal if possible, in order that they will apply also to new fields and applications which are not yet developed. It would be rash to say that the important distinction above pointed out between the circuit itself and its conductor might not in the future lead to some important development, even though in the standard apparatus of to-day it is of no importance.—I am, &c.,

Philadelphia, June 30. CARL HERING.

* An Imperfection in the Laws stated as Fundamental for Electromagnetic Induction. Transactions of American Institute of Electrical Engineers, Vol. XXVII, 1908, p. 1331. The Electrician, Vol. LX., p. 946. See also "A New Factor in Induction, or, the Cutting Lines of Force." Electrical World, March 14, 1908.

WIRELESS TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If your readers who are interested in the article appearing in your columns of June 4, 1915, on "Wireless Telephony," by Mr. H. J. Round, will compare the photograph there shown with one in your issue of June 12, 1914, they will, I think, note a striking resemblance between the so-called "Marconi and Round telephone apparatus" and the oscillating audion as a source of undamped oscillations for wireless telephone transmitters which was there described.

In a letter in THE ELECTRICIAN, July 21, 1914, I cited patents and early development work on this invention.

If interested further in the remarkable similarity between recently announced "innovations" by that company and devices described in patents issued to me, as well as in various prior publications, they may compare the "magnifying valve" just described by Mr. Round and the audion amplifier of my U.S. patent 841,387 of 1907, and with its later commercial forms, as described in THE ELECTRICIAN of November 12, 1913; the "Proceedings" of the Institute of Radio Engineers, March, 1914; the "E.T.Z." of June 18, 1914, &c.

The "great improvement utilising a principle due to C. S. Franklin," as described by Mr. Round, is one form of oscillating audion circuit, similar in principle to the ultraudion circuits discovered by the writer as early as 1912, publicly demonstrated before the Washington meeting of the American Physics Society in April, 1914, and recently described in the "Electrical World" of February 20th, and elsewhere.

Let them, furthermore, compare the accompanying photograph of a "valve" detector recently manufactured and installed by the American Marconi Company in the Lackawanna Railroad radio station at Hoboken, N.J., with that



of any grid-and-plate audion detector bulb made since 1906, or double plate-and-grid audion made since 1908.

This, and all other types of "gas relays" built by others, contains that sine qua non of all sensitive, or amplifying, ion-operated detectors, the "grid" or intermediate electrode, first disclosed and broadly claimed in my U.S. patent 879,532 of 1907.

The plain facts are that the frank imitation by one of the foremost wireless companies of various important improvements in the radio art previously invented and introduced by others has become of late one of the most striking features of the modern radio "development" of that organisation.—I am, &c.,

New York, June 23. LEE DE FOREST.

THE GYROSCOPIC COMPASS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—Mr. Longland's letter of July 9th puts me into a difficult position.

Everyone who understands the elementary principles of the gyroscope and the pendulum must agree that *no combination of gyroscopes and pendulums can form a compass free from errors of ballistic acceleration and velocity*. It follows then, that unless the Sea-Star employs in principle something more than gyroscopes and pendulums it cannot be free from the errors named.

Now, it is to me quite obvious that the Sea-Star, irrespective altogether of deadbeatness, irreversibility, and other such details consists, in principle, of nothing more than a gyroscope and a pendulum. This has been obvious to me all the time, but in view of Mr. Longland's definite and earnest claim that the compass was free from latitude error I could but try to assume that *his* idea of its construction made the compass involve, in principle, something more than gyroscopes and pendulums. Mr. Longland now insists that his ideas are in accordance, on all points, with Mr. Scott's Paper and thus forces me, unless he can point out some new principle in the Sea-Star, to one of two painful conclusions, either that Mr. Longland does not admit the truth of the proposition in the second paragraph of this letter, or that he is one of those who, though they cannot deny that the solution of the problem before them is, on first principles, impossible, allow their sense of logic to be overcome by mere mechanical ingenuity.—I am, &c.,

London, July 12. F. M. DENTON.

[This correspondence is now closed.—ED. *E.*]

CRACKED AND SEIZED PISTONS ON DIESEL ENGINES.*

BY GEO. E. WINDELER.

(Chief Engineer to Messrs. Mirrlees, Bickerton & Day, Ltd.)

In dealing with the internal-combustion engine as a heat motor certain marked differences between it and the steam engine must be remembered. In the steam engine everything is done to keep the temperature of the cylinder liner, pistons, ports and surrounding spaces as nearly as possible at the same temperature as that of the live steam. The case is quite otherwise in the internal-combustion engine. In a well-designed Diesel engine 40 per cent. of the heat units admitted to the combustion space is absorbed in useful work; of the remainder, 25 per cent. passes to the exhaust and 35 per cent. passes away to the circulating water and is lost in radiation, &c. Consequently very special means have to be adopted in order to remove a considerable amount of heat. Any defect in the water circulation is liable to cause local overheating. Investigations by Messrs. Mirrlees, Bickerton & Day have shown that most defects that had arisen in cylinder covers and pistons were due to serious deposits of salts in the water spaces and that such deposits were not formed during times of working. The explanation is that the flow of water is generally stopped when the engine is stopped and the heat remaining in the walls of the cylinder is sufficient to cause a deposition of salts to take place. Instructions have therefore been given—with excellent results—to continue the flow of water for some time after an engine has ceased running.

I have myself personally inspected a cylinder cover which contained a water space about 6 in. deep and found a deposit of as much as 5 in. thick in the water space. Naturally, the cover had cracked. The aforesaid suggestion was adopted in this particular station, and the results have been very satisfactory indeed.

In an internal-combustion engine without a water-cooled piston, the heat units that have been absorbed by the piston crown must, out of necessity, be dispersed from the crown down the body of the piston, and passed away through the liner to the water space by the contact that the piston forms with the liner. It is therefore necessary to study carefully the design of the piston head to obtain the best results. At the same time the piston must be designed in such a way that the load that is applied to the crown shall be transmitted to the crosshead pin which attaches to the connecting rod, without causing any distortion of the piston, which has to maintain its roundness to enable it to work without trouble in an accurately bored cylinder.

In Fig. 1 is shown a piston with the usual dished top and which is supported by four radial ribs, two ribs being carried down to the piston pin boss so as to form a more or less rigid connection between the piston crown and the piston pin, to enable the forces to be transmitted direct with the minimum amount of distortion. It will be noted that this piston is comparatively thin in the crown and in the body, and when fitted to a number of engines, was found to work admirably; but ultimately distortions appeared between the ribs, and it was deemed advisable to modify the design to that shown on Fig. 2, in which six radial ribs are carried well down the body of the piston from the crown, two being carried to the piston pin boss, with a thicker rib behind the main rib to assist in the transmission of the load. The piston crown was made slightly thicker, and generally this design has been satisfactory.

Figs. 1 and 2 refer to a piston 12 in. in diameter; Fig. 3 shows a piston 20 in. diameter, the design of which was similar to the 12 in., but the piston crown was supported by a number of circular ribs projecting into the interior of the piston. Radial ribs were also carried down from the crown of the piston to the piston pin boss. This piston at first appeared to be quite satisfactory, but it was noticed on examining a number of castings which had been annealed that slight cracks had taken place across the tips of these ribs, and on examination it was found these cracks had been set up by the cooling of the casting. A number of such castings were broken up and found to contain many flaws. It was therefore

* Abstract of a contribution to a discussion at a meeting of the Diesel Engine Users' Association, June, 1915.

decided to cast the piston in two portions, and Fig. 4 illustrates the type of piston which is now generally adopted by the firm. The construction of the upper portion of the piston is secured to the main body of the piston by six or eight square-necked studs ; the object of the square-necked stud which fits into a square hole in the body of the piston, is to ensure that the stud itself will not come out or get slack when the engine is at work.

The design of this piston top is somewhat novel, in so much that there are no ribs embodied in the design, the support to the crown of the piston top being obtained by throwing out a conical chamber, which also has the advantage that it forms another lane by which heat units can reach the body of the piston for transmission to the water spaces. The internal cone formed in the head is filled with asbestos to prevent the heat being thrown down from the crown of the piston on to the connecting rod bearing. This design has several advantages, one being that different qualities of material may be used for the upper portion of the piston and the lower portion. The other is, that, should any cracks develop, it is a comparatively simple and inexpensive matter to replace the top.

Reverting to the question of seizures of pistons, we have formed the opinion that almost invariably these seizures are due to heating of the piston pin and its bearing, and from our investigations we have found that such seizures take place almost immediately after starting up. The opinion we have formed is that, when an engine has been set to work and shut down, the heat stored in the piston body is thrown down and tends to evaporate the oil in the top-end bearing, with the result that when the engine starts up again, this particular bearing is not amply supplied with lubricating oil, and seizures take place. Again, running the circulating water through the engine after shutting down tends to minimise this difficulty.

In our enclosed type of engines, where forced lubrication is used, this difficulty is to a large extent removed by the fitting of a hand lubricating pump, by means of which lubricating oil under pressure can be pumped to all the bearings, including the piston pin bearing, whilst the engine is being barred round into its starting position before being started up.

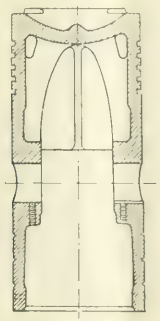


Fig. 1.

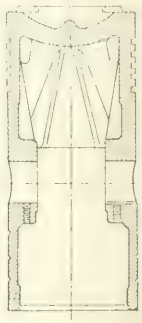


Fig. 2.

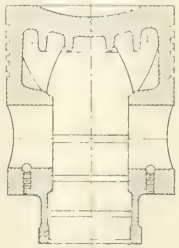


Fig. 3.

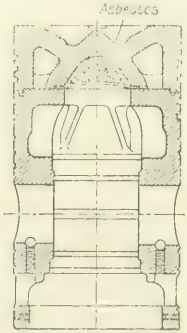


Fig. 4.

As proof of our contention that the heating of this bearing is generally the cause of such seizures, I may mention that the abrasions generally show seizure to have taken place at four points of the circumference of the piston and liner, and if careful note is taken of the position of these abrasions, it will be found that they occur at the point where the piston pin bosses join on to the thinner section of the body of the piston. At this point there is a comparatively sudden reduction in the section of material, allowing one portion of the piston to be extremely rigid, and the other portion more or less flexible ; when seizures take place the piston pin becomes overheated, and by reason of its friction fit in the piston body, plus its greater coefficient of expansion, causes an extension to take place, which forces the piston out of shape, flattens the crosshead portion of the piston body, and causes distortion to occur at the four points referred to. If the engine is not shut down quickly, other seizures are liable to occur, but the main seizures will almost invariably be found to occur at these four points. When piston seizures do occur, it is desirable that the connecting rod bolts should be carefully examined, as extension of the length of the bolt is likely to take place, and if examination is not made, ultimately fractures of the bolts are likely to occur, with most disastrous results.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from The Electrician Office, post free (unless otherwise stated), on receipt of published price. Orders are executed under 2s. and 5 per cent. for books published net. Add 1s. per £ for postage of foreign books.]

"Proceedings" of the Rugby Engineering Society, Session 1913-14. (Rugby : The Society.) Vol. XI. 10 : 6d.

"The American Journal of Science." Edited by E. S. Dana. New Haven : Tuttle, Morehouse & Taylor Co.) Fourth Series, Vol. XL., No. 235. $6 per annum.

"Journal" of the Franklin Institute. Edited by R. B. Owens. (Philadelphia : Franklin Institute of the State of Pennsylvania.) Vol. CLXXX., No. 1. 50 cents.

LEGAL INTELLIGENCE.

Osram Lamp Works (Ltd.) v. Pope's Electric Lamp Co. (Ltd.)

The hearing of this case has been continued by Mr. Justice Joyce.

Mr. Horatio Ballantyne gave evidence for defendants, and said that in 1904 there was no manufacture in this country of incandescent electric lamps made with anything but carbon filaments. In Vienna an osmium filament lamp was made, but only on a small scale. The carbon filaments were made by the soft paste process. The modern hard paste process was quite different. Tungsten, in a very fine condition of subdivision, was mixed with a small quantity of sticky lubricating substance. It was not necessary to use a material capable of making a filament by itself. That mixture of metal and binder was rubbed together in a cup or a mortar with a pestle, and when the mixing seemed to be about complete the substance was placed between steam rollers for the operation of calendering. It was then rolled up and put into the chamber of a hydraulic press capable of exerting a very high pressure. The die through which the material was pressed consisted of a diamond finely perforated, and as the filament was pressed through the die by the press it was received on to a card. By this time the filament consisted mainly of metallic tungsten, which adhered together because of the pressure to which it had been subjected in going through the die. The organic material with which the tungsten had been mixed was mainly a lubricant to enable the powder to be forced through the die in the form of a filament. Having got the filament to that stage, the organic substance played no more useful part in the process. He did not consider that when the filament was made by the hard paste process and was brought to a high temperature that was carbonisation. The proportion of carbon in the original mixture in defendants' process prior to any evaporation of the constituents of the binder amounted to about 12·29 parts per 100 of tungsten metal. There was, of course, no carbon as such present in the filament, but the constituents of the binder contained chemically combined carbon to that extent. The constituents of the binder were to a large extent volatile, and during the process of calendering, followed by the drying operation, a large proportion of the volatile matters was expelled, so of that 12·3 per cent. of carbon, which they originally contained, only about 2 per cent. was left of carbon before any heating took place at all beyond the drying. On heating in the furnace the amount of carbon left became only about 0·2 per cent., so that to him, as a chemist, the production of 0·2 per cent. of a substance which might be called carbon out of 12·29 per cent. of carbon was not carbonising. He had made a filament by the soft paste process as he understood the specification sued upon to mean. He used tungsten of collodion, which he denitrated before carbonising the filaments. After carbonisation the filament contained 8 per cent. of carbon. The filament was then brought to a state of bright incandescence in an atmosphere of moist hydrogen. After the carbon had been burnt out the filaments were left more or less of a porous character. In making those filaments he passed direct current through them, of course. The first time he saw filaments treated in bulk by external heat was in 1913, and he was greatly surprised to see filaments produced in that way with such fine results. In the specification sued upon the process described was substantially the process described in Welsbach, except that tungsten was substituted for osmium. In his view, the conditions involved in Just and Hanaman implied a soft paste process. There was no real resemblance between the Pope process and the process described either in Welsbach or in plaintiffs' specification. Defendants' process differed from the process in Just and Hanaman and in Welsbach by the very small quantity of lubricant used, in the deliberate from the engineering point of view of the process and plant used in preparing the filament, and by the continuous working of the furnaces. The continuous working of the furnaces prevented any adventitious moisture getting to the filaments, as it was said to do in the Z case. Moreover, if the specification relied upon were wide enough to include hard paste filaments, there was no sufficient description to enable him to make a filament with zinc chloride cellulose. So far as following the directions in the specification went, he failed, but after a

good deal of [illegible] the knowledge up to date in one or two cases he succeeded in getting some sort of a filament. He had tried cupro ammonium cellulose and tungsten metal, and he agreed that they would fail with hard or soft pastes. Assuming that one used the class of binding media referred to in the specification sued upon to produce a good filament, the equalising process was a necessity by the soft paste process, because the filament, after decarbonising, was a very porous irregular filament: and, in fact, when one switched on current so as to make it incandescent, one saw as a rule spots of bright and dull illumination.

Cross-examined by Mr. WALTER, Witness said he was not aware and he did not know that Welsbach had used gum for his binder in 1904. In a subsequent specification for making a filament of oxide and metal, Welsbach did suggest gum. Hard paste differed from soft paste in the proportion of the binder. If one started at the soft paste stage one could increase the thickness of the paste over a large range of consistency and still be able to extrude it through the jet by means of the usual apparatus and get a filament. But the apparatus sets a limit to the increase of stiffness to which one could go. So far as he knew, what was now known as the hard paste process was not perfectly well known in 1904. In Welsbach 13,11[illegible], of 1898, he was directly telling them to keep down the binding agent, but not for making a metal filament. That was a composite filament composed of oxide of thorium, with so much metallic tungsten as would make it conductive. He did not say that there were not in 1904 known methods of making stiff mixtures of materials which were used to form into rods. From 1898 to 1904 a large number of specifications were published. He had never tested by analysis the effluent gas that passed from the bottom of the furnace in defendants' hydrogen process. Temperatures such as one obtained in defendants' furnace were sufficient to cause steam to oxidise carbon.

Prof. FREDK. G. DONNAN said there was no distinction between plaintiffs' method of removing carbon from the filaments and one of those described in Welsbach. A considerable difference existed between the method of heating the filaments by current and that of heating them by external heat. Where the filaments were composed of a relatively non-coherent material, heating by direct current would be the better; but in defendants' process, when the filaments were put into the first furnace, heated up to 950° C., only the non-volatile portion of the binder remained. That was not removed by the action of steam or water vapour, as prescribed in the specification sued upon.

Mr. ALFRED CHARLES CHAPMAN also gave evidence, and agreed with what Mr. Ballantyne had said.

Mr. [illegible] said that between 1908 and 1909 he had studied the specification sued upon with a view to putting the directions given in it into practice. He used the soft paste method (thinking that to be indicated), carbonised the filaments so obtained, and heated it in an atmosphere of steam and hydrogen to remove the carbon. The result was that it burned out very rapidly. It oxidised the carbon particles so rapidly that it caused scintillation and the filament broke.

Cross-examined by Mr. WALTER, Witness said that he knew the Osram Company had made filaments on a large scale, but he could not tell when they started. He was never successful in getting a filament. If they were being made by the Osram Company in 1908 they were made by a process unknown to him.

Mr. T. A. ROSE said he first heard of metal filaments being made in this country in 1908. For the purpose of that action, he had taken the [illegible] and tried to make a filament in the way he [illegible]. Without importing into the specification any knowledge of hard paste, which did not exist in 1904, he had [illegible] to make [illegible] he failed entirely. In others his results could only be called filaments by courtesy. [illegible] and that there were [illegible] to call a filament made [illegible].

This concluded the evidence, and at the conclusion of the arguments his lordship reserved judgment.

Trade Mark Action Settled.

In the [illegible] Mr. [illegible] mentioned in the action of A. P. [illegible] Swan Electric Co., Limited, for plaintiffs said the action was for alleged infringement of a trade mark. Defendants had [illegible] and would submit to a perpetual injunction in the terms of the notice of motion. They would [illegible] a small quantity of [illegible] and he [illegible] Lord Justice [illegible].

Re Bristol Tramways & Carriage Co., Ltd.—On Tuesday Mr. [illegible] the petition by the company for [illegible] to enable the company to engage [illegible] and to [illegible] and to [illegible] Mr. [illegible] petition.

Light Tractors for Handling Freight Trucks.—It is stated [illegible] the Lancashire & Yorkshire Railway Company [illegible] Liverpool [illegible] Railway [illegible] of [illegible] and are handled [illegible] the amount saved is about £1,000 per month.

PARLIAMENTARY INTELLIGENCE.

RHONDDA TRAMWAYS BILL.

Last week this Bill, which has already passed the House of Commons, was considered by a Select Committee of the House of Lords.

Mr. FREEMAN, K.C., for the promoters, said the only opposition came from the Taff Vale Co., whose mineral line crossed a level road over which the proposed tramway would be carried. It was difficult to understand what the objection could be, because there was no more danger for a tramcar to pass a level crossing than for a char-à-banc or any other carriage. There was no possible danger, and the responsible officer of the Board of Trade had reported that there was no reason why the tramway should not be allowed.

After hearing evidence for the Taff Vale Railway Co. the Committee allowed the Bill to proceed.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1,445 B[illegible] H[illegible]. [illegible]
A [illegible] right angles to their plane is staggered in relation to the centre line of the salient poles of the armature, the said stagger amounting substantially to half a pole pitch, for the purpose of multiplying the number of the alternations of the current without simultaneously increasing the number of the reversals in the magnetisation of the iron of the armature.

21,574 B.T.-H. Co. (Allgemeine Elektricitats Ges.) Mercury vapour electric rectifiers. A seal for a leading-in conductor of a mercury vapour rectifier comprising an exhausted preliminary chamber through which the leading-in conductor passes, said chamber being water-cooled and sealed from the rectifier by refractory packing material and from the atmosphere by india rubber or the like.

21,959 ALLGEMEINE ELEKTRICITATS-GES. Coil bobbin for electric meters, measuring instruments, or the like. (28/11/12.)

22,[illegible] Siemens & [illegible]. [illegible] (17/10/12.)

23,348 ALLGEMEINE ELEKTRICITATS-GES. Electric switchgear in which all current-carrying parts are immersed in oil or embedded in an insulating mass. (15/10/12.)
Switchgear with divided 'bus bar system whose several parts are arranged in separate oil chambers, each separate switch mechanism or unit comprising a 'bus bar system and an oil switch and in which connection between the 'bus bars of the several switch mechanisms or units is established by removable plug connectors, all the parts under tension or carrying current being immersed in or covered by an insulating medium.

6,859 HERRMANN. Current collectors for use in the galvano-plating of wires, strips bands, or the like.

6,992 HEINS & WILD. Electric ignition systems for internal-combustion engines. (19/3/13.)

7,007 B.T.-H. Co. (Allgemeine Elektricitats-Ges.) Regulators for electric circuits.

7,200 STILLE. Telegraph or telephone relay.

7,202 STILLE. Method of transmitting sounds electrically.
Transmitting sounds by means of sound vibrations impinging directly upon an electric arc by an inductance connected across the terminals of the arc and con-[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
gas) through which the high-frequency currents are flowing.

14,021 SIEMENS SCHUCKERT-WERKE GES. Electrically driven drilling machine. (13/6/13.

14,163 WINEBERG & PARKER. Appliances for maintaining electric conductivity in conduit systems for carrying cables for power, light or other electrical installations.

14,[illegible] M[illegible]. [illegible]
14,[illegible] B[illegible]. [illegible]
14,[illegible] M[illegible]. A[illegible]
14,[illegible] E[illegible]. T[illegible]
14,[illegible] T[illegible]. [illegible]
14,[illegible] [illegible]. [illegible]
14,[illegible] [illegible]. [illegible]
14,[illegible] [illegible]. [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
and placed closely together [illegible] tirely above the water at starting. By this arrangement there is no flash [illegible]
14,[illegible] R[illegible]. [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
for use in coal mines [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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GENERAL ELECTRIC PROGRESS.

In another column of this issue we publish a full abstract of the annual report of the General Electric Company. Dealing as it does with the period of trade covered by the war, it is a document of more than ordinary interest. Mr. Hugo Hirst and his colleagues are to be congratulated upon the financial result of the Company's operations during an extremely trying time. The position of the Company, and especially in relation to the electric lamp industry, gave rise in the early stages of the war to a situation which must have occasioned the management no little anxiety. Reference is made to the attacks of a certain section of the lay press on the Osram Lamp Works, with which the General Electric Co. have been, and are, so intimately associated. It is pointed out that these critics were either unwilling or incapable of distinguishing between German owned trading concerns and factories established in this country performing valuable commercial, and, as the war emphasises, national work. In this connection the interesting statement is made that a way has been found, with the knowledge of the Treasury and the Public Trustee, which will put the future control of these works into British hands.

It will be observed that the Company has given liberally of its men from all parts of the country to the fighting forces which are now operating in the various theatres of war. Upwards of 1,000 of the Company's employés are with the Colours, and already a toll has been taken of them, for we read that 11 have been killed and 50 are either invalided, wounded or missing. We have already referred to the loss of Lieut. H. Byng and of Mr. George Maurice, the former in action and the latter in the "Lusitania" disaster, a loss which the staff of the Company deplores, and which only the passage of time can remedy.

As to the active operations of the various manufacturing departments of the Company, the most interesting is undoubtedly the carrying on of the Witton Carbon Works. When these were laid down and put into service some 10 years ago it was generally felt throughout the trade that they would be unable to compete with the products of Continental works. This prophecy proved only too true, but the factory was kept going from patriotic motives, and the war has in every way justified the policy of the Company in laying down these works. It is stated in the report that numerous products of the Company were unobtainable from other sources, and that this had proved of immense importance both to the Admiralty and to the War Office. The report states that the time is not yet opportune for detailed reference concerning the recent developments in connection with certain industries which the Company had maintained single-handed and for patriotic reasons. Mr. Hirst, however, expressed the opinion that when the facts were made known they would fill an important page in the history of the Company, and also prove a valuable lesson to the country as a whole. We feel sure that the manufacturing element throughout the electrical industry will join with us in complimenting the General Electric Company upon the manner in which it has established important factories in various industrial centres throughout the country, thereby giving employment to several thousands of working people, and also for its enterprise in establishing outlets for trade in the principal colonial and foreign countries which are normally open to British products. Various properties owned by the Company represent a valuable electrical engineering asset for this country, and the war has conclusively proved their capacity to assist in the furnishing of not only their normal quota of electrical manufactures, but also material which is being added to the national pile of war munitions.

Mercury Vapour Rectifiers. According to the "Electrical World," Dr. P. Cooper Hewitt has made a further advance in his well-known mercury vapour lamps and rectifiers. The vacuum tube rectifier has been improved so as to be suitable for high frequency currents as used in radio telegraphy, and a converter has also been produced for the transformation of direct current into alternating current of any frequency.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week July 5, 1915, to July 10, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]: 11 pkgs.

[illegible]: [illegible] parts, 13 pkgs.

[illegible]: [illegible]

London.—*U.S.A.:* Elec. machinery, £4,969; elec. lamps, £931; elec. carbons, £25; telephone materials, £433; carbon rods, £74; elec. wire, £143; unenumerated, £594—97 pkgs. *Switzerland:* Elec. carbons, £550. *Holland:* Elec. lamps, £1,987; elec. lamps, 144 pkgs.; elec. machinery, £394; elec. wire, £1,325; unenumerated, £91. *Sweden:* Elec. machinery, £767. *France:* Elec. carbons, £670; lamp parts, £310; elec. glow lamps, 311 pkgs. *Denmark:* Unenumerated, £395. *Norway:* Telephone material, £45. *Italy:* Carbon candles, £93; elec. wire and cable, £453—143 pkgs. *Canada:* Unenumerated, £105.

[illegible]: 10 pkgs.

EXPORTS.

To Australasia.—*Auckland:* Elec. machinery, £93; unenumerated, £21. *Melbourne:* Elec. machinery, £7,358; wire and cable, £129; unenumerated, £306. *Sydney:* Wire and cable, £980; unenumerated, £1,263. *Wellington:* Wire and cable, £3,278; unenumerated, £468. *Brisbane:* Wire and cable, £85; unenumerated, £500. *Dunedin:* Unenumerated, £65. *Christchurch:* Unenumerated, £25. *Perth:* Unenumerated, £20. *Lyttelton:* Elec. machinery, £180; unenumerated, £16. *Fremantle:* Wire and cable, £39; unenumerated, £36. *Adelaide:* Unenumerated, £323. *Patea:* [illegible]

Africa.—*Durban:* Wire and cable, £150; elec. machinery, £58; unenumerated, £1,079. *Port Elizabeth:* Wire and cable, £384; elec. machinery, £23; unenumerated, £106. *Cape Town:* Elec. machinery, £166; unenumerated, £125. *Beira:* Unenumerated, £50. *Delagoa Bay:* Unenumerated, £47.

Egypt.—*Alexandria:* Unenumerated, £131. *Suez:* Submarine telegraph cable, £2,200.

Russia.—*Archangel:* Unenumerated, £34.

Gibraltar.—Unenumerated, £69.

[illegible]

[illegible]: *Aden:* Elec. machinery, £20; unenumerated, £105. *Antofagasta:* Unenumerated, £25. *Barbados:* Unenumerated, £41.

Holland.—*Amsterdam:* Wire and cable, £1,175. *Rotterdam:* Wire and cable, £383; unenumerated, £290.

Italy.—*Naples:* Unenumerated, £114.

Japan.—*Yokohama:* Unenumerated, £12. *Kobe:* Unenumerated, £161.

China.—*Hongkong:* Elec. machinery, £330; unenumerated, £72. *Shangha:* Unenumerated, £211.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Elec. machinery £115; unenumerated, £412. *Calcutta:* Wire and cable, £390; elec. machinery, £464; unenumerated, £151. *Colombo:* Elec. machinery, £21; unenumerated, £145. *Madras:* Wire and cable, £58; unenumerated, £364. *Singapore:* Elec. machinery, £101; unenumerated, £293. *Karachi:* Unenumerated, £83. *Sourabaya:* Wire and cable, £553. *Penang:* Unenumerated, £47. *Samarang:* Unenumerated, £37.

Canada.—*Montreal:* Elec. machinery, £70; unenumerated, £186.

France.—*Paris:* Elec. machinery, £37; unenumerated, £51. *Dieppe:* Unenumerated, £621. *Havre:* [illegible] £423. *Calais:* Elec. machinery £57.

Greece.—*Piraeus:* Elec. machinery, £19.

Roumania.—*Bucharest:* Unenumerated, £1,500.

FOREIGN GOODS (duty paid and free).

Dieppe: Unenumerated, £333. *Madras:* Unenumerated, £18. *Melbourne:* Unenumerated, £44. *Morocco:* Elec. machinery, £35. *Newcastle:* Unenumerated, £80. *Piraeus:* Unenumerated, £85.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The business of publisher of medical and technical books, founded in 1844 by Mr. Henry King Lewis, has been converted into a private limited company under the title of H. K. Lewis & Co. (Ltd.).

Mr. E. J. Sowerby, Mr. H. L. Jackson, Mr. J. E. Simpson and Mr. R. H. Smith, who have been responsible for the conduct of the business in the past, have been appointed governing directors, so there will be no alteration in the proprietorship or management of the business. All debts and liabilities of the firm are undertaken by the company, and all debts due to the firm are to be paid to the company. The conversion will not affect the general conduct of the business, which will be carried on as heretofore.

Mr. Geo. E. Crocker has joined Messrs. Douglas Primrose & Co., 163, Hope-street, Glasgow, and has transferred to them his two agencies for Messrs. Frankenburg & Son and the Jackson Electric Stove Co. The firm are also desirous of taking up other agencies.

Plant Wanted.—The Northampton Electric Light & Power Co., [illegible]-street, Northampton, want for immediate delivery a 500 kw. [illegible] to be generated, 50 cycles, 6,600 volts [illegible]

Patent Development.—The proprietor of patent No. 17,518, 1907, relating to "Induction generators for ignition and like purposes," desires to grant licenses to manufacture in this country or to dispose of the patent rights. Apply to Messrs. Dyson, Pollak & Dorrington, chartered patent agents, Holton House, 20 to 23, Holborn, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

In connection with the voluntary liquidation of the Electrica Power Storage Co. (Ltd.) (for the purpose of amalgamation with Pritchetts & Gold, Ltd.), claims are to be sent to Mr. James Gray and Mr. W. A. Reid, Westferry-road, Millwall, London, E., by July 31.

The amalgamation took effect on the 30th ult. The E. P. S. Company will discharge its liabilities to that date. Goods delivered after June 30 on account of orders placed by the Company prior to that date will be paid by the new Company, Pritchetts & Gold and Electrical Power Storage Co., Ltd.

A resolution has been passed to wind up voluntarily Venner's Electrical Cooking & Heating Appliances (Ltd.). A meeting of creditors will be held at Blomfield House, 85, London Wall, London, E.C., on Thursday, July 22, at 12:30 p.m., for the purposes provided in sec. 188 of the Companies' (Consolidation) Act, 1908, and claims are to be sent to the liquidator (Mr. G. E. S. Venner) at that address by Aug. 24.

Herbert Page (trading as Smeeton & Page), electrical engineer, 63, Queen Victoria-street, London, E.C., and 32, Marlborough-road, Chiswick, has been adjudicated bankrupt. The first meeting of creditors will take place on July 22 and the public examination on Sept. 7, both at Bankruptcy-buildings, London, W.C.

John Boult and John Hugh Bolt (trading as John Boult), electricians, 3, Grosvenor-street, Chester, have been adjudicated bankrupt. The first meeting of creditors will take place on July 14 at Crypt-chambers, Chester, and the public examination on July 27.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aldershot.—The Council has decided to spend up to £700 in the purchase from Nuneaton Corporation of an engine for the electricity works.

Bradford.—Application is to be made to the L. G. Board for sanction to borrow £20,000 for laying electric supply mains, &c., giving a supply of current in connection with war requirements.

Fulham (London).—An expenditure of £130 is to be incurred on a further extension of mains in order to supply St. Oswald's Church.

Halifax.—The Council have applied for sanction to a loan of £24,000 for additional generating plant.

St. Helens.—The Electricity Committee recommend that sanction be obtained to borrow £14,000 for extensions of the generating plant.

Sheffield.—Mains are to be extended in various parts of the city, at an approximate cost of £3,660.

The general manager (Mr. S. E. Fedden) has reported upon the difficulty in obtaining a sufficient supply of water for condensing purposes at Neepsend during the summer months, owing to the prior rights of the Old Park Silver Mills Co., and negotiations and proposals have been submitted to the company for the transfer of their rights to the Corporation. Application is to be made to the L.G. Board for sanction to borrow £10,500 for the installation of 2,000 kw. of electric plant. Owing to the heavy demands upon the department for power supplies the committee has decided to instal a small plant (2,000 kw.), which will enable the department to connect a further 5,500 kw. without reducing the margin for spares. The plant has been offered by the British Westinghouse Co. at £8,500, and the foundation and pipe work amounts to about £2,000 in addition.

The Electric Supply Committee is of opinion that there is no present necessity for increasing the existing charges for current.

In view of the short term allowed by the Board for the repayment of money borrowed, the Finance Committee has decided to defray the cost (£3,614) of two water cooling towers out of current revenue.

Walsall.—The L.G. Board have sanctioned a further loan of £18,944 for cables, transformers, switchgear, &c.

GENERAL.

Bedford.—The following is to be added to the conditions for the supply of current for power purposes:—

For every 6d. increase in the price paid per ton of coal, over and above 13s. 1d., the rate per unit be increased by 0·016d.

The Electricity Committee has been informed by the comptroller that it is clear the Electric Lighting (Clauses) Act, 1899, contemplates that a reserve fund should be created before money is applied to relief of rates, and he strongly recommends the building up of a reserve fund of at least £10,000. As the profit for the past year was £3,610, against an estimated profit of £1,528, it seemed a very favourable opportunity of placing £2,610 to the fund without disturbing the finances of the year 1914-15, leaving £1,000 to go in relief of rates. The Electricity Committee, however, recommends that £1,610 be set aside for reserve fund, and £2,000 in relief of rates. After discussion, in which it was stated that as the

concern was insured against all possible losses by fire there was no need to establish a reserve to the extent of 10 per cent. of the whole undertaking, the Council at their meeting last week decided to adopt the committee's recommendation.

Blackburn.—The local Munitions Committee includes Mr. P. P. Wheelwright, borough electrical engineer.

Burnley.—The following increases in the price of current have been decided upon: Lighting, heating and domestic purposes, ½d. per unit; power, 5 per cent.; traction, 0·05d. per unit.

Burnley Paper Works Co. recently intimated that they were about to erect a 60 h.p. motor, and as they would probably be consumers of electricity to a greater extent than 100,000 units per annum, they desired to know whether the electricity department could quote a less rate than 0·7d. per unit. The committee have replied that they cannot see their way to quote any reduced price at present.

Burton-on-Trent.—The Lighting Committee has decided to enter into an agreement with electrical contractors regarding the hiring out of electrical apparatus.

Chester.—At a recent meeting of the Corporation it was reported by the Electricity Committee that the city electrical engineer (Mr. S. E. Britton) had intimated that the increase in the present cost of fuel (approximately £900 per annum) had led him to consider the means of possible further utilisation of the water-power at the Weir.

Mr. Britton suggested that by raising the crest of the Weir 12 in., at a cost of approximately £50, a considerable increase of power would be obtained and the quantity of fuel required by the electricity undertaking correspondingly reduced. He had submitted the suggestion for approval to the Board of Trade and was awaiting their reply. The Council were recommended that, subject to the Board of Trade offering no objection to the proposal, the committee be authorised to proceed with the work.

The proposal caused some discussion, but ultimately it was adopted.

Colchester.—The charge for electric current has been increased by ½d. per unit.

Colne.—Owing to the increased price of coal the Corporation have increased the charge for current for power by ¼d. per unit.

Dartford.—The salary of Mr. R. Jones, assistant electrical engineer, is to be increased from £150 to £180 by three annual increments of £10 each.

Dewsbury.—At the last meeting of the Corporation the electrical engineer (Mr. R. H. Campion), was empowered to accept new lighting consumers up to an aggregate of 50 kw.

No extensions of mains are to be made unless to connect new consumers on time-switch system, and existing consumers applying for an increased supply of electricity for power will only be supplied on the time-switch system. The price of electric current to lighting consumers has been increased by 10 per cent., to rateable value consumers 12½ per cent. and to power and heating consumers 15 per cent.

The Corporation have increased the price of electric current for lighting by 10 per cent., and for power and heating 15 per cent.

Edinburgh.—The Lighting Committee recommend the Council to meet the deficit of £6,200 on the electric supply department out of the reserve fund. The charge for electric current for private lighting is to be increased by ½d. per unit from 2·5d. to 2·d., that for power is to remain as at present (1½d. per unit), but there is to be an increase in the charge for public lighting, the charge to be based on the number of hours the lamps are actually in use.

Farnworth.—At a meeting of the Council on the 6th inst. the Chairman of the Electricity Committee reported that the electrical engineer (Mr. A. J. Hutchinson) had an opportunity of accepting a commission in the Royal Engineers, and was desirous of doing so.

The Council gave full consideration to the matter, and in view of the depleted staff it was resolved to request Mr. Hutchinson to continue his duties here as he is serving his country in a useful capacity in the performance of his present duties.

Gellygaer.—The Urban Council have asked the L.G. Board to reconsider their application for sanction to a loan for the electric lighting of Fochriw.

Glasgow. Last week the Electricity Committee recommended that the charge for electrical energy be increased by 15 per cent. as from June 1.

The convener (Baillie Smith) reported that coal contracts had been fixed and it was now recommended to purchase the balance necessary for the year 1915-16. This would exceed about 4s. 6d. per ton above what it was the year before last, and 2s. 6d. on what it was last year.

Mr. Dollan moved as an amendment that only 10 per cent. supply be purchased, the remainder of the purchases to be delayed, the Government took action in the matter. It was a matter of common knowledge of the Scottish Coal Trade Conciliation Board had agreed between the colliery-owners and miners and Sir George Askwith, that the new minimum of wages granted recently meant an increased cost per ton of 1s. 6d., of the Corporation were asked to pay, as compared with last year's prices, an increased cost of 6s. 2d. per ton.

The minutes were, however, approved.

Ilford.—We are pleased to notice that a member of the inquiry office of the Council's electric supply department, who is serving in France with the 6th Battalion London Regiment (Rifles), has been awarded the D.C.M. Through the courtesy of the engineer and manager of the electric supply department (Mr. A. H. Shaw) we have seen a communication from Rifleman Burke and also one from a comrade which has appeared in the "Territorial Service Gazette." We reproduce the following extract from the latter:—

The big surprise of the week is two D.C.M.s awarded to members of our battalion. As no doubt you know, our brigade took part in a recent big battle in which it suffered heavy losses, and during a heavy bombardment by the Germans our communication wires got broken. Two men, Rifleman Layton and Rifleman Lambert, set out to mend these wires, but, sad to say, they never returned. The bombardment was growing more severe when Rifleman Burke, of the signallers, volunteered to run a wire from the firing line to headquarters. This seemed almost certain death, as the road which he was to take was nothing more than a death trap. The road (Willow-road) was being heavily shelled when he set out, but somehow he managed to get the wire through this "hell of fire," for which he has just been awarded a well-deserved D.C.M.

Lytham.—The Electric Lighting Committee has reported on the question of a bulk supply of electricity for St. Anne's-on-the-Sea.

It has been decided that the proposed agreement shall run for 10 years from the date of the sanction of the L.G. Board, each party to be bound by the agreement to apply for the sanction to the loan at the same time, and in the opinion of the Committee, separate inquiries should be held by the L.G. Board.

Rotherham.—Last week the Corporation decided to increase the charge for electric current to private consumers by ½d. per unit as from Oct. 1. The charge for gas for lighting was also increased 6d. per 1,000 ft.

Torquay.—The Electric Lighting Committee has been in negotiation with the L.G. Board in regard to the application for authority to raise loans already sanctioned.

The Board are not disposed to permit expenditure of money if possible. With regard to orders for plant not yet delivered, little hope is expected that the Board will consent to these being paid for immediately, the alternative being to so dispose of the plant as to assist in the supply of munitions of war, thereby avoiding direct payment. The committee have held a conference with probable purchasers of the plant, and have adopted the certain principle of disposing of the plant.

Wallasey.—Last week the Council agreed to increase the charge for electric current for lighting by ½d. per unit and for power and heating ¼d. per unit.

West Ham.—Having considered the accounts of the electricity undertaking for the year ended March 31, together with the Borough Treasurers' report thereon, the Electric Lighting Committee recommends that the Finance Committee be requested to include the deficiency of £8,852 in the supplemental estimates at September next.

The committee has decided to enter into new agreements with six firms in substitution for existing agreements, consequent on the increased charges for current recently adopted.

West London Linking-up Scheme.—The Finance Committee of Hammersmith Borough Council has had under consideration the financial aspects of the scheme for linking up the generating stations of the Battersea, Fulham and Hammersmith Councils.

The committee considers that the Council is fully warranted in proceeding to carry out the scheme at present, and recommends application being made to the L.C.C. for sanction to borrow £8,313 to defray the Council's proportion of the cost.

Wimbledon.—The Council propose to apply for a provisional electric lighting order for Cuddington.

The agreement with Messrs. Stuart & Moore for the maintenance of the call bell and fire alarm systems has expired, and the firm has made an offer for overhauling and maintaining the system for seven years further. If the work specified by the firm be carried out they are prepared to undertake the maintenance of the two systems for seven years at £30 per annum for the maintenance of the fire alarm system, and £15 per annum for the call bell system.

TRACTION NOTES.

Bradford. The Tramway Committee proposes to expend about £15,000 on renewal of tramway track in various parts of the city.

Lancashire & Yorkshire Railway.—It is announced that the work of connecting the line between Victoria Station, Manchester, and Bury, via Prestwich, is making good progress, and it is anticipated that the service will be available by the beginning of November.

The war has caused considerable delay to the construction of the new power house at Clifton Junction, but a temporary supply of electricity will be obtained from Manchester Corporation. Trial runs have already taken place over certain parts of the line. Unlike the Bee and Holcombe branch, the third-rail system is used, as in the Liverpool and Southport line, and the cars will also be of the corridor type, each one accommodating between 90 and 100 passengers. The districts served by

the Manchester to Bury line include Woodlands Road (Cheetham), Higher Crumpsall, Heaton Park, Prestwich, Whitefield and Stand. At present there are about 60 trains each week-day in each direction, and the electrification of the service will enable this number to be increased to accelerate the speed.

Leeds. The Corporation have postponed the construction of some of their projected extensions, but it has been decided to complete the extension from York-road terminus to the Manston Fever Hospital, and the line to link up Gunsley with Otley and Burley-in-Wharfedale on the trolley omnibus system.

L.C.C. Tramways.—It is stated that no new proposals are to be submitted to the Council for the construction of new tramways, and the Highways Committee recommends that application be made to Parliament for an extension of the time allowed for the construction of the lines from Farringdon-road into Clerkenwell-road, from Battersea-park-road into Battersea-bridge-road, from Southcroft-road into Mitcham-road, in Bridge-road, Hammersmith, and from the Broadway, Hammersmith, into Bridge-road.

Tramway Assessment.—The dispute between the London County Council and Islington Assessment Committee in regard to the assessment of the tramways in that borough, has been settled. The assessment is to be reduced by £3,330 gross and £5,000 rateable as from Dec. 20, 1913; the reduced assessment to remain in operation until the new quinquennial valuation list comes into force; each party to pay its own costs.

Wolverhampton. The Council are recommended to grant an honorarium of £50 to Mr. C. Owen Silvers, deputy tramway manager, in recognition of the extra services rendered by him in connection with the laying of the double track in Bilston-road, and also for increased responsibility due to the absence of the manager (Mr. W. A. Luntley) through illness.

Women Tramcar Conductors.—There are now 570 women acting as conductors on Glasgow Corporation tramcars or training for the duties.

Birmingham and Belfast Corporations have also decided to employ women conductors.

TELEGRAPH AND TELEPHONE NOTES.

Postal Telegraph Servants. Sir Jas. Woodhouse, the arbitrator agreed upon, has given his decision in regard to the claim for a war bonus by the postal servants.

The men claimed a bonus of 4s. a week for those in receipt of 40s. a week or less; 3s. for those in receipt of 65s. a week or less; and 2s. for those in receipt of £210 per year and more than 65s. a week.

Sir James Woodhouse has decided that all men whose wages are 40s. a week or less shall receive 3s. a week as from March last; those whose wages are above 40s. a week and including those earning 60s. a week 2s. a week. Women are to receive half the above bonuses, and part-time employees are to receive proportionate increases.

Radio-telegraph Notes.—It is now stated definitely that the U.S. Government has taken over the Sayville Telefunken wireless station, to which reference was made in our issue of July 2, p. 488.

According to latest returns, of a total of 310 land stations and 1,068 ship stations recorded by the International Union for 1913, Germany and her then colonies had 23 land, 227 mercantile and 112 warship stations, against 44, 549 and 213 respectively owned by Great Britain, in addition to 85 (chiefly land stations) in the British Colonies. Dr. N. Hansen, of Berlin, calls this "an English wireless monopoly," and calls upon the German Government to give sufficient support to the Telefunken system "of which the experience of the war" to enable it to compete capitalistically with the Marconi monopoly. Dr. Hansen's deductions from the figures he presents do not lend [illegible]

FOREIGN NOTES.

China.—H.M. Consul-General at Shanghai says the importation of machinery and the installation of electric lighting apparatus in China is mostly in the hands of [illegible] firms.

[illegible] on account of increasing demand for electricity. The Shanghai [illegible] electricity works supplied over 40,000,000 units during 1914, compared with 21,000,000 units in 1913. The annual report of the department was given in THE ELECTRICIAN for June 18.) 1,500 radiators [illegible] installed in Chinese houses and small motor cars very popular. [illegible] of plant in the interior cannot be attempted without [illegible] The business was largely in the hands of [illegible] firms, especially those who were willing to undertake entire [illegible] and maintenance. Local firms who have been authorized [illegible] to erect the local electric supply plants have given the greatest satisfaction to the Chinese companies [illegible] Electric installations [illegible] Government and Municipal Roads, etc. [illegible] Government [illegible] smaller plants have been [illegible]

The U.S.A. and Latin-American Trade Relations.—The "Electrical World" reports that as the outcome of the recent Pan-American Financial Conference, Mr. McAdoo (Secretary of the U.S.A. Treasury) has appointed a number of prominent business men and financiers of the United States to act on committees which are to promote closer trade and other relations between the United States and the Republics of Latin America.

Ten members (including Mr. McAdoo) will constitute an international High Commission authorised by the Conference to deal with uniformity of legislation in Pan-American countries, including laws on patents, trade marks and copyright, bills of exchange, bills of lading, uniform classification of merchandise, Customs regulations, port charges, &c. A committee of 11 are charged with the duty of arranging a visit to South and Central American countries by business men and financiers of the United States. At the recent conference the Uruguayan delegation, after consulting the other foreign delegates, obtained the passage of a resolution inviting United States business men and financiers to make a return visit to South and Central American countries as the guests of those nations. The chairman of the committee appointed by Mr. McAdoo to arrange such a visit is Mr. James A. Farrell, president United States Steel Corpn. It is proposed that the International High Commission should meet in Buenos Ayres on Nov. 1, 1915. Each of the 18 Latin-American countries represented at the recent Washington conference is to name nine members to this International Commission, and it is believed that an itinerary for the proposed visit of business men and financiers to South and Central America can be arranged which would put them in Buenos Ayres on that date. Mr. McAdoo, in selecting the permanent group conference committees, has included a number of men known in the electrical engineering industry, and among these are:—

Argentina: Messrs. James A. Farrell, president United States Steel Corpn.; Henry Ford, president Ford Motor Co.; and Frank A. Vanderlip, president National City Bank, New York. *Brazil*: Mr. E. W. Rice, jun., president General Electric Co. *Colombia*: Mr. Maurice Coster, export manager Westinghouse Electric & Mfg. Co. *Ecuador*: Messrs. E. M. Herr, president Westinghouse Electric & Mfg. Co., and J. G. White, of J. G. White & Co. *Honduras*: Mr. H. B. Thayer, president Western Electric Co.

United States Trade with China and Brazil.—The "Electrical World" also announces that there is a proposal to establish foreign trade correspondence centres in important cities in South America and China, while it is also intended to found a commercial museum in China, where materials and manufactured products of the United States can be on exhibition.

The initiative in the latter case has been taken by the Chinese, who are at present very hostile towards the Japanese. Vice-chairman Chi-Che-Nieh, of the Chinese Commercial Commission, has also suggested to Mr. J. H. Fahey, President of the Chamber of Commerce of the United States, that the trade opportunity correspondence be conducted by the Chinese Chamber of Commerce and the National Chamber of the United States.

During the past year the National Chamber has endeavoured to secure a reduction of tariffs by South American countries on certain articles as to present a barrier to their export by American manufacturers. Mr. Edwin V. Morgan, American Ambassador to Brazil, has advised that the Brazilian Minister of Finance is about to appoint a special commission to study the subject of revision of the Brazilian tariff and report to Congress.

MISCELLANEOUS NOTES.

Electrical Contractors' Association of Scotland.—The annual meeting of the Glasgow branch of this Association was held on the 8th inst. The Chairman said that during the past year there was a net increase of seven in the membership of the branch.

During the past year the Committee had had many meetings and the various sub-committees had had important work to carry through. In regard to the Glasgow electrical showroom, he said that over a year ago they received a deputation (Bailie Smith, Councillor McNaughton and Mr. W. W. Lackie) from the Electricity Committee of the Corporation, and they were offered the opportunity of opening and carrying on the showroom. The Committee considered that a showroom was neither a necessity nor a profitable thing for either party to run, but the representatives of the Corporation stated that a showroom must be opened. After many meetings it was arranged that the showroom should be opened and be run by the Corporation and the principal points arranged were: (1) The showroom should exist primarily for exhibition of electrical appliances; (2) if a sale was made it would be at the usual trade retail selling price; (3) all work resulting from inquiries at the showroom to be done direct by a contractor; (4) there would be no hiring. The agreement was for a first period of five years. It had been stated that the conditions agreed to were less favourable to them than those in the I.M.E.A. Bill, but any contractor reading the two sets of proposals would have no difficulty in seeing that in their case they were protected from rate-aided cutting with its attendant inferior workmanship, whereas in the I.M.E.A. proposals that trade would have been cut away from them to be run at a loss by a municipal "Kaiser." Another thing was that they knew Mr. Lackie and what he intended to do with the showroom. In connection with the question of showrooms they had on the Showroom Committee representatives from the Ironmongers' Association, the Plumbers' Association and from the manufacturers, all of whom gave their valuable help.

[illegible] the weights and measures Bill and the opinion with the architects and measures regarding conditions and form of contract, and Mr. Askwith was asked to arbitrate [illegible] raised. In order to settle the matter the architects were brought in and the representatives of the Association attended a number of meetings regarding it. As they knew hitherto a measure's schedule had [illegible] contractors could not place definite orders for the exact quantities of materials as they never knew exactly what work might be proceeded with and also if measurements were correct. That was no contract, only a schedule of rates, and under it an architect might cut out any amount of the proposed work or add indefinitely without any recompense to the contractor. The new proposal was that they should have a contract total price accepted, not a schedule of rates, and any alterations beyond a small margin to be a mutual arrangement between architect and contractor. A complete set of conditions and rules of contract was being arranged, and later a model form of schedule would be drawn up for use by the measurer. They were waiting word from Sir G. Askwith fixing the date for the next meeting, at which representatives from the Municipalities, County Councils, &c., would be present. The War Office and Admiralty had stated they would favourably consider the mode.

They had had proposals for agreements between the E.C.A. of Scotland and the Dynamo and Motor Manufacturers and also the Tungsten Lamp Association. They were not satisfied in either case with the inducements offered. The Committee had now started to consider the question of rules for apprentices. A draft set of rules had been drawn up and would be considered at an early date. They had given their men an extra 1d. per hour war bonus under their agreement with the engineers and shipbuilders. They had made a slight alteration in the rules for workmen. The Central Board had had various questions of municipal trading before them and had satisfactorily dealt with them. The Central Board previously paid for the issue of the "Electrical Contractor" to the members, but last year it was left to members to arrange themselves for the supply of the paper.

Tenders and Foreign Capital.—At the last meeting of Manchester Corporation objection was raised to the acceptance of [illegible] tender of Messrs. Siemens Bros. Dynamo Works, Ltd., on the ground that the company was [illegible] partly of German capital.

It was stated that the company was [illegible] entirely British directorate, and that the works of the company were almost wholly engaged upon work for the Government. One member, however, thought that it might not be an injurious thing for the country to use German capital for its own purposes. The Town Clerk said that, so far as the information in his possession went, 80 per cent. of the company's capital was German at the beginning of the war. It was now represented that the percentage had been reduced to 59. If the Council desired to have fuller information he could obtain it from Somerset House for the next meeting. The chairman of the Committee agreed to take the matter back.

TENDERS INVITED.

Cables, Transformers, Meters, &c.

The Electricity Supply Committee of Dublin Corporation invite tenders for High-pressure and Low-pressure Cables and Accessories, Transformers and Transformer Pillars, and Electricity Meters. Specifications, &c., from the City Electrical Engineer, Fleet-street, Dublin, and tenders addressed to the chairman, Electric Supply Committee, Lord Edward-street, Dublin, by noon July 2[illegible]. *Further particulars are advertised.*

Rotherham Electric Light and Traction Committee require tenders by July 24 for 12 months' supply of Steel Armoured Cable, h.t. Cable, Rubber-insulated Cable and Trolley Wire, Amp.-hour Meters and Coal. Specification, &c., from the Engineer and Manager.

Telephone and Telegraph Material, Wire, Instruments, &c.

The Deputy Postmaster-General, Adelaide (South Australia) will receive tenders until 2 p.m. Aug. 25 for Ammeter, Lightning Arresters, Testing Set, Resistances, Voltmeters, &c. (schedule 383), and Dry Cells, Earth Clips, Switches, Telephones, &c. (schedule 389), and until 3 p.m. Aug. 11 by the Deputy Postmaster-General, Perth (W. Australia) for measuring instruments [illegible] Australian Commonwealth [illegible] Dept. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *Further particulars appear in our advertisement columns.*

Water Service Conduit, &c.

Sheffield Electric Supply Committee [illegible] July 20 for Water Service Conduit, Penstocks, &c., and Pump-room for Cooling Tower Plant. Specifications from Mr. S. E. Fedden, electric supply department, Sheffield.

Turbo-Alternators, Motor Generators, Boilers, &c.

The Electricity Committee of Hull Corporation [illegible] tenders for the supply, erection and testing at the [illegible] Turbo-alternator, with Exciter, and [illegible] Forms of tender and specification from the city treasurer, Mr. T. G. Milner, and tenders, to the chairman of the Electricity Committee, Guildhall, Hull, by first post Thursday, July 22.

Sydney (N. S. W.) Council require tenders by 3 p.m. July 19, for supply and erection of 12,000-kw. [illegible] cation from the Electric Light Department, Town Hall, Sydney.

Tenders are invited for the supply and delivery in Melbourne of one 1,000-kw. direct-current Generator with Field Regulator [illegible] &c. Tender forms, &c., from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Propy. Ltd., Billiter-square Buildings, London, E.C., to whom tenders by noon Aug. 11.

Wiring.

[illegible] July 19 for Electric Wiring and Fittings in Workmen's Cottages [illegible] Engineer and Surveyor, Town Hall, Mexborough.

Electrical Stores, &c.

Edinburgh Corporation will receive by July 17 for three, six or nine months' supply of Electrical Material, Tools, Ironmongery, Engineers' Stores, Iron Tubes, &c. Forms of tender from the Electrical Engineer, Dewar-place, Edinburgh.

Hull Corporation invite tenders by first post July 22 for supply of Machinery Oils for their electricity department. Forms of tender from the acting City Electrical Engineer.

Telephone and Telegraph Material, Wire, Instruments, &c.

The Deputy Postmaster-General, Adelaide (South Australia) will receive tenders until 2 p.m. Aug. 18 for Battery Material (schedule 385) and Magneto and Trembling Bells (schedule 386) for the Australian Commonwealth Postmaster-General's Dept.

The Deputy Postmaster-General, Perth (W. Australia) requires tenders by 3 p.m. July 21 for 40 Trembling Bells, 3 lb. Gran. Carbon, 1,000 Earth Clips, 33,000 Fuses in tubes and 6 [illegible] (Schedule 423 W.A.) [illegible] 3 p.m. Aug. 11, for Telegraph Instruments and parts (Lightning Arresters and Mica Discs, Resistance Boxes, Condensers, Galvanometers, Morse Sounders and Switches (Schedule No. 422 W.A.) for the Australian Commonwealth, Postmaster-General's Dept. Specifications from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Meters and Maximum Demand Indicators.

Tenders are invited for the supply of a.c. and d.c. Meters and m.d. Indicators to the City of Melbourne. Copies of specification, &c., from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Propy. (Ltd.), Billiter Square-buildings, London, E.C., to whom tenders by noon July 27.

TENDERS RECEIVED AND ACCEPTED.

Hammersmith [illegible]. The following tenders have been accepted by the Metropolitan Asylums Board for wiring four blocks at the Grove Hospital:

Titan Lift Co. (*recommended*)	£540
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Rotherham. On Tuesday the Corporation [illegible] & Electric Mfg. Co. [illegible] Works [illegible] 19 Lamps [illegible] 19 Lamps [illegible] 19 Lamps

MANCHESTER.—The Corporation have placed orders with the British Insulated & Helsby Cables (Ltd.) and W. T. Glover & Co. for the supply of cables: with B. Thomas for wiring the Baguley sanatorium; and with Siemens Bros. Dynamo Works for metal filament lamps for the sanatorium.

WATFORD.—The Council have placed an order with W. T. Henley's Telegraph Works Co. for the supply and laying of cables.

WOLVERHAMPTON.—The Tramways Committee has decided to purchase 12 motor equipments from Dick, Kerr & Co., at £1,380.

SALFORD.—The Corporation have placed an order for welding about 550 tramway rail joints with Tudor Accumulator Co., at £1. 7. . 6d. per joint

Osram Lamp Contracts.—The General Electric Co. has been successful in securing a yearly contract from the Great Northern Railway Co. for the supply of standard Osram drawn-wire lamps and for Osram Ames type lamps. These lamps are manufactured at the Osram Lamp Works (Hammersmith, London, W.), the bulbs being blown at the Lemington Glass Works, Newcastle-on-Tyne.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Chili Telephone Co. (Ltd.)

The twenty-sixth ordinary general meeting was held on Wednesday, Mr. GEORGE KEITH presiding.

The SECRETARY (Mr. W. G. Mare) having read the notice convening the meeting and the auditors' certificate,

The CHAIRMAN said: The past year has been an abnormal one, and of great difficulty for our business in Chili. The Company's revenue increased very favourably during the first four months of the year, but then came the crisis due to the outbreak of war in Europe, closing Chili's principal markets for the export of nitrate, her chief source of revenue. The subsequent naval activities off the West Coast also interfered greatly with her shipping trade. Exchange fell to 7d., lower than it ever was before, and the whole business of the country became difficult and seriously depressed. You will see by the comparative figures given in the report the aggregate number of subscribers has fallen off about 6 per cent. due to the telephones given up in consequence of economy or bad business. Fortunately the loss of revenue incurred thereby was more than compensated for by the increase during the four months preceding the war, and the gross currency revenue comes out showing a small increase for the year. Working expenses have also increased. The total working expenditure took 54 per cent. of the revenue and the net currency comes out showing a small decrease for the year. Then the lower value of the Chilian dollar reduced the average rate of exchange to about 8¼d., or near 12 per cent. less than it was for the previous year, and the net income in Chili when converted into sterling shows a decrease for the year of £8,030. The total income from all sources, including interest on investments and transfer fees amounts to £54,392. The London expenses are £92 less, while income tax has increased £1,266. These disbursements leave a net credit balance for the year of £17,965, of which the sum of £3,838 was expended in Chili on replacements and renewals of plant. An interim dividend of 3 per cent. was paid in January, and after carrying £12,344 to the general reserve and setting aside £5,000 as a special reserve against loss by depreciation on investments, the Directors now recommend the payment of a final dividend of 5 per cent., making with the interim payment, a total distribution for the year of 8 per cent., the same as last year, on the share capital, free of income tax, and carrying forward £1,338 as compared with £3,956 brought forward from last year's account.

Considering the setback which our business has suffered in consequence of the abnormal conditions in Chili due to the war, I think I may congratulate the shareholders upon the result of the year's working. The general reserve now stands at £96,000. The depreciation of the sterling value of the liquid assets over liabilities in Chili due to the fall of exchange amounts to £6,344. Investments remain unaltered, and a special reserve of £5,000 now covers the depreciation in their market value, which has unfortunately increased during the past year after the issue of the war loan. The capital expenditure is increased by £6,137 expended in Chili on extensions to the property and plant.

Since the commencement of the present year the general situation in Chili has shown signs of improvement. The shipment of nitrate to the United States and other neutral countries is having a reassuring effect, and some of the oficinas, which had stopped production, have again commenced work, but any great renewal of prosperity in this industry is not to be expected while the war lasts. High prices are also benefiting the mining and agricultural interests, and are leading to an increase in the exportation of these products, while the reduction of public expenditure and low imports are producing a healthy state of things in the money market. Our business as far as it has gone this year shows an improvement, which, it is hoped may continue and at least cover the setback which has taken place since the war broke out. I now beg to move the adoption of the report and accounts.

The motion having been carried unanimously, the retiring director re-elected, and the auditors reappointed, a vote of thanks to the chairman, directors and staff terminated the proceedings.

GENERAL ELECTRIC CO. (LTD.).—Mr. Hugo Hirst, who presided at the meeting on Friday last, said that a company such as theirs, with its factories and branches distributed over the country, and, indeed, through out the Empire, had a pulse which beat in perfect unison with that of our country. On August 3, 1914, on the eve of the war—the Government desired prompt execution of emergency orders, and for that the immediate return of their staff to certain works was essential. It was a matter of pride to them, and also reflected great credit on their workpeople, that, in spite of its being holiday week, over 99 per cent. turned up to give them the best of their work. The few days of financial unsettlement which followed the outbreak of hostilities did not seem to affect materially the electrical industry, while the month of August, which with them was generally the quietest month of the year, became one of the busiest. It appeared that factors and the trade, fearing a shortage of supplies, decided to fill up their stocks and consequently indulged in overbuying. The reduction of their stock was largely due to their policy on the part of the trade, and owing to their reduction of output in consequence of the shrinkage of labour and lack of raw material they had not yet been able sufficiently to replenish. Their considerable export business was partially checked owing to difficulties of freight and insurance and also by their desire to safeguard the supplies for the home market. Early in September they suffered severely by well-meant but ill-conceived attacks by a portion of the Press on the Osram Lamp Works, with which they were so intimately associated, owing to the prevalence in that company of German capital. Their critics did not then sufficiently distinguish between German-owned trading concerns and factories established in this country which were useful and essential to national purposes. The importance of the Hammersmith works, not only to themselves but also to the Government and the country, was very great, and it was therefore exceedingly gratifying to them to announce that a way had been found, with the knowledge of the Treasury and the Public Trustee, which would give the future control of those works, he trusted for ever, into British hands. By the end of September or the beginning of October they felt the first effects of the depletion of their staff and workpeople. A great many of their employees enlisted on the declaration of war, and it required no recruiting officers at their works to encourage young men to join the Colours, about 1,000 of whom were now serving with His Majesty's forces. On the declaration of war three of the sons of the late Chairman (Mr. G. Byng), and brothers, of the present Vice-Chairman, enlisted, one of them (Mr. Harry Byng), a man trained as an engineer, who had won honours at Harrow, Faraday House and Harvard University, he was sorry to say had since fallen in action in Flanders while leading his platoon to attack. He was not only a great loss to his family, but also to the company. Of their men, 11 had already laid down their lives for their country, 50 were invalided, wounded or missing, 31 had obtained commissions, among whom were Mr. Leonard Byng, a director of the company, and also his (the speaker's) only son. They all readily volunteered to leave the work they loved, in order to offer their all to that greater cause which had absorbed their thoughts unceasingly for 11 months, and he feared would occupy them for as many months to come, or even longer. They had arranged to keep open all the positions of those who had enlisted, and to pay 50 per cent. of the salary to the dependents of all married men, to make special allowances to a certain number of unmarried men who had relatives dependent upon them, and to set aside 10 per cent. of the salary of all unmarried men other than above, so that they might have some cash reserve on their return to civil life. It was not until the end of October that they realised what great quantities of their normal productions were required for war purposes. Up to date direct orders from Government Departments and indirect war orders from Government contractors amounted to the end of March to fully half a million sterling. The products included searchlight carbons, signalling and wireless apparatus, incandescent lamps (both carbon and metal filament), power, lighting and ventilating plant for H.M. dockyards and battleships, motors, dynamos and every kind of electrical equipment for the Army Service Corps, hospitals and munition works, &c., field telephones and batteries, targets, exploders and shells for both services. That list might convey very little to them, but it was one of which they were exceedingly proud, because it contained a number of items which only that company could produce, items of the most momentous importance both to the Admiralty and to the War Office, manufactured at some of their works which had been the least remunerative in the past owing to foreign competition. It was a matter of great satisfaction to the Board that their determination to maintain

single-handed certain industries for patriotic reasons had at last been rewarded by the knowledge that they had proved not only of indispensable service, but of vital importance to the welfare of the country. The time was not yet opportune to make a statement of recent developments referring to that subject, but whenever that moment arrived it would be a fine page in the history of their company and a lesson to the country at large. They had, in addition, lately started the manufacture of certain types of shells, and arrangements were in progress to make themselves thoroughly efficient in that department. The company was fortunately in so strong a position that should there be in the immediate future, owing to exceptional circumstances, a reduction of profits, they should quickly be able to make good, after victory had been achieved, when those markets which were now being starved called for replenishments from British works. In order to cope efficiently with the increased work created by the growth of their business, it had been found necessary to add to the number of their directors. They had selected from among their staff Mr. James Young Fletcher, who had been with the company for over 20 years, and had graduated from the ranks to the position of branch manager and subsequently manager of the Osram Lamp business; Mr. Sidney D. White, who had grown up with the company since its inception, and who was in charge of all the Government work carried on by the company; and Mr. George Maurice, who was head of their fixtures business, also a servant of the company of over 20 years' standing, and fully conservant with their intricate and detailed business. They would be asked to confirm the election of Mr. Fletcher and Mr. White, but he was sorry to say it would not be possible to confirm that of Mr. Maurice. At his own suggestion he decided on a trip to America in the month of March in order to open up business connections, principally for the purchase of raw materials which were unobtainable elsewhere. He was most successful, but unfortunately fell a victim to the murderous "Lusitania" crime. His loss would be deeply felt by them all and the blank caused in their organisation would be very difficult to fill. Although the year showed a progress in profits, the absorption of some £22,000 extra for dividends, owing to the increase of capital, had somewhat affected certain other items in the appropriation. The Pirelli-General cable works had started manufacturing for certain Government contracts, but, owing to conditions of labour, it might be some time before those works could be considered as being in full swing. The steelwork of their Kingsway building was up, but it seemed to them wrong at this juncture to pursue any scheme which did not add to national production or efficiency, and they had suspended building operations for the moment.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—At the meeting last week Mr. Godfrey Isaacs, who presided, expressed regret for the absence of the chairman, Mr. G. M. Marconi, who had been called by his Government to Italy, and he had joined the engineering staff of the Italian army to superintend the organisation of its wireless communications. In consequence of the bigger business last year, expenses and salaries showed an increase over the figures of the preceding year, but those figures had not increased in the same ratio as the increase of business. The revenue shows an increase amounting to between £28,000 and £29,000. In consequence of the outbreak of war, the receipts from ships' telegrams and news services during the last five months of the year suffered very materially. Under the circumstances, the result of the year's operations was satisfactory. It showed a continuous development year by year of a sound and growing organisation. The net profit was £55,668 after deducting £28,000 for depreciation and debenture interest, and out of the available balance (£64,856) they were paying a final dividend of 5 per cent., making 10 per cent. for the year. Owing to the destruction of ships by enemy submarines, and having regard to the fact that that method of warfare continued, the directors had thought it desirable to place £10,000 to a special reserve account to provide for any eventualities. After allocating a further sum of £3,500 to the repayment of debenture account, £20,747 would be carried forward. Every week they were adding new installations, entailing additional capital expenditure, but, nevertheless, adding steadily to the growth of their revenue. At the end of last year they had installed and were operating 905 telegraph stations upon the high seas. Up to June 19 this year the number had increased to 970, and contracts continued to be entered into in much the same ratio. After referring to the deaths of General Thys and Major S. Flood Page, he said that at no time before had the value of Mr. Marconi's invention and the utility of the company's organisation been more prominently emphasised than since the outbreak of war, and when peace once more obtained an interesting chapter might be written of the part played by the 2,000 Marconi stations fitted upon the vessels of the mercantile marine under the control and management of the Marconi companies. Their thanks were due to their manager, Mr. Bradfield, and the other members of the staff, who had so ably handled their business during very difficult times; and the greatest appreciation was due to their magnificent army of telegraph operators, who had unflinchingly carried out their duties on board ship.

CITY NOTES.

MEMORANDA (July 14).—Bank rate 5 per cent. since Aug. 8, 1914. Consols 65. Consols Pay Day Aug. 5. Stocks and Shares Ticket Days July 28 and Aug 11. Pay Days July 29 and Aug. 12. Price of silver, 22 $\frac{3}{8}$d.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended June 30 of 1½ per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock (less tax), payable on the 31st inst.

BRITISH ELECTRIC TRACTION CO. (LTD.)—Particulars have been issued of the proposed scheme of re-arrangement and reduction of capital. The existing four classes of stocks (£2,947,380) are to be rearranged and divided into two classes, viz.: £686,107. 5s. 6 per cent. cumulative participating preference stock and £1,259,670. 10s. new ordinary stock. This provides for writing down the existing issued capital by £1,001,602 5s. The unissued capital consisting of 105,262 ordinary shares of £10 each, it is proposed to subdivide into shares of £1 each and to convert 313,893 of such shares into 6 per cent. cumulative participating preference shares. The £403,592. 10s. 6 per cent. cumulative preference stock now outstanding and 35 per cent. (£282,514. 15s.) of the present £807,185. 7 per cent. non-cumulative preference stock are to be converted into 6 per cent. cumulative participating preference stock. The remaining 65 per cent. (£524,670. 5s.) of the present 7 per cent. non-cumulative preference stock is to be converted into new ordinary stock. The present £1,070,097. 10s. 6 per cent. preferred ordinary non-cumulative stock is to be reduced by 50 per cent. (£535,048. 15s.) and the balance is to be converted into new ordinary stock. The present £666,505 deferred ordinary stock is to be reduced by 70 per cent. (£466,553. 10s.), and the remaining 30 per cent. is to be converted into new ordinary stock. The £266,371. 1s. income certificates are to be surrendered and cancelled and the holders are to receive in exchange pari passu among them 35 per cent. (£93,230) of their face value, viz., 10 per cent. in fully-paid new 6 per cent. cumulative participating preference and 25 per cent. in fully paid new ordinary shares.

DIRECT UNITED STATES CABLE CO. (LTD.)—The board have resolved to pay an interim dividend of 2s. per share (less tax), being at rate of 4 per cent. per annum for quarter ended June 30, payable on the 31st inst.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—The directors have declared interim dividends for the half-year ended June 30 at rate of 6 per cent. per annum (less tax) on the Preference shares, and at rate of 5 per cent. per annum (less tax) on the Ordinary shares, payable on the 7th prox.

READING ELECTRIC SUPPLY CO. (LTD.)—Mr. Spencer Hawes, M.I.E.E., has been appointed managing director of this company. Mr. E. Rowley Hill retired from the post of engineer and manager at the end of June.

WAR LOAN.—Amongst the important applications for the War Loan is one for £77,000 by Messrs. W. T. Henley's Telegraph Works Co. (Ltd.) Mr. H. Hirst at the meeting of the General Electric Co. on Friday last announced that the company had taken up £100,000 in the new War Loan in addition to the £100,000 of the 3½ per cent. loan which had been previously taken up by the company.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, July 14. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	NAME.	Price, Wed. July 14.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9⅛	7 2 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	10½	5 17 1	Feb Aug
5	10%	Brompton & Kensington Ord.	34⅜	6 0 0	Mar, Sept
St.	4%	Central Elec. Supp. C. Deb. St	90½	4 8 5	
St.	4%	Charing Cross West End & City Debs...	83½	4 15 10	Jan, July
5	2·3	Do. 4½% Pref.	4⅞	5 10 10	..
5	..	Do. Ord.	4	6 5 0	Aug, Feb
10	9%	City of London Elec. Lt. Ord.	13⅞	6 13 4	Feb, Aug
10	6%	Do. 6% Pref.	12⅜	4 17 0	Mar, Jly
St.	10%	Do. 5% Deb. St.	110	4 10 11	Jun, Dec
10	..	County of L. Elec. Ord.	11	6 7 3	Mar, Sept
10	6%	Do. 6% Pref.	11	5 9 1	Feb, Aug
St.	4½%	Do. 2nd Deb.	97	4 12 9	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs...	7⅞	5 14 2	July
5	2½	Kensington and Knightsbridge Ord. ..	7⅛	6 4 2	Feb, Aug
St.	4%	Do. Deb. St.	85	4 13 0	Jan, Jly
5	5%	London Elec. Supp. 5% Pref.	5¼	5 19 3	
St.	4%	Do. 4% Mort. Debs.	86½	4 11 11	Jan, Jly
5	3½	Metropolitan E. Supp. Ord.	..	6 7 3	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	94½	4 15 3	Jan, Jly
St.	..	Midland Elec. Corpn., 1st Mort. Deb. St.	..	5 1 0	Jan, Jly
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs ..	98½	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S.5%2dMt.Db.St.	100	5 0 0	Mar, Sept
1	5%	North Metropolitan E.P. Supp. 6% Pref	1⅛	5 11 6	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs. ..	95	5 5 3	Apl, Oct
St.	4½%	Do. 4½% Mort. Deb. St.	84	5 7 7	Jly, Jan.
1	..	Waste Heat & Gas Elec. Gen. Stations.	1⅜	7 12 9	Apl, Oct
5	..	Westminster E.S. Corp. Ord.	7	6 8 6	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4⅝	4 17 8	Jan, Jly.
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	79½	6 6 2	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	78	5 11 6	Feb, Aug
St.	4%	Central London Guar. Assented Ord. ..	73	5 9 4	..
St.	4%	Do. Assented Def. Ord. ..	7½	5 5 3	..
1	4%	Do. 4% Pref.	93	4 6 3	May, Nov
..	..	Do. Pref.	87	9 .. 7	Feb, Aug
1	5%	Liverpool Tramway	17	5 17 6	Feb, Aug
1	4%	London United Ry. (1903)	14	5 .. 7	Jan, July
St.	4%	Do. 4% Pref.	62½	6 8 3	Mar, Sept.
St.	4%	Do. 4% Deb.	85	4 14 1	Jan, Jly.
St.	4%	Metropolitan Ry. Con. Ord.	20⅜	4 1 10	Feb, Aug
St.	4%	Do. 4% Pref.	7½	4 10 6	Feb, Aug
St.	4%	Do. 4% Cum. Pref.	74½	4 14 3	Feb, Aug
St.	4%	Do. 4% A Deb.	84½	4 4 7	Jan, July
5	3½%	Do. 3½% Deb.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	13½	.. ..	Feb, Aug
St.	4%	Do. 4% Pref. Ldn.	92	4 7 0	May, Nov

†Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	NAME.	Price, Wed., July 14.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*	£ s. d.		
[illegible]	4½	[illegible] 4½ Pref	6		Feb, Aug
[illegible]	[illegible]	[illegible]	12-4	4 12 8	Jan, July
[illegible]	[illegible]	Do. [illegible]	4	4 15 0	Jan, July
[illegible]	4½	Do. 5 Debs. (1903-5)	5	4 11 1	Jan, July
St.	4½	[illegible]	5	5 6 0	Mar, Sept
1	..	[illegible] E [illegible]	..	..	..
1½	..	Do. A Ord.	..	..	..
St.	6%	[illegible]	10[illegible]	5 11 [illegible]	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 15	[illegible]	[illegible] 1 [illegible]	Mar, Sept
..	4½	Do. [illegible]	9	4 13 7	Jan, July
5	..	Y [illegible]	[illegible]	..	March
5	6%	[illegible]	4 [illegible]	6 11 6	Jan, Jly
		Electric Manufacturing, &c.			
1	1½	[illegible]	2 [illegible]	[illegible] 1	Apl, Oct
1	1/0	[illegible]	1 [illegible]	4 14 [illegible]	Mar
100	5%	Do. Prior Lien Debs.	[illegible]	[illegible] 3	Jan, July.
1	6	Do. 6% Pref.	[illegible]	6 [illegible]	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	11[illegible]	6 [illegible]	Aug, Feb
5	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
1	5%	Brit. [illegible] Mfg. Co. 6% Pref.	1 [illegible]	[illegible]	Mar, Sept
2	7½%	Brit. Westinghouse Pref.	1[illegible]	5 [illegible]	April
100	6	Do. 6% Prior Lien Debs.	[illegible]	5 [illegible] 8	Apl, Oct
St.	..	Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11	6 [illegible] 4	Jan, July
5	[illegible]	Do. 5% Pref.	[illegible]	6 [illegible]	Feb, Aug
1	15%	Castner Kellner	[illegible]	[illegible]	May, Nov
1	[illegible]	Dick, Kerr & Co. 6% Pref.	[illegible]	6 18 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	[illegible]	..	Feb, Aug
1	6%	Elec. Construction Ord.	[illegible]	[illegible] 1	May
1	[illegible]	Do., 7% Cum. Pref.	1 [illegible]	[illegible] 0	Jan, July
St.	4%	Do. 4% Debs.	[illegible]	5 15 4	Jan, July
10	6	General Electric 6% Pref.	[illegible]	[illegible] 6	Jun, Dec
5	[illegible]	W. T. Henley's Teleph. Wks. Co. Ord.	14 [illegible]	[illegible] 7	Feb, Aug
5	[illegible]	Do. 4½% Cum. Pref.	[illegible]	5 0 [illegible]	
St.	4½%	Do. [illegible]	98	4 11 10	Jun, Dec
10	[illegible]	India Rubber, G. P. &c., Ord.	[illegible]	[illegible] 17 [illegible]	Feb, Aug
10	[illegible]	[illegible]	[illegible]	[illegible] 15 11	Apl, Oct
15	4	[illegible]	98	4 1 8	Apl, Oct
1	[illegible]	Telegh. Con. & Main. Co.	31[illegible]	[illegible] 7 [illegible]	Mar, July
100	4%	[illegible]	93	4 6 0	Jan, July
1	..	Vickers Ord.	1 [illegible]	[illegible]	May, Aug
1	[illegible]	Do. 5% Pref.	[illegible]	5 3 3	May, Aug
St.	4%	Do. [illegible]	93	4 [illegible] 0	Jun, Dec
10	4½	Do. 4½% 2nd Debs.	[illegible]	4 [illegible]	Jun, Dec
		Telegraphs.			
1	[illegible]	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	[illegible]	Anglo American 6% Pref. Ord.	[illegible]	5 [illegible]	[illegible], May, Aug, N
St.	[illegible]	Do. Def. Ord.	[illegible]	6 [illegible]	Feb, May, Aug, N
St.	4%	Commercial Cable 4% Debs.	72[illegible]	5 10 4	Ja, Ap, Jly, O
1	..	Cuba Submarine Ord.	[illegible]	5 13 6	May, Nov.
1	10	Do. 10% Pref.	15[illegible]	[illegible]	..
5	[illegible]	Direct Spanish 10% Pref.	[illegible]	6 13 [illegible]	
10	4	Direct United States	[illegible]	6 19 1	Ja, Ap, Jly, O
St.	25/0	Eastern Tel. Co. Ord.	[illegible]	[illegible] 3	Ja, My, Jly, O
St.	17/6	Do. [illegible]% Pref.	[illegible]	4 17 3	Ja, My, Jly, O
St.	4%	Do. 4% Debs.	[illegible]	[illegible]	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	[illegible]	4 14 [illegible]	Feb, Aug
10	7%	Do. Ord.	[illegible]	[illegible] 5	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. with Coup. 8	[illegible]	6 [illegible]	Ja, My, Jly
25	13%	Indo-European xd and bonus	[illegible]	[illegible] 4	May, Nov
1	2/0	Marconi's Wireless Tel. Co.	1	10 [illegible] 4	April
1	[illegible]	[illegible]	[illegible]	[illegible]	July
1	[illegible]	[illegible]	[illegible]	[illegible] 13 11	May, Nov
10	6%	West India & Panama Ord.	[illegible]	7 3 4	May, Nov
10	3/0	Do. 1st Pref.	[illegible]	5 [illegible] 3	May, Nov
St.	4	Western Teleph. Co.	12[illegible]	4 [illegible] 8	Mr, Jly, O. Dec
		Do. 4% Deb. St.	[illegible]	4 [illegible] 8	Jun, Dec
		[illegible]	[illegible]	4 14 [illegible]	May, Nov.
		Telephones.			
..	[illegible]	American Telephn. & Teligh. $100 Cap.	12[illegible]	6 9 [illegible]	Ja, Ap, Jn, O
..	[illegible]	Cuban Telephn. Co. 5% Bds.	[illegible]	6 [illegible]	Jan, Jly
1	7	Man. te Video Telephn. Ord.	[illegible]	5 [illegible] 5	Nov.
..	5%	New York Telephone 4½% Bds.	[illegible]	4 11 7	May, Nov
1	1..	Oriental Telephone Ord. (ex bonus)	[illegible]	5 [illegible] 1	Apl, Oct
St.	4	Do. Db. St.	[illegible]	4 12 6	Jan, July
St.	4½	Telephn. Co. of Egypt Db. St	5[illegible]	5 [illegible] 3	Jan, July
	[illegible]	United River Plate Ord.	[illegible]	[illegible] 3	Apl, Oct
	[illegible]	Do. 5% Cum. Pref.	[illegible]	[illegible] 3	Jan, July
St.	[illegible]	Do. Deb. Stk.	[illegible]	5 [illegible]	Jan, July
		Financial and Investment.			
10	[illegible]	GlobeTelegh. & Trust	[illegible]	[illegible] 1	Sp, Dc, Mr, Jn
[illegible]	[illegible]	[illegible]	11[illegible]	[illegible] 6 1	Sp, Dc, Mr, Jn
1	5%	[illegible]	[illegible]	[illegible] 5 0	Ja, Ap, Jly, O
..	4	Do. $100 Pref	[illegible]	5 14 [illegible]	Ja, Ap, Jly, O
10	[illegible]	Submarine Cable Trust Certs.	12[illegible]	4 15 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	[illegible]	[illegible]	Jun, Dec
St.	4½%	Do. 4½% Debs	[illegible]	[illegible]	Jan, July
St.	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
5	2/9	[illegible]	4	[illegible]	Jan, July
		[illegible]	[illegible]	[illegible]	Jan, July
1	[illegible]	Brazilian Traction Ord.	[illegible]	11 15	Feb, M, Aug, N
1	[illegible]	[illegible]	[illegible]	[illegible]	Ja, Ap, Jly, O
5	8%	Brisbane Trams Ord.	[illegible]	[illegible]	[illegible]
5	2/6	[illegible]	[illegible]	[illegible]	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	70[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	[illegible]	[illegible] 5	Feb, Aug
	[illegible]	Madras Elec. Trams 6% Cum. Pref.	[illegible]	6 [illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
	[illegible]	Mexico Trams Common St.	[illegible]	[illegible]	Feb, M, Aug, N,
	[illegible]	[illegible]	[illegible]	[illegible]	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	100[illegible]	[illegible]	Feb, Aug
	[illegible]	[illegible]	[illegible]	[illegible]	Jun, Dec
1	[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
		Adelaide Elec. Supply 6% Pref.	[illegible]	[illegible]	Mar, Sept
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Jun, Dec
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	Mar, Sept
	[illegible]	[illegible] adian Gen. Elec. Common St	[illegible]	[illegible]	Ja, Apl, Jly, O
	[illegible]	[illegible]	[illegible]	[illegible]	June, Dec
	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
	[illegible]	[illegible]	[illegible]	[illegible]	Ja, Apl, Jly, O
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	May, Nov.
	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July

‡ Free of interest.

METAL PRICES

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date July 14, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Tubes	14½d.	Antimony	£[illegible] 0 0
Solid Drawn Copper Tubes	14½d.	English Lead	£26 5 0
Brazed Copper Tubes	14½d.		
Brazed Brass Tubes	[illegible]	**Old Metals.**	per ton.
Brass Wire	[illegible]	Clean Scrap Copper	£[illegible] 0 0
Copper Wire	[illegible]	Brazierv Copper Scrap	£[illegible] 0 0
Rolled Brass	14½d.	Clean Scrap Brass	£[illegible] 0 0
Brass Sheets	[illegible]	Old Lead	£[illegible] 0 0
	per ton	Old Zinc	£65 0 0
Copper Sheets	£[illegible] 0 0	Hollow Pewter	£120 0 0
Spelter	£105 0 0	Black Pewter	£85 0 0
		Gun Metal	£64 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date July 13, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£[illegible]	Old Lead	£21 0 0
Clean Mixed Brass	[illegible]	Tea Lead	£19 0 0
Clean Copper	£68 0 0	Old Zinc	£62 0 0
Brazlery Copper	£62 0 0	Hollow Pewter	£120 0 0
Gun Metal	[illegible]	Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended	Increase or Decrease	Net Receipts	Aggregate. Amount	Aggregate. Increase or Decrease (-)
		£	£	£	£
Aberdeen Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Anglo-Argentine	[illegible]	82,553	— 1,[illegible]	1,385,244	— 12,[illegible]
Ashton-under-Lyne	[illegible]	452	— [illegible]	7,243	— 1[illegible]
Ayr Corporation	[illegible]	487	— [illegible]	3,108	— 1[illegible]
Bath Electric Trams, Ltd	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Birkenhead Corporation	[illegible]	1,449	— 1[illegible]	19,892	— 779
† Birmingham Corporation	[illegible]	14,257	[illegible] 14	176,740	— 2,[illegible]
Blackburn Corporation	[illegible]	1,193	— 236	19,594	— 1,071
Blackpool Corporation	[illegible]	1,932	— 1,130	19,533	— 5,653
Blackpool and Fleetwood	[illegible]	1,108	— [illegible] 7	13,951	— 3,110
Bolton Corporation	[illegible]	2,786	— [illegible]	39,124	— 3,549
Bournemouth { Trams	[illegible]	2,085	— [illegible] 14	29,365	— 305
Bournemouth { Buses	[illegible]	37	— [illegible]	341	— 23
Bradford Corporation	[illegible]	6,596	— [illegible]	89,786	+ 1,521
Brighton Corporation	[illegible]	1,148	— 1[illegible]	15,615	— 1,330
Bristol Trams { Trams	[illegible]	4,935	— [illegible] 2	124,491	— 1,930
Bristol Trams { Buses, &c.	[illegible]	5,197	— [illegible]	126,064	+ 22,591
Burmah E. Trams & Ltg.	[illegible]	[illegible]	[illegible]	[illegible]	R46,589
Burnley Corporation	[illegible]	1,700	— [illegible] 15	38,109	— 1,632
Burton Corporation	[illegible]	317	— [illegible] 1	4,191	— 333
Bury Corporation	[illegible]	1,403	— [illegible] 1	20,411	— 670
Calcutta Tramways Co.	[illegible]	[illegible]	[illegible]	R1,788,488	— R86,559
Cardiff Corporation	[illegible]	139	— [illegible] 7	3,661	— 129
Cardiff Corporation	[illegible]	2,727	— [illegible] 14	36,299	— 3,342
Cork Electric Trams Co.	[illegible]	[illegible]	[illegible]	13,233	— 234
Coventry Corporation	[illegible]	[illegible]	[illegible] 7	14,088	+ 1,269
Croydon Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
*Derby Corporation	[illegible]	[illegible]	[illegible] 11	[illegible]	[illegible]
Dover Corporation	[illegible]	[illegible]	[illegible] 1	[illegible]	[illegible]
Dublin & Lucan Railway	[illegible]	190	[illegible]	190	[illegible]
Dublin United	[illegible]	6,421	— [illegible]	163,147	— [illegible]
Dundee Corporation	[illegible]	1,429	[illegible]	10,331	[illegible]
East Ham Council	[illegible]	1,397	[illegible] 10	19,155	— 3[illegible]
Exeter Corporation	[illegible]	408	[illegible] 1	5,476	[illegible]
Glasgow Corporation	[illegible]	21,700	[illegible]	129,301	[illegible]
Glossop Trams	[illegible]	126	[illegible]	3,324	[illegible]
Gloucester Corporation	[illegible]	[illegible]	[illegible]	4,678	[illegible]
Halifax Corpn. { Trams	[illegible]	[illegible]	[illegible]	31,877	— [illegible]
Halifax Corpn. { Buses	[illegible]	[illegible]	[illegible]	705	— [illegible]
Hastings Elec. Trams Co.	[illegible]	1,328	[illegible]	22,950	[illegible]
Huddersfield Corpn.	[illegible]	2,629	[illegible]	39,417	[illegible]
Hull Corporation	[illegible]	[illegible]	[illegible] 10	44,265	[illegible]
Ilford District Council	[illegible]	[illegible]	[illegible]	9,622	[illegible]
Ilkeston Corporation	[illegible]	[illegible]	[illegible]	1,814	[illegible]
Ipswich Corporation	[illegible]	[illegible]	112 14	7,613	[illegible]
Isle of Thanet Co.	[illegible]	[illegible]	635 401	13,402	[illegible]
Kilmarnock Corporation	[illegible]	[illegible]	[illegible]	1,357	[illegible]
Lanarkshire Trams Co.	[illegible]	2,114	[illegible]	50,235	[illegible]
Lancashire United	[illegible]	2,020	[illegible]	45,403	[illegible]
Leeds Corporation	[illegible]	8,853	[illegible]	130,534	[illegible]
Leicester Corporation	[illegible]	3,045	[illegible]	81,121	[illegible]
Lewis's Ltd.	[illegible]	825	[illegible]	6,405	[illegible]
Lincoln Corporation	[illegible]	135	[illegible]	2,006	[illegible]
Liverpool Corporation	[illegible]	14,393	[illegible]	343,021	[illegible]
Llandudno Urban Dist.	[illegible]	418	[illegible]	8,483	[illegible]
London County Council	[illegible]	[illegible]	— 1,094	530,397	[illegible]
Lowestoft Corporation	July	233	— 23	6,736	[illegible]
Maidstone Corporation	[illegible]	[illegible]	[illegible]	3,142	[illegible]
Manchester Corporation	[illegible]	17,824	[illegible]	262,548	[illegible]
Nelson Corporation	[illegible]	726	[illegible]	2,832	[illegible]
Newcastle-on-Tyne Corpn	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Newport (Mon.) Corpn.	[illegible]	875	[illegible]	11,307	[illegible]
Northampton Corporation	[illegible]	721	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	53 434	[illegible]
Oldham Corporation	[illegible]	2,406	[illegible]	[illegible]	[illegible]
Portsmouth Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Preston Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1,683	[illegible]	25,315	[illegible]
Rotherham Corporation	[illegible]	1,153	[illegible] 11	[illegible]	[illegible]
Salford Corporation	[illegible]	[illegible]	— [illegible] 11	77,772	[illegible]
Sheffield Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Southampton Corpn.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Southend Corporation	[illegible]	[illegible]	[illegible] 17	11,9[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] 1	11,4[illegible]	[illegible]
St'lyb'dge, Hyde, &c., Jt. B.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sunderland Corporation	[illegible]	1[illegible]	[illegible] 1	21,519	[illegible]
Swansea District	[illegible]	[illegible]	[illegible]	19,812	[illegible]
Swinton & Pendlebury Corpn.	[illegible]	[illegible]	[illegible]	2,796	[illegible]
Todmorden & Dist. Co.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wallasey Corporation	[illegible]	[illegible]	[illegible] 1	18,550	[illegible]
Walsall Corporation	[illegible]	[illegible]	[illegible]	19,281	[illegible]
West Bromwich Corporation	[illegible]	[illegible]	[illegible]	13,678	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Warrington Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
West Ham Corporation	[illegible]	3,324	[illegible]	44,399	[illegible]
Wigan Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wolverhampton Corpn.	[illegible]	1,119	[illegible] 14	15,437	[illegible]
Yorkshire W.R. Trams	[illegible]	1,080	[illegible]	43,223	[illegible]

(a) Three months ended 13 as with the corresponding period last year. * Partly electrical. † Including suburban. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 3 days. ** Compared with one week in corresponding week last year.

THE ELECTRICIAN:

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NOTES.

The Coal Strike.

We venture to think that the lamentable coal strike which the past week has witnessed in South Wales would not have been possible in any other country. Fortunately it has now come to an end, but there has been no credit gained by the course of events. On the part of the men the strike has been nothing short of treason against the State, and on the part of the Government there has been a lamentable want of foresight. Rightly or wrongly, the men have considered that their labour was being exploited for the benefit of capital, and that the lever of patriotism was being used to induce them to work under financial conditions which, although good from their point of view under peace conditions, were not sufficiently good at the present time with coal at what appeared to be an inflated price. We do not suppose that any feeling of injustice is calculated to give trouble more readily than the idea which we have just described. That being so, and considering the fact that such ideas are by no means new, the Government should have faced the position long ago, and should have limited the price of coal at an early date to a reasonable figure. This has not been done, and only now are preliminary steps being taken in this direction. It is useless to wait until such feelings produce their inevitable result and lead to complications which may have terrible consequences. Let the Government act promptly and with a strong hand between capital and labour, for the present time [illegible] measures.

Dielectric Losses.

In searching the literature one at once realises that few extended researches have been conducted along the line of dielectric losses. The most notable ones have been carried out during the past few years by RAYNER, by PATERSON, RAYNER and KINNES, and by FLEMING and DYKE. The latter made use of the bridge method, while the two former made use of the electrostatic wattmeter. Both of these methods have the disadvantage of being limited in the voltage at which they can be used, and the electrostatic wattmeter is a troublesome instrument with which to work. As far as we are aware, Prof. RYAN first suggested the use of the cathode ray tube for the purpose of measuring small losses at very high voltages, and showed how it could be used by giving a number of examples of measurements made with the instrument. Before the American Institute of Electrical Engineers Mr. J. P. MINTON recently read a Paper on "An Investigation of Dielectric Losses with the Cathode Ray Tube." To MINTON credit is due for the development of the *cyclograph*, which is the name given to the cathode ray tube wattmeter. It seems to be a satisfactory apparatus for the measurement of dielectric losses up to almost any desired voltage, from very small to large losses, and from low to high frequencies. The application of the cyclograph to this work, its development, some of the results obtained with it, and a study of dielectric losses made possible by its use, are embodied in the Paper; and the results and information ably set forth by the author may be considered as opening up a new avenue for insulation research for both the electrical engineer and the scientist.

Senseless Obstruction.

At the Congress of the Tramways and Light Railways Association last week Mr. JAMES DEVONSHIRE described one of those senseless cases of obstruction to private enterprise which unfortunately occur only too frequently in this country. The networks of the London United Tramways and the Metropolitan Electric Tramways at one point come very near together, and it was thought that there would be a considerable advantage in having a physical connection, so that through running might be adopted. Permission was, therefore, sought to this end from the local authority concerned. The latter saw an opportunity of making money, and therefore fixed an exorbitant sum for street improvements. The sum was, in fact, so exorbitant that the companies decided to give up the idea. Recently the matter has been revived, because the London United Tramways Co.

have handed over their repair shops to the Munitions Department, and have arranged that all their repairs shall be carried out in the shops of the Metropolitan Electric Tramways. Obviously, such an arrangement would be materially hampered if the cars could not be run from one network to the other. Consequently the Board of Trade was asked to use its good offices with the local authority in order to obtain the desired connection ; and this permission has now been granted, but it has been coupled with the stipulation that no passengers are to be carried on the connecting link ! We are tempted to ask whether this stipulation is to the advantage of the general public, more particularly if would-be passengers are munition workers. And is it not time that this short-sighted policy was put down with a strong hand ?

The Case of Tunbridge Wells.

THE same sort of spirit is to be found elsewhere. For example, the Corporation of Tunbridge Wells recently applied for a provisional order to extend their area of supply so as to include certain outlying districts. The Corporation obtained the consent of the Southborough Council, one of the authorities concerned, but failed to obtain consent in three other cases. Finally, they appealed to the Board of Trade. As a final result certain districts have been admitted and the Board has decided to dispense with the consent of Tonbridge Rural Council. The whole matter, of course, is only a local squabble of no great importance, but the fact remains that it is characteristic of much that has gone on in connection with electric lighting. More often than not, there is no question of what will be best in the long run for the ratepayers of any particular district, but rather the glorification of the parish pump, and the idea that each local authority will in due time have a generating station of its own which will be a profitable investment, and which will give some relief to the rates. It is forgotten that the user will inevitably find the price which he is charged for energy from a small concern higher than that obtained for energy from a large network. It is just this policy which retards the general development of electricity so much, and which was exemplified in such a striking manner recently when the Bill of the Yorkshire Electric Power Co. was withdrawn.

Melting Points of Elements.—A table has just been issued by the Bureau of Standards, Washington, giving melting points of [illegible] and also certain standard temperatures. All values have, as far as possible, been reduced to the thermodynamic [illegible].

Beit Fellowships.—The Trustees of the Beit Fellowships for Scientific Research [illegible] and appointed two [illegible]. Mr. Clive E. Lawson-Peebles, to hold fellowships. Mr. William Burgess Haines, B.Sc., of Leytonstone ; Mr. Christopher K. Ingold, B.Sc., A.R.C.S., of Chiswick ; and Mr. Harry S. Webb, [illegible]. These will enable [illegible] to work in the Imperial College of Science and Technology.

Paris "Metro" Results for 1914.—Work on the extensions of the Paris Metropolitan Railway has been greatly hindered owing to the war, but the total length of line is now 79 km., while the number of trains run in the year was [illegible]. The net profits for the year were 11,178,000 fr., as compared with 11,417,000 fr. in 1913. The net receipts were [illegible] and the earnings per kilometre were 142,837 fr. instead of 187,694 fr. ; but according to the report just issued this is not so great a falling off as might be expected from the fact that the country was so disturbed and the service had to be reduced.

Electric Welding of Platinum Contacts.—A process has now been perfected for welding platinum contacts on to springs, thus saving the amount of platinum used. The process is facilitated and the welding current reduced by having a thin coating of copper plate on the platinum. The welding machine is automatic, and takes a strip of platinum sheet 0·005 in. thick and 0·115 in. wide, or a coil of platinum wire, according to whether a flat or pointed contact is required. The strip of wire is fed to the clamping device, which cuts off the proper-sized piece, deposits it on the spring and holds it in position during welding. The welded contact is flattened or pointed by a die as it leaves the machine.

Mobilisation of Invention.—On Friday, 16th inst., a conference was held at King's College, London, to discuss the best method of testing scientific ideas for military purposes. Prof. Geddes, in the chair, said that a Government organisation was needed in which experiments could proceed apart from the conditions of tense activity that characterised the present work of the War Office. Mr. Denniss, M.P., said that neither the committees set up by the War Office nor the advisory committees of the Royal Society could be occupied with sifting out crude ideas, for which purpose he proposed a National Inventions Association, consisting of scientific men. Mr. Cloudesley Brereton, speaking for Dr. Clay, Principal of the Northern Polytechnic, who was unable to attend, outlined a scheme for such a body. Mr. Jerome Dyer said that he and others had submitted an identical scheme to the departments and Ministers. He had been informed, however, that nothing could be done, as the Admiralty was organising a committee for inventions and the War Office purposed doing so. The conference was adjourned, but Prof. Geddes invited suggestions, which should be addressed to the Secretary, Mobilisation of Science and Inventions Conference, King's College.

Personnel of the Inventions Board.—The complete arrangements for the organisation of the Inventions Board established to assist the Admiralty have now been made. The Board will comprise : (*a*) A Central Committee ; (*b*) a Panel of Consultants composed of scientific experts who will advise the main Committee on questions referred to them. The Central Committee will consist of Lord Fisher of Kilverstone, G.C.B., O.M. (President), Sir J. J. Thomson, O.M., F.R.S., the Hon. Sir C. A. Parsons, K.C.B., F.R.S., and Dr. G. T. Beilby, F.R.S. The Consulting Panel will comprise the following list, which will be added to from time to time as necessary :—

Prof. H. B. Baker, F.R.S.	Prof. Bertram Hopkinson, F.R.S.
Prof. W. G. Bragg, F.R.S.	Sir Oliver Lodge, F.R.S.
Prof. H. C. H. Carpenter.	Prof. W. J. Pope, F.R.S.
Sir William Crookes, O.M., F.R.S.	Sir Ernest Rutherford, F.R.S.
W. Duddell, F.R.S.	G. Gerald Stoney, F.R.S.
Prof. Percy Frankland, F.R.S.	Prof. the Hon. R. J. Strutt, F.R.S.

The Board is accommodated temporarily in the Whitehall Rooms, Hotel Metropole, Whitehall-place, S.W., but at an early date (which will be announced in due course) it will be transferred to permanent offices at Victory House, Cockspur-street, S.W. Communications should be addressed to the Secretary, Board of Invention and Research. According to "The Times," the Board is already at work.

"Telenews" Signs.—Striking new advertising devices have recently been installed at three London railway termini—Victoria, London Bridge and Broad-street. They are erected by Telenews Limited, and the apparatus is the joint invention of Mr. J. A. Powell and Mr. A. B. D. Lang. On a screen placed high up in a prominent position the shadow of a pen is seen to write remarks or draw sketches in obedience to the movements of the hand of an operator seated near the lantern. This is effected by employing in the place of a lantern slide a sheet of a special preparation called Celanoid, which is perfectly transparent and colourless, though more inflammable than paper. Above this screen a pen [illegible] by two arms connected by a system of levers and pulleys with two fine wires that transmit

motion from a similar system moved by the operator's pencil. At any moment the pen can be lifted off the sheet by a cross-arm worked by an electromagnet. The "Zilkaloid" is in the form of a long strip, a section of which is rolled up after each sketch has been completed, so as to leave a clear space for the next. In order to make the screen luminous by daylight, a very powerful arc is employed for the lantern. The largest set is at Victoria Station, where a motor generator is employed to convert from 460 volts to 120. The screen there is 12 ft. square, and the current taken is 120 amperes in the daytime or 70 to 80 at night.

Series-connected Indicator Lamps.—In the "Elektrotechnische Zeitschrift" Dr. L. Bloch draws attention to the certainty obtained by using series-connected signal lamps for lighting, heating, cooking and other circuits. As a result of his suggestions, metal filament lamps have been designed and made by the Allgemeine Elektricitäts Gesellschaft, which take about one volt only, with a considerable range of current, *e.g.*, 0·4 to 0·6 ampere, and are so made that, within that range, variations of current can be detected by the variation in the brightness of the lamp. Thus, in addition to indicating whether current is passing through the circuit in which they are connected, they roughly indicate the amount of such current. This is extremely useful in many cases. The following are the 10 ranges in which these lamps are made, viz., 0·4 to 0·6A, 0·6 to 0·85A, 0·85 to 1·25A, 1·25 to 1·7A, 1·7 to 2·5A, 2·5 to 3·5A, 3·5 to 5A, 5 to 7A, 7 to 9A, and 9 to 12A. They have a life of considerably more than 1,000 hours.

A 3,000-volt Continuous Current Electric Railway.—According to the "General Electric Review," the plans are now completed for the electrification of the first portion of the Chicago, Milwaukee and St. Paul Railway. Eventually a length of 440 miles from Harlowton, Montana, to Avery, Idaho, will be electrified and should be in operation by the beginning of 1918. Three-phase power at 100,000 volts and 60 cycles will be supplied by the Montana Power Company and converted at the sub-stations to continuous current at 3,000 volts for the line. This is the highest voltage that has yet been used for continuous current electric traction, and it allows the sub-stations to be spaced about 35 miles apart. An overhead twin-conductor catenary system will be employed, with two 4/0 trolley wires side by side. The locomotives, which will weigh about 260 tons, will have a continuous rating of 3,000 H.P., which is more than that of any existing steam or electric locomotive. Eight 375 H.P. motors will be used, each driving a separate axle. Regenerative breaking will be embodied in the control arrangements, and is to be of sufficient power to hold back a train on down grades, so that the air brakes need only be used in case of emergency.

A 2,400-volt Third-rail Line in America.—The cities of Grand Rapids, Kalamazoo and Battle Creek, in the United States, are now connected by a high-speed electric railway, which is unique in that it is the first 2,400-volt line built to work on continuous current collected from a third-rail. It is operated by the Michigan Railway. The Kalamazoo Grand Rapids section has been built for speeds up to 90 miles per hour. At present this 50-mile stretch is covered in 1 hour and 10 minutes by the fastest cars, which run singly. The "Electric Railway Journal" has recently given a description of the line. The third-rail is an 80 lb. A.S.C.E. section low-carbon rail, placed 32 in. outside the running rails. At certain places, however, overhead catenary construction is used with a No. 0000 trolley wire, the cars being equipped for both systems. The fastest "Flyer" cars are of 69 ft. overall length, and seat 52 passengers. Luggage is also carried, and there is an observation compartment in which the windows reach almost to the floor to give a clear view from every seat. Four General Electric 1,200-volt motors of 140 H.P. are used, working two in series. The cars are of all-steel construction, no wood of any kind being used. The [illegible] which is a trailer and the other [illegible] Westinghouse interpole motors. The ventilation is supplied by a Sirocco blower discharging fresh air over the [illegible] under the seats.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Mr. A. Press contributes an article on "Iron Losses in a Transformer Plate" (p. 585).

We publish an article on "The Electric Crane Applied to the Handling of Coal and Ore," by Mr. H. H. Broughton (p. 575). The same subject is dealt with editorially in our Leading Article (p. 588).

A report is given of the Annual Congress of the Tramways and Light Railways Association (p. 590).

An abstract of Mr. W. H. L. Watson's Paper on "Battery Vehicles as an Adjunct to Tramways" appears on p. 591.

An abstract is given of a Paper by Mr. John P. Minton on "An Investigation of Dielectric Losses with the Cathode Ray Tube" (p. 579).

We also give a full abstract of a Paper by Mr. Linn Eddy on "Practical Applications of Electrical Precipitation and Progress of the Research Corporation" (p. 582).

Legal.—Mr. Justice Joyce's judgment in the action brought by the Osram Lamp Works against Pope's Electric Lamp Co. is reported (p. 595).

Companies' Meetings and Reports.—Meetings of British Dyes, Kalgoorlie Electric Tramways, Mond Nickel Co., Welsbach Light Co. and Western Union Telegraph Co. are reported, and the directors' reports abstracted include those of Davey, Paxman & Co., Deutsch Uberseeische Elektricitäts Gesellschaft, Electric & General Investment Co., Marconi's Wireless Telegraph Co. and J. Stone & Co. (p. 606).

OBITUARY.

HENRY ALEXANDER MAVOR. We regret to record the death of Mr. Henry A. Mavor, whose death took place at Mauchline, Ayrshire, on the 16th inst. Mr. Mavor, who was the fourth son of the late Rev. James Mavor, M.A., was educated at St. Matthew's School and at the University of Glasgow. He was born at Stranraer in 1858. After a commercial training he became associated with Mr. R. E. Crompton in the year 1879 in the application of electricity to lighting purposes. A few years later he founded the firm now known as Messrs. Mavor & Coulson (Ltd.), and in the early days of the industry he carried out much pioneer work. It was to the enterprise of Mr. Mavor that Scotland owed its first public supply of electricity, and the generating stations of his company, which were taken over by the Corporation of Glasgow, were the nucleus from which have grown the gigantic business of the city's electric light and power supply. Mr. Mavor's scheme for a large power station on the bank of the canal at Port Dundas, and the transmission of the power by high-power tension electric current to sub-stations is the line of development which has in fact been followed, although at the time it was discarded in favour of the since abandoned power station in Waterloo street.

After the acquisition by the Corporation of the supply business, Mr. Mavor directed his energies and his original and inventive resources to the design and manufacture of electrical machinery, and his firm has been in the front rank throughout the strenuous history of electrical development during the last 25 years. The latest important work which engaged Mr. Mavor's attention was the problem of electrical propulsion of ships, and many patents on this subject are evidence of his inventive fertility. His experimental work on a practical scale included the equipping of a vessel of 2,000 tons with electric propulsion. The value of his work in this connection has had wide recognition both from electrical engineers and from naval architects, and his last two visits to America were made in the capacity of consultant to the company which equipped the United States navy collier "Jupiter," a vessel of 12,000 tons, with electric propulsion. As the result of the success of the "Jupiter," further vessels of the same type have recently been announced in the placing of a contract with the same company for the electric machinery for driving the new 30,000-ton battleship "California" for the United States Navy.

Mr. Mavor's membership of the Institution of Civil Engineers and of the Institution of Electrical Engineers, and of many other scientific societies, and the long series of Papers contributed to their transactions, bear the stamp of the active character of his scientific and technical interests. As a Governor of the Royal Technical College of Glasgow, chairman of the Glasgow Branch of the Board of Trade Committee on Industrial Employment, chairman of a branch of the Charity Organisation Society, member of the Executive of the Engineering Employers' Federation, and in other spheres Mr. Mavor found scope for his organising capacity, and for his deep interest in educational and social problems. His relationship with his em-

ployés was exceptionally cordial, and among those with whom he came into personal contact his loss will be that of a valued friend. Endowed with a singularly alert and penetrating intellect, and with a gentle, sympathetic and generous nature, Mr. Mavor attracted to himself a very wide circle of friends. To them he was known as a man of versatile talents, broad culture and refined tastes, with an extensive knowledge and fine appreciation of literature, music and art. A skilful and facile draughtsman he found recreation in sketching, in painting and in modelling, and dainty examples of his artistic work are treasured by some of his more intimate friends.

Mr. Mavor is survived by his wife and three sons. All his sons are in the service of their country at the present time. One is a lieutenant in the 6th Battalion of the Highland Light Infantry at the Dardanelles, another is a lieutenant in the R.A.M.C. in Flanders, and the third is a major in the Royal Engineers on home service.

The funeral took place last Monday. Among those present were Major Mavor, Mr. Sam Mavor, Prof. Andrew Gray, Prof. Henderson, Prof. Gibson, and many others.

KILLED IN ACTION.—We regret to record the death of Lieut. Cuthbert Hartnell, of the 1st-8th West Yorkshire Regiment (Leeds Rifles), who has been killed at the front. He was a director of the firm of Wilson, Hartnell & Co., electrical engineers, Leeds, of which his father was the head. He received his commission in 1911, after being in the Officers' Training Corps of the Leeds University, where he received his technical training. He was only 27 years of age at the time of his death.

We regret also to record the death of Lieut. G. J. O. Bull, who was a pupil in the works of the British Westinghouse Co. at the outbreak of war.

PERSONAL.

Mr. Horace Boot, M.I.Mech.E., M.I.E.E., was married to Miss Mabel Baker at St. Margaret's Church, Westminster, on Wednesday.

Dr. Robert Robinson, of the University of Sydney, has been appointed to the chair of organic chemistry in the University of Liverpool.

Mr. George G. L. Preece, who for some years has been in charge of the Manchester office of Messrs. Bruce Peebles & Co. (Ltd.), has temporarily left that company's employment owing to his having accepted a commission in the Lancashire Fusiliers. During his absence Mr. E. W. Browne, the company's representative in Birmingham, will act as manager in Manchester.

APPOINTMENTS VACANT.

An assistant lecturer and demonstrator, ineligible for military service, will be required in the engineering department of the Borough Polytechnic Institute, London, S.E., in September. Commencing salary £130, rising to £150. Applications by Aug. 9.

A switchboard attendant is required. Wages 35s. per week, plus 3s. war bonus. *See advertisement.*

An assistant is wanted for electric testing department of large cable factory. *See advertisement.*

A meter tester is required for the period of the war. Salary about £2 per week or according to experience. *See advertisement.*

Stretford Council require a shift engineer. Salary £2. Particulars from the Resident Engineer, Electricity Station, Stretford.

Gloucester Electricity department require a charge engineer and a switchboard attendant. Salaries 40s. and 25s. a week respectively. Applications by July 31.

An electric supply company advertise for a junior for their meter test room.

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply department. Salary £650, rising to £700 per annum. Applications to the town clerk (Mr. Thos. H. Nesbitt), by Sept. 13.

INSTITUTIONS AND SOCIETIES.

Programme of British Association's Meeting.—Among the Papers to be read before Section G of the British Association at the annual meeting to be held this year in Manchester are the following: "The Thermal Efficiency and a Gas Engine," by Profs. Ackawai and Petavel, F.R.S.; "The Mechanical Engineering Department of the Manchester School of Technology," by Prof. A. B. Field; "The Heating of Iron when Magnetised at very High Frequencies," by Mr. N. W. McLachlan, B.Sc.; "The Apparent Specific Heats in Gaseous Explosions," by Prof. W. M. Thornton, D.Sc.; "Some Experiments to determine whether there exists Mutual Induction between Masses," by Prof. Miles Walker, M.A.; "The Eddy Current Losses in the End Plates of Large Turbo-Generators," by Prof. Miles Walker, M.A.; "Electric Oscillations in Coupled Circuits—a Class of Particular Cases," by Dr. W. Eccles and Mr. A. J. Makower, M.A.; "Exposure Tests on some Metals and Alloys," by Prof. Ernest Wilson; "The Capacity of Aerials of the Umbrella Type," by Prof. G. W. O. Howe; "The Calculation of the Effect of Masts and Buildings on the Capacity of Aerials," by Prof. G. W. O. Howe.

EDUCATIONAL NOTES.

University of Manchester.—In the Faculty of Science complete courses of study (extending over three years) are arranged for the University Degrees in civil, mechanical and electrical engineering. Good facilities are provided for laboratory and research work, and the electrical engineering laboratory is housed in a new building. Complete theoretical and practical training is given to students preparing for the higher positions in the electrical engineering profession. Particulars of the courses can be obtained from the Registrar. The new session commences on Oct. 7.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses, giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

University of Birmingham.—The new session commences on Tuesday, Oct. 5. At this university there are full courses of instruction in mechanical, civil and electrical engineering The courses extend over four years, and students who enter after matriculation, and pass successfully the examinations at the end of each year will be entitled to the degree of Bachelor of Science in the branch of engineering to which they devote themselves. There are good facilities for practical and research work. Syllabus, giving particulars of university regulations, lecture and laboratory courses, fees, &c., may be obtained from the secretary.

University of Bristol (Faculty of Engineering).—In the final examination for the degree of B.Sc., July, 1915, the following obtained second-class honours:—

S. Bartlett (electrical engineering), L. G. Frise (mechanical engineering), F. W. Keys (mechanical engineering). F. S. N. Sheppard passed in civil engineering, J. G. M. Bevan and R. C. Parsons in mechanical engineering, and E. G. Moody and L. G. H. Sarsfield in electrical engineering.

The following candidates passed the intermediate examination for the B.Sc. degree: H. K. Austin, E. W. Bartlett, E. S. Britton, L. J. Clark, E. A. Cockett, R. L. Coggins, E. B. Cole, H. C. Collis, W. E. S. Ellis, W. Hare, A. F. Heinrich, J. G. Heslop, H. E. Sharp, W. J. Sparkes, H. O. Vallis.

In the final examination for the certificate the following passed: Civil engineering: A. G. Lewis, M. H. Maggs. Electrical engineering: R. J. Perry. Automobile engineering: R. S. Crump.

Those successful in the intermediate examination for the certificate were R. F. Damsell, D. A. Gough and R. Yendoll.

City & Guilds Technical College, Finsbury.—The day courses at this college are adapted to the needs of various students, including pupils from secondary schools above the age of 15 who desire to receive a practical and scientific training, and young men who, having previously served a pupilage or apprenticeship, desire to go through a more systematic training. Programmes from the Registrar.

Bradford Technical College.—At this college there are diploma courses in civil, mechanical and electrical engineering, power generation and transmission, &c. Full courses are also offered in all branches of the textile industries, including dyeing. Prospectuses post free on application.

ARRANGEMENTS FOR THE WEEK.

WEDNESDAY, July 28th

ROYAL SOCIETY OF ARTS.

5.30 p.m. Special War Lecture on "Field Telephones," by Mr. Charles R. Darling, F.I.C., with Experimental Illustrations. Admission free by ticket, to be obtained on application to the Secretary, at the Office of the Society, John-street, Adelphi, London, W.C.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week ending July 31, 1915:

Monday, Wednesday and Friday: Drills 6.30 p.m. and 7.30 p.m.

THE ELECTRIC CRANE APPLIED TO THE HANDLING OF COAL AND ORE.

BY H. H. BROUGHTON.

Summary. The author points out that few engineering firms in this country lay themselves out for the design and construction of electric crane and hoist equipments for the handling of coal and ore in considerable quantity. He briefly deals with the hydraulic and electric systems of power transmission for the working of dock machinery, and suggests a careful perusal of the Papers devoted to the description of hydraulic coal hoists. The electric cranes used at the ports on the Great Lakes of America are described in considerable detail and particulars are given of two equipments, one for handling coal and the other for handling ore.

Notwithstanding the fact that the electrically-driven crane has asserted its superiority over every other kind of crane in every industry which necessitates a reliable and efficient crane service for its pursuit, it is remarkable that practically none of the engineering firms in this country lay themselves out for the design and construction of electric crane and hoist equipments for the handling of coal, ore and such like material in considerable quantity.

Enormous sums of money have been sunk in providing hydraulic coal-handling plants at the home ports, and from time to time Papers devoted to the description of these plants have been read. These Papers deserve the serious consideration of all engineers interested in the subject, for they record the progress which has been made in overcoming the many difficulties inherent to the hydraulic system of power transmission. It is only in recent years, however, that the interest of dock and harbour authorities has been awakened to the possibilities of the electric crane when applied to the handling of coal, but, with minor exceptions, such interest seems to have been more of a passive than of an active kind.

The provision of a dozen pumping stations in a relatively small area is not engineering, and we most seriously hope that in the near future the generation of power, in any shape or form, in the amateurish way to which many have grown accustomed, will be abolished in favour of the rational system of buying in bulk from concerns in a position to supply at a low rate with minimum waste. For the economical working of a dock it is now generally recognised that merchandise cranes, capstans and repair workshops should be electrically driven, and that electricity must be used for illuminating purposes. There is, therefore, a very strong case in favour of the electrification either of the whole or of the greater part of the machinery. Such electrification would secure maximum economy in working and would entirely eliminate the power generating station from the dock site or would result in all the generating plant being housed under one roof.

We take it that a dock load running into many million units per annum would be welcomed by most engineers in a position to give bulk supply, and that the load is of the kind which could profitably be dealt with at a low rate. Much harm is, and has been, done to the electrical cause by a lot of vague talk about 1d. per unit for power supply. Discussions have taken place in which the figure of 1d. per unit has been accepted as a sort of irreducible minimum, and facts and figures have been deduced from this which are erroneous and misleading. This is not the occasion to deal with the cost of power for industrial purposes, but we venture to suggest that the power people should endeavour to educate their customers to the fact that they are in a position to supply power at a maximum charge of 1d. per unit less discounts.

From carefully kept records it appears that the absolute cost of water, at 750 lb. per square inch, varies from 4·49d. to 20d. per thousand gallons. The former figure is taken from Mr. Macaulay's contribution to the discussion on Messrs. Baxter & Dixon's Paper on "Electrical Dock Equipment" read before the Institution of Mechanical Engineers in 1911, is for a modern installation (at Newport) pumping about 170 million gallons per annum. Including coal and coke exported and general imports and exports, the tonnage handled in 1910 amounted to about 5·8 million which gave 0·365d. as the average total cost of energy per ton, including water for locking and all other dock purposes. At Swansea the average quantity of water pumped during the three years 1906-8 was 214 million gallons per annum, and the average cost, including working costs, capital charges, and administration allowance, was 8·22d. per 1,000 gallons at a pressure of 750 lb. per square inch. The corresponding cost of electric energy was 0·21d. per ton of coal shipped during the three years 1906-8. Baxter and Dixon's figures for the two 32-ton electric coal hoists installed at Rothesay Dock, Glasgow, are self-explanatory, and the following note is taken from the Paper referred to above: "The total coal and other material shipped by the two hoists during 12 months was 556,419 tons. The units consumed during this period was 80,164, and the number of waggons dealt with 70,604. During this period as much as 23 tons of coal per unit have been shipped, while, including all distribution losses and also the power necessary for the working of all auxiliary apparatus on the hoist, including the jib-crane, adjusting of shoot and shoot point, &c., the current consumed over the whole period only averaged one unit per 6·94 tons of coal shipped. As emphasising the adverse conditions under which the hoists are at present working, it will be noted that 70,604 waggons were handled in shipping 556,419 tons of coal, or an average of only 7·88 tons of coal per waggon."

Although these were the first electric coal hoists to be erected in Great Britain the author doubts whether a lower input has ever been recorded by the most modern hydraulic hoist working under full-load conditions, and he puts it to the hydraulic

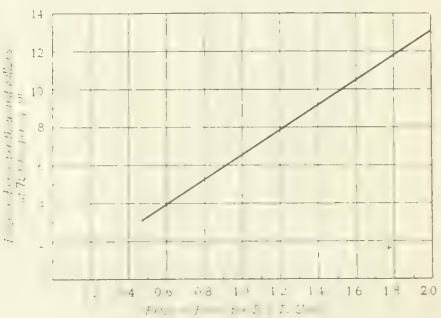


FIG. 1.

engineers that a modern 32-ton hoist worked under the conditions set out above would have given a sorry performance in comparison with that obtained with the Glasgow hoists.

In comparing electric and hydraulic transmission systems it is desirable to be able quickly to convert from one set of units to the other, and the curve, Fig. 1, connecting the cost of the one and the cost of the other, has been prepared from the well-known relation that 1,000 gallons of water at 750 lb. pressure per square inch are equal to 6·53 Board of Trade units.

It is our purpose in this article briefly to describe the systems in use in America for the unloading of coal and ore. The rapid advance of the steel industry in the United States is directly traceable to the attention which has been paid to the handling of materials, and two names, Brown and Hulett, stand out prominently as pioneers in the development of the art. To the late Mr. A. E. Brown is due the credit for the design and construction, in 1880, of the first mechanical unloader to take ore or coal from the hold of a boat and deliver it either into trucks or on to the stock piles without rehandling. Twenty years later Mr. G. H. Hulett put into operation the automatic ore unloader which bears his name, and which raised the unit of bulk from a shovelful to 10 tons. In recent years the unit of bulk has been further increased and lifting capacities of 15 and 17 tons are common. The early machines were all operated by steam, and later electricity combined with hydraulic pressure was tried. At the present time nearly all the machines are

electrically operated throughout, and users agree that for this service electricity is indispensable and stands unrivalled.

Apart from the ordinary types of crane fitted with grab-buckets the unloading equipments which have been brought to such a high state of perfection by the Brown Hoisting Company are of two kinds—fast plants and bridge tramway plants.

A fast plant consists of a number of high-speed movable gantry cranes having single or double cantilever extensions and grab-buckets. Each crane is mounted on a pier of portal form which spans two or more railway tracks. The front cantilever extension, or apron, reaching out over the dock, is hinged in order to admit of its being raised to clear a passing vessel, and the back cantilever extension is of sufficient length to span several railway tracks, so that it is possible to have six or more trains standing under the cranes. The machines are compact in form and the bucket movements are short and fast. In such a plant there is either no accommodation immediately alongside or the accommodation is limited.

grab-bucket depending from a movable trolley. The trolley travels at high speed along a track extending from end to end of the bridge, and the whole of the motions of the crane are controlled from a cab fixed to the trolley. The bridge spans one or more storage piles, and extends out over the vessel being unloaded at the front end, and over railway tracks at the rear end. A typical bridge tramway, installed at the works of the Astoria Light, Heat & Power Co., of Astoria, N.Y., is shown in Figs. 2 and 3.

The grab-buckets used have capacities up to 8 tons for coal and up to 15-20 tons for iron ore. The shape of the spades, Fig. 4, is such that when the grab is lowered on the material ready for filling the entire weight of the grab is resting on the digging edges of the spades. When the grab is open the back of the spades stand vertical, and as soon as the operation of closing commences the backs become inclined in such a manner that the material gathered assists or causes the bucket to penetrate deeper into the material for its load. To guard against overloading in the case of iron ore, the backs of the spades in buckets for this use are left open so that any excess may spill out before hoisting. The mechanism consists of a fixed set of sheaves in

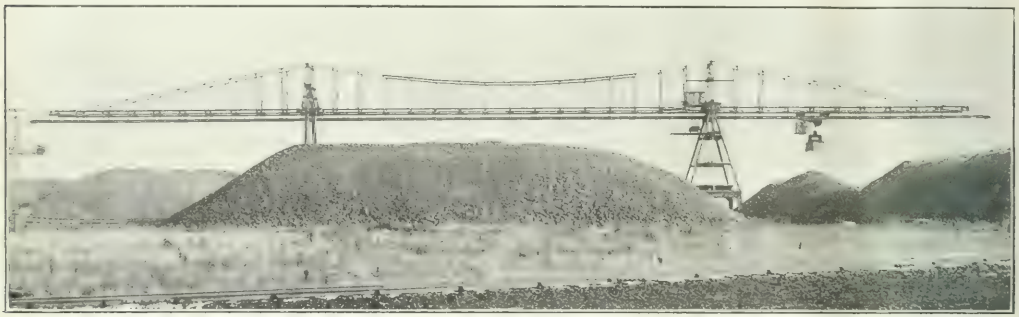


Fig. 2.—Brownhoist Bridge Tramway for Handling Coal, Astoria Light, Heat & Power Co., N.Y.



Fig. 3.—Brownhoist Bridge Tramway for Handling Coal, showing Main Trolley and Grab Bucket, Astoria Light, Heat & Power Co., N.Y.

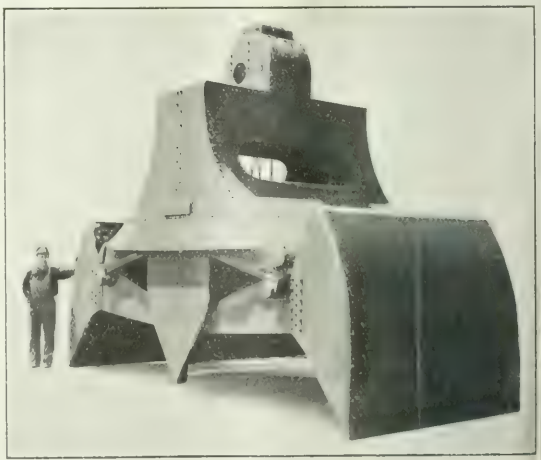


Fig. 4.—Brownhoist 8-ton Coal Grab Bucket, Astoria Light, Heat & Power Co., N.Y.

A modern tramway plant generally consists of a number of movable gantry frames or bridges of considerable span, mounted side by side on common tracks, each crane having single or double cantilever extensions fixed or hinged, and a

the top and a set attached to the spade arms that moves up and down with the arms as the bucket is opened and closed. The rope that passes over the sheaves mentioned is called the closing rope. Another rope, called the dump rope, passes

round a single sheave in the top of the bucket. If the dump rope is held stationary the bucket closes when the closing rope is taken up, and the bucket opens when the closing rope is let out. The spades are so balanced that with the aid of the inclined guides on the side of the shell the bucket will always open to the extreme position.

The outstanding feature of these cranes is the high speed of each of the several motions. The traversing distances vary from 50 ft. to 600 ft. and the speed may reach 1,500 ft. per minute, the weight of the loaded trolley being about 45 to 50 tons for a coal bridge. The lifting height varies from 40 ft. to 180 ft., and the duration of the lifting period may be anything from 6 to 15 seconds. Lifting is effected at the rate of 200 ft. to 700 ft. per minute, depending on the height of lift, the allowable time and the load. With spans of as much as 500 ft. to 600 ft. the travelling speed of the entire bridge is from 60 ft. to 100 ft. per minute. So as to get uniform distribution of weight, and maximum tractive effort, it is customary to provide two motors, in parallel, for driving the traversing mechanism. In the lifting mechanism two hoisting drums are used, one for the closing rope and one for the dump rope. The closing rope drum is geared directly to a motor, while the dump rope drum may be either driven from the closing rope drum through a clutch or geared to a separate motor. In a Paper on "Direct

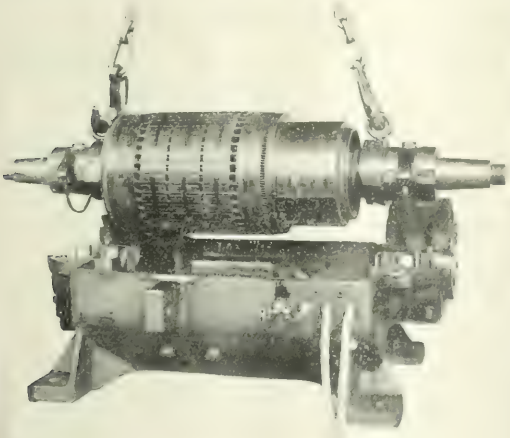


Fig. 5.—Westinghouse Mill Motor.

Current Motors for Coal and Ore Bridges," Mr. R. H. McLain* recommends series-wound motors for driving the trolley, and discusses the proper method of gearing the motors so as to obtain the most economical results. Either series or shunt-wound motors may be used for driving the lifting mechanism, the former for low-speed hoists and the latter for high-speed hoists. In the Paper referred to the relative merits of the two methods of winding are considered.

Both continuous-current and alternating-current equipments are largely used, and the motors are especially suited to heavy intermittent service. The special features of the continuous-current motors are commutating poles, fireproof insulation, great strength and accessibility. They are capable of standing a heavy overload current, 300 or 400 per cent. of full-load current for short periods, say, 5 seconds, without injurious sparking, and of giving a momentary-safe torque of at least 100 per cent. more than this. The shafts can be removed without disturbing the armatures and in some cases fans are provided for cooling purposes. Some idea as to the ease with which an armature can be removed will be obtained from Fig. 5. The ratings are based on the horse-power associated with a maximum temperature rise of 75° C. in the core and windings,

* "Proceedings" Am. Inst. Electrical Engineers, June, 1914.

and 80°C. on the commutator, for continuous operation at normal voltage for a stated period, the temperatures being measured by thermometer according to the rules of the American Institution of Electrical Engineers. In alternating-current equipments, the motors are of the three-phase induction type and have a pull-out torque ranging from 2·5 to 3·3 times the full-load torque, the air-gaps being sufficiently large to permit considerable wear of the bearings.

As a rule it is possible to put down a cycle of operations for each of the principal motors, and from this cycle the size of motor can be determined by the root-mean-square method. In applying this method it should be remembered that maximum rate of heat dissipation occurs only while the motor is operating at full speed, and in computing the motor rating only the duration of cycle equivalent to operation at full speed should be considered. While accelerating or retarding and while the armature is at rest, heat dissipation occurs only about one-half as fast as at full-speed for enclosed motors.

Magnet-switch systems of control arranged for automatic limitation of the current are indispensable for these equipments, and the layout of a number of magnet-switch controllers for coal and ore bridge service was described in these columns some time ago.

A combined ore plant and bridge runs away but the unloading

* The Electrician, November and December, 1914.

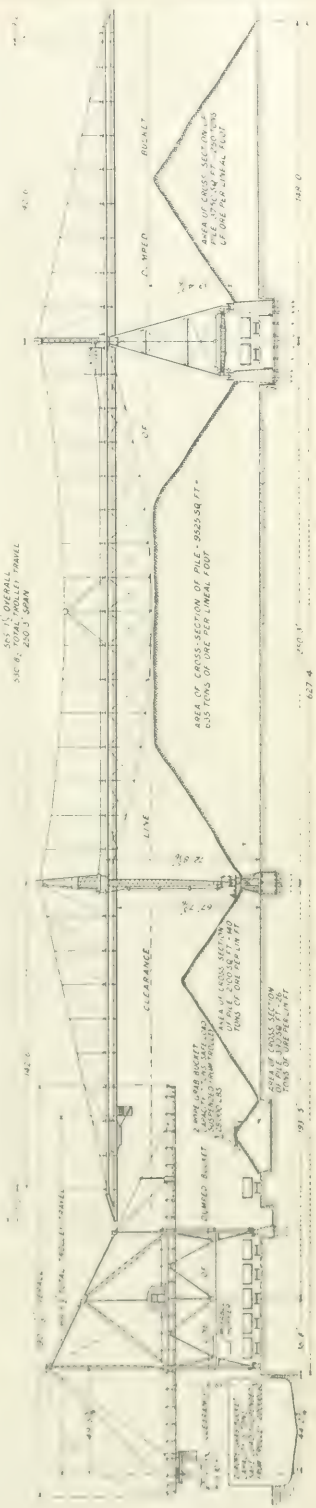


Fig. 6.—Combined Ore Plant and Bridge Tramway for the Unloading and Storing of Iron Ore.

and storing of iron ore is depicted in Fig. 6. In this equipment the fast plant consists of four cranes, each of which is provided with a two-rope grab-bucket of 5 tons capacity. The bucket depends from a movable trolley which can be racked through a distance of 166 ft. 6½ in. on a track about 40 ft. above ground level. The maximum outreach of the bucket from the dock wall is 44 ft. 2 in., and the clearance line of the dumped bucket is 25 ft. above the ground. Sufficient clearance is provided between the legs of the pier to allow of the passage of five trains, and the rear cantilever extension covers a railway track as well as a storage pile of 390 sq. ft. cross-section which corresponds to 26 tons of ore per lineal foot. The buckets discharge either into movable weighing hoppers immediately above the trucks, or direct on to the storage pile just mentioned. Each crane is mounted on four compensating trucks, the maximum load per wheel being 20·5 tons, of which 4·92 tons is allowance for wind-pressure on the structure.

The bridge-tramway spans four storage piles of an aggregate cross-section of 15,765 sq. ft., corresponding to 1,051 tons of ore per lineal foot, and in addition serves three railway tracks, two of which pass under the main pier of the crane. The distance between the shear and the pier is 250 ft. 3 in., and a cantilever extension at each end brings the total length of the bridge to 565 ft., which admits of a trolley travel of about 531 ft. The pier and the shear legs are each mounted on equalising trucks. Of the maximum wheel loads of 23·6 tons and 21·5 tons for the pier and shear respectively, 25 per cent. is allowance for wind, and the bridge is designed to give maximum strength with the smallest dead weight and area of material with the members of such shapes and so arranged in the trusses as to expose the least possible surface to wind pressure. The bridge trusses are pitched at 20 ft. centres and are supported by the shear on sliding bearings under the top chord. Cranes depending from the I beam cross girders cover the dock track which is about 9 ft. gauge and some 40 ft. above ground level. Hoisting is effected by means of a 7 ton two-rope grab-bucket, and arrangements are provided so as to enable the operator to turn the bucket through an arc of 90 degrees. When fully loaded the 5 ton buckets used with the fast plant weigh 9 tons each, the corresponding weight of the 7 ton bucket for the bridge tramway being about 12·5 tons.

A Hulett unloader, Fig. 7, consists of a trolley, running upon a movable gantry, which supports a massive rocking beam to which is attached the vertical bucket leg. A light connecting brace is pin-connected to the trolley and to the bucket leg in order to give to the latter a parallel motion. The hoisting, bucket-closing and slewing mechanisms are located in the house at the rear end of the rocking beam thus helping to balance the load, and the counterweight is adjusted so that the maximum downward pressure is about 10,000 lb. In addition, in case of over winding and fracture of ropes, there are latches which catch the rocking beam and prevent the bucket from falling.

The operator is located in the bucket leg just above the bucket; he therefore descends into the hold and is always in full view of his work. Special ore-carrying steamers have been built to work in conjunction with these machines, with special hatches and bottoms so arranged that a minimum of shovelling is required. The bucket is also slightly offset with the vertical leg so that the operator can slew it round to all corners under the hatch. The unloaders are generally arranged to discharge either into trucks under the gantry or on to a temporary stock pile under the cantilever arm. A rehandling bridge crane draws its supply from this pile and delivers the ore to the main storage yard. Extreme speed in unloading is necessary in order to enable the boats to make a maximum number of trips during the short season that the lakes are open.

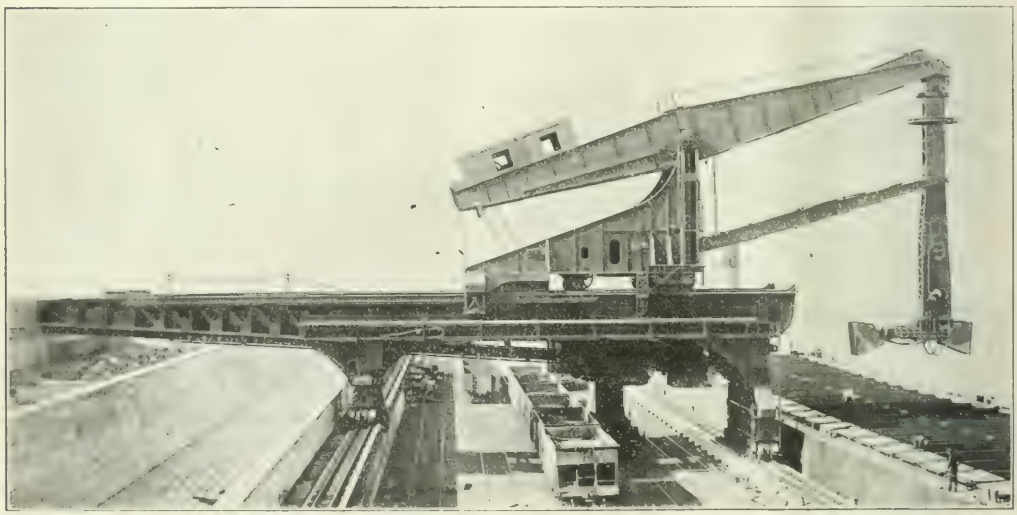


Fig. 7.—15-ton Ore Unloading Machine, Lake Shore Railroad Co., at Ashtabula.

As an indication of how thoroughly all the operations in connection with these unloaders are effected may be cited a record made at Ashtabula Harbour in 1912 with eight 15-ton unloaders.* During an operating day of 20 hours there was unloaded from eight boats a total of 70,000 tons of ore. This required 1,319 trucks for its removal, or a truck every 55 seconds as an average, and as this time included the moving of the boats to and from the dock it is evident that there must have been the utmost precision and harmony in the operation of the entire equipment. One of the docks equipped with four 15-ton machines unloaded 10,000 tons in four hours. For cleaning up the boat, four men per machine are usually employed during the last 20 per cent. of the cargo. Further particulars will be given in a later section of the article.

(To be concluded.)

* "Journal" of the Cleveland Engineering Society, Vol. VI., p. 23.

AN INVESTIGATION OF DIELECTRIC LOSSES WITH THE CATHODE RAY TUBE.*

BY JOHN P. MINTON.

Synopsis.—The author discusses the theory of the cathode ray tube wattmeter, and shows how it can be used to determine directly the power factors of insulations. The current and voltage are measured independently so that the dielectric losses in insulation can be calculated. Measurements and curves of dielectric losses, power factors and currents for varnished cloths and oil-treated pressboard are given, and empirical equations are derived from all the curves. The large and harmful effects of moisture are clearly shown by the results, and the weakening effects due to high temperature are of much importance.

Careful study of insulating materials is becoming more and more important. Formerly, if an insulating material was not satisfactory, it was discarded and a new one substituted. In this way considerable progress was made. However, as the number of possible insulators became less, it became more evident that it was necessary to study the electrical properties of those with the hope of improving them. At the present time this tendency toward a careful study of various dielectrics is quite prominent, and it is certain to become much more noticeable in the near future.

Object of the Investigation.

The object of the present investigation was three-fold. First, to show the usefulness of the cathode-ray tube in studying the

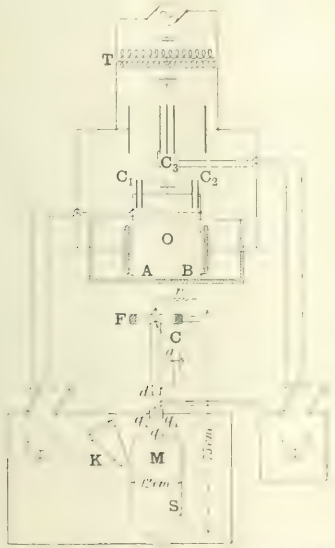


Fig. 1.—Arrangement of Cathode Ray Tube Wattmeter.

dielectric losses which occur in insulating material. Second, to measure dielectric losses, power factors and currents at different voltages and temperatures in different insulating materials under various conditions. Third, to obtain a better understanding of the mechanism of dielectric conduction and to obtain a better knowledge concerning the electrical phenomena occurring in insulation when it is subjected to high-voltage stresses.

Method of Determining Dielectric Losses.

Since the author's method of determining the dielectric losses is quite different from that described by Prof. Ryan† it is necessary to show how the apparatus is used for this purpose. Fig. 1 shows the diagram of connections used. In order that the corresponding spots on the screen may be symmetrical with respect to the centre, it is necessary to use two similar pieces of insulation. These are represented by A and B and placed between the two terminals in the oil box, O, as shown in Fig. 1. Suppose now that a sine-wave potential wave is applied to these test pieces by means of the transformer T, and that it is desired to measure the dielectric losses in them. For this purpose, a sine-wave potential, proportional to the voltage across the test terminals in the oil box is applied to the potential quadrants, q_2, q_2. This potential, obtained from the air potential condenser C_3 as shown in the diagram, produces the deflections of the spot on the screen S, as shown by $b\,b$ in Fig. 2. Since the cathode rays possess no appreciable inertia, it follows that this deflection is proportional to E.

To the current quadrants, q_1, q_1, is applied a potential proportional to the current passing through the insulation under test. This potential, obtained from the air-current condensers, C_1 and C_2, as shown in Fig. 1, produces the deflection $a\,a$ (Fig. 2) of the spot.

When both these potentials are simultaneously on the cathode ray stream, an ellipse is traced on the screen. The author shows that the area of this ellipse is given by

$$A = KEI \cos\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where E is the effective voltage applied to the system, I is the effective current passing through the insulation, and $\cos\theta$ is the power factor of the system. Since the loss in the air condensers C_1 and C_2 is negligible, it follows that the area of the ellipse is proportional to

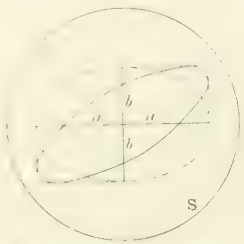


Fig. 2.—Ellipse Produced by the Fluorescent Spot on the Sensitive Screen S (Fig. 1).

the dielectric loss in the two pieces of insulation under test. This is the same result obtained by Prof. Ryan by a different line of reasoning. However, the use of the instrument—which the author calls a *cyclograph* in this manner would require calibrating under various conditions in order to determine the multiplying factors necessary to reduce the area to units of power. Calibration is avoided by the use of the cyclograph as a power factor meter by measuring the currents and voltages independently.

Use of the Cyclograph as a Power Factor Meter.—Equation (1) gives the area of the ellipse when the power factor of the circuit (consisting of the two test pieces and air condensers C_1 and C_2) is equal to $\cos\theta$. If the power factor of the circuit were unity the area, A_0, of the ellipse would be KEI, and it is represented by the dotted ellipse in Fig. 2. It is evident that:—

$$\frac{A}{A_0} = \frac{KEI\cos\theta}{KEI} = \cos\theta. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

A can be obtained by measuring the major (a') and minor (b') axes of the actual ellipse formed by the fluorescent spot on the screen. A_0 can be obtained by measuring a and b, Fig. 2. Hence, $\cos\theta$ can be

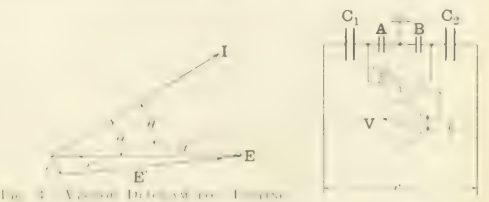


Fig. 3.—Values Determined by Exposures (Fig. 4).

Fig. 4.

determined. This shows that it is advisable to make three exposures for each photograph, one of the ellipse, one of the deflection a, and one of the deflection b. These photographs are taken at an angle as indicated in Fig. 4, but on account of the ratio of A to A_0 no errors are introduced by the value obtained for $\cos\theta$.

Equation (2) gives the value of the power factor of the circuit, but one desires the power factor of the insulation which is being tested. This is obtained from Fig. 3. In the diagram the power factor of the insulation is $\cos\theta$, and it can be shown that

$$\cos\theta = \frac{C_1}{C_1} \cos\theta \cos\theta + \sqrt{\left(1 - \frac{C_1}{C_1}\cos^2\theta\right)} \sin\theta$$

$$\cos\theta = \frac{C_1}{2C_1} \sin 2\theta \text{ approximately.}$$

* Abstract of a Paper read before the American Institute of Electrical Engineers on July 2, 1915.

† "Transactions" A.I.E.E., Vol. XXX., p. 1056.

In this expression e_1 is the potential drop across the air condensers and E′ is the voltage drop across the insulation.

Measurement of Current.—The current that passes through the test specimens passes through the air condensers C_1 and C_2. The potential drop across the air condensers is equal to the current passing through any air condenser multiplied by its reactance, or

$$E_1 = e_1 = 10^9 \frac{I}{2\pi f C} \text{ volts},$$

where e_1 = potential in volts across the condenser, C = capacity, in microfarads of the condenser, f = frequency of the applied potential. So that this equation can be used to obtain the current passing through the insulation.

The voltage, e_1, across the air condensers has been determined with a 120-volt Kelvin electrostatic voltmeter used in conjunction with two auxiliary condensers, one connected on each side of the ground between C_1 and C_2 in Fig. 1. The connections are shown in Fig. 4 and the average of the readings across A and B is taken to represent the value of e_1 to be used. This method is quite satisfactory, and can be relied upon to give accurate results. The auxiliary condensers, A and B, are made of waxed bond paper. They are subdivided, and one section or another can be switched in or out depending on the amount of current passing. The loss in these condensers is less than one part in 200 or 300 of the total losses. The air condensers, C_1 and C_2 range from about 0·003 to 0·015 mfd.

Measurement of Voltage.—The voltage, E, applied to the test terminals, was obtained by reading the voltage on the low-tension side of the testing transformer, and calculating E by the ratio of transformation. The voltage E′, across the insulation, can be calculated from the equation derived from the geometry of Fig. 3.

Calculation of Losses.—The watts lost in the two test specimens are given by the equation,

$$W = EI \cos \theta',$$

where the potential and current are in volts and amperes respectively. The loss per cubic centimetre can be obtained by dividing the total watts by the actual volume of insulation under test.



Fig. 5.

One is likely to imagine that considerable time is required to secure data for one point, that is, data for calculating the power factor, current, voltage and watts. As a matter of fact, about 30 seconds are required to make the three exposures for each photograph, and about a minute more is required to obtain all the other necessary readings. With these data a considerable amount of data may be taken in a very short time. In about 10 minutes data can be secured for curves connecting watts and voltage, current and voltage, and power factor and voltage.

Determinations by the Oscillograph.

Some of the important observations made in the development of the calculating and measuring part of the work, observed with those of other investigators, appear to the author, and reference should be made to the Paper for information concerning vacuum character [illegible] peculiarities of the tubes.

Insulating Conditions.—The specimens are made of pieces of bakelite or micanite. They must be supported by a material which has a very high insulation resistance and which does not change due to surface leakage or otherwise. The reason for this is that the [illegible] The insulators connecting the leads to the potential quadrants should have ebonite bases with considerable [illegible] The current condensers are so much larger than the potential condensers, it is not necessary to have such highly insulated switches. To ensure accurate results it is necessary to make the [illegible] the quadrants, and cellulose nitrate applied in the form of a paste with ether has been used for this purpose.

Commutator for the Tubes.—The rectifying method has been largely used for producing the cathode rays. The form of commutator used and the diagram of connections are illustrated in Fig. 5. The commutator, R, is connected to the shaft of a small four-pole motor-generator which supplies the low-tension side of the transformer, T. The commutator can be adjusted so that it will rectify the peaks of the alternating-current wave, and the rectified direct potential charges the condenser, C, to a voltage corresponding to the adjustment of the commutator.

Potential and Current Condensers.—The potential condenser consists of hollow metallic tubes with their ends closed by hemispherical caps. About six of these are joined together with metallic rods and supported from the ceiling with insulators. Two such plates constitute the outer plates of the potential condenser shown in Fig. 1. The inner plates are about 2½ ft. by 2 ft. by ⅛ in. The middle one is grounded and supported firmly, while the two adjacent ones on either side are supported from the ceiling with ebonite. It is essential to have air as the dielectric for the potential condenser because an error would be introduced into the results if the phase angle of it were not 90 deg.

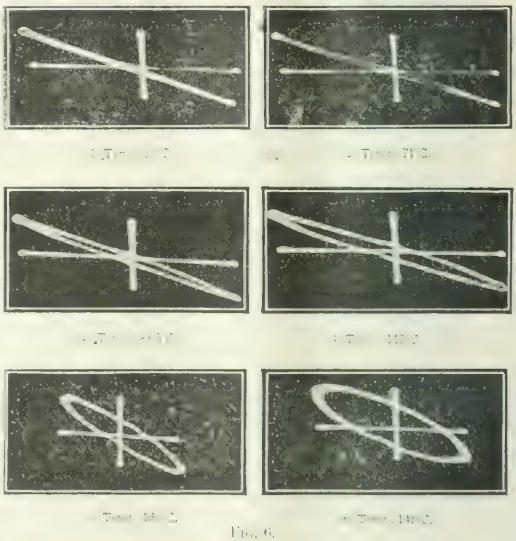


Fig. 6.

The current condensers should have air for the dielectric for at least four reasons. First, if these condensers are broken down as they are when the test pieces are broken down then those with air dielectrics are self-restoring. Those with other dielectrics might be broken down and cause one considerable trouble in repairing them. Second, it is necessary to have current condensers which never change in capacity. The air condensers used have not changed more than 1 per cent. in capacity during the past 2½ years. Condensers with other dielectrics would be likely to cause errors in the results due to capacity changes. Third, if condensers with dielectrics other than air are used, then it is necessary to correct the results for the losses in them. It is better to eliminate these losses rather than correct for them. Fourth, in the formulæ used for calculating the current and power factor of the insulation, a perfect condenser was assumed. These current condensers are constructed so as to have the minimum current possible pass through the supporting frames.

Experimental Results.

All the tests embodied in this Paper have been made at 60 cycles with a generator which produces very nearly a sine wave. The tests were made in good transformer oil to avoid corona, and the brass test terminals were either 20 cm. or 25·4 cm. in diameter and 0·5 cm. thick.

As a further means of illustrating how the results are obtained there are given in Fig. 6 reproductions of a series of six photographs taken on a sample of varnished cloth at 200 volts per mil and at various temperatures. These illustrations show that the figures on

the fluorescent screen are very steady and well defined, and the following table gives the measurements made on the negatives :—

Photo. No.	a cm.	b cm.	a' cm.	b' cm.	Cos α per cent.	Cos α' per cent.	Temp deg. C.
1	2·70	0·85	2·91	0·045	5·7	6·3	30·0
2	2·79	0·85	3·05	0·055	7·1	7·9	71·0
3	2·83	0·87	3·12	0·102	12·9	14·4	99·5
4	2·90	0·87	3·17	0·187	23·5	26·2	115·0
5	1·55	0·85	1·83	0·290	40·3	42·2	130·0
6	1·93	0·88	2·15	0·515	65·2	68·6	145·0

Varnished Cloths.—A large number of tests have been made on various kinds of varnished cloths. The different test samples were about 30 cm. square, and were built up of separate sheets of the same

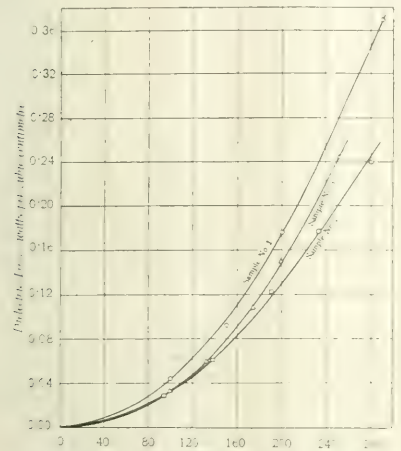


Fig. 7.—Twelve-Mil Black Varnished Cloths.

Comparative curves showing dielectric loss vs. volts per mil at 100° C. 60 cycles—sine wave; total thickness: (1) 0·1214 in.; (2) 0·1245 in.; (3) 0·1093 in.

size to the required thickness. From the many results given by the author, Figs. 7 and 8 have been selected.

Oil-Treated Pressboard.—The samples of pressboard used were

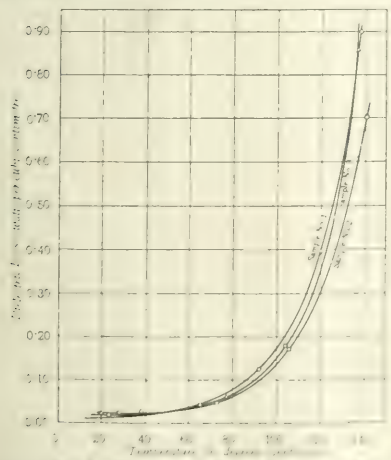


Fig. 8.—Twelve-Mil Black Varnished Cloths.

Comparative curves showing dielectric loss vs. volts per mil at four different temperatures; 60 cycles—sine wave; total thickness: 0·1093 in.

about 30 cm. square and were cut from regular [illegible] stock. After receiving a certain amount of drying, the samples were impregnated with good transformer oil for several hours. The results on the samples of pressboard, selected for this Paper, have been chosen so as to be able to show the characteristic curves and to compare the results for similar insulation under different conditions. Each of the test pieces A and B (Fig. 1) consisted of one sheet of oil-treated pressboard of the dimensions given above. Figs. 9 and 10 show a set of curves taken on pressboard samples.

Effect of Moisture in Oil-Treated Pressboard.—In order to determine how the losses, power factors and current for oil-treated pressboard are affected by the quantity of absorbed moisture, a number of samples of the same kind of pressboard as tested above was taken. Certain of the results of these tests are depicted in Figs. 11 and 12.

Study of Experimental Results.

In order to study the subject more carefully, the author expresses the results in the form of empirical equations. By this means, a

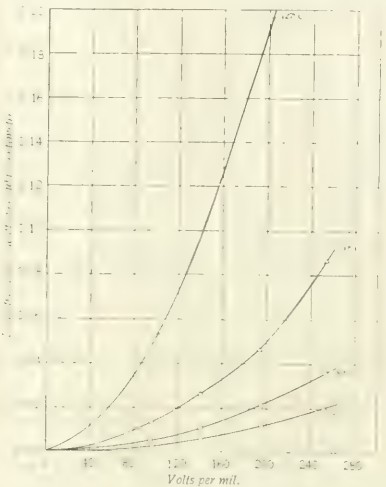


Fig. 9.—Sample No. 1—3/32 in. Oil-Treated Pressboard.

Comparative curves showing dielectric loss vs. volts per mil at four different temperatures; 60 cycles—sine wave; total thickness: 0·1093 in.

comparison of the results lead to a better understanding of them and show clearly the fundamental nature of the results given in the Paper. In experimental results, the order in which the figures were given was dielectric loss, current and power factor. Equations are given by the author for current and power factor, and these are followed by equations for dielectric losses as a function of the voltage, tempera-

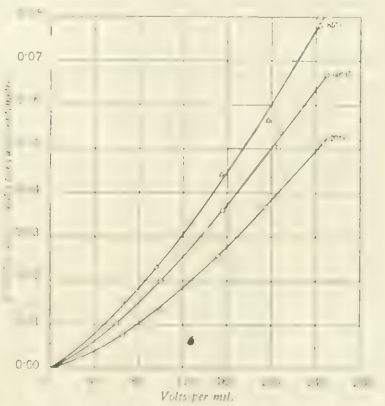


Fig. 10.—Sample No. 2—3/32 in. Oil-Treated Pressboard.

[illegible] comparative curves showing dielectric loss vs. volts per mil at four different temperatures; 60 cycles—sine wave; total thickness: 0·1093 in.

ture and percentage of moisture. For particulars of these equations the reader is referred to the original Paper.

Accuracy of Results.—It will be well to devote a short space to the consideration of the accuracy of the results given in this Paper.

Both the current and voltage can be measured to within 1 or 2 per cent., but the largest error is introduced by the measurement of the minor axes, b', of the ellipses on the photographic plates. Referring to the illustrations in Fig. 6, it will be seen that no great difficulty would be encountered in measuring b' for illustrations 3, 4, 5 and 6. The measurement of b' for photographs 1 and 2 might be in error as much as 5 per cent. If one desires to check the measurements given in the Paper for these illustrations, he may do so in order to see how accurate the measurements can be made. Experience in

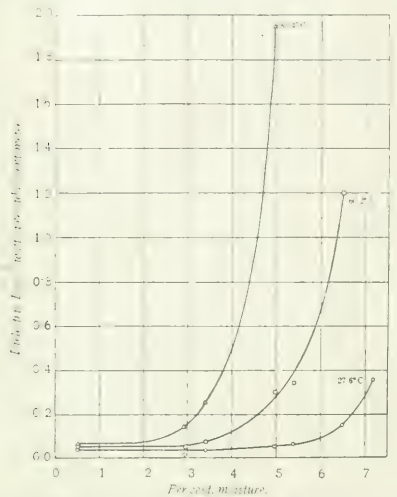


Fig. 11.—Oil-Treated 3·32 in. Pressboard.

Comparative curves showing dielectric loss vs. per cent. moisture at three different temperatures and at 200 volts per mil; 60 cycles—sine wave; average thickness of the seven samples used was 0·196 in.

making these measurements will be found valuable. It should be said that the measurements can be made on the originals with a greater precision than on these reproductions. For low-power factors, as shown in the first two illustrations, each point for dielectric loss may be in error by $\sqrt{1^2\times 2^2+5^2}=5{\cdot}5$ per cent. One, two, and five per cent. are used respectively for the errors due to voltage, current and power-factor measurements. When points for a curve are taken it is probably true that a point taken off an average curve will not be in error by more than about 2·5 per cent. Certainly, with

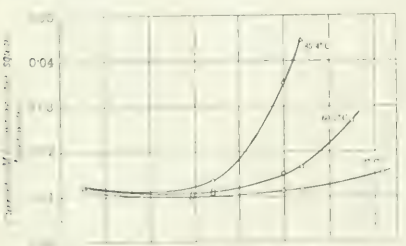


Fig. 12.—Oil-Treated 3·32 in. Pressboard.

Comparative curves showing current vs. per cent. moisture at three different tempera-

the larger power factors this precision can be obtained with the cyclograph. An accuracy of the cyclograph equivalent to this is quite satisfactory for the kind of work to which this apparatus is adapted.

Conclusions.

The following conclusions are arrived at as a result of this investigation on dielectric losses:

1. The successful application of the cyclograph in determining dielectric losses in insulations is amply demonstrated by the results given in this Paper.

2. For good insulation the current should vary directly as the applied voltage. If the current increases more rapidly than this, the insulation will show weakening properties.

3. The dielectric losses vary over wide limits depending on the condition of the tests and the nature of the insulation. The losses show clearly the electrical value of an insulation.

4. The results given in the Paper show that the power factor of insulation may vary from about 2 to 99 per cent. The nature of the insulation and the condition of the tests determine its value.

5. It is shown that the watts do not vary as the square of the voltage, but may vary from the 1·32 to the 2·52 power of the voltage.

6. The weakening effects in insulation, as shown by the dielectric losses, power factors and currents, may increase as great as the fifth or sixth power of the temperature.

7. The weakening effects in pressboard, and very likely other water-absorbent insulations, may also increase to as much as the fifth or sixth power of the per cent. absorbed moisture. When the free moisture is above 3 per cent. the weakening effects due to its presence are quite pronounced.

8. Empirical equations are derived that will express the dielectric losses, currents and power factors, as functions of the voltage, temperature and absorbed moisture.

PRACTICAL APPLICATIONS OF ELECTRICAL PRECIPITATION AND PROGRESS OF THE RESEARCH CORPORATION.*

BY LINN BRADLEY.

Summary.—The general design of treaters for electrical precipitation is outlined, and the author gives particulars of a large number of installations. Curves showing various electrical relations in typical cases are given.

The technical and financial progress of the Research Corporation,† which was brought into being for the purpose of developing patents on the electrical precipitation held by Dr. F. G. Cottrell is first dealt with by the author, who then goes on to a brief statement of the method adopted in removing suspended matter from gases.

The electrical equipment must be of such design and construction as to be suitable for the peculiar type of circuit, and it should be compact, economical and foolproof and still allow and ensure uninterrupted operation where desired. The transformers must be strongly built, but not too expensive. The treater proper, which contains the so-called "discharge electrodes" and "collecting electrodes," past which the gases travel, must be of such material and construction that corrosive gases, if present, cannot too quickly destroy them. It is good practice to design the treaters of ample proportions, easily accessible to the electrodes and insulators, and with due regard to conducting the gases into and out of it and to the location of flues, furnaces, stacks, buildings, &c. Under some circumstances it is desirable to treat the gases while travelling horizontally, while in others a vertical gas flow should be adopted. Sometimes special types of electrodes must be employed, but the variety of problems and conditions is so great that it is not considered desirable to endeavour to prescribe any general rules in this regard. The treaters must be arranged so that the dust, fume or liquid may be readily removed after deposition. In some problems a leakage of air into the gas to be treated is not harmful, while in others, such as the burner gases in sulphuric acid manufacture, dilution is objectionable.

A partial record of the results obtained since 1912 is given below. The first problem undertaken since that time was to recover the valuable fumes from silver refinery gases at the Raritan Copper Works, Perth Amboy, N.J., after they had passed through a water scrubber which was supposed to recover practically all the values. In this installation very corrosive gases were encountered. The construction problem finally was solved by the use of heavy cast-iron in parts and a mixture of lead and antimony for other parts. Insulation and natural draft troubles also were encountered, but finally they were overcome, with the result that the installation has already saved several thousand dollars' worth of valuable fume. The power consumption is about 2·5 kw. to 3 kw. and the voltage averages about 35,000. Recently we have installed some 12 in. and some 24 in. diameter lead pipes for additional treaters of very simple construction, and also a 10 k.v.a., 25-cycle, single-phase 100,000-volt transformer, a 500 revs. per min. motor-generator set, and a large rectifier

* Abstract of a Paper read before the American Institute of Electrical Engineers.

† Particulars of this Corporation are also given in a Paper by Dr. F. G. Cottrell. See p. 544 of our last issue.—Ed. *E.*]

Opinion was widely divided as to the probability of successfully adapting the processes to Waterside Station No. 2 of the New York Edison Co., the problem being to remove cinders from the boiler plant gases. Nevertheless, for various reasons, efforts were made and the following conclusions reached. There was not sufficient available space for treaters in the building to ensure successfully treating all gases, especially without imposing prohibitive restrictions upon the natural draft. Tests under ordinary conditions of installation showed that the cinders could be removed while moving at a velocity between 10 ft. and 15 ft. per second without using water, and that they could be cleaned at a considerably higher gas velocity when water was used; but the consensus of opinion was that tests should be discontinued until better assurance of success in this problem might be obtained. Perhaps this same type of problem will be again undertaken at some future date, as the prospects of success are much brighter now than formerly.

At the plant of the Hooker Electrochemical Company, a large volume of air, containing a small percentage of chlorine gas, is treated for the removal of the latter. Hydrated lime dust is used to assist in the removal, and a few tons per day of weak bleaching powder are collected. The volume of gas is about 30,000 cubic ft. per minute, with a power consumption of from 3 kw. to 5 kw. Weak bleaching powder, chlorine gas and hydrochloric acid are not conducive to a simple insulation problem, as can be readily imagined; nevertheless it was successfully handled, even for 50,000 volts. The chief difficulty here was to obtain a steady introduction of hydrated lime into the gas and at a given rate. Other mechanical problems were met and solved.

The gases from a hand-fired 80 H.P. boiler at the U.S. Bureau of Mines are treated for the elimination of black smoke when certain coals are being tested and it is not expedient to prevent the production of smoke. The removal of the carbon and other particles of the smoke is accomplished quite readily, but the question of suitable disposal of the collected soot is still under consideration, and some further tests are being made. As is to be expected, the results obtained thus far indicate that it is best to prevent formation of smoke whenever feasible, and not adopt methods for collecting it.



FIG. 1.—VIEW OF ELECTRIC TREATER.

Elaborate tests upon gas volumes, composition, temperature, fume, content &c., were conducted for the Chase Rolling Mill Co. In order to secure reliable data upon which to base designs for full scale commercial installations. The fume is mostly zinc oxide originating at the crucibles in which zinc and copper alloys are produced. The results were very gratifying, showing that the financial returns would pay well. Plans have been prepared for large commercial installations at the various locations, and a contract for a portion of the installation has been awarded.

Prof. A. H. White has succeeded in cleaning the entire make of illuminating gas at the plant of the Ann Arbor Gas Co. by means of the process, the installation requiring a very small amount of power. The tar removal was practically complete. At times during the testing period the gas velocity past the electrodes was over 30 ft. per second. The installation is very simple and compact, and, judging from his reports, should warrant its rapid and general adoption as standard equipment for this purpose by gas manufacturers.

The installation at Garfield, Utah, consists of two units each of 40 5 in. pipes, 2,520 in all. The volume of gas treated is approximately 200,000 cubic ft. per minute. The collected material is quite high in lead, and several carloads have already been shipped for refining. It is a large, well constructed installation and reported operating very successfully, the collection being about 95 per cent. of total solids. Semi-commercial tests also were conducted upon main flue gases, coming from blast furnaces, roasters and reverberatory furnaces. These tests likewise were successful, and eventually these gases also may be treated by the processes. The electrode spacing is 2½ in., the potential about 30,000 volts, and the power consumption approximately 50 kw. The building which contains the motor-generator sets, rectifiers, control apparatus and switchboard panels is one to be proud of. Fig. 1 gives a general view of the treater. It is divided into seven electrical and mechanical sections. The converter gases, mixed with more or less air, come from the converter building through a long steel balloon flue, drop considerable of the heavier particles throughout the length of the flue, then enter the bottom header, pass upward through the 5 in. pipes, into the upper header, then through the long radius pipes into the main flue, which also carries gases from other parts of the smeltery. The illustration was made prior to actual connection of the flue to the new stack, which is in the right background.

Small scale tests were conducted on gases from sintering machines at Tooele, Utah, carrying large amounts of lead, elementary sulphur, &c., and upon gases from roasters, converters and blast furnaces. In all cases the results were satisfactory. Two large units are now in successful commercial operation on the sintering machine gases, and it is planned to instal several others on these gases as soon as possible, and later to instal treaters on other flues at this plant as well. Each of the two units contains 48 pipes 12 in. in diameter by 15 ft. long, placed vertically. The electrode spacing is 6 in., the volume of gas treated is approximately 20,000 cubic ft. per minute, the power consumption measured at the transformer at present is less than 5 kw., the recovery of fume, when the treaters are not overloaded by forcing the blowers at the sintering machines, is practically complete. The fume contains a fair percentage of elementary sulphur which formerly wrought havoc with baghouse installations, especially when it exploded. The potential on the treater as indicated by transformer ratio and primary voltage is around 70,000 volts. At this plant also some changes in the metallurgical operations have resulted in a considerable reduction of the values lost in the fumes, hence the electric processes are not called upon to recover as much as was being lost a year or so ago.

A treater was installed without conducting any preliminary test for the Milk Flour Co., as sufficient experience with the various influencing factors had been obtained to be able to make a successful installation without them. It is a very inexpensive outfit, used for collecting powdered milk, sugar, eggs, malt, grape fruit juice, &c. The powders are obtained from an evaporating plant wherein solutions, emulsions, &c., are deprived of their water by spraying the liquid into a current of hot air. The powder is removed from the gas before it cools sufficiently to allow deposition of the evaporated moisture. Excellent powdered organic materials are recovered in this manner at a small expense. Several very interesting and some fairly important facts were learned from this installation. A small electrical treater was subsequently installed for removing dust from the air before heating it, thus insuring a food product free from dirt specks.

In response to a telegraphic request apparatus was shipped to the Washoe Smelter, Anaconda, Montana, to be used for removing valuable metals and acids from gases arising from a modified MacDougal roaster, in which the Anaconda tailings were being subjected to an oxychloridising roast under the direction of their Mr. Laist. ("Bulletin" of A.I.M.E., August, 1914). The gases at that time were being passed through a scrubbing tower without obtaining a complete recovery of the values. The electric apparatus and treater were quickly erected and tried out but at first with what was apparently unsatisfactory results. As similar phenomena had been encountered elsewhere it was possible to soon show that the cloud emerging from the treater was due to moisture being condensed from the gaseous to the liquid condition upon the gases mixing with cold air, resulting in a condition of supersaturation for the temperature existing after admixture of the gases. It was also noted that if the furnace fires were poked so as to produce black smoke, no black could be discerned in the cloud above the treater when the electric field was on, but this was plainly visible when the current was turned off; the difference between the white cloud (current on) and the dark gray cloud (current off) being very pronounced. This was a good indication that all solids were being collected and that by a study of certain meteorological tables the proper explanation might be had. The temperature of the gases going to the treater was then so reduced that no cloud would result after the gases had passed through the treater. The results then showed a complete clean up when the current was on and a dense white cloud above the treater when it was off.

This "fogging out" has been encountered repeatedly in practice. When tests are made during the winter season a visible "mist" is

formed after the gases are discharged from the treater, when warm saturated gases are discharged from treaters. During the periods of dry and warmer weather the "fogging out" is greatly decreased. In other cases, where the temperature of the discharged air, saturated with moisture, is only a few degrees above that of the outside air, no mist or fog is produced. It is possible to predict from calculations made in a similar manner whether or not a mist or fog will be produced under any given conditions. It is further possible to show by calculations whether mixing two or more gases, varying in temperature and in percentage of saturation, in given proportions prior to passing through the treater, will avoid this formation of a mist or fog when the discharged gases mix with the outside air. An installation of the processes was also made at the arsenic plant where flue dust is roasted to remove the arsenic from the metal values, and then the concentrated arsenic is recovered and refined. The plan was to separate the mechanically carried impurities from the gases at a high temperature, next cool the gases so as to condense the pure arsenic, and then recover it directly, thus saving a second refining. The first test gave a precipitate in the second treater carrying 99·4 per cent. arsenic trioxide. A portion of the impurity was due to volatile compounds from the wood used for fuel. Coke fuel in place of wood gave arsenic of a higher purity, sometimes reaching 99·9 As_2O_3. This was the first really serious effort made to use electrical precipitation as an adjunct in fractionating components of fume. The results at the arsenic plant showed conclusively that it was a feasible method, and after sufficient data had been obtained a commercial installation was designed and started, but construction work was suspended on account of the situation resulting from the European war, and this installation has, therefore, not yet been completed, although reports state that it is now going forward.



Fig. 2.—Voltage off.

Treating the enormous volume of gases in the main flue at Anaconda presents several problems. In addition to magnitude, there are the numerous problems connected with the handling of the fumes and dust and of their metallurgical treatment, so that it will be some months at least before any very definite progress can be reported. However, the results thus far obtained were so encouraging that the smelting company purchased a license for the use of the processes throughout their plants at Tooele, Great Falls and Anaconda, paid a large cash sum, and now they are in position to make rapid progress with their installations. The Research Corporation still has a financial interest in certain elements of the fume which are to be collected when the processes have been installed. Figs. 2 and 3 show how completely the fume is precipitated by the electric processes, the views showing respectively the "voltage off" and "voltage on" effects. The fume contained, among other things, hydrochloric acid, sulphuric acid, dissolved sulphur dioxide, carbon, compounds of copper, silver, iron and arsenic. A potential of 63,000 volts (as calculated from transformer ratio and primary voltage) was maintained on the treater.

At Catasauqua, Pa., is an installation for collecting potash salts volatilised from feldspar. This is operating successfully. At present this scheme as a whole is still in the experimental stage, but the collection of the salts by the electrical processes is proved. The treater was designed for 12,000 cubic ft. per minute, but it handles as high as 18,000 cubic ft. per minute at times. There are 40 pipes 14 in. in diameter 15 ft. 12 in. long, the electrode spacing being 7 in. The temperature of the gases ranges from 500 F. to 1,000 F. A potential of about 70,000 volts is maintained on the treater, low tension alternating voltage about 190, and amperes 20 to 25. The power factor varies between 70 and 80 per cent. when operating on the hot gases and fume. This same treater has been tested with only ordinary air in it, and at that time it was easy to furnish even more than 50 amperes to the transformer without any arcing in the treater. This is a good example of a difference in electrical conditions due to a change in the gas characteristics.

It is difficult, if not impossible, to predict what the power consumption and voltage may be for a specified gas until actual tests have been made. For instance, in tests with the same treater and electric apparatus, the line current to the treater varied from 1 to 19 milliamperes, the voltage being constant. The considerable variety of gas conditions already encountered has made it possible to divide gases into classes. Furthermore, methods have been developed whereby a close approximation of the required power and voltage may be obtained from the results of small scale tests. With a large treater containing many electrodes the effect of the corona load upon the transformer and source of E.M.F. is different from an ordinary resistance load, due to the fact that above a certain point the current flowing through the gas between the electrodes increases more rapidly with a given rise in potential than would be the case if the electrodes were shunted by an ordinary high-resistance metallic conductor. For these and other reasons it is best to employ certain potentials and electrode arrangements for some gases and others for gases having other characteristics. Also the mechanical handling of the collected material must be duly considered when designing a treater. Other problems upon which tests have been made with the processes are mentioned below. The most recent final installation was made in Worcester, Mass., at the North Works of the American Steel & Wire Co., for collecting volatilised hydrochloric acid, thus mitigating or eliminating a nuisance and preventing further damage to surrounding vegetation. The exit gases are so free from acid that it is almost impossible to detect a trace of it even by delicate chemical methods.

In Cleveland, Ohio, at a sulphuric acid plant, the gases come from



Fig. 3.—Voltage on.

an M. & H. kiln, in which very finely divided zinc sulphides are roasted. The sulphurous gases are to be freed from the suspended particles and then delivered to a Glover tower of a lead-chamber sulphuric acid plant. The gases are to be treated at a temperature of about 800°F. to 1,000°F. The gases contain some free sulphuric acid, which tends to complicate the insulation problem. However, our semi-commercial tests at this plant showed that the problem could be solved, and pointed the way. Designs of several types of treaters were prepared, and at a recent conference one design of horizontal treater was decided upon and it is to be installed at once. There are to be three sections, any two of which will clean the gases. Thus, one section may be repaired when necessary. In this problem it is necessary to conserve the sensible heat of the gases and to avoid their dilution with air, as this would materially affect the subsequent chemical operations.

The above statements show that the electrical processes are applicable to a great variety of materials and conditions, especially when it is also considered that the range of operating temperatures is from a point at least as low as zero Cent. to at least as high as 600 deg. Cent., and at all temperatures between these two limits. Materials can be selected for each specific problem which will withstand the local conditions as regards temperature, corrosion, mechanical strength, expense, &c. In addition to collection of material because of nuisance or of value of the suspended matter, it is worth noting that the processes are useful as adjuncts to other manufacturing processes or methods, either for improving operations or reducing expense. Both the lead-chamber process and the contact processes of producing sulphuric acid have several places in which the electrical processes should be valuable. The use of the electric processes in conjunction with ventilation of the railway tunnels in Baltimore is also under consideration, and they may be installed there unless electrification of the railways is decided upon, in which

event, of course, there will be no smoke to precipitate. Furthermore, since it is so easy to remove dust from air by these processes, they may be useful in connection with the ever-present problem of suitably ventilating subways.

The typical curve shown in Fig. 4 gives the relationship between the high-tension direct current flowing into the treater and the high-tension voltage impressed upon it, the latter being shown on the curve sheet as the alternating potential delivered to the rectifier from the transformer and calculated from the measured low-tension voltage and the transformer ratio. Under certain conditions it would be preferable to measure the effective high-tension voltage maintained between the treater electrodes by means of a suitable voltmeter. In general, however, the voltage as indicated by the

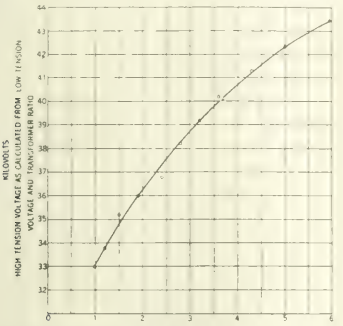


Fig. 4.—Curve showing the Ratio of High-tension Voltage to the Current Consumption. (Measurements taken at treater installed for Balbach Smelting & Refining Co., Newark, N.J.)

ratio method is sufficiently accurate for field work. The lower portion of the curve shows the uniform increase in the current with the voltage, due chiefly to insulator leakage. The upper portion of the curve shows the more rapid increase in the current as the voltage is raised above that at which corona started. The bend in this particular curve is somewhat more gradual than is usually found. This is due to a special arrangement of the electrodes, whereby the corona starting voltage varies in different parts of the treater.

Fig. 5 shows the results obtained from tests made with various electrode spacings in fume-laden gases at different temperatures.

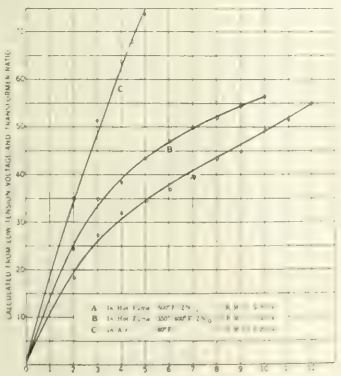


Fig. 5.—Curves showing Sparking Potentials for Rectified Current between Wires and a Parallel Plate, for Various Gap Spacings.

Curve A shows the potential (measured by transformer ratio and the low-tension voltage) which, when rectified, caused a spark-over to occur between a number of parallel wires and a plate placed at varying distances from them. The wires and plate were placed in a flue, through which passed zinc oxide fumes at a temperature of 400 F. Curve B shows similar data obtained with the gas temperature reduced to between 350 F. and 400 F. Curve C shows similar data obtained from the same electrode system with air in the flue. The relative positions of curves A and B are what would be expected. Data are being obtained in order to plot a series of curves between corona starting voltage (ratio method) and electrode spacings. This work has not been completed.

Fig. 6 gives in a specific case the distribution of the electrical losses in transformation, rectification and transmission of the electrical power taken from the supply lines and delivered to the treater. Those of transformation (from 220 volts low tension) are the greatest. The additional load losses of the transformer are readily calculated. The added load losses of the rectifier are not definitely known, but experience indicates that they are small in proportion to the other losses. The added load losses of the transmission line are negligible. These latter losses consist almost entirely of corona loss and insulator leakage, both of which depend upon the voltage, and not upon the current. From such data it is possible to estimate very closely the capacity of apparatus required to deliver to the treater any given

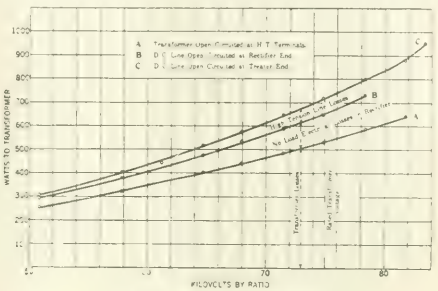


Fig. 6.—Power Loss Data.

Transformer 7½ k.v.a., 75,000 volts, 60 ∼. Rectifier type, two arm, eight shoe. Steel shaft. Line insulators, two per line from transformer to rectifier, 11 in d.c. line.

power at a certain voltage. The author concludes by giving detailed results of various tests on different plants and a short account of the financial status of the Research Corporation. The past three years have seen the electrical processes (Cottrell patents) in constantly growing use and demand, several commercial installations having produced excellent results, and the future is full of promise. The Research Corporation has definitely established itself commercially in the short time intervening since its organisation. The total capital paid into the treasury was £2,020. From the receipts so far obtained for technical services and for patent rights all the Corporation's stockholders have been fully repaid, and there is on hand at present nearly £50,000 in good and negotiable securities as a net surplus, with only ordinary current accounts owing. Further income as royalties from installations now in operation, under way or contracted for will materially increase the above amount, so that a fund for further scientific research has already been created, and this directly from the industries benefited by the processes administered by the Corporation.

IRON LOSSES IN TRANSFORMER PLATE.

BY A. PRESS.

Summary.—The problem of iron losses and the effective flux penetration in a transformer plate is solved on the assumption of mean constant permeability, but taking into account the simultaneous effect of hysteresis on the total iron loss. In the problem a new operator is introduced defined by the relation $Q_m \sin pt = \sin mpt$. Starting with a sinusoidal magnetising current, the impressed voltage is found. Combining the components of current and voltage in phase with each other, the iron losses are determined and then the harmonic damping factor.

In dealing with ordinary transformer plate, taking the permeability μ as a constant implies that the locus of the critical points of the B-H loops is a straight line, and that the loops themselves merge into the same locus. In the following this permeability relationship μ will be held to refer to the locus of the critical point values only of the B-H loops, and a mean invariable loop shape will be assumed independent of the numerical maximæ of B and H. Thus, with iron, if

$$H = H_{max.} \sin pt \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

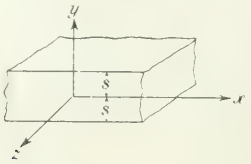
$$B = \mu H_{max.} \{\alpha_1 \sin pt + \alpha_3 \sin 3pt + \alpha_5 \sin 5pt + \ldots + \beta_1 \cos pt + \beta_3 \cos 3pt + \beta_5 \cos 5pt + \ldots\} \quad . \quad . \quad (2)$$

where the coefficients α, β are constants.

However, the last equation can be put into a more manageable form by the introduction of a mathematical operator, Q_m, defined by the relation

$$Q_m \sin pt = \sin mpt \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This operator can be interpreted in terms of the ordinary



differential operator by a method kindly communicated to the author by Mr. Oliver Heaviside; for, writing $t_1=\frac{d}{dt}$, then, with operand unity,

$$\text{Sin } pt = \frac{p}{t_1 - \frac{p^2}{t_1}}$$

and

$$Q_m = m \frac{1 - \frac{p^2}{t_1^2}}{1 - \frac{m^2 p^2}{t_1^2}} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

It will be found that

$$Q_m{}^2 \sin pt = \frac{m}{2}\left[\left(1 - \frac{1}{m^2}\right)\sin mpt + \left(1 - \frac{1}{m^2}\right) mpt \, . \cos mpt\right],$$

and generally that if we write $x=mpt$

$$(Q_m)^n \, . \sin pt = m^{1-n}\left[A_1 + A_2 P + \frac{A_3}{2} P(P+1) + \ldots \right.$$
$$\left. \frac{A_n P(P+1) \ldots (P+n-2)}{n-1}\right] . \sin x \, . \quad . \quad . \quad (5)$$

$$P = \left(\frac{1}{2}\frac{d}{dx} \, . \, c\right)$$

$$A = \frac{1}{k-1} \frac{(n-1)(n-2) \ldots (n-k)}{(n-k)} \, . \, (m^2-1)^{-1}$$

The above really follows from (writing $x_1 = \frac{mp}{t_1}$),

$$(Q_m)^n = \frac{1}{(1-x_1^2)^n}\left[1 + \frac{1}{k-1} P(P+1) \ldots (P+K-2)\right] . \sin x.$$

However, in the development of the final formulæ, the Q functions will not appear.

Thus, (2) can be written

$$B = \mu H_m \left\{\left(\alpha_1 + \beta_1 \frac{t_1}{p}\right) + \left(\alpha_3 + \beta_3 \frac{t_1}{3p}\right) Q_3 + \ldots \right\} \sin pt \quad . \quad (6)$$

If, then, the effective H at any point of the lamina is dependent on t and y, one can write in (1) as a substitute

$$H = H_s h, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where H_s is the skin amplitude (corresponding to B_s) and h is a time operator function involving t_1, Q_m and also y, the depth of plate from the centre, which function h is to reduce to unity for $y=\pm s$, since $2s$ is the thickness of plate by condition.

Since the fundamental equation to be solved is

$$10^{-7} \rho \frac{dB}{dt} = \frac{d^2 H}{dy^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

(ρ = the resistivity of the iron about 10^{-6} ohms), by [illegible] writing $k = \frac{4\pi\mu}{10^7 \rho}$,

$$\frac{d^2 h}{dy^2} = q^2 h \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

$$q^2 = kt_1 \left(\alpha_1 + \beta_1 \frac{t_1}{p}\right)\left\{1 + \left(\alpha_3 + \beta_3 \frac{t_1}{3p}\right) Q_3 + \ldots \right. \quad . \quad . \quad . \quad (10)$$

The solution is

$$h = \frac{\cosh qy}{\cosh qs} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

$$H = H_s \frac{\cosh qy}{\cosh qs} \sin pt, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

$$B = \mu H_s \, . \frac{\cosh qy}{\cosh qs} \, . \frac{q^2}{kt_1} \, . \sin pt. \quad . \quad . \quad . \quad . \quad (13)$$

The magnetising current with one turn per centimetre axially is

$$J = \frac{10}{4\pi} H_s \sin pt, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

and to get the iron loss per cubic centimetre the voltage per turn per cubic centimetre will be

$$E = 2 \, . \frac{10^{-7} t_1}{2s} \int_0^s B dy = 10^{-7} \frac{\tanh qs}{qs} \frac{q^2}{k} \sin pt^*. \quad . \quad . \quad (15)$$

It will then be necessary to find the watts per cubic centimetre (hysteresis and Foucault) to multiply the sin pt component of (15) with J of (14), and integrate over a complete cycle to obtain the effective value.

If, then, the Q's are ignored in estimating the iron losses (it also appears to be warranted by an inspection of the development of $Q_m{}^n \sin pt$, &c., and the series development of (15)), it follows that $t_1 = ip$.

$$q^2 = kip(\alpha_1 + i\beta_1). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

$$\alpha = \sqrt{\frac{kp}{2}} \sqrt{\sqrt{(\alpha_1^2 + \beta_1^2)} - \beta_1} \quad . \quad . \quad . \quad (17)$$

$$\beta = \sqrt{\frac{kp}{2}} \sqrt{\sqrt{(\alpha_1^2 + \beta_1^2)} + \beta_1} \quad . \quad . \quad . \quad (18)$$

and the sin pt factor or real component of $\frac{q^2}{k}\frac{\tanh qs}{qs}$ of (15) is

$$\frac{2p}{1+\frac{\beta^2}{\alpha^2}} \sqrt{(\alpha_1^2 + \beta_1^2)} \frac{\sinh 2\alpha s - \frac{\beta}{\alpha}\sin 2\beta s}{2\alpha s \left(\cosh 2\alpha s + \cos 2\beta s\right)}. \quad . \quad (19)$$

Thus, performing the necessary integrations to arrive at effective values, the watts per cubic centimetre of iron are given by (writing $\beta_{11} = -\beta_1$)

$$W = \frac{\sigma B_s^2}{4\mu 10^7} \sqrt{(\alpha_1^2 + \beta_{11}^2)} + \beta_{11} \frac{1}{2\alpha s} \frac{\sinh 2\alpha s - \frac{\beta}{\alpha}\sin 2\beta s}{\cosh 2\alpha s + \cos 2\beta s} \, . \quad (20)$$

This last agrees with the formula given by Sir J. J. Thomson† for $\beta_{11} = 0$, $\beta = \alpha$.

To arrive at the corresponding damping factor for iron, the average B with infinite resistivity of plate is, for the fundamental

$$B = \mu H (\alpha_1 - i\beta_1) \sin pt. \quad . \quad . \quad . \quad . \quad (21)$$

The amplitude is, therefore, $\mu H_s \sqrt{(\alpha_1^2 + \beta_1^2)}$. With normal resistivity the average B is

$$\frac{1}{s} \int_0^s B dy = \mu H \frac{2}{1 + \frac{\beta^2}{\alpha^2}} (T_s - i\mathfrak{T}_s)(\alpha_1 + i\beta_1) \sin pt, \quad . \quad (22)$$

where

$$T_s = \frac{1}{2\alpha s} \frac{\sinh 2\alpha s + \frac{\beta}{\alpha}\sin 2\beta s}{\cosh 2\alpha s + \cos 2\beta s} \quad . \quad . \quad . \quad . \quad (23)$$

$$\mathfrak{T}_s = \frac{1}{2\alpha s} \frac{\frac{\beta}{\alpha}\sinh 2\alpha s - \sin 2\beta s}{\cosh 2\alpha s + \cos 2\beta s} \quad . \quad . \quad . \quad . \quad (24)$$

The amplitude is, therefore, $\mu H_s \frac{2}{1+\frac{\beta^2}{\alpha^2}} \sqrt{(\alpha_1^2 + \beta_1^2)(T_s^2 + \mathfrak{T}_s^2)}$

and the damping factor D is on reduction found to be

$$D = \sqrt{2}\left\{1 + \frac{\beta_{11}}{\sqrt{(\alpha_1^2 + \beta_{11}^2)}} \frac{1}{2\alpha s}\left(\frac{\cosh 2\alpha s - \cos 2\beta s}{\cosh 2\alpha s + \cos 2\beta s}\right)^{\frac{1}{2}}\right\}^{\frac{1}{2}} \quad (25$$

* The evaluation of E must be left for another occasion.

† THE ELECTRICIAN, 1891, p. 599.

‡ Compare also THE ELECTRICIAN *loc. cit.*

QUICK EXCITATION AND SUPPRESSION OF REMANENCE IN ELECTRICAL MACHINES.*

BY W. WOLF.

If the strength of a magnetic field is altered, electromagnetic forces arise in the electric circuits connected with the field, which are proportional to the rate of change in the strength of the field; these forces tend to oppose any change in the field. A result of this is that a certain time has to be allowed to build up the field or to alter its strength in any way. In electrical machines, especially those of the continuous-current type which are used on the Ward-Leonard system for reversible motors, this is apt to cause inconvenience. In machinery used in rolling mills it is necessary to produce rapid changes in the speed and quick reversals. On such systems this is done by a quick change in the voltage of the generator, which is produced by an alteration in its field. However, the self-induction of the field is a decided impediment to any such rapid change. Further, if a direct-current generator feeds several motors, and if its voltage has to be varied over wide limits, the magnetic remanence is a very disturbing factor, as it prevents the strength of the field from following the variation in the exciting current immediately. It is, therefore, proposed to discuss means by which this can be avoided.

In order to bring the strength of the field rapidly to its full value, it is possible at the moment of switching on to apply a higher voltage than it is intended to use permanently. Thus, an external source of variable pressure is required, or a portion of the available E.M.F. must be permanently wasted in resistance throughout the steady running. To avoid this the firm of Brown, Boveri employ the Sprague method of coupling the field coils successively in series and in parallel in order to produce a temporary over-excitation of the

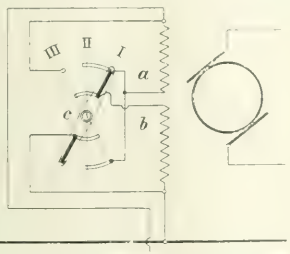


FIG. 1.—DIAGRAM OF THE BROWN-BOVERI METHOD.

magnet field, and by suitably connecting the field windings in parallel for an instant it is possible by this plan to reach the desired end. In Fig. 1 is shown the winding of the magnet field divided into two portions, *a* and *b*, which can be connected up by means of the switch *c* in different ways. Fig. 2 shows the various arrangements that are possible; the passage from the one to the other takes place without breaking the circuit. This allows of two steps and uses no resistances. The first step gives double the number of ampere-turns that the second does. For the quick excitation of an induction coil, at the moment of switching on, the connections shown in III. (Fig. 2) are used; the switch is then turned so as to make connections as in I. and then in I. If the voltage is constant and the two halves of the winding have the same number of turns, at the moment of switching on the ampere-turns are twice what they are in II. or in I. This decreases the time required to excite the coils. When the full excitation is reached the switch is moved from III. to I. At the moment of switching on there is an overloading of the coils, which, however, does no damage owing to the short time it lasts. In order to prevent too long an overload or a too rapid passage to I., the switch handle can be actuated by a spring mechanism. There is an arrangement by which the switch handle is kept in the one position till the field has reached its full strength, and it is then released and allowed to pass to the other contacts.

Felten & Guilleaume have employed another method. They switch the main generator on the circuit of the coil which is to be excited. A field winding is so arranged that it generates a voltage opposed to that of the exciter voltage. Thus the voltage at the terminals of the coil which is to be excited will be considerably higher so long as the dynamo gives no current, and will sink to a predetermined value when the current from the dynamo reaches its final value. If the exciter voltage is removed, the generator will give a negative voltage until the exciter current reaches its zero value. According to this method, the time-constant of the circuit of the coil which is to be excited—*i.e.*, the ratio of its inductive to its ohmic resistance—is decreased exactly as if an ohmic resistance is inserted in the circuit. The equivalent ohmic resistance is given by the ratio in which the drop of voltage of the counter-compound-wound exciter, corresponding to a given current strength, stands to this current. In order to shorten the period of excitation still further, the A.E.G. produces an artificial lag of the voltage-drop of the exciter machine behind its current by providing the poles of the counter-compound-wound exciter machine with damping windings. Thus the decrease in the lines of force in the exciter machine, and therefore its voltage-drop, lags behind the increase in its current. Thus the time-constant of the circuit which is to be excited is much diminished.

On the Ward-Leonard system, the Siemens-Schuckert Works insert a counter E.M.F. in the excitation of the regulating generator or its exciter. The amount of this E.M.F. depends on the voltage and speed of the motor. The voltage of the motor can react on a special winding, *f*, in the field of the regulating dynamo or its exciter. An improvement on this method is shown in Fig. 3. The regulating generator *g*, with its exciting windings *d* and *f*, is driven by the driving machine *t*. In the circuit of the coil *f* an adjustable resistance *n* is inserted. As the motor *m* slows down the resistance is gradually cut out. This has the effect of increasing the action of the counter windings *f*. It is an advantage to interlock the regulation of this resistance *n* with the main regulator *r*, which adjusts the main excitation. As the motor speed increases the resistance *n* is, of course, inserted, and thus the increased effect due to *f* is somewhat neutralised. If the resistance *n* is suitably proportioned, the counter excitation has little effect at high speeds, but its influence increases as the speed of the motor falls. Thus the motor speed, when low, depends largely on the position of the regulating lever,

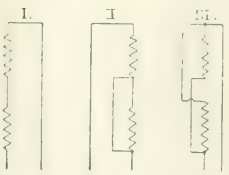


FIG. 2.—THE THREE METHODS OF COUPLING UP THE FIELD WINDINGS.

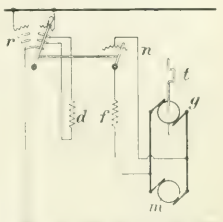


FIG. 3.—DIAGRAM OF THE SIEMENS-SCHUCKERT METHOD.

and the control is very effective and sensitive when the motor is nearly at rest. This, in point of fact, is the case with which we usually have to deal. If the main excitation is cut off, the strong counter excitation due to the remanent magnetism in the controlling dynamo is almost entirely suppressed, and tho motor comes consequently to rest.

The arrangement shown in Fig. 3 is only effective up to a certain motor speed—*i.e.*, so long as the counter E.M.F. of the motor, which depends on the speed, is less than the terminal pressure due to the regulating dynamo. Even so, an improvement is possible by arranging that above a certain speed the counter winding *f*, in series with a resistance, shall be reversed, so that it acts in the same direction, so to speak, as the main exciter winding *d*. The reversal of the counter windings has the advantage that it contributes to a saving of copper in the windings of the regulating dynamo, seeing that both windings act in the same sense precisely at that time when strong fields are required. Under certain conditions it is possible to have a smaller machine for regulating purposes.

* Abstract of an article in the "Schweizerische Elektrotechnische Zeitschrift." Heft 44. 1914.

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COAL AND ORE HANDLING PLANT.

In an article on another page of this issue the subject of "The Electric Crane Applied to the Handling of Coal and Ore" is dealt with. The machines described are installed principally at the ports on the Great Lakes of America, and the conditions under which they work are very severe. In the relatively short time during which the lakes are open to navigation the whole of the coal and ore required for the 12 months has to be transhipped. This necessitates a service working with clocklike regularity at very high pressure. The conditions are such as to demand facilities for the storage of enormous quantities of coal and ore, and appliances have to be provided for the rapid and economical handling of the stored material. Certain of the figures given in the article are very striking, and the remarkable development in recent years is largely due to the introduction of electric plant—notably the electric crane. At Duluth the receipts of coal increased from 2,600,000 tons in 1900 to 9,500,000 in 1914, and the storage capacity of all the docks at this port was increased from 1,000,000 tons to 9,500,000 tons in the same period. In 1909, 26 per cent. of the coal received was handled by electrical energy, and in 1914, 70 per cent. was so handled.

During a test on one of the first electrified plants the trolley made 356 trips in 4 hours 48 minutes. Of these about 40 per cent. were to the first hopper for loading direct into the trucks and about 60 per cent. went back 150 ft. on the storage pile. This gives an average rate of operation of 74 trips per hour, and the maximum rate of operation over one hour was 83 trips, the number being about evenly divided between trips to the hopper and to the pile. The capacity of the bucket averaged a little more than 5 tons and the total weight of coal handled during the test amounted to 2,050 tons. The Brownhoist equipment at the

Pittsburgh Coal Company's Dock, Duluth, unloaded a vessel containing 8,983 tons of lump coal in 10 hours 15 minutes, and another cargo of 8,747 tons of coal was taken out in 10 hours 55 minutes actual working time. Equally remarkable are the results obtained with the Hulett unloader. At Ashtabula, in 1912, during a working day of 20 hours there was unloaded from eight boats a total of 70,000 tons of ore with eight 15-ton unloaders in operation. This ore required 1,319 trucks for its removal, or a truck every 55 seconds as an average. At one of the docks four 15-ton machines unloaded 10,000 tons of ore in four hours.

Since RYERSON and CRANE's Paper was published (THE ELECTRICIAN, Vol. LXIX, p. 136), there has been apparently little development in the coal-handling plants except that there seems a greater tendency now to use continuous-current motors supplied by rotary converters. This type of plant, particularly when a flywheel load equaliser is used, is thought to be economical in so far as the flywheel sets reduce the peak demands. With the first two docks, however, where this equipment was used, it was found that different adjustments of the relays controlling the equaliser-set were necessary when the operating conditions at the docks changed—that is, when one, two or more bridges were at work; otherwise the equaliser-set would not properly cut down the peaks. As fast as the old steam-operated machines wear out their equipments, it is almost a certainty that electrically-operated machines will replace them, and that purchased power will be utilised. Several attempts have been made by the coal companies to obtain co-operation in the building of a central generating station for furnishing power to two or more coal docks located close to each other, but the coal companies have not yet succeeded in demonstrating that such a station could sell its power at as low a cost as it can be purchased from the power company already serving the district.

There is one other type of equipment, not described in Mr. BROUGHTON's article, in use at Duluth, in which the bucket discharges the load into a hopper at the edge of the dock, from which point the coal is carried across the dock by a travelling belt conveyor, discharging at any point required; but from the results so far obtained it is doubtful whether the experiment will be repeated. Fixed or movable high-speed hoists having inclined cantilever extensions out over the dock are also used. As a rule these hoists have two independent lifting mechanisms, each capable of hoisting about $1\frac{1}{4}$ tons of coal per lift, or 100 tons per hour. For smaller outputs there are several different equipments giving satisfactory service. Of these, the Hunt system of movable elevators and cable railway was fully described and illustrated in these columns some years ago. The transporter devised by TEMPERLEY is another well-known and deservedly popular equipment for the rapid and economical handling of coal and ore. It is well for our readers to remember that by paying attention to the handling of raw and finished materials the steel makers of the United States have been able to overcome many of the disadvantages under which they laboured and to find for their products markets which would otherwise have been closed to them.

REVIEWS.

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The Principles and Practice of Electrical Engineering. By A. GRAY. (London: Hill Publishing Co.) Pp. xix. + 391. 12s. 6d. net.

With the number of new text books multiplying so rapidly as at the present time it is seldom that one finds a book that shows individuality in the method of treatment. As the author points out in his preface, there are many students who are taking civil, mechanical and mining courses and who have only a limited time at their disposal for the study of the subject of electrical engineering. For these men and others who require a book that covers the broad principles of the subject without entering into unnecessary details, this book will certainly prove to be of the greatest assistance.

The author has developed a concise style of his own that has enabled a very large field to be covered in a reasonable length, and this result has been facilitated by the device of including in many places groups of diagrams that tell a story of their own and call for a minimum explanation in the text. The diagrams throughout the book are a model of clearness and much thought has been expended on them, and the common mistake of including numbers of views out of makers' catalogues has been avoided. Wherever external views have been included they are associated with explanatory diagrams of connections showing the various parts of the apparatus in positions corresponding to those which they occupy in the photographic views.

For those who wish to make a detailed study of the subjects referred to, reference to special text books or the aid of teachers will be desirable, as hardly any reference is made to the design of apparatus, and the greatest stress has been laid on practical applications, limiting the discussion of principles to the strict minimum consistent with the understanding of such applications. Mathematics have been kept in the background, but in some cases the avoidance of even simple algebraic treatment in favour of verbal explanation has been followed too strictly, with the result that some of the arguments are open to criticism. The following few instances have been selected as examples.

In explaining why a shunt generator cannot give more than a certain maximum current, it is stated that, after a given point, a reduction of the external resistance causes an increased current to flow *for an instant*, and that this increase in current reacts by armature reaction on the voltage in such a manner that the current cannot be maintained. Again, in the discussion of the action of balancers supplying an unbalanced load, it is stated that one machine *tries to* run faster and the other *tries to* run slower, with the result that one acts as a generator and the other acts as a motor.

In other cases the avoidance of algebraical calculation has even led to an arrival at incorrect conclusions. The action of an equaliser in enabling a correct division of load to be effected with compound generators running in parallel is based on the mis-statement that when one machine increases in speed momentarily *the total load is unchanged*, and so part of this load is automatically thrown on the machine with the higher voltage. An algebraical solution would have shown that when such a change of speed takes place the external current would, in fact, be affected thereby.

Turning now to the action of the Entz reversible booster, in which the exciter field of resistance r is connected as a bridge across the junction of two resistances, r_1 and r_2, and the junction of two E.M.F.s, e_1 and e_2, the incorrect statement appears that the current in the field winding r is the difference between the currents $\frac{e_1}{r_1}$ and $\frac{e_2}{r_2}$.

Difficulties of the above kinds are bound to present themselves when attempting to discuss without mathematics the interconnection of variables that are connected by simultaneous relations, and the above have been selected to show that, with the best intentions to spare the student, there are

times when it is necessary to inflict a certain amount of mathematics on him.

Among minor inaccuracies it may be noted that Figs. 72A and 72B should be interchanged, and that in Fig. 404 the lightning arresters should be connected on the line side of the protecting choke coils, instead of on the station side, as shown, and that on page 256 the maximum output and the breakdown point of a synchronous motor have been confused.

A useful conclusion to the book consists in a chapter containing short instructions for the carrying out of 20 typical laboratory experiments, with the addition of a number of suggestive questions arising from them. A. J. M.

The Theory of Alternating Currents. By ALEXANDER RUSSELL, M.A., D.Sc. Vol. I. Second Edition. (Cambridge: University Press.) Pp. xiv. + 534. 15s. net.

Since the first edition of Dr. Russell's work was published 10 years ago the rapid development of wireless telegraphy theory has called for greater attention to the theory of high-frequency currents, whilst with the increase of transmission voltages more light has been thrown on some of the obscure resonance effects in high-tension networks. In this edition four chapters have accordingly been added dealing with these problems; in the older chapters a certain amount has been added, but the alterations here are comparatively slight.

In general the book may be termed a veritable "Golden Treasury" of formulæ and results in mathematical electricity, but it must be added that Dr. Russell's treatment is at times apt to be more mathematical than seems strictly necessary, when one considers that the average student of electricity has attained a standard of mathematics by no means high.

Besides the original investigations embodied in the text, we have evidence of the author's wonderfully complete knowledge of the work of others, and the references are conveniently arranged at the end of each chapter.

With regard to the actual subject matter, little need be said in respect of the older chapters, but of the new matter possibly the most useful and interesting is a full discussion of the problem of two spherical electrodes, solved by Poisson and Kelvin; these solutions were of little use in practice, but Dr. Russell has succeeded in evolving convenient working formulæ which, combined with the tables given, enable the capacity of spark gaps and the "break-down" P.D. to be calculated with ease; such data are particularly valuable in high voltage work. Another useful feature is the collection of values of Bessel functions needed for calculations in connection with the "skin effect," the theory being given both for parallel and concentric conductors. In the sections more immediately concerned with wireless telegraphy problems, we find a discussion of the effective capacity of horizontal antennæ, and of the amplitude of the oscillations in two coupled circuits.

A criticism which may, perhaps, be made on the book as a whole is that it is a little difficult to define the class of student to whom it would be useful; the class is necessarily limited by the fact that considerable mathematical knowledge is required, and some of the problems considered lie in the domain of the physicist rather than in that of the engineer. On the other hand, such considerations as polyphase meters and the like are essentially for the commercial electrician, who in turn would hardly concern himself with a model of a polyphase cable. But a class to whom the book would be invaluable is that of research student, for the formulæ and references are so wide in scope and so carefully chosen that guidance is given on most problems with which such a student would deal.

F. J. DYKES.

THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

On Friday, the 16th inst., the Tramways and Light Railways Association held their eighteenth ordinary general meeting and seventh annual congress. Owing to the war the attendance was very small, and the weather was by no means propitious, so that the meeting differed very considerably from the enjoyable gatherings which have become associated with this Association, and which are always held in the provinces, where business and pleasure can be more easily mingled. Owing to the present abnormal conditions, it was decided to hold this year's congress in London, at the Institution of Civil Engineers, and the programme was confined to a meeting extending over a single morning, followed by an informal dinner in the evening.

The chair was taken by the chairman of the Association, the Hon. Arthur Stanley, M.P., who extended a hearty welcome to visitors, and then proceeded to deal briefly with the affairs of the Association. With regard to finance, the past year's revenue from subscriptions was £832 (against £805 in previous year). Expenditure was £822 (against £657), the increase being due to special expenditure which would not have been incurred if they had foreseen the war. Three of the earliest members had died, Mr. Thos. Holliday (Hastings), and Mr. Gordon and Mr. Tresilian (Dublin). The last mentioned was on the Council at the time of his death. He desired to express the sympathy of the Association with their relatives. He thought the Association had done useful work for the tramway industry during the past year. They had given evidence before the Local Government Board on questions relating to the maintenance of tramway tracks. One of their committees had prepared and submitted a report on tramway controllers which had been sent to the Board of Trade who had acknowledged their receipt. The Council had been considering the question of approaching the Munitions Department in view of the serious situation which had arisen owing to the restriction of output and the difficulty of transport of materials essential to the tramway service, with a request that the Minister of Munitions be requested to receive a deputation from the Association at an early date. Tramwaymen all over the country were assisting in the war, and a very large percentage of them had joined the colours.

The retiring members of the Council were Messrs. F. Coutts, E. H. Edwardes, A. L. C. Fell, H. F. Parshall, Wm. Thom and (last but not least) C. G. Tegetmeier. He thanked them for the assistance they had given the Association, and hoped to see them back before long. The vacancy caused by the death of Mr. Tresilian necessitated seven elections, and the council recommended the election of Messrs. J. B. Tippets (member of the British Electrical Federation), E. L. Hatton (Newcastle), H. L. White (Grimsby), C. D. Stanley (St. Helens), W. G. Burdon Smith (Bristol), James Devonshire (Metropolitan and London United Tramways) and W. T. Robson (Southampton Corporation Tramways).

The Chairman moved that the report and accounts for the year ended Dec. 31, 1914, be approved, and that the seven gentlemen above mentioned be elected members of the Council. Both resolutions were carried.

GLIMPSES INTO THE OBVIOUS.

At the conclusion of the business meeting the chair was vacated by Mr. Stanley and was taken by the vice-chairman, Mr. Harry England, and after a short interval the meeting proceeded to the technical business, which consisted of the reading and discussion of three Papers. The first of these was by Mr. A. V. Mason, general manager of the South Metropolitan Electric Tramways, who explained that he had written his Paper rather as a stop-gap than as anything else, and had originally entitled it "Rambles Around Tramways." The secretary, however, had altered the title into "Glimpses into the Obvious," and Mr. Mason thought there was no objection to a Paper of this kind, as it was very often the obvious that was missed. The Paper dealt with a number of details connected with traffic, such as the use of bell punches, point numbers, inspectors, the fixing of fares and kindred matters. The opinion was expressed that many accidents would be avoided if passengers, when merely in ones and twos, would pay their fares on entering, so that the conductor might remain more upon the platform. Mr. Mason also expressed the

view that it was a good policy to have half fares for children, and, in his opinion, the workman received better treatment than the shop assistant and regular rider as regards fares. In the concluding part of his Paper the author dealt with discipline, free travelling by members of the staff, seniority and other details, and as a sort of appendix to his Paper he gave 30 bread-and-butter tips. Among these we notice that the author "won't waste time over meters." He has tried a bonus system with good results for keeping down consumption, paying 1s. per week to every motorman who keeps below the prescribed limit.

The Paper was followed by quite an animated discussion, in which the "spare list" figured largely. Some members took the view that men on the spare list were always a difficulty owing to the fact that they were liable not to get sufficient work; consequently, such a man only gained about 15s. per week, on which amount he could not be expected to remain honest. Other members expressed the opinion that if the spare list were properly proportioned the men could always be kept reasonably at work, and might even gain more than the regular men. There was less difficulty in such matters in a large undertaking than in a small one, and this remark also applied to the question of inspectors. In a large undertaking there were always a few men who were very much above the others, and might be selected for this work with the assurance that the work would be done properly and not in collusion with those they were supposed to supervise. At Sheffield retired army men had been used for inspecting, and this had been found to be a satisfactory method of getting the class of men that was required.

Mr. R. J. HOWLEY, of Gateshead, stated that pay-as-you-enter cars had been used at Gateshead with satisfactory results, except at termini, where the number of passengers entering was too large to be dealt with in this way; consequently at the termini it was necessary to deal with the passengers in the ordinary way, but the pay-as-you-enter principle was used on the remainder of the route, and the result had been that there were less accidents. He was of opinion that high speeds would necessarily entail power brakes, and if these were introduced at all they might lead to the demand for their universal use.

Mr. C. D. STANLEY stated that high speed was desirable, but if this speed was raised above a certain figure the costs ran up enormously; for example, at points and crossings.

Mr. C. J. SPENCER, of Bradford, made some interesting remarks in regard to the affect of the war. The greatest difficulty was the drain of skilled mechanics through enlistment, and this might lead to the curtailment of services. On the other hand, he understood from the Government that a tram service must not be stopped so long as it carried munition workers. He was now trying to get definite recognition from the Government for the men working those tramways, and who were as necessary as the men who were making shells. There was a great likelihood that the Government would grant war badges to tramway men in towns where munitions were manufactured.

Mr. ENGLAND then proposed a vote of thanks to Mr. Mason (which was carried), and added (in reference to the Paper) a remark that he thought that money could be saved by painting cars more cheaply.

TRAMWAYS DURING WAR TIME.

The second Paper was by Mr. J. W. Dugdale, and was entitled "Tramways During War Time." In this Paper the author dealt with the effect which the war is having upon tramway undertakings. One effect was that large sums of money were being paid weekly for the dependents of those away on active service. Thus, the cost on this account at the present time to the London County Council was £1,568, to Glasgow £1,000, to Liverpool £520, and to Manchester £1,360. It would have been better for this subject to have been a matter of discussion between representatives of municipal and company owned tramways so as to arrive at a uniform method of dealing with such grants. In the case of local authorities it would have been better for war grants to be distributed amongst all the departments on some pro rata basis. The positions of those who had volunteered had been taken by poorly trained men, with results which were to some extent unsatisfactory. Thus, in Oldham the hasty training of these men had entailed an increase in the bill for electric energy by as much as £20 per week for a considerably less mileage. There had been a certain transfer of labour from the less well paid to the better paid tramways in the country. Although a certain amount of munitions work could be done by tramways it could only be done efficiently by the largest undertakings. It should also be borne in mind that tramway concerns were now handicapped in obtaining quick delivery of material, such as car wheels, axles, tyres, &c. Owing to the fact that many undertakings had down rails in the year 1900 a great rush for tram rails might be expected in the near future, and the prices were likely to rise this matter should be kept in mind.

In the discussion of this Paper, Mr. C. D. STANLEY said if Mr. Dugdale was able to get steel tyres at 50 per cent. increase he was lucky. He (Mr. Stanley) could not get an order accepted on these terms. He doubted whether leaving over repairs of track was a measure of economy. High speeds were bad for car maintenance, but bad track was even worse. He took it that any Government recognition of tramway men would be given to men on tramways carrying not only munition workers, but also other things necessary in connection with munitions work.

Mr. MASON thought that the men remaining at work should subscribe something in support of the dependents of those who had gone to the front. He found that the men were not unwilling to do this and to subscribe, say, 1 per cent. of their wages for this purpose.

Mr. C. G. TEGETMEIER expressed the view that if grants were made in addition to War Office allowances wives might find themselves much better off in war time than during peace, and that there would be subsequent trouble on this account.

After some further discussion, the Chairman mentioned that the Council had been considering the question of war badges, and the retaining of men to a sufficient extent to keep the undertakings running. The Council had not come to any decision as to whether they should approach the Government and ask for badges for motormen and conductors, but they had decided to ask for badges for their skilled men in the power stations and sub-stations.

Mr. JAMES DEVONSHIRE said they had been able to arrange in London with the Ministry of Munitions that men engaged on certain services would be regarded as essential for the particular undertaking, and the Government would enter into an undertaking not to remove them or to attract them away by higher wages. In the Metropolitan Electric Tramways, the London United Tramways and Mr. Mason's company (the South Metropolitan) they had forms on which the men's names were enrolled, and they stamped them "On public utility service." The London United had agreed to give up to the Ministry the whole of their Chiswick shops for the manufacture of munitions of war, and the shops of the Metropolitan Electric Tramways would deal with the repairs of the London United. The two systems were not physically connected, and as it would be easier to deal with the repairs if the cars could be brought over the rails they had asked the Board of Trade to use their good offices with the local authority in whose district the connecting line would be situated, and who had made their terms for allowing its construction so high as to be tantamount to refusal. The local authority had now agreed to the track being laid provided no passengers were carried, which was unfortunate, as passengers were sometimes munition workers. With regard to badges, he had got a verbal agreement, which he hoped to get confirmed in writing, that all the men employed on the tramways should be regarded as just as much munition workers as the men employed at Chiswick, and that they would all be given a button or badge which would satisfy them. With regard to motormen and conductors, they thought it would be well to get recognition for them, but the munitions question must come first. They had on their system the Enfield Small Arms Factory, and ran special cars day and night to carry the workers. Therefore, it was essential that the motormen and conductors—or at any rate a certain percentage of them—should be recognised in the same way as munition workers.

Mr. G. CHIVERS thought that something should be done to facilitate the introduction of female labour.

Ald. RODGERS objected to including drivers and conductors in the class of munition workers.

Mr. HARRY ENGLAND said he would take the sense of the congress on the badge question. It was proposed that the exemption should be obtained for the skilled men, but not for motormen and conductors.

This resolution having been carried, Mr. England said they would take action accordingly.

A vote of thanks to Mr. Dugdale was then passed.

Mr. W. H. L. WATSON then read his Paper on "Battery Vehicles as an Adjunct to Tramways," an abstract of which is given below.

BATTERY VEHICLES AS AN ADJUNCT TO TRAMWAYS.

BY W. H. L. WATSON.

After dealing briefly with the history of the subject, the author refers to the ordinary lead cell with flat plates, the iron clad exide and the Edison cell. The time available only permits a discussion of the performance of each type, expressed in mileage and money. The following table will show the desired information, and it will be for those interested to decide whether it is better to pay a smaller

initial cost with a heavy maintenance charge or a heavier sum with a proportionate saving in these later expenses :—

Comparison between Three Different Types of Batteries of 150 165 Ampere-hour Capacity.

	Kw.-hours.	List price.
150 ampere-hour flat plate	11-12	£85
150 ampere-hour iron-exide battery	11-12	£150
150 ampere-hour Edison nickel-iron	11-12	£216

Total Cost of Operation over 60,000 *miles service.*

	Lead.	Iron-exide.	Edison.
Guaranteed mileage	Nil.	18,000 to 20,000	60,000
Plate maintenance	1½d. per mile	...	...
Fair mileage to expect	6,000	20,000	150,000
Original cost	£85 0	£150	£216
Plate maintenance for 54,000 miles at 1½d.	337 10	...	...
Renewal of plates at 70 per cent. of original cost (£105) × 2, representing 40,000 miles	...	£210	...
Plate maintenance	...	...	Nil.
Total cost of battery at completion of 60,000 miles	£422 10	£360	£216

In such a town as Morecambe (Lancashire), where the conduit system of tramways is barred owing to the possibility of interference of service by incursion of the sea, not to mention the high cost of such an installation, and where the overhead system is regarded as a menace to the scenic surroundings, the battery tram will be of great service. Horse trams have operated successfully for many years. With the advance of time electric traction has been seriously discussed, with the result that a scheme for installing battery-driven trams was considered, whereby a capital expenditure of, approximately, £18,000 was involved for the installation of 12 56-passenger, double-deck trams, and the necessary depot complete with charging equipment and the extension of mains. The running costs were guaranteed not to exceed 5½d. per car-mile, covering writing-off of capital, labour and all running charges. If this installation is made it will be the first of its kind in this country, but there are existing trams working on this principle in the United States. It is interesting to note that battery-rail cars, capable of carrying 40 passengers with a total weight of 15 tons, average a current consumption of 600 watt-hours per car-mile ; maximum speed 30 miles per hour ; miles per charge of battery, 100.

The battery omnibus will probably prove to be the more popular method of building up routes, prior to the extension of a full tramway service, owing to its cheaper installation and greater mobility. These 'buses are already installed in Southend, South Shields, York, West Bromwich and Loughborough. In the first three instances the results have been very gratifying, the vehicles not only having given a highly satisfactory service, but the low running costs expected have been proved conclusively. At Southend-on-Sea, where one battery-driven 'bus was installed to run on equal terms with a fleet of petrol and petrol-electric 'buses, a saving of 2d. per mile, plus ½d. profit to the electricity department, making a net saving of 2½d. per mile, has been shown in favour of the battery vehicle.

At South Shields I find that the current consumption per mile varies between 1·63 and 2·10 units, the variation being specially noticeable owing to the road surface conditions encountered and variable weather. The maintenance charges have proved very slight, and with such low average weekly revenue as 5·92d. the service covers expenses.

At York Mr. Hame announces that the four Edison 'buses have run 13,600 miles with an overall energy consumption of 1·1 units per mile.

The ideal method of employing these vehicles is to fix a terminus at which point the vehicle awaits passengers for a few minutes. Here current can be taken at a high rate of input. The time taken to replace sufficient current (at six times the normal rate) to cover 1 mile of even road surface being 1½ minutes. Therefore, a stay of 12 minutes will in many cases replace sufficient current to cover the next part of a journey. At Southend on Sea it is the infrequent occurrence for the battery 'bus to return to its garage at night with no more than 40 ampere-hours used out of a total capacity of 300 ampere-hours after a day's journey of 100 miles. Where "boosting" by direct current to arrive at a larger size battery may be necessary, but a mileage per day of 120 to 150 miles could easily be accomplished, providing the district is not of an extremely hilly nature. Upon hills the vehicle proceeds at a reduced pace, and where considerable gradients are met this is sometimes reduced to little more than a crawl. It should be appreciated, however, that it is possible to run 'buses under these conditions at a running cost which will render light services profitable, or at least self-supporting, whereas either petrol or petrol-electric 'buses would prove uncommercial. The "electric" has been developed to travel at a useful speed under the most economic conditions. It is a peculiarity of the vehicle that when under way it appears to be journeying at a much slower speed than the mileage really registered. Including stops, it has been found capable of averaging a speed of 7½ miles per hour. This compares very favourably with the London 'bus, whose average rate of travel is approximately 8 miles per hour. For country service high speed is not essential.

Where the district is so scattered that a vehicle becomes a matter of necessity to the manager when doing his round of inspection, an electric coadster or coupé seems an ideal car to suit his purpose. Such a car has been in the service of Mr. A. C. Cramb, borough electrical engineer of Croydon, which does an average service of 24 miles per day. The total cost per mile, on the basis of 5,000 miles per annum, is 5·785d.* Mr. Cramb has only given the battery credit for a life of five years, which in total amounts to 36,000 miles ; whereas under more stringent conditions the suppliers of the battery guarantee full-rated capacity at the completion of 60,000 miles, which, under these conditions, cover at least 10 years' service. But for the condition of the country during the past year a new vehicle would have been placed upon the market suited for the conveyance of members of the staff on their duties. This vehicle is designed on very light lines similar to the petrol cycle-cars, which have become so popular. It is believed that such a vehicle would find much favour as a means of conveying inspectors, also for the collection of coppers, distribution of tickets, &c. This vehicle, it is hoped, will not exceed a cost of £300. Upon a similar chassis will be mounted a trade body of the box variety. This has been specially designed for the use of tramways departments in connection with their parcel delivery service. Here, again, low price has been given the utmost consideration—initial cost will be approximately £270. So great will be the advantage of such a vehicle to parcel delivery services that it seems likely a number will be employed once the low running costs have been suitably demonstrated. Assuming that an average mileage of 30 miles per day is accomplished during 300 days per annum, and current can be obtained at 1d. per unit, including current, maintenance, tyres, insurance, depreciation (seven years) and interest at an average rate of 5 per cent., the total running costs will not exceed 2½d. per mile.

The tramway departments of Ilford, Derby and Belfast employ battery-driven tower wagons, each of which amply satisfy their requirements. These vehicles have a speed of from 11 to 12 miles per hour, which is generally found sufficient for the traffic to be negotiated. When out of service the opportunity is seized to revive the battery. The mileage available per charge is from 40 to 45 miles, which has proved more than sufficient for a day's work. As an illustration of the benefit of these vehicles, the following extract from an article written by Mr. L. E. Harvey, tramways manager to the Ilford Urban District Council, whose Edison electric tower wagon has now been in service for 12 months, is interesting :—

"This tower wagon, designed by Mr. Harvey, was purchased on the basis of tenders which showed lower all-round costs in comparison with petrol and steam vehicles. In actual practice the electric vehicle has improved upon the estimates.

"The running costs are very low, being only a little over one unit per mile, although the wagon weighs about 3 tons when loaded with its equipment of tools. Maintenance costs have been zero, except for a little distilled water at intervals to make up for evaporation. The vehicle is, in fact, running better than ever. So far there is no sign of wear on the tyres.

"Any ordinary workman can drive the vehicle. Several of the depot hands are licensed, so that there is not a moment's delay in getting the vehicle out on repair work.

"The absence of a bonnet enables the vehicle to be driven close up to the pole where repairs have to be carried out. With petrol wagons manœuvring backwards and forwards had always to be done to get the platform in position. For pole to pole inspection the electric vehicle is a great time-saver.

"Another advantage is that electric light is available. Flare lamps are exceedingly troublesome in windy weather, and are at all times less convenient than the cluster of electric lamps, which can be hung on the wires or fixed to the rail of the platform.

"Everything being electrical, any repair work can be carried out by the depot staff. There is no need to have men specially acquainted with petrol engines ; neither is there any nuisance with storing petrol."

Supplementing Mr. Harvey's statement, the battery will provide current for operating electric drills, saws and riveters for bonding, and any other small tools in which either power or heat are required.

* For details, see the report, THE ELECTRICIAN, Vol. LXXV., p. 379.

The immense advantage to the testing engineer of having a large capacity battery at 70 volts available at any section or feeder pillar for testing purposes during times when the network is dead will be easily realised.

For maintenance of the track and road repairs, vehicles of 2 or 3 tons carrying capacity would be of great general utility. For carrying materials such as pillars, sets and other weighty equipment required on permanent tracks or extensions this vehicle will do all that is required, and by provision of an interchangeable tank body of 500 gallons capacity a further field of usefulness will be provided for watering at any time when current is not available. This same vehicle has been utilised for carrying and drawing in cables into the ducts. It may sometimes be found useful for removing cars from a section where a breakdown has occurred, thus releasing the vehicle to proceed with its curtailed journey.

Mr. WATSON added that they did not propose to employ battery vehicles for big services for which tramways were suitable. They would be of no use there, but they were useful for communicating with small villages where there had been no means of transit. He had been confirmed in that opinion since he had been to Yorkshire recently discussing the question with various municipalities. In districts such as he had described the people wanted a lift—it might be 2½ miles—and do long as they go, it they were not particular about doing it in the fastest time. These battery vehicles were low in average running costs, and they would be suitable for services such as he had mentioned. He expressed the opinion that the other methods proposed would be heavy financial failures.

DISCUSSION.

Mr. W. T. ROBSON (Southampton), in opening the discussion, said his experience of battery vehicles (at South Shields) was very satisfactory. On gradients of 1 in 6 or 1 in 8 the 'bus went up with equal speed to that of petrol buses, but it would not hang for gradient of 1 in 20 that the speed was too low. On flat country the battery 'bus was exceedingly nice, and the speed was fast enough. The passengers also liked the freedom from smell and noise. He had no trouble with maintenance work. By a system of numbering the switches the charging could be done by unskilled men. On the system referred to they were one-man vehicles, and that reduced the running costs. The boosting was also carried out by the motormen by means of numbered switches. The only maintenance necessary was the cleaning up of the controller contacts and the filling up of the batteries with distilled water about twice a week. During the 10 months he controlled them they never had to clear a commutator. It might, perhaps, be possible to have a switch which would insert extra cells when going up a gradient. The initial cost of the vehicles was much too high, and he hoped it would be reduced. Unless that were done he did not think the electric 'bus would take the place of the petrol 'bus as an adjunct to tramways.

Mr. HARVEY said his electric tower wagon had never given him trouble; it was used not only for overhead wires, but for hauling 60 lb. rails about. There had been no expense for maintenance except the distilled water. The cost was £675. It ran about 10 to 12 miles an hour, which he thought ample.

Mr. WYLD said he had given attention to battery vehicles for removal of dust and refuse. With an Edison battery vehicle they were able to do for 19s. 6d. what had cost 35s. with horses. He could not say much about it from a tramway point of view.

Mr. E. L. HATTON said no doubt such vehicles would have great uses, but it would probably be for odd jobs and not for omnibus services.

Mr. WATSON (in reply) said they had made experiments with change-speed gear for use on gradients, but this had not yet been very successful. The effect was not increase of speed, but reduction of current consumption. On a short hill at Southend (350 yds.) the petrol buses were not allowed to stop at the foot, as they frequently rolled back, but the electric bus stopped and picked up passengers on that hill, and went on again. With regard to switching in extra cells, the disadvantage was that the batteries would not be equally discharged for charging. It was desired to get managers of undertakings to take battery vehicles, owing to the price, but when they did they were well satisfied. [illegible] company (including Lord Harmsworth and the Mediterranean Trading Co.) were using the vehicles, and were well satisfied. His managing director had decided that it was impossible to continue the tramways at Halifax, the town being too hilly. It was not for they to ask gentlemen to use battery [illegible] which he was not confident that they would be successful. The present Halifax 28-passenger 'buses sometimes carried 50 people. This could not be done by battery vehicles; the limit would be 30 or 35 passengers.

A vote of thanks to Mr. Watson having been passed, the Chairman said, in reply to Mr. ROBSON, the Association had approached the Minister of Munitions to give them facilities for the manufacture and delivery of any materials required for tramways, and also facilities for transport. That would be pressed, particularly regarding places where it was difficult to obtain steel tyres. Some systems had plenty of tyres on order, but they might not be delivered. They must press the Government for facilities for obtaining what were on order. Undertakers who had Provisional Orders or Acts and who required extensions of time should communicate with the Association. The Council had asked the Board of Trade to pass one Act to cover all the tramway undertakings and so save expense.

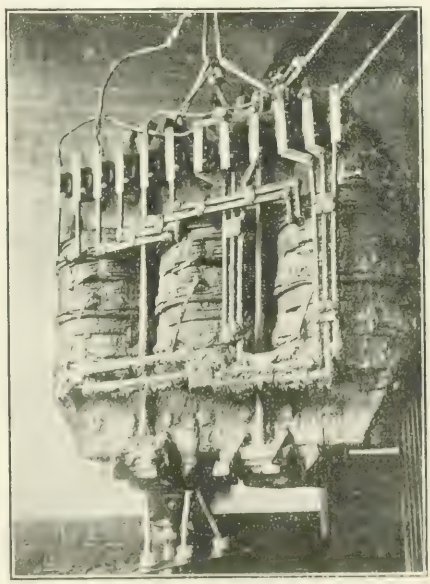
A vote of thanks to Mr. England closed the proceedings.

CORRESPONDENCE.

THE NEED FOR NON-SLUDGING OIL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may interest some of your readers to see the enclosed photograph of a 380-k.v.a. three-phase oil-cooled Westinghouse transformer. This transformer has been in use since the year 1909, and for the past two years it has been run at



[illegible]

full load for between 12 and 13 hours per day. During this time it has transformed approximately 7,000,000 units. The oil used was the ordinary yellow transformer oil and it has not been changed since the transformer was originally put to work. Records have been kept and that the temperature rise of the transformer was measured and an observation was made, with the result shown in the photograph.

A full load test was carried out and the transformer was cleaned and a temperature rise of the top at the end of 102° F.; after cleaning and filling with fresh oil, the temperature rise under the same conditions was only 84° F.

It seems safe to say that this is one of the instruments that has stood up to full load duty for so many hours a day without becoming overheated and damaged.

Our experience with other transformers is that when filled

cyl. the ordinary yellow transformer oil and run at approximately full load, sludging takes place in about two to three years, sufficient to necessitate the oil being changed.

For some time now we have been using nothing but the white non-sludging transformer oil, and this is giving excellent results. This oil is, of course, more expensive than the ordinary yellow oil, and we find it difficult to convince some of our consumers that the extra cost is fully justified both in prolonging the life of the transformer, in obviating the necessity for taking it out of service whilst the oil is being changed, and in saving the cost of replacing the cheaper type of oil after three or four years.

I hope that the object lesson of this particular transformer will enable other supply station engineers to convince their consumers that the cheapest in this case is certainly the dearest in the long run.—I am, &c.,

R. A. CHATTOCK,
City Electrical Engineer and Manager.

Birmingham, July 14.

ELECTRICAL PRECIPITATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with the two abstracts appearing in your issue of July 16th dealing with "Electrical Precipitation," it might be of interest to you to learn that about 10 years ago the late Mr. B. H. Thwaite took up this subject with a view to its application for the purification of blast furnace gases. A number of experiments, in which my firm was associated with him, were carried out on some furnaces on the north-east coast, employing alternatively high-frequency high-tension discharges and ordinary static high-tension discharges. Neither of these experiments was a commercial success: the efficiency of the high-frequency discharge was low, and the maintenance of the mechanical interrupters employed was difficult.

The static discharge was produced by means of a large Wimshurst machine of Mr. Thwaite's own design, which, although it showed mechanical features of considerable merit, could not be termed a practical piece of apparatus, a disqualification which all static machines have in common.

High-tension mechanical rectifiers, though they mark great progress in the means of obtaining a unidirectional high-tension discharge, are not likely to satisfy the essential conditions of robustness and simplicity of design, and I quite agree with the view expressed in your leading article that some form of vacuum rectifier, such as the Kenotron, will ultimately realise the practical requirements of electrical precipitation.

After all, however, the "vacuum valves" employed by Sir Oliver Lodge many years ago, and demonstrated by him on the occasion of his Royal Institution discourse on "A Persistent Current," were certainly the forerunners of those vacuum rectifiers which recent researches on thermionic currents have placed in our hands.—I am, &c.,

London, July 16. A. W. ISENTHAL.

LEGAL INTELLIGENCE.

Hamilton v. Marconi's Wireless Telegraph Co. (Ltd.)

The action came before Mr. Verey, Official Referee, last week, having been remitted for inquiry as to damages on a verdict by a special jury in plaintiff's favour.

Mr. [illegible], K.C., and Mr. Eustace Hills appeared for plaintiff, and Mr. Leonard Pollock, K.C., with Mr. Stewart Bevan, for defendants.

Mr. [illegible], K.C., said that for some years prior to 1910 plaintiff was engaged in wireless telegraphy in Australia and the South Pacific, and in that year he entered into an agreement with defendants to [illegible] certain purposes and upon certain terms. By 1913 plaintiff alleged that defendants had failed to carry out the agreement and essentially disregarded [illegible] and he claimed £50 a month as a retainer, certain remuneration, damages and an account. [illegible] damages. But [illegible] and for the purpose of the matter, because on March 24, 1914 (about a year before the verdict) an order had been made by the Master in Chambers directing that all matters of account, &c., should stand over until after the trial of the action. These matters were not, therefore, submitted to the jury, but the taking of the accounts was directed. What remained were the questions which the verdict of the jury did not cover, and the matter was not quite simple, owing to the difficulties which plaintiff had experienced in obtaining discovery of documents from defendants. The discovery was still incomplete. The agreement between the parties as contained in a letter dated May 11, 1910, addressed to plaintiff by the deputy manager of defendant company, in which he said that the company accepted his services as sole agent for the Colonies and various places abroad. It was understood that the agency should date from the date of that letter, and continue for three years, subject to determination in May, 1911, by either party. It was also stipulated that should the result of the business prove satisfactory the engagement should be for three years certain, with the option of continuing it for another three years. In consideration of plaintiff agreeing to devote his whole time to the service of the company he was to receive a commission of 5 per cent. on the gross value of all contracts within the area mentioned, and it was agreed in the case of shipping contracts that a sum of £10 per ship should be paid in addition to 5 per cent. on the amount of subsidy paid by the shipowners to the company. All payments in respect of commission were to become due as received by the comapny and the £10 per ship was to be paid at the date when the contract was signed by the company. Defendants also agreed to pay £50 a month as a contribution towards plaintiff's expenses, and in the event of the grouping of the Pacific Radio Co. he was to be offered the position of managing director in that company. Then the plaintiff said that he had conducted negotiations and had rendered services in procuring business in South Africa, and asked that an account should be taken of all sales that had taken place within that district, and for payment of 5 per cent. on the gross value of all sales in South Africa. Plaintiff was summarily dismissed by defendants in January, 1913, and he was dismissed upon what the jury had found to be an insufficient pretext, that he was doing other work. In 1912 defendants made arrangements to join forces with the Australian Wireless Co. That was to be done by the creation of a new company to take over the business of the Australian Wireless Co. and the business of defendant company in Australia and New Zealand. That arrangement having been made, defendant had found occasion to dispense with the services of plaintiff, by which he was deprived of two things, one of which was the prospect of a renewal of his agreement for three years further and of his commission. The verdict of the jury had left undecided the 5 per cent. on the gross value of sales effected, the payments on the shipping contracts of the £10 per ship, and the 5 per cent. commission on the payment by the shipping company. Another matter connected with the business in South Africa was that, on or about Oct. 23, 1911, it was agreed, through Mr. Godfrey Isaacs, the managing director, that plaintiff's authority should be extended so as to include South Africa, and the jury had decided that question in favour of plaintiff. Counsel then dealt with the sale of two high-power stations to the British Government by defendant company. Those high-power stations were in connection with what was intended to be an Imperial chain of wireless stations, one of them at Singapore and the other at Pretoria, and plaintiff said that those sales were within his territory, according to the finding of the jury, and that they were effected at the time the contract of sale was made. What happened there was that defendants undoubtedly did not receive payment for those stations under the contract made at the time, and the reason why they did not had become a matter of history. Speaking generally, defendant company repudiated that contract, but plaintiff had performed his part. The contract was made on July 19, 1912. Each station was to cost £60,000, and defendants were to have 10 per cent. royalty on the gross receipts for 18 years. What these royalties might be expected to be was a matter of calculation. On the whole six stations the royalties were estimated at something between £4,000 and £30,000 a year. Even if the smaller figure were taken, and assuming that the two stations would be no more than the average, each giving a sixth of the whole, they might be expected to yield £1,300 a year, which for a period of 18 years would give £23,400. The royalties were only a deferred part of the purchase price of the stations. The contract was not performed and the stations were not erected, for the reason that defendant repudiated the contract, in circumstances that were well known to all. But plaintiff had nothing to do with that. Afterwards, when a calmer atmosphere prevailed, a similar contract was made. Plaintiff said that he did his part and was entitled to his commission, notwithstanding the fact that defendants did not carry out the contract.

The plaintiff gave evidence in corroboration of counsel's statement. He claimed for any business done by the Marconi Company within his territory at any time. As to the limit of time over which he would continue his claim, witness thought he could make them during the whole of his life, as, when he joined the Marconi Company, he took over to them all his business and all his friends. He could not say whether an installation set up which was within the Admiralty agreement of 1903 would come within his agreement, as this question had yet to be decided. The Australian fleet belonged to Australia, but the New Zealand ship became a branch of the British Navy. It depended upon the agreement made between the Marconi Company and the Admiralty whether the [illegible] would receive royalties. He would expect to be paid on the value of the apparatus supplied. [illegible] Admiralty was fitting up ships with wireless installations, but at the time there was no Australian Navy, and he claimed to have been instru-

mental in introducing wireless telegraphy to the Australian Government, and the negotiations in regard to it extended over a long time.

Mr. Pollock, K.C., for defendant company, said that from plaintiff's documents his claim now reached something over £13,000, and it might be that some other sums had to be added, so that very heavy liabilities on the part of defendants were involved. Defendants had been found by the jury in the King's Bench to have committed a breach of their agreement with plaintiff, who had been awarded damages. But his story now was that, in addition to the two or three thousand pounds awarded by the verdict of the jury, he was entitled to ask for a further sum of something over £13,000 under the agreement for work done during the period between August, 1910, and March, 1911, and that that entitled him to £13,000 beyond the amount awarded by the jury, and that he was further entitled for the rest of his natural life to receive commission upon payments made to the company for this work. It was argued for the plaintiff that there was no time limit. For the defence he (counsel) argued that it was quite unnecessary to introduce a time limit, because the agreement contained a margin of time in regard to other matters, and it was for that time alone that defendants were liable to plaintiff. The period of the contract for the installation of ships was 10 years. The system was to hire to the shipping companies the Marconi apparatus, in return for which a subsidy of £250 per annum was paid in most cases for 10 years, and in respect of each ship fitted the plaintiff was to receive £10 and 5 per cent. on the subsidy. That could only be meant to last for the period during which the contract was running. It was not always 10 years; in some it was for three years only. It was necessary to put a time limit in the case of ships, but it was not necessary in the case of the other business. The agreement ran from May 2, 1910, and it was alleged at the trial that from July, 1912, defendants had not properly treated plaintiff by giving him information, and that they dismissed him for causes which were inadequate. The agreement said that it was to last for three years, but it was understood that it should be for a further term of three years in the event of the business being satisfactory. The jury had answered the question as to the damage the plaintiff had sustained by giving him £640 up to May, 1913, and for his chance of renewal £1,700. In the High Court the judge did not put it to the jury whether plaintiff was entitled to commission during his life. The point had not been raised.

Mr. Eustace Hills said that it was more than once stated at the trial that matters of construction, except in one instance, were to be left to the Referee.

Mr. Stuart Bevan said the question of a life long agreement was never raised.

Mr. Pollock (continuing) said that the judge did consider the possibility of a renewal. According to the plaintiff's case, it seemed that they were now only at the beginning of things. The claim to-day was for £13,000, and it was proposed to add all the years of Mr. Hamilton's life to it. If that were allowed, he did not know where the company would be when Mr. Hamilton died. It was not, he contended, possible for Mr. Hamilton to substantiate his claim of £2,751 as commission upon the amalgamation of the German Company with the Australian Company, although he contended that by his agreement he was to get £1,200 a year from it as managing director. As there was no security of tenure in regard to that appointment, the jury had been asked to say what was the value of the plaintiff's expectations in that direction, and they answered by saying that it should be £1,700. The true position was that a contract was made in 1903 between the British Admiralty and the Marconi Company, seven years before the coming of Mr. Hamilton. The Admiralty had an agreement, under which they paid a sum of £5,000 a year and £20 down, for which they had the right to fit up Marconi wireless on payment for the installation. This agreement lasted for 11 years. The Admiralty had the right to provide and make their own apparatus. There was also a claim for £9,000 for the high-power stations, which Mr. Hamilton said he made because the company wrongfully withdrew from the contract which they had made with the Postmaster-General to extend to the Imperial wireless chain. Under the agreement, which was made on July 19, 1912, the sum of £60,000 was to be paid for the installation, and in addition there was to be paid a royalty. What that would amount to it was impossible for anyone to say. It was not alleged that any stations under the agreement had been built, but it was said that they had the chance of holding the Postmaster-General to the contract, and if they had built they would have got their money at some time. Plaintiff said he was, therefore, entitled to claim the £9,000 for the two stations which would have been within his area and 10 per cent. on the gross rents, which he (plaintiff) put at £2,000 per annum for each station. Why it was put at that figure he counsel did not know. There was a Treasury minute to the effect that no accurate forecast could be made of the probable rents. On July 2, 1912, the then Postmaster-General announced that he did not intend to enforce the contract with the Marconi Company, but Mr. Hamilton wanted to say that some one should pay him all the same. His right to commission was only when payments were received by the company. A more favourable contract was entered into by the Government on July 30, 1913, and ratified by the House of Commons, but in December, 1914, the Postmaster-General [illegible] the whole thing, and no stations had been built and no money had been paid. The whole scheme of the Imperial chain in fact, [illegible] There was no ground for saying that any portion of the amount [illegible] defendants.

The Recorder said the reference to him was [illegible] but it could not be contended that the [illegible] companies, and therefore the money ought [illegible]

Mr. Eustace Hills argued that the commission was due although the money might not have been received by the principal.

Mr. Arthur Caffalare, accountant to the defendant company, said he did not know whether the "New Zealand" was equipped with wireless, but he did know that no payment had ever been made in respect of it.

Mr. Stuart Bevan said the "New Zealand" was equipped by the Admiralty under the agreement of 1903, under which the company received £20,000 and £5,000 a year.

Witness said that there was a similar claim with regard to the battleship presented to the British Government by the Malay States. The company had received no payment for the installation on that ship by way of royalties or otherwise.

Mr. Stuart Bevan: All we know is that we never received a penny for the equipment, and, in fact, we do not know that the ship has ever been built.

Witness: All the apparatus supplied to the British Admiralty has been paid for according to the prices set out in the schedule of the 1903 agreement.

Mr. Gordon Hewart said that the money paid into Court included commissions on subsidies, but not upon the sale of apparatus, and the plaintiff's contention was that there had been sales of that kind as to which he had not had discovery.

Mr. Stuart Bevan said that the plaintiff claimed to be entitled to 5 per cent. on all sales to the New Australian Co. That company was not formed until July, 1913, after the material dates in the action, and he therefore resisted any application for further discovery of the business done, as plaintiff's right to any claim in regard to that business depended upon his ability to establish the fact that he was entitled to commission for his whole life.

Replying to Mr. Gordon Hewart, Witness said he arrived at the amount due to plaintiff by two items only, the percentage on shipping companies' subsidies and the £10 per ship fitted.

The further hearing was adjourned until yesterday (Thursday).

Csram Lamp Works (Ltd.) v. Pope's Electric Lamp Co. (Ltd.)

On Tuesday Mr. Justice Joyce delivered his reserved judgment in this case (reported in our issues of June 25 and July 2, 9 and 16).

His Lordship said: This is an action for an alleged infringement of a patent, No. 23,899 of 1904. This patent, among others, was judicially considered by Mr. Justice Warrington in the action of Osram Lamp Works (Ltd.) v. "Z" Electric Co. Defendants in that case were entirely different from the defendants in the present case, and were held to have infringed. The validity of the patent, which was disputed, was upon the evidence there upheld as against those defendants. There was no appeal from the decision of Mr. Justice Warrington, as I understand, the case being settled, as is not infrequent, by the defendants taking a licence. The present case, I am warned, is to go to the House of Lords. In a case which has been referred to in the course of the argument, Attorney-General v. Nottingham Corporation (L.R. 1904 (1) Chancery, page 684), it was decided by Mr. Justice Farwell, with reference to a former trial concerning the same patent, and by the Court of Appeal, that the former decision, so far as it decided the construction of the patent, was to be followed; but whether the claim was too wide, or whether there was proper subject matter, or whether the invention was novel and useful, were questions depending partly on fact, and must be decided de novo. The patent in the present case is for "Improvements relating to the manufacture of incandescent electric lamps." To a great extent it is what I may call a chemical patent; and I at once state that I am not bound to be an expert in chemistry, or in anything else, for the matter of that. As Mr. Justice Farwell said, at page 684 of the case that I have just referred to: "As Lord Justice Bowen has pointed out in the Fleet case, it is no part of the functions of the Court to qualify itself as an expert in science. The Court acts on the opinion of experts whose qualifications can be tested by cross-examination, and weighs the evidence so given and tested." There are two claims by this patentee. The first is for "Incandescing bodies for incandescent electric lamps consisting of tungsten." I understand it to be clear that if the first claim had stopped there the patent would have been bad for want of subject matter; but it proceeds, "manufactured substantially and in the manner hereinbefore described." The first claim, I think, is for the product, and then the second claim is really for the process of making the product. But this patent, according to my reading of it, if and so far as valid at all, is only valid as a patent for the manufacture of tungsten filaments by the [illegible] particularly described in the specification. The patent is not merely for making a tungsten filament, but it is for making by the method or processes specified in the specification, and in my opinion for nothing else. Now, what is the method or what are the processes described in the specification? This is at page 3, line 4, of the specification: "For the manufacture of filaments of this kind finely divided tungsten or tungsten compounds, such as tingstite, tungstic acid or tungstic sulphide, is mixed with an organic binding medium, such as collodion, or a solution of cellulose in chloride of zinc, or cupreous ammonia oxide or the like, from which mass filaments are formed in the usual manner." I suppose that means in the manner in which carbon filaments were made. It appears from the evidence that the usual manner of forming filaments there referred to, as I understand, was to make the materials into hardly a paste, but a compound of [illegible] to squirt this through a glass nozzle into alcohol, whereupon the [illegible] and having stood for a short time is hardened and tenacious and capable of being handled. I have read that from page 476 in the evidence of

Mr. Ballantyne. Then the patent proceeds "and are then" — that is the filaments—"carbonised." There is nothing more about the manner or method of carbonisation. I suppose that meant by the usual method—"in some cases after denitration has previously been effected." I do not think those words "after denitration has previously been effected" are very material. Everybody agrees that where nitro-cellulose is used denitration would be necessary, and, as I understand, the manner of doing it is perfectly well known. That that would be the exact correct scientific description of the process of carbonisation I am not going to say, or commit myself to any view on that subject. Then follows a paragraph beginning at the 13th line on page 3. It really begins two lines earlier, and this to my mind is a very important part of this specification: "The filaments so produced and consisting of tungsten and carbon are then submitted to the following further treatment. First of all the carbon, which has only served as a binding medium, is removed, by subjecting the filaments to the passage of current in an atmosphere of steam and hydrogen and thus raising it"—which in my opinion must be the atmosphere [illegible] a high temperature. By this process the carbon is completely oxidised so as to form carbonic oxide and a filament of tungsten is left. These filaments are then rendered uniform in a manner similar to that employed in the treatment of the usual carbon filaments, by submitting them to the action of current in an atmosphere of volatile tungsten compounds in the presence of a large quantity of hydrogen, whereby the tungsten deposited equalises the filaments." Then there is a sentence not very important, I think: "The filaments which have been rendered uniform in this way are then sealed in glass bulbs in the usual manner."

The validity of the patent in this action has been questioned on three or possibly four grounds: want of subject matter, insufficiency of the directions as to the way in which the invention is to be carried out, and also want of utility of the process, or whatever it is that is patented. What is it that the defendants do? Of the materials they use they make a paste much stiffer than a mixture of the viscosity of treacle, which paste is used in the usual manner of making carbon filaments, and this, it seems can be called squirting, is squirted as described by Mr. Ballantyne. There are other processes after the mixing, but the stuff is then rolled up and put into a chamber with a hydraulic press capable of exerting a very high pressure. A die is used consisting of a diamond finely perforated, and the stuff is forced through the die by the press so as to make a filament and is directly received on a card. Then the filaments are dealt with in a certain way. That again is from the evidence of Mr. Ballantyne, at p. 477 of the shorthand notes. With reference to the carbonisation of the filament that is produced by thus pressing it at enormous hydraulic pressure; as to whether it is carbonised or not according to the defendants' process in the usual manner there is some dispute. I am not going to involve myself in a chemical discussion as to whether it be carbonised in the usual manner or not; but it is denied, I think with some show of reason, that the defendants do carbonise in the usual manner. I have some doubt as to whether they do or not in the manner indicated or intended to be indicated by the specification. But upon the question whether the defendants take or use the series of processes described in the 12 lines, beginning on page 3, line 10, "The filaments so produced and consisting of tungsten and carbon are then submitted to the following further treatment," or indeed whether they take any of them, I do not feel much doubt. Rightly or wrongly, I do not think they use any of them. They certainly do not pass current through the filament; the filaments are not subjected to the passage of current in an atmosphere of steam and hydrogen. In my opinion they do not use an atmosphere of steam and hydrogen in the sense in which that phrase is used in the specification or is intended by the patentees. Nor indeed, in my opinion, do they use steam at all in the ordinary sense of that word. I understand steam to be the vapour of water. The dictionary to which I generally refer says: "Usually applied to hot vapour given off at boiling point." Then it is quite true that it is added that "true steam is invisible, the white cloud termed steam being really a collection of fine drops of water formed by condensation." That Mr. Walter has insisted upon very strongly. The hydrogen the defendants use is dry, but it is said, if I understand the matter rightly, that, though no steam or water vapour is introduced, an infinitesimal amount of water vapour, or rather of the ingredients, or some of the ingredients, which, together with hydrogen, will make water vapour or steam in the true or scientific sense—not the popular sense—are evolved or somehow produced from the immature filament in the process the defendants use, and in the then condition of the materials necessarily used, to form the filament. This may be so, but this is certainly not, in my opinion, subjecting the filament to the passage of current in [illegible] specification: nor, in my opinion, is it an equivalent process in the sense [illegible] Law [illegible] do the defendants employ [illegible] steps prescribed by the specification are omitted from, or not to be found [illegible] only patented invention here is, I am unable to bring myself to the con- [illegible] relied upon the evidence of Dr. Oberlander. I think I must say that I [illegible] character of an impartial scientific expert, he did not appear to me to be unbiassed or as candid as I should have wished, and I am glad that it is not necessary for me to base my opinion in this case upon what I might consider to be the result of his evidence. As to want of utility, that was not much insisted upon, but I do not understand that this patent has ever been worked commercially. Upon the whole I consider that the method and series of processes used by the defendants are so different from those particularised in the specification that there is no infringement, and this action must be dismissed with the usual consequences.

After some discussion between Counsel on the subject, it was agreed that costs should be granted on the higher scale, and his Lordship made an order accordingly.

Mr. TERRELL said his friend would give notice of appeal this side of the vacation and set the appeal down this side of the vacation.

Telephone Wayleaves.

At Leaves County Court last week His Honour Judge Mackarness heard an application by the Postmaster-General, Mr. A. B. Hutchings being the respondent.

Mr. ALSOP, for the Postmaster-General, said the matter involved the question of the terms upon which the Postmaster-General was entitled to do both overhead and underground work in certain roads on the Sutton estate at Seaford, the owner being the respondent. On the estate was a number of roads which had not been dedicated by the public authority, but which had been thrown open for years. The Postmaster-General's case was that they were public ways, though not dedicated. Mr. Hutchings claimed rental.

RESPONDENT said the estate was in course of development. There were over 80 telephone posts on it. He had not refused his consent, but had asked that a rental should be paid for the usage of his land, and also for the erection of posts. The posts were to be about 40 ft. or 50 ft. high; and he considered their erection would be detrimental to the letting of the property. Therefore, he applied for compensation.

Mr. F. TANDY, superintendent engineer for the South-eastern District (which includes Seaford), said all the work would be underground except for the distributing poles. The Postmaster-General had spent a considerable part of £3,000 in Seaford generally in improving the telephone system and in providing for the future, and there was something like £800 still to be spent in connection with the Seaford development scheme.

RESPONDENT said he did not think the Post Office ought to work over the roads which he had provided without paying something. To his mind the presence of distributing poles would seriously depreciate the value of the property.

His HONOUR said it had been suggested that the roads under which the Post Office proposed to put down wires were not streets or public highways within the meaning of the Act. He was of opinion that they were. It was clear from the evidence that for many years respondent allowed the public to use the roads without interference. In those circumstances the law would presume dedication. Then it was alleged that the Postmaster-General proposed to trespass upon respondent's land by putting telephone wires under the ground and distributing poles above, and respondent wanted compensation. His Honour thought the contention of the Postmaster-General—that the Act did not allow any compensation except by way of indemnity upon proof of damage—was not a sound one. The Court had to say what damage had been inflicted at the present moment and was likely to be inflicted in the future by the erection, whether above or below ground, of telephone plant. Up to the end of last year it was not disputed by the Postmaster-General that about three guineas a year was the amount to be paid, and was paid. Respondent thought he ought to receive £10 a year. His Honour believed he had not made out his right to compensation to that extent, but that he should be paid at £5 a year. He awarded costs on Scale B.

Robertson & Adams v. Adnil Electric Co.

In the City of London Court last week Messrs. A. C. Adams and Alex. M'Lean (trading as Robertson & Adams), of Glasgow, sued the Adnil Electric Co. (Ltd.) for £7. 2s. 11d. for an allowance under an agreement made in April and for electric lamps supplied.

Defendants' solicitor said the action ought never to have been brought. The claim was brought under a contract by which plaintiffs were to act as agents for defendants in Glasgow, and a clause of the contract specified that, in the event of a dispute, the matter should be referred to arbitration. Both parties had appointed their arbitrators, and therefore he asked that the action should be dismissed.

Mr. ADAMS, one of the plaintiffs, said they had submitted other matters to arbitration, but that had nothing to do with the dispute before the Court. In his view, however, there was no dispute, because plaintiffs were employed to act as agents for defendants at a salary of £100 a year. That salary was payable monthly, and it was for one of those monthly payments that the present action was brought.

Judge RENTOUL said it was pretty plain, according to the agreement, that if a dispute arose it was to be referred to arbitration.

For defendants it was contended that the contract was terminated by the end of March by verbal arrangement.

Mr. ADAMS said plaintiffs had been carrying out defendants' commands as late as last month. They could not be out of defendants' employment if that were the case.

Judge RENTOUL did not think that the failing to pay wages was a dispute, but arbitration would be a more satisfactory tribunal, and he would send the case to arbitration.

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THE ELECTRICIAN
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TRAMWAYS AND ELECTRIC VEHICLES.

Apart from the fact that the war is making a difference to everything nowadays, the attendance at the annual conference of the Tramways and Light Railways Association last week was very disappointing. However, that is a matter which does not concern us at the moment. Among the Papers read was one on the subject of "Electric Battery Vehicles," by Mr. W. H. L. Watson. An abstract of the Paper will be found on another page of this issue, and it will be noticed that a very fair case for the electric battery 'bus, the battery tower wagon, and the battery truck is made out by Mr. Watson. The discussion of the Paper was comparable with the attendance—very meagre. It seems to us that the electric tramway is one of the best fields for the use of the electric battery vehicle. Energy is distributed at a good pressure and by large feeders throughout the district served by the trams; there should, therefore, be no difficulty in arranging charging facilities. There appears to be no need for excessive speed for the motor vehicles employed by the tramway undertakings; therefore the tower wagons and lorries, also the passenger vehicles, may appropriately be battery propelled. On the general score of simplicity and economy, the battery driven vehicles would appear to be ideal for electric tramway purposes.

We were surprised to find that so little attention was paid to the small platform battery-driven truck. Many tramway undertakings have [illegible] services, and at the depots a considerable amount of re-handling would appear to be necessary. Much of this [illegible] could be economically reduced by battery platform trucks, bearing in mind always that such a truck will pull many times its own loading on trailers. It must also be remembered that these trucks can be driven through the streets, because, although their speed is low, they have an excellent mileage range. There is a great deal to be said for these little vehicles from the tramway manager's point of view, and also the battery operated crane must not be forgotten. This latter type of battery-propelled vehicle would be found of considerable service in car sheds for handling armatures, motor cases, wheels and other heavy parts such as are usually handled by an overhead crane. Further, when the power is shut off the car shed, the battery truck may be brought into service as a tractor.

A considerable amount of time at the conference was devoted to the discussion of labour difficulties and the shortage occasioned by the enlistment of men both for fighting and munition work. So far as the battery vehicle is concerned, no reference was made in the discussion to its labour-saving characteristics. Admittedly its initial cost is high, but it is possible to obtain money, whereas it may be extremely difficult to procure labour. For this reason the tramway undertakings may turn with confidence to the battery vehicle to solve certain problems which have been accentuated by the present shortage of men. We venture to think that the use of battery propelled vehicles of all types by tramways has now passed beyond the stage of experiment. The tramway manager did not hesitate to utilise petrol 'buses when they were in an admittedly imperfect stage of development. His experience contributed to that of other petrol 'bus users in bringing that particular vehicle to its present efficient and economical position. Similarly, we think he need have no hesitation in placing confidence in the battery-propelled vehicle, faced as he is with the early prospect of labour difficulties and with the need for the employment of mechanism requiring either unskilled or female labour.

French Electrochemical Works.—A new hydro-electric plant is to be built at Lancey, [illegible] for the manufacture of [illegible] nitrate by the electric furnace, a [illegible] has been granted by the Conseil d'Etat in 1913. Artificial nitrates will also be made at Berriat-le-haut, Aspinchelle (Savoie), with power from the Arc at La Chartreuse. At Venissieux, near Lyons, the Electrochemical Company will use the [illegible] Rhone. The output in 1913 [illegible] tons. The Société Générale des Nitrures at present makes [illegible] at its works at St. Jean de Maurienne, but [illegible] and Aigle (Switzerland) and the Norwegian firm [illegible] Odda into France. Another company is [illegible] by Compagnie.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week July 12, 1915, to July 17, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

Belgium.—[illegible]

Denmark.—[illegible]

London.—*U.S.A.:* Elec. machinery, £13,382; elec. lamps, £400; elec. carbon candles, £668; telephone materials, £680; elec. fans, 108 pkgs.; insulating tape, 45 pkgs.; lamp parts, £1,092; elec. wire and cable, £3,474—183 pkgs.; unenumerated, £2,492—351 pkgs. *Switzerland:* Carbon candles, £279. *Holland:* Elec. lamps, £1,446—138 pkgs. *Sweden:* Elec. lamp parts, £264; telephone material, £21. *France:* Elec. carbon candles, £316; elec. machinery, £50; wire and cable, £80. *Norway:* Telegraph poles, 2,712. *Italy:* Elec. wire, 49 pkgs.; elec. wire and cable, £1,894. *Canada:* Unenumerated, 3 pkgs. *Spain:* Elec. carbons, 273 pkgs. *Belgium:* Telephone materials, £168.

EXPORTS.

To Australasia.—*Auckland:* Unenumerated, £130. *Melbourne:* Elec. machinery, £105; wire and cable, £1,616; unenumerated, £238. *Sydney:* Telegraph material, £1,500; unenumerated, £1,917. *Wellington:* Unenumerated, £141. *Brisbane:* Wire and cable, £25; elec. machinery, £61; unenumerated, £117. *Dunedin:* Unenumerated, £76. *Lyttelton:* Elec. machinery, £61; unenumerated, £138. *Fremantle:* Unenumerated, £261. *Adelaide:* Elec. machinery, £1,696; wire and cable, £506; unenumerated, £53. *Hobart:* Elec. machinery, £164; unenumerated, £74. *Newcastle:* Elec. machinery, £793. *Wanganui:* Unenumerated, £90. *Invercargill:* Elec. machinery, £95; unenumerated, £139. *Townsville:* Unenumerated, £15.

Africa.—*Durban:* Wire and cable, £293; telegraph material, £12; unenumerated, £675. *Port Elizabeth:* Elec. machinery, £61; unenumerated, £340. *Cape Town:* Elec. machinery, £19; unenumerated, £657. *Beira:* Elec. wire and cable, £47; unenumerated, £27. *East London:* Elec. machinery, £240; unenumerated, £659. *Zanzibar:* Unenumerated, £32.

Egypt.—*Aden:* Elec. machinery, £125. *Port Sudan:* Elec. machinery, £19; wire and cable, £112; unenumerated, £58.

Russia.—*Archangel:* Wire and cable, £130; unenumerated, £189. *Petrograd:* Wire and cable, £1,505.

Gibraltar.—Elec. machinery, £385

Spain.—*Bilbao:* Unenumerated, £53.

South and Central America.—*Buenos Ayres:* Elec. machinery, £480; wire and cable, £131; unenumerated, £2,643. *Rio de Janeiro:* Unenumerated, £219. *Rosario:* Unenumerated, £64. *Santos:* Unenumerated, £259. *Guayaquil:* Unenumerated, £82. *Fernambucc:* Telegraph material, £259; unenumerated, £453.

Holland.—*Amsterdam:* Wire and cable, £3,009.

Japan.—*Yokohama:* Unenumerated, £45. *Kobe:* Unenumerated, £32.

China.—*Shanghai:* Unenumerated, £147.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Elec. machinery, £1,190; wire and cable, £99; unenumerated, £410. *Calcutta:* Wire and cable, £373; elec. machinery, £128; unenumerated, £307. *Colombo:* Telegraph material, £249; unenumerated, £100. *Madras:* Unenumerated, £311. *Singapore:* Elec. machinery, £82; wire and cable, £54; unenumerated, £412. *Karachi:* Unenumerated, £41. *Sourabaya:* Wire and cable, £553. *Penang:* Elec. machinery, £221; unenumerated, £307. *Fort Swettenham:* Unenumerated, £436. *Kilindini:* Elec. machinery, £90; unenumerated, £121. *Rangoon:* Unenumerated, £98.

France.—*Paris:* Unenumerated, £23. *Dieppe:* Elec. machinery, £198; unenumerated, £133. *Bordeaux:* Unenumerated, £35.

Sweden. *Stockholm:* Elec. machinery, £29; telegraph material, £117; wire and cables, £103.

Malta.—Unenumerated, £160.

FOREIGN GOODS (duty paid and free).

Dieppe: Unenumerated, £97. *Cape Town:* Unenumerated, £445. *Sydney:* Unenumerated, £122. *Turin:* Unenumerated, £325. *Amsterdam:* Unenumerated, £262. *Hongkong:* Unenumerated, £245. *Perth:* Unenumerated, £66. *Port Elizabeth:* Unenumerated, £20. *Stockholm:* Unenumerated, £85.

FOREIGN FREE GOODS, entered in transit on through Bills of Lading.

Perth: Unenumerated, £258.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

(*Concluded from p. 596.*)

Alloa Burgh v. Alloa Theatre Co.

In the Alloa Sheriff Court recently an interesting decision was given in a case which turned upon the question as to what is "power supply." Pursuers sued defendants for the recovery of money for electricity supplied and which the quantity was consumed for lighting. Defenders pleaded that, as the electricity they had supplied for a motor generator set, and although it was for the purpose of the supply was lighting, yet as the immediate consumption took place on a motor they were entitled to power rates. Much evidence was led and the hearing occupied three sittings. On the last occasion Mr. J. E. Sayers said that the reduction of the current by the motor generator was merely for economy and hitherto another supply or other power had been given at lighting rates. The differential rates for power and lighting were based on cost of generation, [illegible] consumption for power and short-hour consumption for light. A genuine motor was supplied with electrical energy at one end to produce rotary motion for driving [illegible] purpose to be [illegible] was different. The whole of the electric current registered at defendant's Pavilion was consumed by the motor and the motor was used for driving a dynamo. The [illegible] current supplied by the Corporation, but the current used for the [illegible] could be supplied without the Corporation current.

Mr. N. Thomson said that the current produced by the motor generator was not what the Corporation supplied. It was wholly generated on the premises by the generator, and was not simply the Corporation current altered. The current from the Corporation entered the motor and left it again, going back to the Corporation's main. That current drove the dynamo. The current used by the motor was wholly consumed by it. None of the current passing through the 440-volt meter could be used for lighting.

Mr. Thomson (for pursuers), after further evidence, addressed his Lordship and contended that even though defenders were entitled to power rate, the Corporation were entitled to make their own charges so long as they did not exceed the maximum rate laid down in the Provisional Order.

The Sheriff, without calling upon defenders, decided in their favour, with expenses against the Corporation. Both expert witnesses, he decided, were clear in stating that the energy was supplied by the Corporation to drive the motor, and there the supply ceased. The rate to be charged should be the power rate. If the burgh had chosen to say that one kind of motor was to be charged at a different rate from another, that might have entered into this discussion.

Membership of Institution of Civil Engineers.

The Court of Appeal (the Master of the Rolls and Lords Justices Pickford and Warrington) allowed an appeal by Mr. J. S. E. de Vesian against a decision by Mr. Justice Neville that the Institution of Civil Engineers were within their rights in erasing appellant's name from their register and in declaring him to be no longer a member of the Institution.

It was stated that the appellant became a director of L. G. Mouchel & Partners (Ltd.), and that the company issued an advertisement which the Institution claimed was at variance with their rules as to professional conduct.

The Master of the Rolls said the appellant was only asking now for an injunction until the trial of the action. There were points of difficulty and of some importance in the case, and it was more satisfactory that a decision on these should be reserved until the trial. An injunction until the trial of the action would not hurt defendants and would prevent plaintiff from being in any way injured pending a final decision. The Court would, therefore grant an injunction until the trial.

Lords Justices Pickford and Warrington concurred.

Lamp Packing Patent.

In the Court of Session, Edinburgh, last week, before Lord Ormidale, Alex. A. Brown, box manufacturer, and the Economic Packing Co. (Ltd.), of Glasgow, sued W. C. Yuille & Co. (Ltd.), electrical supplies dealers, Glasgow, for interdict prohibiting respondents from infringing a patent obtained by complainers for improvements in and in connection with packing and testing incandescent electric lamps. The patent was issued in 1911, and it was stated that complainers' cases, while affording protection to electric bulbs, allowed for their inspection and testing in the cases, and that the cases fixed the lamps inside so as to prevent damage in transit. Respondents alleged anticipation by prior publication and use, and also that the patent contained no patentable matter and suffered from want of utility.

It was announced in Court that complainers had abandoned the action and paid respondents' expenses, and accordingly his lordship dismissed the action.

Electrical & Industrial Investment Co. (Ltd.).—In the Chancery Division Mr. Justice Younger on Tuesday sanctioned a reduction of the capital of this company in accordance with resolutions passed by the various classes of shareholders.

PARLIAMENTARY INTELLIGENCE.

Electric Lighting Provisional Orders (No. 4) Bill.—This Bill, which relates to Harrogate (Extension), Keighley (Extension) and Ystradgynlais, was amended by a House of Lords Committee on Thursday last, and the Committee's report was received and agreed to in the House on Tuesday.

Electric Lighting Provisional Orders (No. 2) Bill.—This Bill, which relates to Tenby, also passed through Committee in the House of Lords on Tuesday.

London County Council (Tramways and Improvements) Bill. A House of Lords Committee has refused sanction to the scheme for the proposed tramway in Mansell street from Aldgate to Tower Hill. This reverses the decision of a House of Commons Committee. The scheme has now been rejected by Parliamentary Committees four times.

London Electric Railway Companies' Facilities Bill.—This Bill was read a third time and passed in the House of Lords on Tuesday.

Harrogate Provisional Order Confirmation Bill.—This Bill, which confirms a Board of Trade provisional electric lighting order granted to the Corporation of Harrogate for parts of Knaresborough and

Pateley Bridge rural districts, was passed by a Select Committee of the House of Lords last week.

Plymouth Corporation Bill.—The Local Legislation Committee of the House of Commons passed this Bill last week. In regard to the electricity supply undertaking, a new clause was inserted, enabling the surplus profits to be applied if need be to the improvement and extension of the works.

Unopposed Measures.—The House of Lords Committee on Unopposed Measures passed the following Bills which have all passed the House of Commons) last week :—

Lincoln Corporation Bill, and provisional order Bills, including Haworth Electric Lighting, Skipton Electric Lighting, the Hessle (Hull) Electric Lighting, Harrogate Electric Lighting, Keighley Electric Lighting and Wath-upon-Dearne, Bolton-upon-Dearne and Thurnscoe Joint Electric Lighting.

Dunfermline and District Tramways Extension Order Confirmation Bill.—This Bill was read a third time and passed in the House of Lords on Thursday last.

Royal Assent.—On July 15 Royal Assent was read to the Aberdare Council and Rotherham Corporation Acts.

Loans to Local Authorities.—In the House of Commons on Tuesday in Committee on the Public Works Loans Bills, Sir F. Banbury objected to the powers given to the National Debt Commissioners to issue loans to local authorities to the amount of £4,000,000, and moved to reduce the figure to £2,000,000.

Mr. Montagu pointed out that the present commitments of the local authorities amounted to £2,255,000, and he was prepared to reduce the amount stated in the Bill by one million pounds.

Sir F. Banbury's amendment was defeated by 56 votes to 10 and Mr. Montagu's proposal to reduce the sum to £3,000,000 was agreed to.

BUSINESS NOTICES.

Edwd. H. Birch and John Harris, electrical engineers, &c., Prince's-street and Coton-road, Nuneaton, have dissolved partnership. Debts by Mr. Birch, who continues the business.

Walter Edwd. King and Wm. B. Robertson Gethen, trading as W. Edward King), electrical engineers and contractors, 82, Lamb's Conduit-street, London, W.C., have dissolved partnership. Debts by Mr. King, who continues.

H. K. Lewis's Technical Library.—Electrical men will be interested in the announcement that the well-known business of technical publishers and booksellers, founded in 1844 by Mr. Henry King Lewis, has been converted into a private limited liability company (H. K. Lewis & Co., Ltd.). Messrs. E. J. Sowerby, H. L. Jackson, J. E. Simpson and R. H. Smith, who have been responsible for the conduct of the business in the past, have been appointed governing directors, so no alteration in the proprietorship, management or conduct of the business will arise from the change.

Manganesite.—Messrs. John Hudson & Co.'s Successors, of 4, Victoria Warehouses, Mansell-street, London, E., write us as follows: "To dispel any misapprehension, we shall be glad if you would state that since September last we have sent out no manganesite except that made at our works in London. Our firm is an entirely British firm, the proprietors of which are the registered owners of manganesite."

Plant Wanted.—The Northampton Electric Light & Power Co., Bridge-street, Northampton, want for immediate delivery a 500 kw. to 750 kw. three phase turbo-generator, 50 cycles, 6,600 volts through step up transformer.

Plant for Sale.—The Macintosh Cable Co. (Ltd.) advertise for a motor generator.

BANKRUPTCIES, LIQUIDATIONS, &c.

Application for discharge of Vernon C. Cobb, elec. engineer trading with W. Longdon as Longdon & Cobb, at 101A, Derby-road, Nottingham, will be heard at the Court House, Nottingham, on Aug. 19.

Claims against Consolidated Diesel Engine Manufacturers (Ltd.) are to be sent to Sir W. B. Peat, 11, Ironmonger-lane, London, E.C., by July 29.

Mr. P. S. Booth, 2, Bixteth-street, Liverpool, has been appointed trustee in the bankruptcy of John Boult and John Hugh Boult trading as John Boult's, electricians, 3, Grosvenor-street, Chester.

A meeting to receive an account of the winding up of the Heywood & District Electric Light & Power Synd. (Ltd.) (in vol. liq.) will be held at the office of Messrs. Cole, Sons & Co., 70, Cannon-street, London, E.C., on Aug. 9.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barnsley.—An inquiry was held last week into the application of the Corporation for sanction to borrow money for extensions of the generating plant and mains.

The original application was for power to borrow £21,850, but the amount was reduced to £15,073 by the postponement of certain work.

Mr. W. P. Donald (town clerk) explained that the scheme was originally postponed owing to the outbreak of war, but the increased demand last winter rendered the application imperative. The Corporation had now a large number of applications for supplies of power, which could not be delayed. The Corporation were now only able to give one-quarter of the power required by the munitions factory which was being established in the town. The L.G. Board had authorised preparations to supply the munitions factory. The original proposal had been reduced to the absolute minimum.

After hearing evidence, the L.G. Board inspector (Mr. H. S. Bidwell) said he would report as early as possible.

Mr. E. S. Raynor, electrical engineer of Doncaster Corporation (on behalf of Mr. E. A. Barker, borough electrical engineer, who is serving at the front) supplied technical details, and said tenders had been obtained.

Bridlington.—An inquiry was held last week into the application of the Corporation for sanction to a loan for a refuse destructor in connection with the electricity works.

It was stated that a tender for a Horsfall type destructor, including building work, had been accepted provisionally at £6,332, and that the destructor would practically eliminate the emission of black smoke from the electricity works, and would save £846 a year in dealing with the refuse.

After hearing some opposition to the proposed site, the inquiry was adjourned.

Dunfermline.—The Fife Electric Power Co. propose to extend their supply to Hilbeath by means of overhead wires.

The District Public Health Committee have been asked to report upon a proposal to give a supply of current for street lighting, the lamps to be hung on the existing poles. The supply main will be run from the works at Townhill to Touch. The company had also been authorised to open the roads for the laying of electric cables in the village of Kelty.

St. Pancras (London).—The Joint Finance and Electricity Committees recommend the Council to postpone until after the war the second half of the boiler contract and the remainder of the extension scheme, representing estimated postponed expenditure of £25,057.

The contractors for the four boilers on order (the British Niclausse Boiler Co.) agree to the postponement so far as concerns the third and fourth boilers, on condition that the Council will pay any extra cost involved by the postponement, on account of labour, raw material, &c., that a substantial payment be made on account of work already executed, &c. The company state that an immediate cash payment on account of the contract is necessary for reasons which relate to war work carried out by them. They ask for £6,000. The Joint Committees agree that the firm should receive a payment on account, but cannot recommend payment except for work actually delivered.

The Electricity Committee recommend that arrangements be made for the installation of two of the boilers at the earliest possible date and that the boiler house extension, coal bunker, temporary coal conveyor and lift installation (which is estimated to cost £13,000) be put in hand forthwith.

GENERAL

Accrington.—Private Frank Burke, an employé of the Corporation's electricity department, has been awarded the D.C.M. "for repairing a telephone wire under shell fire."

Bermondsey (London).—The electrical engineer (Mr. W. E. J. Heenan) does not consider it necessary to enter into a contract for coal indicators.

The Council are recommended to increase their charges for electrical energy by 10 per cent.

Church Stretton.—The Finance Committee of the Council have been asked to report upon the proposed application of the Church Stretton Electric Supply Co. for a provisional electric lighting order.

Consett.—At the recent meeting of the Urban Council, Mr. J. Jones, J.P., announced that the negotiations with the Cleveland & Durham County Electric Power Co. had been completed, and he thought the public ought to know that the street lighting would not cost the ratepayers a penny piece for the next 15 years. Hitherto the Council had paid £900 a year for that purpose.

Donaghadee.—The Board of Trade have agreed to defer the revocation of the electric lighting order for a year from August next.

Ellesmere Port.—The Board of Trade have deferred the question of the revocation of the provisional electric lighting order for 12 months from Aug. 15.

Extra Payments to Contractors.—Camberwell (London) Council recently asked the L.C. Board for sanction to pay certain contractors [illegible] as in the case of other payments for goods supplied or for work done. The Board declined to sanction payments of the kind before the audit, so as to prevent them being withdrawn from the auditor's review. Camberwell Council have, therefore, decided to make certain extra payments to their contractors, the latter giving an undertaking that if the auditor declines to sanction the extra amount they will refund it.

Harrow.—If the Council are desirous of purchasing the undertaking of the Harrow Electric Lighting Co. at the expiration of 21 years from the date of the deed of transfer, 12 months' notice has to be given before Oct. 14 next. The Council has agreed that under existing conditions no action be taken in the matter.

Ilford.—The Electricity Committee have quoted the Fuller Accumulator Co. the following terms for supply of energy to their proposed new works :—

£1 per kilowatt per quarter, plus 0·5d. per unit with coal at 15s. per ton, with an increase or decrease of 0·05d. per unit for each increase or decrease of 1s. 3d. per ton, with a maximum of 1d. per unit for a minimum consumption of 10,000 units per quarter.

Islington (London).—The Council has decided to take up a loan of £20,919 for electricity and paving purposes.

In reply to Mr. Copeland Mr. Albert Gay (borough electrical engineer) said it was a fact that an employee in the electric lighting department asked for permission to enlist, and was refused unless a man could be found to fill his place. The man or a suitable substitute was necessary to maintain the public supply, and a suitable substitute could not be found. Thirty-six men had joined the colours from the electricity department. A list containing the names of employees who should not be accepted for enlistment on account of the difficulty of obtaining men to fill their places was sent to the Recruiting Office. Mr. Tennant, in the House of Commons, on April 27 stated that "Recently officers have instructions not to enlist skilled employees of electrical services without the sanction of their employers."

Keighley.—Last week the Council accepted tenders for additional generating plant and authorised expenditure of £18,900 for the generating plant, foundations, piping, &c.

The chairman of the Electricity Committee (Mr. Whitehead) explained that more plant was needed to meet the requirements of consumers. Most of their power contracts were engaged on the production of some kind of war material, and it was very important that the department should put itself in a position to meet all their demands. They would get delivery of the new machinery before mid-winter, because it had been put in hand for Salford, and when three-quarters finished certain circumstances had arisen which had enabled the makers to offer it elsewhere. By the system of deferred payment they hoped to arrange for the committee expected to be able to meet the obligations of the new expenditure out of revenue without coming on to the rates for any contribution.

Lynn.—[illegible] Council have decided to increase their charges for [illegible] from 3d. to 4d. per unit and for power by 5 per cent.

Malvern.—A sub-committee of the Finance Committee has been appointed to report on the best method of drawing a commercial balance-sheet of the gas and electricity undertakings, with power to consult auditors who specialise in such work.

Queensbury.—The Electrical Distribution of Yorkshire has notified the Council that it intends to apply for a provisional electric lighting order, and at an early meeting of the Council the engineer (Mr. Wall Winstanley) is invited in order to explain the company's proposals.

Swansea.—Owing to the high price of coal now ruling, the charge for electricity supplied to private consumers has been increased by 10 per cent.

Tunbridge Wells.—A provisional order by the Board of Trade, under the Electric Lighting Act, 1888, has been granted on the Tunbridge Wells Electric Lighting Extension Order of 1915.

The Tunbridge Wells Corporation applied for a provisional order to [illegible] under the Tunbridge Wells Electric Lighting Order, 1899, [illegible] to the Urban District of Southborough and parts of certain parishes in the rural districts of Tonbridge and Sevenoaks and part of the Parish of East Peckham in the rural district of Tonbridge. The Corporation obtained the consent of Southborough Council to the application, but failed to obtain the consents of the three rural district [illegible] to the application in so far as it [illegible] Board of Trade to dispense with the consents of the Tonbridge and Tunbridge Wells Gas Co. At the [illegible] Council decided to withdraw their opposition to the application, and the Board of Trade [illegible] Board Director of Tonbridge, the Rural District under orders made by the Board under sec. 6 of the Electric Lighting Act, 1909. Last year the Board of Trade informed the Corporation that if they were desirous of supplying further premises outside their authorised area of supply they should apply for a provisional order to extend that area. Tonbridge Rural Council lodged objections to the application, but they subsequently informed the Board that they did not desire to persevere with their objections. Later they passed a resolution to the effect that they declined to consent to the granting of the order, but left the matter in the hands of the Board of Trade. After careful consideration of all the circumstances of the case the Board decided to dispense with the consent of Tonbridge Rural Council and to grant the order in respect of the parts of the Rural District applied for, in addition to the Urban District of Southborough.

Wallasey.—The Council have decided not to proceed further with an application from a Seacombe firm of manufacturers for a supply of current for power purposes, on the ground that no margin would be left for the increasing number of small consumers.

Walsall.—The Electricity Committee recommend that no change be made in the price of electric current for private lighting, but the discount of 2½ per cent. allowed for payment within one month will be withdrawn.

Whitehaven.—At the Council meeting last week Mr. Hinde said it had been decided not to increase the charges for electricity.

Wirksworth (Derbyshire).—The Council recently had an interview with Messrs. Best & Lea[illegible] in reference to a scheme for equipping electricity supply works for the district.

Mr. Best said he and Mr. Pullen (consulting engineer) had jointly carried out a number of small electric lighting schemes, and he thought the cost of a supply undertaking for Wirksworth would be about £2,000. A private company would be formed, and he and Mr. Pullen would be prepared to take their remuneration in shares of the company. Overhead wires would be used and the Council would have the option of purchasing the undertaking after a stipulated time. It was arranged that Mr. Best should submit a draft agreement to the Clerk.

LIGHTING, POWER & HEATING NOTES.

Asylum Lighting.—At a meeting of the Committee of Management of the Cavan and Monaghan Asylum last week it was reported that the Monaghan Gas Co. had informed the Committee that the price of gas had been raised 5d. per 1,000 ft. since May 1.

The CLERK stated that there was no binding contract with the company.

Dr. CONLAN said no committee had at any time made inquiries as to the capital cost of an electric lighting installation.

Mr. FINLAY said they must have an estimate to find out whether gas is cheaper than electric light.

It was agreed that the R.M.S. consult with Mr. Martin (a member of the gas company) as to the price.

Barnes.—The Council have adopted a report by their electrical engineer, Mr. C. S. Davidson, recommending that electric cookers be installed in the workmen's dwellings erected by the Council.

Occupiers are to be charged 1d. per unit, from which ¼d. will be deducted to cover the Public Health Committee's outlay. Mr. Davidson estimates the life of a cooker at 10 years and the probable consumption at 624 units per cooker per annum. It is proposed to commence with about a dozen cookers.

Dock Equipment.—At a recent meeting of the Mersey Dock and Harbour Board it was decided to erect two electric discharging elevators at the west block of the Waterloo Goods Warehouses, at an estimated cost of £8,750.

In connection with the extensive improvements now being made by the Port of London Authority in the East India Docks, a powerful electric pumping plant has been installed which will ensure an additional 2 ft. of water, making the minimum depth 28 ft.

Electric Pumping.—Hythe Council are in negotiation with Folkestone Electricity Supply Co. for the supply of an electrically driven pump at the Saltwood reservoir.

Mr. [illegible] reported to the committee [illegible] that the centrifugal pumps available in Folkestone were not suitable to that class of work, and it would be necessary to obtain one specially from the manufacturers. He thought prompt delivery could be secured as the pump was required chiefly in connection with the water supply to the camp. The company would undertake the work at net cost, plus 10 per cent., and would advance the money for the installation and the necessary cables, the Council paying quarterly instalments of the principal and 5 per cent. per annum on the outstanding expenditure, current being supplied by the company at 1¾d. per unit for [illegible] 10,000 gallons of water per day. As an alternative the company would undertake to pay for the plant themselves and pump the water at 3d. per 1,000 gallons with a minimum of 40,000 gallons per day, upon a 10-year contract. The Mayor was authorised to [illegible] the latter proposal, as the company would always have to keep in reserve plant for 10,000 gallons daily supply available.

Hammersmith (London).—The Finance Committee recommend that owing to the reduction in street lighting £150 per quarter be

allowed off the accounts of the electricity department for street lighting, as from and including the December quarter last.

Mr. C. H. Thorne, engineer and manager, has resigned his appointment.

The Council has been recommended to enter into an arrangement for the supply of electricity to occupiers of premises in the grounds of the Shepherd's Bush Exhibition through the mains and apparatus of the exhibition company, in consideration of the Council paying the company 15 per cent. of the receipts for current supplied for power and lighting to occupiers other than the company, and 12½ per cent. on the receipts for current supplied for cooking, heating, &c.

Hendon.—At the last meeting of the Rural Council it was stated that for the public lighting of Pinner a tender was invited from the National Electric Construction Co., but they declined to tender, as the capital expenditure would be such that the quotation would be very high. They would, however, be pleased to tender after the war.

Melbourne (Derbyshire).—The Parish Council have renewed the contract with the local electric lighting company for street lighting.

Southampton.—Electric light is to be substituted for the present gas lighting at the St. Mary's Police Station.

Southend-on-Sea.—Following is an abstract of the report of the Highways Committee to the Corporation regarding the contract for pumps for the sewage works :—

A fracture was discovered in a casting of the first pump fixed, and owing to the war there was likely to be considerable delay in obtaining a new casting. The contractors (Siemens Bros. Dynamo Works) agreed to cancel the contract so far as the second pump was concerned and the Committee recommended this course, and that the arrangement be approved whereby the contractors will pay the Corporation £400 in respect of the expense for the foundation and increased power of materials and also £3 per week in respect of additional fuel consumed ; also that authority be given to purchase the necessary engine and pumps at a cost not exceeding £1,000.

Workmen's Dwellings Lighting.—At the last meeting of Gillingham Council the electrical engineer (Mr. A. D. Chalmers) reported that six out of the eight occupiers of the Council's model dwellings in Old Brompton had agreed to take electric current at a fixed rate of 6d. per week, payable with the rent. There was considerable opposition on account of the lowness of the charge, but it was decided to make the experiment for 12 months.

TRACTION NOTES.

Birmingham. The Tramways Committee have engaged about 20 women to act as conductors on the Pershore-road route.

A letter has been received by the Committee from the Tramwaymen's Union stating that the men are willing to work with the women and to render them every possible assistance.

Bradford.—In a recent interview on the subject of women conductors, Mr. C. J. Spencer (manager of the Corporation tramways) said the gradients in Bradford are severe, and emergency duties sometimes devolve upon the conductor. Owing to the element of risk, he thought the employment of women conductors would be one of the last expedients resorted to.

Hull.—On Friday a deputation from the Trades & Labour Council put before the Hull Tramways Committee the tramwaymen's views on the employment of women on the cars.

The Committee declined to enter into an agreement, but expressed approval of the proposed clauses providing that (1) suitable men be employed in preference to women ; (2) the Committee are willing to consider applications which may be submitted by the union prior to the employment of women ; and (3) women will be dispensed with when the war come to an end, and the regular employés return to the work are available.

London County Council.—*Tramwaymen's Conditions of Service.*—At yesterday's Council meeting the Highways Committee submitted the agreement (dated July 9) of the Traffic Conciliation Board on applications from conductors and motormen for alterations in their conditions of labour. The requests of employés numbered 1 to 10, and the Board's decisions are given as follows :—

1. Rate of pay to be increased by 1s. per week.—*Not granted.*
2. 6d. a day to be granted to motormen during [illegible] time to be paid for at the rate of time and a half.—*Not granted.*
3. Hours of labour to be reduced to eight a day.—*Not granted.*
4. [illegible] be granted.—*Not granted.*
5. [illegible] £30 a year [illegible] years' service.—*Not granted.*
6. Payment to be made to [illegible] for [illegible] to and from [illegible] to be paid.—*Not granted.*
7. Extra allowance to be made to [illegible] which they are ordered [illegible] first [illegible] to be granted [illegible] to Brondesbury.
8. Full uniform to be granted.—(*Not granted*).
9. Extra allowance of 1s. a day to be granted to motormen and conductors while training other men.—(*Temporary arrangement under which motormen and conductors are paid the ordinary rate while engaged [illegible] other men to the service.*)
10. The period of spread-over time not to exceed 12 hours a day.—(*Not granted*).

The award of the Court of Arbitration dated June 4, 1915, relating to a war bonus payable to certain grades of employés in the electrical section, to apply to employés in the traffic section. By this award the war bonus of 3s. per week or 6d. per day given to men earning less than 30s. per week is continued, and is extended to men earning 40s. per week and under. The grant is payable during the continuance of the war, but shall not extend beyond three years. It comes into force as from the pay week beginning July 22, 1915. The cost will be about £36,200 for the current financial year, and £58,300 for 1916-17.

The Committee recommended that the agreement, dated July 9, 1915, of the Traffic Conciliation Board, relating to the conditions of labour of motormen and conductors be approved, and that a temporary war grant in the terms set out above be made to the grades of employés in the traffic section of the tramways department.

TELEGRAPH AND TELEPHONE NOTES.

Argentine Radiotelegraph Regulations.—The "Review of the River Plate" states that, owing to the difficulties created by the European war of procuring materials, the period allowed by the Argentine Government for vessels flying the Argentine flag to be equipped with wireless telegraph installations is extended to May 1, 1916.

Hull Municipal Telephone Service.—The Telephone Committee are holding an inquiry into the alleged unsatisfactory working of the municipal telephone system.

On Monday Mr. FUSEY stated that he had 280 complaints to make.

The MANAGER (Mr. T. Holme) said complaints were inseparable from telephony. People were changing their telephone numbers at the rate of about 30 per week. They had lost 39 per cent. of the staff when the National undertaking was purchased, and when the war broke out the staff was further reduced by 25 per cent.

EMPIRE NOTES.

Australasia. The "Australian Mining Standard" states that Mr. C. E. Norman, the new chairman of the Victorian Railways Commissioners, has been appointed for four years. Mr. W. McClelland has been re-appointed as a Commissioner for seven years, and the new Commissioner, Mr. E. B. Jones, is also appointed for seven years.

It is proposed to spend a further £22,500 on the equipment of the Victorian State ship-building yards at Williamstown. The largest item of the new plant, for which tenders have been called, is a travelling crane for the handling of heavy loads. In addition there will be required various machine tools and a new generating set of about 40 kw. for supplying electric light and power to the Naval Depot and Harbour Trust at night.

The Mount Lyell (Tasmania) Mining & Railway Co. has entered into a contract to supply to British Insulated & Helsby Cables (Ltd.) 250 tons of electrolytic copper (E.S.A. brand) monthly.

"Tenders" (Melbourne and Sydney) says the Te Kuiti (N.Z.) electric supply duplication scheme will be started shortly. The estimated expenditure is £4,000.

A company has been formed to supply Toora and Foster (Victoria) with electric current generated by hydro-power. Mr. V. J. Crowley is [illegible].

The Hydro-Electric Power & Metallurgical Co. is entering into a contract with the Tasmanian Government for a bulk supply of electric power in their proposed works. The initial quantity of power required will be 3,500 [illegible].

Melbourne Council have decided to invite tenders for 1,381 meters and 75 to 4 [illegible] during the next 12 months, at an estimated cost of £7,000.

Electric Cooking Appliances in Australia.—Recently Messrs. W. G. Watson & Co., of Sydney, received an order for the supply of 180 electric ranges and stoves for a block of residential flats in Hyde Park, Sydney.

The value of the order is about £750, and it is stated to be the largest [illegible] placed in Australia for cooking appliances. The [illegible] lower fires are controlled by three-heat switches. Messrs. W. G. Watson & Co. Ltd. are [illegible] the Hotpoint electric appliances.

India.—"Indian Engineering" says under the aegis of Messrs. Killick, Nixon & Co., of Bombay, the city of Ahmedabad, which is famous for its cotton and flour mills, has been provided with a modern electricity supply undertaking.

The work was carried out by Callender's Cable & Construction Co., with Messrs. Crompton & Co. as sub-contractors. The generating plant includes Crompton dynamos and Diesel oil engines. The municipality have agreed to take a supply of current for street lighting for 15 years. The rates for current are 6 annas (6d.) per unit for lighting and fans, and 2 annas for power. A considerable demand for electricity is expected from private residences, hospitals, oil mills, &c.

The Great Indian Peninsula Railway Co. has recently carried out the electrification of their goods shed and yard at Wadi Bunder, and it is reported that a great saving in labour and material has resulted.

Straits Settlements.—Senhor Geo. d'Almeida, Portuguese Consul in Singapore, says in a communication to the "Journal of the Royal Society of Arts," it rejoices the heart of the engineer to see the measures adopted to develop British Malaya.

Great improvements have been made in several ports and the road system has been improved. In 1913 the Federated Malay States imported machinery valued at £340,113 (increase £112,200 over 1912), and railway and tramway materials £324,882 (increase £233,248), telegraph and telephone materials £67,753 (increase £42,460), gas and electric lighting materials £34,375 (increase £10,090). Railway and telephone and telegraph material came almost exclusively from England, electrical machinery came from the United Kingdom to the vlaue of £58,415 (against £32,160 in 1912) and from Germany £9,474 (against £9,109), and miscellaneous machinery from U.K. £127,763 (£81,753) and from Germany £8,068 (£6,262).

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says a decree has been issued authorising the operation as a joint stock company of the Sociedad Electrica de San Carlos, in Bolivar.

Negotiations are pending for the installation of electricity works in Coronel Dorrego, Colon (Entre Rios), Suarez, Halsey, Pellegrini, Pintos and Casilda.

The La Plata Cold Storage Co. have been authorised by the Government to construct a special fireproof department for electric pumps.

Señor M. S. Romero has applied to the Government of the province of Buenos Ayres for permission to equip an electric power station at Punta Alta.

The directors' report of the Cia Industrial de Electricidad del Rio de la Plata for 1914 states that, in spite of the profound trade crisis their business developed satisfactorily. This was largely attributable to the improved conditions of sale of the products of the company's carbon factory, which has been in a position to supply the country with all its requirements since imports from Europe came to a standstill. The directors have applied the income to reduction of liabilities. Net profit for 1914 was $87,331.67 gold..

Casilda Municipality have received two proposals for public lighting, from the Rosario Electric Co. and Messrs. Buxton, Olditch & Co., respectively.

Berlin.—Herr Karl Conix, of the Siemens-Schuckert Werke, has been appointed commercial director of the Berlin municipal electricity works.

Cuba.—The Government has authorised the following persons to instal electric power and lighting plant in Cuba: Emilio del Real (at Remedios, Santa Clara), E. P. Mahony (at Jaruco, Havana), R. D. Martinez (at Tapaste, Havana), and H. de Stéfano (at San Cristobal, Pinar del Rio).

Japan.—Mr. E. F. Crowe, C.M.G., H.M. Commercial Attaché at Yokohama, says:—

The imports of machinery into Japan showed a large falling off in 1914. The total for 1913 was £3,752,700 and for 1914 £2,500,000. The United Kingdom remains well at the head of the list, and enjoys more than 50 per cent. of the business. Although the war was not responsible for the falling off in the orders placed for machinery to arrive in 1914, it interfered with the deliveries of German machinery. Up to the time when war broke out Germany had 25½ per cent. of this business; by December the percentage had dropped to 22. There is still a little more to come [illegible] from Germany, and from places where German ships have run for shelter, but when this has all arrived imports from Germany will cease, and British makers will have a fair chance of competing, and it is to be hoped they will take full advantage of it.

Confidence is gradually returning, and it is thought that within the [illegible] will be possible to obtain a certain amount of orders. [illegible] are now [illegible] in Japan who, if they can [illegible] experience and [illegible] are increasing in number [illegible]. Were it not for the heavy import duties it would be impossible for them to compete in many lines, but the duties and the [illegible] Mr. Crowe [illegible] [illegible] [illegible]

TENDERS INVITED.

Turbo-Alternators, &c.

BRISTOL Corporation Electrical Committee invite tenders for One 6,000 kw. Three-phase Steam Turbo-alternator, with Condensing Plant. Specifications and forms of tender from the chief engineer and general manager, Mr. H. Faraday Proctor, to whom tenders by noon Monday, Aug. 23. *See also an advertisement.*

Telephone and Telegraph Material, Wire, Instruments, &c.

Tenders are required by Aug. 25, for the supply of Salammoniac (Specification 305), and Steel Galvanised Wire (Specification 414), and by 2 p.m. Sept. 1 for Condensers, Resistance Testing Sets, Relays, Rheostats, Sounders and Wheatstone Transmitters, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *The places where tenders are receivable are stated in an advertisement.*

The Deputy Postmaster-General, Adelaide (South Australia) will receive tenders until 2 p.m. Aug. 18 for Battery Material (schedule 385) and Magneto and Trembling Bells (schedule 386) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept.

The Postmaster-General, Adelaide (S. Australia), will receive tenders until 2 p.m. Sept. 1 for Condensers, Insulation Resistance Testing Sets, Relays, Rheostats, Morse Senders and Wheatstone Transmitters (schedule 384) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Forms of tender, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Cables, Transformers, Meters, &c.

The Electricity Supply Committee of DUBLIN Corporation invite tenders for High-pressure and Low-pressure Cables and Accessories, Transformers and Transformer Pillars, and Electricity Meters. Specifications, &c., from the City Electrical Engineer, Fleet-street, Dublin, and tenders addressed to the chairman, Electric Supply Committee, Lord Edward-street, Dublin, by noon July 26.

ROTHERHAM Electric Light and Tramways Committee require tenders by July 24 for 12 months' supply of Single v.b.-covered Cable, h.t. Cable, Rubber-insulated Cable and Trolley Wire, Amp.-hour Meters and Coal. Specification, &c., from the Engineer and Manager.

Water Service Conduit, &c.

SHEFFIELD Electric Supply Committee want tenders by 10 a.m. July 20 for Water Service Conduit, Screen Chamber, Penstocks, &c., and Pump-room for Cooling Tower Plant. Specifications from Mr. S. E. Fedden, chief supply department, Sheffield.

Steam Piping.

SALFORD Corporation require tenders by noon July 26 for steel Steam Piping for the electricity department. Particulars from the Borough Electrical Engineer.

Wiring and Fittings.

Glamorgan County Council require tenders by July 24 for Improving the Electrical Installation at the girls' intermediate school, TREFOREST. Specification, &c., from Mr. B. J. Day, 3, Park-place, Cardiff.

Motor and Pump.

AYLESBURY Urban Council require tenders by noon July 28 for an Electric Motor and Pump. Forms of tender, &c., from the Engineer and Surveyor, Town Hall, Aylesbury.

Motors, &c.

SYDNEY (N.S.W.) Council require tenders by Sept. 13 for supply of [illegible] and [illegible] Motors during [illegible] months. 382. Specification from the City Electrical Engineer.

Turbo-Alternators, Motor Generators, Boilers, &c.

Tenders are invited for the supply and delivery in MELBOURNE of one 1,000-kw. direct-current Generator with Field Regulator and accessories; one Liquid Starter with accessories, &c. Tender forms, &c., from the agents for City Council (Messrs. Mellwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-bldgs., London E.C. Tenders to Chairman of Electric Supply Committee, Town Hall, Melbourne, by 10 a.m. Aug. 11.

Meters and Maximum Demand Indicators.

Tenders are invited for the supply of a.c. and d.c. Meters and m.d. Indicators to the City of MELBOURNE. Copies of specification, &c., from the agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Propy. (Ltd.), Billiter Square-buildings, London, E.C., to whom tenders by noon July 27.

Fire Alarms.

RANGOON (Burma) Municipality require tenders by Aug. 11 for the installation of a system of Fire Alarms for the town of Rangoon. Specification, &c., from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

MARKET DRAYTON.—The Urban Council have accepted the tender of the local electric lighting company for public lighting.

The gas company quoted 3s. 6d. per 1,000 ft., the Council to undertake lighting and maintenance, or £2. 3s. per burner per annum if the company do the lighting and maintenance. The electric lighting company offered (1) to light the existing lamps contiguous to their mains with 100 c.p. lamps from Aug. 1 to May 31 from sunset to midnight at £2. 1s. per lamp; (2) to light any seven lamps contiguous to their mains all the year round from sunset to sunrise with 100 c.p. lamps at £3. 10s. per lamp; (3) to connect each standard to the existing mains, and fix with bracket and reinstatement, at £2. 10s. per lamp, or to connect each standard to the mains, without new brackets, at £1. 12s. 6d. per lamp. With regard to lamps not contiguous to the mains, they were prepared to light these by means of overhead wires, and the cost would be the same as the others.

LONDON COUNTY COUNCIL.—The Council have accepted the following tenders:

T. Butler & Co. (£87) and Martin & Son (£2,060) iron castings for tramways department; E. Allen & Co. (£370), Hadfield Ltd. (£5,787) and Rennies' Steel Casting Co. (£131) steel and iron casings for tramways department.

BETHNAL GREEN (LONDON).—The Electricity Committee have accepted the tenders of the British Westinghouse Co. for meters, the Reason Mfg. Co. for m.d. indicators and Venner & Co. for time switches, for 12 months in all cases. For meters Venner & Co., British Thomson-Houston Co. and Ferranti (Ltd.) also tendered. The Reason Mfg. Co. also tendered for time switches. No tenders were received for house service fuses.

MONOMETER FURNACES, &c.—The Monometer Mfg. Co., Aston, Birmingham, inform us that they have received orders for furnaces or heat controllers from Mellowes & Co., Simplex Conduits (Ltd.), Hart Accumulator Co., Pritchetts & Gold, Clews & Sons, Shamrock Aluminium Co., Jackson & Co., India Rubber, Gutta Percha & Telegraph Works Co., Sheffield Corporation Tramways Dept., Hadfields (Ltd.), Greenwood & Batley, and D. Callander.

PORTSMOUTH.—The Corporation have accepted the tender of Walter Scott (Ltd.) for 100 tons of B.S.S. No. 3 rails, £10. 10s. per ton; 5 tons of B.S. fishplates, £13. 10s. per ton; 1 ton fishplate bolts, £17. 10s.; and 3 tons of 5 ft. tie-bars, £17. 10s. Hadfield's (Ltd.), Bayliss, Jones & Bayliss, Bolckow, Vaughan & Co., and Chas. Richards & Sons also tendered.

MELBOURNE (VICTORIA).—The Council have accepted the tender of Callender's Cable & Construction Co. for 9,680 yds. of insulated copper cable at £1,742 10s.

SHEFFIELD.—The offer of Cammell, Laird & Co. to supply 500 steel tramcar tyres, and of Brown, Bayley's Steel Works to supply three specimens of 50 tyres each have been accepted.

PENRHYN.—The tender of the Penrhyn & District Electric Supply Co. has been accepted for the electric lighting of the town at £112 per annum.

RHONDDA.—Seven tenders were recently received for wiring the Council offices, and the lowest, that of J. Rees & Son, at £149. 10s. was accepted. The amount of the highest tender was £198. 2s. 6d.

GRANGEMOUTH.—Siemens Bros. Dynamo Works have received an order for the supply of Tantalum and Wotan lamps from the Burgh of Grangemouth for the ensuing 12 months.

PORTSTEWART IRELAND. The Town Commissioners have accepted the tender of the Portstewart Electric Supply Co. for erecting the public lighting standards, &c., at £75.

LEEK.—The Corporation have accepted the tender of the Anglo-American Oil Co. for the supply of 150 tons of fuel oil to the electricity works.

BARROW.—The tender of the Premier Cooling & Engineering Co has been accepted for the supply and erection of a cooling tower.

ECCLES.—The tender of E. Beal (at £60) has been accepted by the Education Committee for wiring Anson-street school.

DERBY.—The tender of Marshall & Plumtree has been accepted for the supply of 10,000 carbons at £25. 15s. per 1,000.

BRADFORD.—The Electricity Committee have placed an order with Ferranti (Ltd.) for six transformers, and with the Brush Co. for two.

SYDNEY (N.S.W.).—The Council are recommended by the Electric Lighting Committee to purchase, under existing contracts, from the Australian General Electric Co. nitro-incandescent lamps, £2,537. 10s.; Janterns and reflectors, £650; spare reflectors, £130; and compensators, £170; and from N. Guthridge, contact and suspension gears, £197. 10s.

The following tenders were received for disconnecting switches and fuses: W. G. Watson & Co., £420, alternative, £792; Australian General Electric Co. (*rec. for acceptance*), £1,413, alternative, £1,154.

The following tenders were received for fibre conduit: Hunt & Eggers (*rec. for acceptance*), 2s. 9d. per yard, (alternative) 1s. 6d. per yard Noyes Bros., 2s. 11d. per yard; W. G. Watson, 3s. 9½d. per yard.

Government Contracts.—The following tenders were accepted by the British Government Departments during June :—

War Office.—Baird & Tatlock, chemical apparatus, &c.; British Insulated & Helsby Cables, Callender's Cable & Construction Co., Connolly Bros., Craigpark Elec. Cable Co., W. T. Glover & Co., W. T. Henley's Telegraph Works Co., Hooper's Telegraph & Indiarubber Works, Johnson & Phillips, Johnson Matthey & Co., Liverpool Elec. Cable Co., Macintosh Cable Co., Midland Elec. Wire Co., St. Helens Cable & Rubber Co., Siemens Bros. & Co., Ward & Goldstone & Western Electric Co., electric cable and wire, &c.; General Electric Co., conduits and fittings; Bruce, Peebles & Co., motor converters; Edison & Swan United Elec. Light Co., Eli Griffiths & Sons and A. Lyon & Wrench, electric lamps; Electric Construction Co., electric motors; Siemens Bros. Dynamo Works, batteries at Scotts House and Whitley Bay; Drake & Gorham, electric generating set, Didcot; Corse & Co., electric lighting Ford House, Devonport.

India Office.—Marconi's Wireless Telegraph Co., wireless apparatus; Lancashire Dynamo & Motor Co., dynamos, testing apparatus, &c.; Creed Bille & Co., printing machines; Siemens Bros. & Co., Morse keys; J. Stone & Co., lighting spares; Siemens Bros. & Co., standards; General Electric Co., telephone sets.

Crown Agents for the Colonies.—Marconi's Wireless Telegraph Co., telegraph apparatus.

Post Office.—India Rubber Gutta Percha & Telegraph Works Co., telegraph apparatus and telephone cable; Western Electric Co., telephone cable and apparatus and modification of A and B positions at Dublin telephone exchange; Siemens Bros. & Co., submarine and telephone cable, and dry cells; Telegraph Construction & Maintenance Co., submarine cable; British Insulated & Helsby Cables, telephone cable and copper wire; W. T. Henley's Telegraph Works Co. and New Gutta Percha Co., telephone cable; London Elec. Wire Co. and Smith's, covered copper wire; F. Smith & Co. (inc. in London Elec. Wire Co. and Smiths), T. Bolton & Sons, Elliotts Metal Co., Johnson & Nephew, Shropshire Iron Co. & Wilkes Son & Mapplebeck, copper wire; Waygood-Otis, lifts at engineers' headquarters, Denman-street, London.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially prepared for us by Messrs. MARKS & CLERK, Chartered Patent Agents, [illegible], W.C.

We cannot supply specifications from the date on which the application was lodged at the Patent Office, but must wait for them to be published after the title.

[illegible] filters. (29.1.13.)

[illegible] ne systems. (Addition to 14,614.13.)

[illegible] utomatically introduced into the

[illegible] nising rotary and cascade

7,760 VON HERZINGER. Memorandum boards for use in connection with telephones and the manufacture thereof.

[illegible] means of rays emanating from a Röntgen tube or other source. (29.3.13.)

A method for the internal irradiation of the human body by means of rays from a Röntgen tube, radium, mesothorium or the like, consisting in causing a relative oscillating or rotating movement between the stopped down source of radiant energy and the body, and concentrating the said rays upon a determined point within said [illegible].

7,796 SIEMENS BROS. DYNAMO WORKS, BEARDSLEY & WILSON. Commutators for dynamo-electric machines.

7,868 SIEMENS-SCHUCKERTWERKE GES. Apparatus for diminishing the air friction in electric machines having flywheels. (29.3.13.)

8,147 GRISSON. Cooling device for the electrodes of vacuum tubes, particularly Röntgen tubes. (14.10.13.)

8,258 SIEMENS-SCHUCKERTWERKE GES. Polyphase commutator electric machines. (3.4.13.)

8,353 SCHMIDT & DOSSLAW. Pocket electric lamps adapted to be used as target illuminating devices for pistols and the like. (28.4.13.)

8,367 MASCHINENFABRIK SUDTH GES. Electrolytic apparatus. (3.9.13.)

8,385 ROSENBERG. Rotary converters provided with boosters.

8,473 SIEMENS BROS. & CO. & GRINSTED. Automatic signalling devices for indicating faults or other abnormal conditions of electric circuits.

12,361 WITHERS. (Cox.) Selenium cells especially adapted for use in connection with telegraphy.

14,470 BERRY. Means for controlling the heating effect of electric heating apparatus.

14,669 DAMEY & BRADLEY. Electric candle lamps.

14,800 MARTIN. Apparatus for and method of operating electric signs, devices, indications and the like.

14,817 BRITISH INSULATED & HELSBY CABLES, BAYLES & HIGHAM. Electrical condensers.

14,891 DAWSON & BUCKHAM. Receivers for use with electrical apparatus for transmitting and receiving signals.

14,894 HOBHOUSE, SLINGO, GUNTON & DOUGLAS. Electric railway system.

15,194 B.T.-H. CO. (G.E. Co.) Electric motor meters.

15,329 SIEMENS BROS. & C. & LE MARECHAL. Metal filament electric lamps.

15,489 JONES. Electric lamps and their holders.

15,585 SIR C. A. PARSONS. Dynamo-electric machinery.

Air-cooling devices for dynamo-electric machinery, comprising radial and axial passages so arranged that cooling air entering any radial passage between stator plates is divided, part passing through axial passages through the stator plates in the neighbourhood of the conductors and part passing direct to the air-gap.

15,617 SABINE. Wire filaments for electric incandescent lamps and other electric resistances.

15,749 DAUM. Electric fuses.

16,590 SIEMENS BROS. DYNAMO WORKS & KIEFFER. Cooling arrangements for dynamo-electric machinery. (Cognate application, 18,396/14.)

16,680 FRANK. Radiators containing liquid and heated by fuel, steam or electricity.

17,415 BETULANDER & PALMGREN. Automatic or semi-automatic telephone exchange systems.

17,797 HILL. (Apparate-Bauanstadt Fischer Ges.) Socket terminals for electric conductors.

18,276 RAILING & KRAUSE. Electric fuses or cutouts.

18,870 PEARSON. Combined lamp-holder and contacts for electric portable lamps.

19,054 ROBERTS. Receiver for wireless systems. (25/8/13.)

A receiver for wireless systems comprising a sound transmitter and a receiver arranged in circuit with a local battery and in the detector circuit of a wireless system wherein a reciprocatory action is produced between the transmitter and the receiver, resulting in the production of a continuous audible sound which is silenced or "dampened" at periods corresponding to the lengths of time that the waves are produced [illegible].

20,549 BEAVER & CLAREMONT. High-voltage insulated cable.

20,552 BRUCK. Magnetic separators. (3.10.13. Addition to 11,898.11.)

21,435 B.T.-H. Co. (G.E. Co.) Electric incandescent lamps.

21,955 BLOGG & STERLING TELEPHONE & ELECTRIC CO. Intercommunication telephone systems.

22,487 LINCOLN. Electric measuring instruments for alternating currents. (29.11.13.)

23,791 BURDON. (Siemens & Halske Akt.-Ges.) Electric ignition apparatus for internal combustion engines.

23,868 BURDON. (Siemens Schuckertwerke Ges.) Slot keys or slot-closing devices for use in dynamo-electric machinery.

23,930 IMRAY. (Siemens & Halske Akt.-Ges.) Selecting devices for telephone or other circuits.

1915 SPECIFICATION.

6,060 CADANEL. Electro-magnetic locking devices. (Divided application on 13,715/14. June 5.)

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Abridgment (within parentheses) are issued communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

June 7. 1915.

8,420, 8,421 B.T.-H. Co. (G.E. Co., U.S.) Electric incandescent lamps.

8,449 GIRAUD. Electric rivet-beaters and the like. (20/6/14. France.)*

8,458 UREN & CAMBLE. Joining up the ends of electrical conduits. (18/6/14. Australia.)*

June 8. 1915.

8,466 SOC. ANON. DES ETABLISSEMENTS L. BLERIOT. Electrical installations. (25/7/14 Belgium.)*

8,468 UNDERWOOD & UNDERWOOD (MANCHESTER) (LTD.). Electrical hand lamps.

8,477 WARREN. Electric lamps for bicycles and the like.

8,480 AUBURN. Telephone transmitters and transmission.

8,485 B.T.-H. Co. (G.E. Co., U.S.) Centrifugal compressors.

8,508, 8,512 MARKS. (Landers, Frary & Clark, U.S.) Electric heaters and electric heating apparatus.*

June 9. 1915.

[illegible]

8,524 DENNIS. Electric vulcaniser.*

8,537 KERR. Electrical heater.*

8,543 B.T.-H. Co. (G.E. Co., U.S.) Electric welding apparatus.

8,546 ROBINSON. Electric fuse carriers.

[illegible] apparatus. (Divided application on 21,921/14. Nov. 3.)*

June 10. 1915.

8,572 NEWLAND. Dynamo-electric machines.

8,610 CORBRIDGE. Electrical taction.

June 11. 1915.

[illegible]

June 12. 1915

8,679 STATTER. Transforming electric currents.

[illegible]

8,712 BRITISH INSULATED & HELSBY CABLES (LTD.). & HARRISON. Telegraph systems and apparatus therefor.*

[illegible]

Thermo-electric pyrometer.*

[illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Burton on Trent. The accounts of the electricity department for the year ended March 31 show gross capital expenditure £124,723 (increase £9,482).

Revenue was £18,593 (compared with £17,124 in previous year), working and general expenses were £8,341 (£8,085), to which is added profit sharing scheme bonus to employes (£230), and £876 (£691) of capital expenditure was provided out of revenue. Interest required £2,853 (£2,720) and redemption fund £3,719 (£2,554), leaving surplus £2,566 (£3,056). Units sold were 2,914,828 (2,526,706). Coal cost 0·205d. (0·295d.) per unit, total working costs were 0·686d. (0·767d.), and total costs (including capital charges) 1·319d. (1·330d.). Total maximum load was 1,405 kw. (1,172 kw.) and load factor was 25·3 (24·6) per cent.

The borough electrical and tramways engineer (Mr. Thos. Hall) says in his report, although there is a decrease in the surplus of £490, £876 has been provided for capital expenditure out of revenue, and there is an increase of £1,336 for interest and repayment of loans. The expenditure during the year, apart from ordinary extensions of mains, &c., was chiefly for the new duplicate turbine which will shortly be ready to take the load. Of the increased sales, 379,469 units were to power and heating consumers (an increase of 25 per cent.). Considering the restricted lighting during the winter and the tendency to economise, the lighting revenue increased by £161. The increase of power revenue is £1,053. During the last two years revenue from power supply has increased £2,128. Revenue from sale of energy for heating was £435, against £214. This is due to the number of radiators, &c., which have been sent out since the opening of the showroom. Average price realised for current was 1·49d. per unit. There was a decrease of £620 in the fuel bill. Though the output increased 37 per cent. in the last two years, thus proving the utility of the cheap unit, and that the average cost of production in any one year cannot be taken as the minimum at which it is possible to produce a unit. Mr. Hall says it is obvious that to take the average price per unit as the basis of the cost of generation for a given supply is entirely wrong in principle. There is a decrease of 20 per cent. in generation costs, but repairs to machinery increased by £192, accounted for by the purchase of two new mechanical stokers, which has been charged to revenue. Mr. Hall thinks the fuel cost of 0·205d. per unit is about the lowest in the country for a similar output, and further justifies the Committee's action in bringing the generating plant into line with modern practice. The new showrooms were opened on Dec. 15, 1914. Previous to the opening of the showrooms the sales of electricity for domestic purposes were very small. For the three months ended March 31 81 radiators (213·5 kw.) had left the showrooms. Sales for heating purposes this year have increased by 104 per cent., and there is every possibility of this rate of increase being maintained. Without a showroom it was useless to tackle the cooking question, but there are at present three cookers out on trial, and the consumers are highly satisfied with their operation. There has also been a fair demand for electric fittings, irons, kettles and sundry apparatus. The profit-sharing scheme was put into operation on April 1 last, and has been a decided success. The bonus works out at 6·28 per cent.

Manchester. The accounts of the electricity department for the year ended March 31 show total capital expenditure £3,052,315 (increase £92,511), and the mortgage debt now stands at £1,793,822.

Last year's revenue was £543,546 (compared with £513,589 in 1913-14), expenditure (before providing for depreciation) was £295,444 (£276,484), leaving £248,102 (£237,105), of which £25,618 (£22,343) has been placed to [illegible] £114,000 (£111,000) interest on [illegible] £9,000 (£8,000) was applied to [illegible] £30,000 (£28,700) was paid to the [illegible] £85,971 (£90,000). [illegible] £2,000 (£2,000), [illegible] £27,772 (£17,959). [illegible] £0·921 (1·024) per unit. [illegible] 40,020 kw. (39,497 kw.) for lighting and power, and 10,440 kw. (9,100 kw.) for [illegible]

The report of the [illegible] Committee states that [illegible] during the period of the [illegible] the [illegible] £3,000, and [illegible] £4,000 (£3,166) are also included in the year's accounts. Renewals and extensions [illegible] £30,000 [illegible] £30,000 [illegible] £30,000

cent. The decrease in power supplies (0·075 per cent.) is not so great as was expected, owing to the extra demand for Government work. New substations varying from 75 kw. to 375 kw. capacity have been connected during the year. Two new underfeed stokers at Hylton-road works have fully complied with expectations. 18,096 yds. of network cable have been replaced during the year, and 1,620 yds. of new l.t. cable, and 328 yds. of new e.h.t. cable have been laid. Consumers number 1,700 (increase 78), and total connections in (equivalent) 32 watt lamps are 620,904 (increase 91,690). Maximum load was 6,300 kw. (6,700 kw.) and load factor 26·27 (25·34) per cent.

COMPANIES' MEETINGS AND REPORTS.

BRITISH DYES (LTD.)—At the statutory meeting last week the chairman (Mr. J. Falconer, M.P.) gave an account of the progress of the company. He said their aims were first to deal with the present emergency, and, secondly, to lay the foundation of a national supply of dye-stuffs that would make us permanently independent of the Germans. They would have a research department, as without research by well-trained chemists they could not keep the lead, and they would also have a technical committee. They were in touch with the universities, and sought to get the assistance of the best experts for the solution of all problems that arose.

DAVEY, PAXMAN & CO. (LTD.)—For the 15 months to March 31 the profit was £17,745, and with £4,295 brought forward the available total was £22,040. A sum of £3,153 has been placed to depreciation reserve, and after allowing £2,375 for directors' fees, paying 1½ years' debenture interest and writing off £1,395 for South African expenses and patent licences, £10,287 has been carried forward.

DEUTSCH UBERSEEISCHE ELEKTRICITATS GESELLSCHAFT. This company, which controls a number of South American electricity supply works and tramway undertakings, has declared a dividend of 10 per cent. for 1914, compared with 11 per cent. in 1913. The net profit was M.14,798,083 (about £739,904), against M.14,728,037 (about £736,400). The reduction in dividend is due to the increased capital and to the South American crisis. The whole of the company's undertaking suffered from the general depression which retarded their development. During the year 239,881,777 units were generated, against 227,190,875 units in 1913, the energy utilised being 191,315,513 units, against 179,462,398 units in 1913. The report also gives some particulars of the position of the subsidiary companies in Buenos Ayres, Santiago, Valparaiso and Montevideo.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—The directors' report for the year ended May 31 shows gross profit £7,423. 4s. 6d. After deducting all general charges, interest, transferring £2,409. 7s. 5d. to reserve, and adding £3,074. 15s. 9d. brought forward, there is a balance of £5,222. 5s. 7d., which the directors recommend should be carried forward. £81,000, appearing as a provision for contingencies in the last balance-sheet, has been debited with £4,255. 1s. 7d. in respect of losses incurred, and after transferring thereto £2,409. 7s. 5d. from profit and loss, there is a balance of £82,154. 3s. 10d., which has been deducted from the value of the company's investment, and is now disclosed as an investment reserve fund.

KALGOORLIE ELECTRIC TRAMWAYS (LTD.)—At the meeting on Monday the chairman, Mr. Allen H. P. Stoneham, said the war had had an adverse effect upon their enterprise, and they were still suffering from the unfair competition of the motorcar service. The depressed condition of the mining industry also affected their receipts. The drought had broken up and heavy rains had fallen. The crops were looking well, and there was every prospect of a good harvest, which would favourably effect receipts.

KRAFTUBERTRAGUNGSWERKE RHEINFELDEN (A.G.)—A dividend of 8 per cent. has been declared as in 1913. The report states that the company suffered from the number of men called up for service, and that there was a falling off in the demand for energy on the outbreak of war, but it is claimed that the greater part of the loss was made good by the end of September.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The gross profit for the year 1914 amounted to £371,071. 11s. 6d. and the net profit to £232,716. 8s. 11d. (an increase over 1913 of £110,392), and with £76,549. 15s. 7d. brought forward, the total was £309,266. 4s. 6d. The basis of remuneration from the Government for the use of the company's high-power stations since the beginning of the war and other services not yet having been settled, it has not been possible to include any sum in respect of them in the profit and loss account of the year. In the balance-sheet shares in Associated Companies and patents are again taken at their cost price (£1,360,125. 15s. 4d.), an increase of £61,382. 1s. 10d., mainly comprised of the company's proportion of the increased capital of the Russian Company. The par value of shares held in Associated Companies now stands at £2,469,858. 14s. 10d., exclusive of shares which have been transferred to special reserve account, which now stands at £807,230 0s. 0d. The French company, Cie Française Maritime et Coloniale de Telegraphie sans Fil, has declared a dividend for 1914 at rate of 10 per cent. on the ordinary shares and 31·25 fr. per share on the founders' shares. The Marconi International Marine Communication Co. has again shown substantial increase of business and profits and dividends amounting to 10 per cent. have been declared. The Russian company (Société Russe de Télégraphes et Télépho nes sans Fil) has made satisfactory progress and a dividend at rate of 15 per cent. for 1914 (compared with 6 per cent.) has been declared. The Marconi Wireless Telegraph Co. of America earned increased profits, but owing to the conditions prevalent in Europe, and the consequent necessity to defer the opening of the transatlantic service, the directors decided not to declare a dividend. The outbreak of war caused considerable dislocation of the company's affairs as well as those of the Associated Companies. Businesses of importance which were on the point of fruition have had to be deferred, many negotiations which were in course of successful progress with Foreign Governments had to be abandoned for the time being; the opening of the direct public telegraph services between this country and the United States of America and Spain have had to be postponed. The sum of £4,347. 0s. 6d., due from the Turkish Government, has not been received. In all the circumstances the directors consider it prudent to recommend the declaration of a dividend of 10 per cent. upon the ordinary shares; to place £100,000 to general reserve account, and, after deducting the dividend of 7 per cent. paid earlier in the year upon the preference shares, to carry forward £69,497. 8s. 6d. The directors do not contemplate that any loss in consequence either of loss in exchange or deferred payments will result, but having regard to the serious war in which the country is engaged, they consider they are best studying the interests of the shareholders in adopting a conservative policy. The board are gratified to be able to state that during the current year the company has been engaged to its fullest capacity in supplying the demands of the British, Colonial and Foreign Governments. The orders in hand justify the anticipation that the volume of business this year will exceed that of any previous year.

MOND NICKEL CO. (LTD.)—At the recent meeting the chairman (Sir A. Mond, Bart.) said their shares in associated companies stood at £161,000 against £89,000. The vast bulk of that sum was represented by a subsidiary company formed in Canada to obtain charters to develop water-power for the purposes of the mine and smelter. A large amount of the increase in the shares of associated companies was in connection with the development of the water-power. The water-power was extremely valuable, producing electricity at a low rate. It had been a source of very great economy indeed to the company: in fact, unless they had developed the water-power their profits would have been very seriously diminished. It worked smoothly, gave very little trouble, took very little labour and was very economical in upkeep.

J. STONE & CO. (LTD.)—The report for 1914 states that the satisfactory condition of the company's trade which prevailed throughout 1913 continued and showed remarkable improvement until the outbreak of war. Since that date the company's works have been devoted to the manufacture of Government requirements. The credit balance (after allowance for depreciation, &c.) is £198,926, making, with £125,162 brought forward, a total of £324,089. After deducting preference dividend and placing £20,000 to reserve fund, the directors recommend a dividend of 10 per cent. per annum and a bonus of 3s. per share on the ordinary shares, leaving £189,039 to be carried forward.

WELSBACH LIGHT CO. (LTD.)—The net profit for the year ended March 31 is £5,096, and with £612 from last year the available total is £5,708, which the directors recommend be carried forward. During the year no dividend was received in respect of the company's share-holding in the Austrian company, but it has been ascertained that a dividend of 5 per cent. was declared in December last.

At the meeting last week the chairman (Mr. J. R. Yates) said that there had been a tendency for expenses to increase in every direction, but the trading profit of over £20,000 (an increase of £6,670 over that of 1913) was not unsatisfactory. Their trading for the current year was shaping as well as could be expected. The figure in the balance-sheet representing the Austrian shares was one which must give cause for reflection, as there would be difficulty in forecasting what would be the actual value of those shares when peace came.

WESTERN UNION TELEGRAPH CO.—The report for the six months to June 30 shows revenue and income $24,019,260, expenses $19,359,745, interest on bonds $668,600, net income $3,990,915 (increase $1,891,080).

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

BERRY & HAYWARD (LTD.) (140,957)—Reg. July 13, capital £2,000 in £1 shares, to take over business carried on at Nottingham as Berry & Hayward, and to carry on business of electrical engineers and contractors, manufacturers of and dealers in electrical apparatus and appliances, manufacturers of electric cables, incandescent lamps, &c. Private company. First directors: J. C. Berry and A. T. Hayward.

BIRMINGHAM CENTRAL SUPPLY CO. (LTD.) (140,884.)—Reg. July 6, capital £2,000 in £1 shares, to take over business carried on as the Central Supply Co., and to carry on the business of engineers, manufacturers of and dealers in electrical apparatus, equipment, machinery and appliances, &c. Private company. W. Parsons is sole permanent director and chairman.

J. FARR & CO. (LTD.) (140,905).—Reg. July 7, capital £1,500 in £1 shares, to adopt an agreement with J. Farr (trading as J. Farr & Co.) for the purchase of the business of an electrical engineer and dealer in electrical goods carried on by him. Private company. Directors are J. Farr (governing director, subject to holding 1,000 shares) and Mrs. M. A. Farr (both permanent). Secretary: H. Onion, 81, Beech-avenue, Nottingham.

MONARCH ELECTRIC CO. (625)—Reg. July 12. Electrical engineers, 23, Scarborough-street, West Hartlepool. Partnership for five years from Feb. 1, 1915. Determinable on or after Feb. 1, 1916, by any partner on six months' notice. General partner: F. Rawcliffe, 77, Bayswater-road, West Jesmond, Newcastle-on-Tyne. Limited partners: R. R. Barkes, 50, Highbury, West Jesmond, Newcastle-on-Tyne, and H. Barkes. Contributing £75 each in cash.

STATUTORY RETURNS.

ALERT ELECTRICAL CO. (LTD.)—Capital in return dated March 27, 1915, is £2,000 in £1 shares. 708 shares taken up. £708 paid. Mortgages and charges nil.

BATH ELECTRIC TRAMWAYS (LTD.)—The capital in return to April 1, 1915 is £230,000 in £1 shares. (75,000 preference, 125,000 preferred ordinary and 30,000 deferred ordinary). 75,000 preference, 75,606 preferred ordinary and 30,000 deferred ordinary shares taken up. £1 per share called up on 75,000 preference and 75,606 preferred ordinary shares. £150,606 paid. £30,000 considered as paid on 30,000 deferred ordinary shares. Mortgages and charges: £155,739

CABLE ACCESSORIES CO. (LTD.)—According to return to May 20, capital was £20,000 in £1 shares (4,000 6 per cent. cumulative preference), 10,500 ordinary and 1,800 preference shares taken up. £1 per share called up on 8,042 ordinary, 15s. per share on 348 ordinary, 12s. 6d. on 1,910 ordinary, 10s. on 200 ordinary, and £1 on 1,800 preference. £8,346. 15s. paid. £3,050 considered as paid. Mortgages and charges: Nil. Return of allotments, made up to May 28, 1915, shows a further 50 preference and 5,500 ordinary shares allotted for cash.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—In return to March 30 capital is £1,200,000 in £10 shares (80,000 ordinary and 40,000 preference). 70,595 ordinary and 40,000 preference shares taken up; £1,105,950 paid. Mortgages and charges, £800,000.

GELL TELEGRAPHIC APPLIANCES SYND. (LTD.)—Capital at March 12 was £40,000 in £1 shares. 37,700 shares taken up. 10s. per share called up on 15,000 and £1 per share on 7,700 shares. £15,537. 10s. paid (including £337. 10s. paid on 1,500 shares forfeited). £22,500 considered as paid, being £1 per share on 15,000 and 10s. per share on 15,000 shares. Mortgages and charges: £1,000. The capital was reduced to £20,000 in 10s. shares on May 25, 1915.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—Return to April 6 gives capital as £200,000 in £5 shares (25,000 preference, 20,000 preference and 11,452 ordinary shares taken up. £5 per share called up on 13,500 preference. £67,500 paid. £89,760 considered as paid on 6,500 preference and 11,452 ordinary. Mortgages and charges: £59,540.

TELEPHONE CO. OF EGYPT (LTD.)—Return to April 28 gives capital as £200,000 in 36,000 preference and 4,000 deferred shares of £5 each. All shares taken up; £5 per share called up on 24,000 preferred; £120,000 paid; £80,000 considered as paid on 12,000 preferred and 4,000 deferred. Mortgages and charges, £184,254

URBAN ELECTRIC SUPPLY CO. (LTD.)—According to return to April 14 capital is £640,000 in 80,000 ordinary shares of £5 each, 50,000 preference shares of £5 each and 150,000 unclassified shares of £1 each. 80,000 ordinary and 50,000 preference shares taken up. £3 per share called up on the ordinary and £5 per share on the preference. £490,000 paid. Mortgages and charges: £408,210.

MORTGAGES AND CHARGES.

G. H. TURNER & CO. (LTD.)—Issue on July 12, 1915, of £60 debentures, part of a series of which particulars have already been filed.

RECEIVERSHIPS.

BRITISH SHERARDIZERS (LTD.)—Notice of appointment of W. R. Gaff, of 54, New Broad-street, E.C., as receiver on July 8, under powers contained in debenture dated June 10, 1915, has been filed.

DUFFIELDS (LTD.)—L. G. Godfrey, 77, Norfolk House-road, Streatham, S.W., ceased to act as Receiver on July 2, 1915.

ERNEST SCOTT & MOUNTAIN LTD.) [illegible] 32, Grainger-street West, Newcastle-on-Tyne, ceased to act as Receiver or manager on May 26, 1915.

R. HERBERT & CO. (LTD.)—G. E. Corfield, of Balfour House, Finsbury Pavement, E.C., ceased to act as Receiver and Manager on June 3, 1915.

RESIDE & CO. (LTD.) Notice of appointment of H. T. Dawson, Bank House, Brighouse, as receiver on July 1, 1915, under powers contained in second mortgage debentures dated Aug. 7, 1911, has been filed.

COMPANY INCORPORATED OUTSIDE THE U.K.

BAUXITES DU VAR [illegible] Capital 250,000 fr. in shares of 100 fr. [illegible] 1915, to deal with work and dispose of Bauxite and [illegible] British address: 52, Coleman-street, E.C., where H. J. Jack is authorised to accept service.

CITY NOTES.

MEMORANDA (July 21).—Bank rate 5 per cent. (since Aug. 8, 1914.) Consols 65. Consols Pay Day Aug. 5. Stocks and Shares Ticket Days July 28 and Aug 11. Pay Days July 29 and Aug. 12. Price of silver, 22⅝ d.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—At an extraordinary meeting last week the resolution recently passed authorising an alteration in the articles of association to extend the objects of the company so as to include electricity supply, &c., was confirmed.

CLONTARF & HILL OF HOWTH TRAMWAY CO. (LTD.)—An interim dividend at rate of 3 per cent. per annum for the past half-year has been declared.

COMPANIES STRUCK OFF THE REGISTER.—On July 16 Illuminated Signs and New Imperial Electric Lamp Co. were struck off the Register of Joint Stock Companies.

JULIUS PINTSCH (A.G.) This company has declared a dividend of 8 per cent. for 1914, the net profit being £74,138, against £75,648 in 1913.

KALGOORLIE ELECTRIC TRAMWAYS (LTD.)—This company's gross receipts for May were £3,269, and estimated working expenses were £2,191. Aggregate receipts from Jan. 1 were £13,472

LANARKSHIRE TRAMWAYS CO.—An interim dividend at the rate of 5½ per cent. for the half-year ended June 30 has been declared.

LIVERPOOL OVERHEAD RAILWAY CO.—The directors have declared an interim dividend at the rate of 5 per cent. per annum on the preference shares and 2½ per cent. per annum on the ordinary shares, less tax at the rate of 2s. 3½d. in the £.

MONTREAL WATER & POWER CO.—The net profit for year ended April 30, after providing for interest charges, &c., was $384,769. The sum of $72,104 has been applied for depreciation, &c., leaving $312,665 to be carried forward.

SAO PAULO TRAMWAY, LIGHT & POWER CO. A dividend of 2½ per cent. on the common stock, payable Aug. 2.

SIEMENS ELEKTRISCHE BETRIEBE A.G. A dividend of 6½ per cent. has been declared for the year 1913-14, the profit showing an increase of about 350,000 marks over the previous year.

TOTTENHAM LIGHT, HEAT & POWER CO.—The full dividends of 7½ per cent. per annum on the A and 6 per cent. per annum on the B consolidated stock are to be paid, and a dividend at the rate of 5 per cent. per annum on the preference stock for the half-year to June 30 is recommended

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, July 21. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shares	Last Dividend	NAME.	Price, Wed. July 21.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 2 9	Mar, Sept
10	4½	Do. 4½% Pref.	9	4 15 6	Feb, Aug
10	5	Do. 5% Pref.	10¼	5 18 1	Feb Aug
5	10	Brentford & Kew Elec. Ord.	5⅜	6 9 2	Mar, Sept
St.	4	Central Elec. Supp. G. Deb. St	90½	4 8 5	..
St.	4½	Central London West End & City Debs.	83½	4 1 10	Jan, July
5	2 3	Do. 4½ Pref.	4⅜	5 10 0	..
5	5	Do. 5% Pref.	4	6 5 0	Aug, Feb
10	5	City of London Elec. Lt. Ord.	13	6 14 6	Feb, Aug
10	7	Do. 6% Pref.	12¾	4 17 0	Mar, Sept
St.	5	Do. 5% Deb. St.	110	4 10 11	Jun, Dec
10	..	County of London Ord.	10¼	6 10 ..	Mar, Sept
10	..	Do. 6% Pref.	..	5 15 ..	Feb, Aug
St.	4½	Do. 2nd Deb.	97	4 12 ..	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	7½	5 17 2	July
5	..	Kensington and Knightsbridge Ord.	7⅛	6 1 2	Feb, Aug
St.	..	Do. .. Deb.	85	4 13 9	Jan, July
5	4	London Elec. Supp. 6% Pref.	..	5 1 ..	..
St.	4	Do. 4% Mort.	89	4 11 11	Jan, July
..	3½	Metropolitan E. Supp. Ord.	..	6 7 3	Mar, Aug.
St.	4½	Do. 4½% Mort.	..	4 14 ..	Jan, July
St.	..	Midland Elec. Corpn., 1st Mort. Deb. St.	..	5 1 ..	Jan, July
..	..	Newcastle & Dist. E.L. 6% 2nd Dbs ..	6¼	6 1 1	Mar, Sept
St.	..	Newcastle-on-Tyne E.S.5% 2d Mt. Db. St.	100	.. .. ..	Mar, Sept
1	..	North Metropolitan E. P. Supp. 6% Pref	1⅜	5 11 ..	Apl, Oct
St.	..	South London E.S. 1st Mort. Debs. ..	..	5 5 3	Jan, July.
St.	4½	United Elec. 4½% Deb. ..	..	5 5 ..	Apl, Oct
..	..	Waste Heat & Gas Elec. Con. Stations.	1	7 12 ..	Aug
..	..	Westminster E.S. Corp. Ord. ..	..	6	Mar, Sept
5	4½	Do. 4½% Cum. Pref. ..	..	4 14 8	Jan, July.
		Electric Railways & Tramways.			
St.	5%	Brighton & Rottingdean 5% Deb. ..	..	 2	Apl, Oct
St.	..	Central London Ry. 4% Deb. ..	..	.. 14 ..	Feb, Aug
St.	4%	Central London Guar. Assented Ord. ..	..	.. 14 ..	..
..	4	Do. do. Assented Def. Ord. ..	..	.. 14 ..	..
St.	..	Do. 4% Deb. ..	..	.. 11 ..	May, Nov
..	..	Do. 4% Deb. ..	89	.. .. ..	Feb, Aug
..	..	Do. 4% Deb. ..	..	.. 13 ..	Feb, Aug
10	1	London Electric Ry. Ord. ..	11	 10	Jan, July
..	..	Do. 4% Deb. ..	..	 3	Mar, Sept.
..	..	Do. 4% Deb. ..	..	4 14 1	Jan, July
St.	..	Metropolitan Ry. Con. Ord. ..	..	4 10 ..	Feb, Aug
St.	..	Do. 4% Deb. ..	..	4 10 6	Feb, Aug
St.	..	Do. 4% Deb. ..	..	4 14 3	Feb, Aug
..	..	Do. 4% Deb. ..	..	4 4 9	Jan, July
..	..	Do. 4% Deb. ..	85	4 4 1	Jan, July
..	..	Metropolitan Ry. Deb. ..	14	.. ..	Feb, Aug
5	4%	Do. 4% Pref. ..	..	4 7 0	May, Nov

†Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Last Dividend	NAME.	Price, Wed., July 21.	Rate per cent.	Yielded.	Dividend Due.
	Electric Railways and Tramways —*cont.*		£ s. d.		
St. 4½	Metropolitan Electric Tramways 4½ % First Pref.	69	6 10 2		Feb, Aug
St. 6%	Do. 6% Second Pref.	12¾	4 12 3		Jan, July
St. 4%	Do. 4% Third Pref.	8¾	4 10 8		Jan, July
St. 4%	Do. 4% Debs. (1903-5)	8½	4 11 7		Jan, July
St. 4%	Do. 4% Debs.	8½	5 6 5		Mar, Sept
10	Underground Electric Railways Ord. Shares	1	.. ..		..
1/0	Do. A Shares	..	.. ..		..
St. 6%	Do. 6% Income Debs.	1½	5 13 6		Mar, Sept
.. 6%	Do. 6% Income Debs. (Assn. 15)	..	5 .. 6		Mar, Sept
.. 4½%	Do. 4½% Bds.	97½	4 12 2		Jan, July
..	Yorkshire (W. Riding) Elec.	..	.. ..		March
5	Do. Pref.	4¾	7 1 6		Jan, July
	Electric Manufacturing, &c.				
1 1/0	Bergmann & Co. Ord.	2½	5 12 6		Apl, Oct
1 1/0	Brit. Aluminium Ord.	1	5 0 0		Mar
1 1/0	Brit. Insulated & Helsby Ord.	9¾	5 0 3		Jan, July.
100 6%	Do. Pref. Ord.	7	6 12 5		Jan, July
1	Do. 4% Pref.	1½	6 14 10		Aug, Feb
5 15%	Brit. Insulated & Helsby Ord.	6¾	4 16 5		Jan, July
5	Do. 4% Pref.	⅝	5 0 4		Mar, Sep
1 6%	British Electric Traction Mfg. Co. 6% Pref.	⅛	6 0 4		Mar, Sep
2 7½%	Brit. Westinghouse Pref.	1	8 13 11		April
100 6%	Do. 6% First Mtge. Deb.	100½	5 19 6		Apl, Oct
St. 4%	Do. 4% First Mtge. Deb.	73	5 9 4		Jan, July
5 5%	Callender's Cable, &c., Co. Ord.	11	6 15 4		Jan, July
5 2/6	Do. 5% Pref.	5	5 0 0		Feb, Aug
1 15%	Castner Kellner	2½	5 3 3		May, Nov
1 6%	Do. Ker & Donaldson Pref.	⅛	6 18 2		Sept
5	Edison & Swan U. Elec. Ltd. A. £3 pd.	1½	.. ..		Feb, Aug
1 6%	Elec. Construction Ord.	1	5 6 11		May
1 7%	Do. 7% Cum. Pref.	6¾	5 7 0		Jan, July
St. 4%	Do. 4% Debs.	6¾	5 15 4		Jan, July
10 6%	General Electric 6% Pref.	9	6 11 5		Jun, Dec
5 2/6	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 3 2		Feb, Aug
5	Do. 4½% Cum. Pref.	4½	5 0 0		..
St. 4½	Do. 4½% Deb.	98	4 11 10		Jun, Dec
10 5%	India Rubber, G. P. &c., Ord.	8½	6 9 0		Feb, Aug
10 5%	Do. Pref.	8½	5 17 1		Apl, Oct
100 4%	Do. 4% Debs.	98	4 1 1		Apl, Oct
12 12/0	Telegh. Con. & Main. Co.	3¾	7 16 0		Mar, July
100 4%	Do. Deb.	93	4 6 0		Jan, July
1 7½	Vickers Ord.	1½	4 19 4		May, Aug
1 6%	Do. 5% Pref.	..	5 3 3		May, Aug
St. 4%	Do. 1st Debs.	..	5 6 0		Jun, Dec
100 4½%	Do. 4½% 2nd Debs.	1..	4 1 0		Jun, Dec
	Telegraphs.				
100 5%	Amazon Telegh. Co. 5% Debs.	96	5 5 3		Jan, July
St. 30/0	Anglo American 6% Pref. Ord.	9¾	6 2 5		Fb,My,Aug,N
St. 30/0	Do. Def. Ord.	21⅛	6 18 3		Fb,My,Aug,N
St. 4%	Commercial Cable 4% Debs.	72	5 10 4		Ja,Ap,Jly,O
10	Cuba Submarine Ord.	8⅛	5 13 6		May, Nov.
10 10%	Do. 10% Pref.	15½	6 11 2		..
5 5%	Direct Spanish 10% Pref.	7½	6 13 4		..
10 4%	Direct United States	6¾	6 10 7		Ja,Ap,Jly,O
St. 25/0	Eastern Tel. Co. Ord.	13½	5 16 5		Ja,My,Jly,O
St. 12½	Do. 3½% Pref.	7½	4 17 3		Ja,My,Jly,O
St. 4%	Do. 4% Debs.	8⅛	4 17 10		Apl, Oct
St. 4%	Eastern Extension Tel. Co. 4% Debs.	7½	5 1 3		Feb, Aug
10 10%	Do. 10% Pref.	11⅛	6 3 1		Ja, Ap, Jly, O
10 7%	Gt. Northern Tel. Co. with Coup. 8	33½	6 11 4		Ja, My, Jly
25 13%	Indo-European xd and bonus	13½	6 0 4		May, Nov
1 1	Marconi's Wireless Tel. Co.	1	5 8 6		April
1	Do. 7% Pref.	1	4 11 8		July
10 6%	West India & Panama Ord.	11	8 13 11		May, Nov
10 3/0	Western Telegh. Co.	7½	7 3 4		May, Nov
St. 4%	Do. 4% Deb. St.	83	4 16 5		Jun, Dec
.. 4½	Do. 4½% Bds.	9..	4 14 7		May, Nov.
	Telephones.				
.. 32	American Telephn. & Telegh. $100 Cap.	12⅜	6 7 10		Ja,Ap,Jn,O
.. 5%	Cuban Telephn. Co. 5% Bds.	7½	6 13 4		Jan, Jly
1 7	Monte Video Telephn. Ord.	..	5 12 5		Nov.
.. 4½%	New York Telephone 4½% Bds.	1..	4 11 7		May, Nov
1 1	Oriental Telephone Ord. (ex bonus)	1½	5 2 11		Apl, Oct
St. 4%	Do. Db. St.	8..	4 12 6		Jan, July
St. 4½%	Telephn. Co. of Egypt Db. St.	8..	5 2 3		Jan, July
5 8%	United River Plate Ord.	..	6 16 2		Apl, Oct
5 5	Do. Pref.	4½	5 3 3		Jan, July
St. 4½	Do. Deb.	..	5 0 0		Jan, July
	Financial and Investment.				
10 6%	GlobeTelegh. & Trust	7⅜	6 7 5		Sp,Dc,Mr,Jn
1	Do. 6% Pf.	11⅜	5 5 6		Sp,Dc,Mr,Jn
100 5%	Marconi Int. Mar. Co.	7..	7 3 9		Ja,Ap,Jly,O
10	Do. Def.	7½	5 14 3		Ja,Ap,Jly,O
10 6%	Submarine Cable Trust Certs.	12¼	4 18 7		Apl, Oct
	Colonial and Foreign Railways, Tramways, &c.				
St. 4%	Anglo Argentine Trams. 5% Debs.	..	5 .. 5		Jun, Dec
St. 4½	Do. 4½% Debs.	..	5 11 ..		Jan, July
St. 4	Do. 4% Debs.	..	.. ..		Jan, July
1	Do. 5½% 1st Pref.	..	6 16 ..		Jan, July
5 2/9	Do. Pref.	3¾	7 7 2		Jan, July
100 $10	Brazilian Traction Ord.	51	11 15 4		Fb,M,Aug,N
100 $10	Do. Pref.	..	6 16 ..		Ja,Ap,Jly,O
..	Brisbane Trams Ord.	7	5 14 3		May
5 2/6	Do. 5% Cum. Pref.	4½	5 5 2		May, Nov
St. 4½%	British Columbia 4½% Con. Debs.	..	6 15 ..		..
..	Calcutta Elec. Trams. Ord.	..	7 18 ..		Mar, Sep
.. 5%	Havana Elec. Ry. 5% Bds.	..	6 18 ..		Feb, Aug
1	Madras Elec. Trams 6% Cum. Pref.	..	6 0 ..		..
100 5%	Manaos Trams 5% Debs.	..	7 9 11		Jan, July
..	Mexico Trams Common St.	..	.. ..		Fb,M,Aug,N,
1	Do. Pref.	..	3 15 ..		Mar, Sep
1	Montreal Street Ry. 4½% Debs. (1922)	100½	4 .. 7		Feb, Aug
1	Do. Pref.	70½	7 .. 3		Jun, Dec
1	Do. Ord.	..	4 14 3		Feb, Aug
	Colonial and Foreign Electric Supply, &c.				
	Anglo-Argentine Tramways Pref.	5..	5 13 ..		Mar, Sept
	Do. Ord.	9½	5		Jun, Dec
	Barcelona Tramways Ord.	10½	.. .. ..		..
	Do. Pref.	..	.. .. ..		May, Nov
	Buenos Ayres Tramways Ord.	..	.. .. ..		Mar, Sept
	Do. Pref.	..	.. .. ..		Ja,Apl,Jly,O
	Calcutta Electric Supply Ord.	9½	.. .. ..		June, Dec
	Do. Pref.	..	.. .. ..		..
	Canton Electric Ord.	7½	.. .. ..		Jan, July
	Do. Pref.	13½	.. .. ..		Ja,Apl,Jly,O
5%	Do. Deb.	..	4		Jan, July
5%	Do. Deb.	..	4		May, Nov
1	Do. Def.	..	.. .. ..		Jan, July
1	Do. Def.	..	.. .. ..		Jan, July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date July 21, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	14½d.	Antimony	£132 0 0
Solid Drawn Copper Tubes	14½d.	English Lead	£25 5 0
Brazed Copper Tubes	14½d.		
Brazed Brass Tubes	14½d.	**Old Metals.**	per ton.
Brass Wire	14½d.	Clean Scrap Copper	£71 0 0
Copper Wire	14½d.	Brazlery Copper Scrap	£71 0 0
Rolled Brass	14½d.	Clean Scrap Brass	£59 0 0
Brass Sheets	15½d.	Old Lead	£20 0 0
		Old Zinc	£15 0 0
	per ton.	Hollow Pewter	£120 0 0
Copper Sheets	£110 0 0	Black Pewter	£85 0 0
Spelter	£105 0 0	Gun Metal	£64 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date July 20, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£75 0 0	Gun Metal	£64 0 0
Clean Mixed Brass	£57 0 0	Old Lead	£21 0 0
Clean Copper	£67 0 0	Tea Lead	£19 0 0
Copper Wire	£71 0 0	Hollow Pewter	£120 0 0
Brazlery Copper	£61 0 0	Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	Aggregate Amount	Aggregate Inc. or dec. (a)
		£	£	£	£
Aberdeen Corporation	July 11	1,753	+ 7	11,561	— 12
Anglo-Argentine	,, 12	47,...	...	1,432,243	— 12,411
Ashton-under-Lyne	... ...	...	...	...	...
Ayr Corporation	,, 12	608	+ 74	3,717	— 123
Bath Electric Trams, Ltd	... ...	...	...	...	...
Birkenhead Corporation	,, 10	1,438	— 137	21,330	— 916
†Birmingham Corporation	,, 10	14,034	— 177	189,929	+ 2,271
Blackburn Corporation	,, 14	1,251	— 138	20,845	— 1,222
Blackpool Corporation	,, 10	1,699	— 1,133	21,232	— 7,127
Blackpool and Fleetwood	,, 10	961	— 258	14,911	— 3,368
Bolton Corporation	,, 10	2,867	— 6	41,991	— 3,541
Bournemouth { Trams	,, 14	1,994	— 361	31,359	— 674
Bournemouth { Buses	,, 14	32	— 33	374	— 61
Bradford Corporation	,, 10	6,474	— 47	96,260	+ 1,568
Brighton Corporation	,, 13	1,186	— 91	16,801	— 1,421
Bristol Trams { Trams	,, 10	5,025	— 214	129,516	— 2,144
Bristol Trams { Buses, &c.	,, 10	5,319	— 164	131,384	+ 22,755
Burmah E. Trams & Ltg.	,, 11	R4,476	— R367	...	— R46,956
Burnley Corporation	,, 14	1,569	— 93	39,678	— 1,725
Burton Corporation	,, 11	307	— 1	4,499	— 33
Bury Corporation	,, 11	1,366	— 21	21,777	— 60
Calcutta Tramways Co.	,, 17	R68,476	— R1,442	R1,856,964	— R88,001
Camborne-Redruth	... ...	...	...	...	...
Cardiff Corporation	,, 10	2,821	— 221	39,119	— 3,563
Cork Electric Trams Co.	,, 11	541	— 45	13,764	— 282
Coventry Corporation	,, 13	1,039	+ 120	15,127	+ 1,445
Croydon Corporation	,, 10	2,069	+ 233	27,001	+ 389
*Derby Corporation	,, 17	1,072	— 22	16,344	— 276
Dover Corporation	,, 11	311	+ 52	4,423	+ 783
Dublin & Lucan Railway	,, 10	164	...	355	...
Dublin United	,, 10	6,310	— 433	169,457	+ ...
Dundee Corporation	,, 11	1 356	— 145	11,687	— 121
East Ham Council	,, 12	1,335	— 172	20,640	— 3,...
Exeter Corporation	,, 10	403	— 6	5,879	— 1...
Glasgow Corporation	,, 12	21,452	1,446	150,763	+ 3,978
Glossop Trams	,, 12	134	— 1	3,458	— 152
Gloucester Corpn.	,, 14	...	16	5,030	— 1...
Halifax Corpn. { Trams	,, 13	...	54	34,120	— 370
Halifax Corpn. { Buses	,, 13	...	1	756	— 20
Hastings Elec. Trams Co.	,, 11	1,059	— 29	24,009	— 1,...
Huddersfield Corpn.	,, 12	2,633	+ 241	42,069	+ 3,968
Hull Corporation	,, 12	3,044	+ 178	47,...	+ 3,415
Ilford District	,, 12	...	— 43	10,291	— 1,795
Ilkeston Corporation	,, 14	1...	— ...	1,951	— 1...
Ipswich Corporation	,, 11	...	— 5...	8,235	— 6...
Isle of Thanet Co.	,, 17	...	— 47	13,900	— 32
Kilmarnock Corporation	... ...	...	...	...	...
Lanarkshire Trams Co.	,, 10	2,013	— 13	52,298	— 1,707
Lancashire United	,, 14	1,777	— 6...	47,188	— 38
Leeds Corporation	,, 12	9,111	— 24	139,645	+ 5,032
Leicester Corporation	,, 13	3,210	— 111	84,331	+ 1,301
Leith Corporation	,, 11	...	— 31	7,235	— ...
Lincoln Corporation	,, 13	...	— 13	2,147	— ...
Liverpool Corporation	,, 10	14,071	— 1...	357,093	— ...
Llandudno&ColwynBayR	,, 10	468	— ...	8,951	— ...
London County Council	,, 10	47,297	— 1,...	577,694	— 1...
Lowestoft Corporation	,, 11	...	— 111	...	— ...
Maidstone Corporation	,, 12	...	— ...	3,346	— 105
Manchester Corporation	,, 13	1...	— 42...	280,593	— ...
Nelson Corporation	,, 13	...	— 1...	3,016	— ...
Newcastle-on-Tyne Corpn	,, 12	...	1,219	97,097	+ 11,791
Newport (Mon.) Corpn.	,, 12	...	— 1...	13,091	— ...
Northampton Corporation	,, 12	...	— 1...	11,...	— 2,359
Nottingham Corporation	,, 12	...	— 12...	57,278	— ...
Oldham Corporation	,, 12	2...	— ...	38,549	— ...
Portsmouth Corporation	... ...	...	...	...	...
Preston Corporation	,, 11	...	— 47	14,404	— 58
R...	... ...	...	...	...	...
Rotherham Corporation	,, 12	1,171	— 116	10,832	— 1,...
Salford Corporation	,, 11	5,42...	— 11...	83,201	— ...
†Sheffield Corporation	,, 11	9,151	— 1,...	142,254	— 10,797
Southampton Corpn.	,, 11	1,566	— 2...	25,061	— 881
Southend Corporation	,, 11	...	— ...	12,202	— ...
S...	... ...	...	...	...	...
St'lyb'dge,Hyde,&c.,Jt. B.	... ...	...	...	...	...
Sunderland Corporation	,, 12	1,572	— ...	23,091	— 1...
S...	... ...	...	...	20,378	— 1...
Swindon Corporation	,, 11	...	— ...	3,002	— ...
Tyneside Tram Co.	,, 11	...	— ...	...	— ...
Wallasey Corporation	,, 11	1,420	— ...	19,970	— 1...
W...	,, 11	7...	+ 169	20,078	— ...
W...	... ...	...	...	...	...
Warrington Corporation	,, 11	4...	— 1	...	— ...
West Ham Corporation	,, 11	3,239	— ...	47,638	— ...
Wigan Corporation	,, 11	1,572	— 1...	...	— ...
Wolverhampton Corpn.	,, 14	1,115	— 3...	16,552	— ...
Yorkshire W.R. Trams	,, 11	1,567	— ...	44,791	— 27...

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ‖ Plus 1 days.

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NOTES.

Organised Research.

TRULY we are an amazing people! During the week particulars have been issued by the Board of Education of a "Scheme for the Organisation and Development of Scientific and Industrial Research." The Board of Education has proved itself in the past to be ill fitted for such a task. It is common knowledge that every branch of education covered by the activities of the Board is in urgent need of reform. How, then, can such an institution expect, or be expected, to organise research? In the document referred to it is stated that a great part of all research will necessarily be done in colleges which are already aided by the State, and that the supply and training of a sufficient number of *young persons* competent to undertake research can only be secured through the public system of education. The scheme provides for the appointment of a small Advisory Committee composed mainly of eminent scientific men and men actually engaged in industries dependent upon scientific research. We put it to the Board of Education that every branch of industry is dependent upon scientific research for its development; such being the case, a scheme which provides for the appointment of a small body of eminent men is doomed before it is launched. We need not tell our readers that we have no fault to find with the names of the eminent scientists already appointed by the Board. We should, however, like also to see names on the list which are household words in industrial development. Let us be candid. Since its inception the Board of Education, empowered by the State, instead of aiding the colleges, has starved them, and the ratepayers have been called upon to make good the deficit. The ratepayers' representatives, instead of giving encouragement to research, have, in many cases, opposed it tooth and nail. How can research be undertaken in our colleges when the Board of Education expects responsible members of the teaching staff to lecture and give instruction for 25 to 30 hours per week? and how can a sufficient number of "young persons" competent to undertake research be secured through the medium of a system of education which is rotten to the core? We shall return to the subject.

The Marconi Meeting.

THE proceedings at the annual general meeting of Marconi's Wireless Telegraph Co. last week were rendered especially interesting (apart from the generally satisfactory statement of the Company's affairs) by the brief but lucid review, by the distinguished chairman and the energetic and resourceful managing director of the Company, of the past vicissitudes and successes of the undertaking. The salient points of both statements are reported on another page of this issue, and will well repay perusal. The story of British Government indifference to the offer of the Marconi inventions is an oft-told tale, and seems to be an inevitable sequence to opportunities for being first in the field presented by inventors to British Governments since the era of progress and invention began. In the light of recent events, the remarkable avidity shown by the German Government to proceed at once to occupy the offered field serves to emphasise the lack of enterprise of our own Government. The ultimate result is not less striking. Germany's precipitancy has not availed her much, for the war has brought about its revenge speedily by the acquisition by the British of all the great German radiotelegraphic stations, so placing in British hands what, in the main, amounts to a monopoly of the world's radiotelegraphic communication. It has been said that the stars in their course favour the British, and certainly it would seem that in this case of the radiotelegraphic chain of stations something of the kind has fortuitously enabled us to occupy the

first place in the world as regards radio as in that of submarine telegraphy. As Mr. Marconi and Mr. Isaacs both put the matter to the shareholders, radiotelegraphic working and the supply of apparatus and material for the purpose has become to a very great extent a British industry, and we certainly owe it largely to the Marconi Company and its leading officials that this is the case.

Italy, it is gratifying to know, has from the first encouraged its learned and brilliant senator in his great work, and in this, as in other things, repays Britain for her oft-shown practical sympathy with the Italian nation in its historic struggles for freedom and recognition as a Great Power. The Marconi general meeting for 1915 was shorn of its old bad features of disturbance and recrimination, and everyone, we are sure, will hope that financial prosperity and technical success will evolve from the situation created by a war in which the Company and its ramifications have undoubtedly played an important part. It has now been clearly proved that there is room, in both peace time and war time, for the successful world-wide operation of Marconi activities side by side with those of the older-established and at least equally important submarine telegraph services. The time has not yet arrived for the full story to be told of the great service rendered to civilisation by the submarine telegraph cable during the past twelve months, but we know enough to say that it will prove of vast public interest when it is told.

An Artificial Transmission Line.

The theory of the transmission line has been investigated by a number of eminent men. Equally eminent men have devoted a good deal of attention to the simplification of the theory, and to the graphical representation of facts which, when expressed in the form of equations, are imperfectly understood by some and are unintelligible to many. On more than one occasion in recent years attempts have been made to construct artificial power-transmission lines in order to be able to verify experimentally the phenomena which one expects on purely theoretical grounds. Artificial lines have been largely used in the past by telephone engineers in various experimental tests. The general use of such lines has resulted in a better understanding of telephonic transmission, as well as in improvements in the art. It is a more difficult and costly matter to design a satisfactory artificial power line than to design an artificial telephone line. In the latter much less conductance is required, and, if necessary, one can employ finely laminated iron cores for the inductance coils. Of the artificial power transmission lines already in use, several are open to the very grave objections of high initial cost, heavy maintenance charges and inflexibility. For instance, the line at Union College, Schenectady, while possessing the desirable feature of uniform distribution of resistance, inductance and capacity, is composed of 400 units, each mounted upon a glass cylinder of 5 ft. in length, and the total weight of the line is about 7 tons. Moreover, the line is limited to one size of wire and one spacing, as the resistance, inductance and capacity are fixed for each unit.

For most purposes a line having adjustable constants is to be preferred, and to minimise the cost a "lumpy" line is essential. Provided that the sections are small, the error due to lumpiness of the line is negligibly small. In an article by Messrs. Magnusson, Gooderham and Rader, which we give elsewhere, is to be found a description of an inexpensive artificial transmission line recently installed in the University of Washington. Prof. Magnusson's line is of the "lumpy" type, and is composed of 20 10-mile sections. It was designed to be adjustable for any spacing up to a maximum of 120 in., and for any size of wire up to No. 1/0 B.&S. hard-drawn copper. To comply with these requirements each section must have a maximum inductance of 0·021 henry, a minimum resistance of 2·59 ohms, and a capacity which can be varied from a minimum of 0·1 mfd. to a maximum of 1·0 mfd. If so desired, the line can readily be changed into a telephone circuit by inserting into each section a 50-ohm manganin resistance. The oscillograph and other test records given by the authors lead us to believe that such a line would be a welcome addition to the equipment of an electrical engineering laboratory. Used in conjunction with the oscillograph and alternating-current potentiometer, the model power transmission line is certainly a valuable apparatus for the investigation of the numerous and complex problems connected with the transmission of power over considerable distances.

The Norfolk & Western Electrification.—With reference to the article on this railway in our issue of July 2, in which we stated that the use of the phase-converter was quite new for railway work, we have received a letter from Mr. V. A. Fynn saying that this system was described by him in his British Specification No. 23,224 of 1907.

Royal Engineers (T.F.)—The following appointments have been made:—

No. 5 Electric Lights Company, Devon (Fortress) Engineers: A. G. Guthrie and G. W. Mayne to be Second-Lieutenants.

Electric Lights Company, North Riding (Fortress) Engineers: A. J. Wright to be Second-Lieutenant.

Tyne Electrical Engineers: Capt. A. K. Tasker to be Temporary Major.

A New X-Ray Motor Ambulance.—The London committee of the Scottish Women's Hospitals at Royaumont are about to send to the front the most up-to-date travelling X-ray motor ambulance that has ever been constructed. It cost over £1,000, which sum was subscribed by the public. The car has been equipped on lines supervised by Mm. Curie, the famous French scientist. It will be driven by a woman, and will be under the direction of lady radiographers—a profession created by the war. The car carries its own gasolene motive power for radiography. A tent is packed up in the rear, in which the work of X-raying patients can be carried on in the open when necessary.

Electric Furnace Power Loads.—A Paper on "Electric Furnace Power Loads," recently presented by Mr. F. T. Snyder to the National Electric Light Association of America, emphasised the fact that this application of electric energy is entering upon a period of rapid growth, and should receive serious consideration from power users. At the present time about 1,000,000 H.P. is used in electric furnaces throughout the world in the aluminium, carbide and nitrogen industries, and in the making of steel alloys and special chemical products. The character of electric furnace loads is well suited for central-station service. Experience shows that electric furnaces give an annual load factor on 12 hour service of about 40 per cent., and about 70 per cent. with whole-day service.

Board of Inventions.—The Admiralty Board of Inventions and Research has left the temporary address announced in our last issue, and is now carrying on its work at Victory House, Cockspur-street, S.W.

British Cable Steamer Wrecked.—The cable store ship "Strathcona," belonging to the Pacific Cable Board, has become a complete wreck on the Minerva Reefs in the South Pacific. The "Strathcona" is not equipped in any way for laying or repairing cables; she is a small auxiliary steamer, built at Auckland, about 180 tons, and is employed almost entirely in carrying mails and stores between Honolulu and Fanning Island. The wrecked "Strathcona" was, we understand, discovered by the "Iris," the Board's cable-repairing steamer stationed in the South Pacific. The whole of the officers and crew of the "Strathcona" were saved.

Mobilisation of Invention.—There has been held at King's College, London, a further meeting of the Conference on Inventions, to which we referred in our last issue. The chair was taken by Prof. P. Geddes.

Mr. DYER, the honorary secretary, explained the object for which the preliminary committee had been formed for the establishment of the National Inventions Development Association, which he said would not trench in any way upon the functions of the Inventions Boards of the Admiralty and War Office. They would select and perfect promising inventions for submission to the Board.

Dr. CLAY, of the Northern Polytechnic, considered the Association would have a large field which the Government Boards would not touch. Possibly the Central Council might be formed by inviting learned and scientific societies to nominate representatives.

Mr. BARTLEY DENNIS, M.P., felt sure the Association would have a national value. Mr. Dennis said he had received a communication from Edinburgh, and the writer informed him that he was associated with a movement of a similar kind in the North.

A resolution was adopted, on the motion of Mr. Charles Bright, endorsing the objects of the Association and recommending their submission to the Government as likely to meet a great national need.

A 150-ton Floating Electric Crane.—According to "Engineering News," a revolving floating electric crane of 150 tons capacity is being constructed by the Wellman-Seaver-Morgan Company to the order of the United States Government. The crane, which will be the first large revolving floating crane to be built in the United States, is intended for the Norfolk Navy Yard, and is to be capable of lifting 150 tons at a maximum reach of 62½ ft. over the fenders of the pontoon. The maximum load is lifted by means of two separate 75-ton hooks, and the mechanism is capable of hoisting a load vertically from a point 25 ft. below the surface of the water to 90 ft. above the water. In addition to these two main blocks, there is a 25-ton auxiliary hoist. The arrangement of the mechanism is such that the jib may be luffed under load from the maximum reach to the highest position, giving a minimum reach of approximately 29 ft. All of the motors used in connection with the various mechanisms are of one size, and are arranged for magnet-switch control, the master controllers being located in the operator's cab. The generating set consists of a non-condensing compound engine direct-connected to a 150 kw. 250-volt continuous-current generator, and is supplied from a 200 H.P. marine boiler. The pontoon is fitted with four electric capstans and two anchor winches. It is of steel, and has the following moulded dimensions: Width, 85 ft.; length, 140 ft.; depth, 15 ft. Watertight compartments extend entirely around the outside of the pontoon, and, in addition, the pontoon is provided with full-depth bulkheads to secure the required strength and rigidity.

Organised Research. Particulars of a "Scheme for the organisation and development of scientific and industrial research" were issued on July 26 by the Board of Education. According to "The Times" the scheme is designed to establish a permanent organisation, and it is pointed out that the research done should be for the Kingdom as a whole, and that there should be complete liberty to utilise the most effective institutions and investigators available. [illegible] therefore, be a single fund for the assistance of research under a single responsible body. The scheme provides for the establishment of: (a) A Committee of the Privy Council [illegible] a small Advisory Committee responsible to [illegible] Committee of Council, and composed mainly of eminent [illegible] men actually engaged in industries dependent upon scientific research. The Committee of Council will consist of the Lord President, the Chancellor of the Exchequer, the Secretary for Scotland, the President of the Board of Trade, the President of the Board of Education (who will be Vice-President of the Committee), the Chief Secretary for Ireland, together with such other Ministers and individual members of the Council as it may be thought desirable to add. The first non-official members of the Committee will be: The Right Hon. Viscount Haldane of Cloan, O.M., K.T., F.R.S.; the Right Hon. Arthur H. D. Acland; and the Right Hon. Joseph A. Pease, M.P. The first members of the Council will be: The Right Hon. Lord Rayleigh, O.M., F.R.S., LL.D.; Dr. G. T. Beilby, F.R.S., LL.D.; Mr. W. Duddell, F.R.S.; Prof. B. Hopkinson, F.R.S.; Prof. J. A. M'Clelland, F.R.S.; Prof. R. Meldola, F.R.S.; Mr. R. Threlfall, F.R.S.; with Sir William S. M'Cormick, LL.D., as administrative Chairman.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. D. Owen contributes an article on the Measurement of Self-Induction by means of an Alternate-current Bridge (p. 630).

Mr. H. H. Broughton's article on "The Electric Crane Applied to the Handling of Coal and Ore" is concluded (p. 617).

We publish an abstract of a Paper by Mr. H. R. Speyer on the development of electric power in India, recently read before the Institution of Electrical Engineers (p. 626). The same subject is dealt with in our Leading Article (p. 628).

The substance of Mr. T. Roles's reply to the discussion on the "Practical Result of the Point Five Tariff," read at the recent meeting of the I.M.E.A., is given on p. 632.

An abstract is given of a Paper on "Insulator Depreciation and Effect on Operation" by Mr. A. O. Austin (p. 615).

We also give an abstract of a Paper by Mr. W. A. Douglas Rudge on "Some Sources of Disturbance of the Normal Atmospheric Potential Gradient" (p. 622).

We publish a description of a 200-mile artificial transmission line by Messrs. C. E. Magnusson, J. Gooderham and R. Rader (p. 613).

Companies' Meetings and Reports. Meetings of the Electric and General Investment Co., Marconi's Wireless Telegraph Co., British Electric Traction Co., Karachi Electric Supply Corpn. are reported, and the half-yearly report of the Metropolitan Railway Co. is abstracted (pp. 645-647).

OBITUARY.

SIR SANDFORD FLEMING. Sir Sandford Fleming died at Halifax, Nova Scotia, on Thursday last week. Although, so far as we know, Sir Sandford attained no particular success in his sometimes lofty but too often ill-timed advocacy of new all-red submarine telegraph cables, he was certainly a persistent advocate of Government adventure in this direction. His arguments were, however, strikingly unconvincing, and this alone must have been the cause of his lack of success in impressing his views upon the statesmen of his time, whether in Canada or in the Mother Country.

He spared himself nothing in supporting his hobby, for such it had become—his time, labour and money were always at the command of those who gave any support to his schemes. This notwithstanding, they petered out, and he died, as he had lived, a disappointed man, so far as his cable-laying ambition was concerned.

When, however, Sir Sandford turned his attention to railway enterprise he was on surer ground. He was essentially a railway man, and a railway engineer of considerable skill and ability. He will take his place in history as a co-worker with Lord Strathcona, Sir Charles Tupper, Lord Mount Stephen, and the present Dominion railway department and its head. Between all these men there must be much kindly sympathies. He was born at Kirkcaldy, Fife, in 1827, and emigrated to Canada in 1845, where he very early took part in the construction of the Northern Railway, becoming chief engineer of that line in 1857. In the limited [illegible] he was [illegible] and head of the old Colonial Railway [illegible] up the most [illegible] of the Dominion with those of Old Canada. Sir Sandford [illegible] a leading part, and later in the building and laying of the Canadian Pacific line he was engaged as chief engineer for [illegible] 700 miles of the line. After an political grounds, he ceased to get [illegible] He [illegible] the company later and continued to [illegible] one of the [illegible] Canadian Pacific Expansion.

PERSONAL.

"Indian Industries and Power" states that Mr. C. C. T. Eastgate, electrical engineer, Calcutta, has been appointed electrical inspector for the Punjab.

On Monday, the 26th inst., at St. Clement's, Ilford, Mr. R. Sellars, of the West Ham electric supply, was married to Miss Jewell, only daughter of Mr. and Mrs. Jewell, of Ilford, and late of Brixton. Mr. Sellars' colleagues at the West Ham electric supply presented him with a handsome timepiece as a memento of the occasion.

INSTITUTIONS AND SOCIETIES.

Diesel Engine Users' Association.—The July meeting of this association was held at the Town Hall, Kingston-upon-Thames. The question of a suitable allowance for depreciation of Diesel engine plant in connection with income tax assessment was further considered. Letters on the subject had been received from many undertakings and firms using Diesel engines, expressing their interest in the matter and their readiness to join in any movement which might result in fairer treatment being obtained in regard to the annual allowance for depreciation of this class of plant. After some discussion the following resolution was unanimously passed: "That, in the opinion of this association, the present allowance made for depreciation by wear and tear on Diesel engine plant by the Inland Revenue authorities is inadequate, and that an allowance at the rate of at least 15 per cent. per annum should be claimed." After the meeting a visit was paid to the electricity station, where the Diesel engines were seen at work. The plant consists of two engines of 400 B.H.P. and 500 B.H.P. respectively, the smaller engine being of the four-cycle horizontal type (four cylinders), and the larger of the two-cycle horizontal type (two cylinders). The next meeting will be held in October.

APPOINTMENTS VACANT AND FILLED.

Sutton Coldfield Corporation require an electrical engineer and manager. Commencing salary will not exceed £250. Applications to the Town Clerk (Mr. R. A. Reay Nadin) by Sept. 1. *See an advertisement.*

York Corporation require a junior charge engineer at their electricity works. Salary £91 rising to £130. Applications to the Engineer and Manager, Electricity Offices, York, by July 31.

An all-time instructor of experimental physics and mechanics, applied mechanics, electrical engineering, machine drawing and workshop practice in connection therewith, is required by the Wimbledon District Higher Education Committee. Salary £150 per annum. Forms of application from the Principal, Mr. W. A. Harwood. *See advertisement.*

A telegraph engineer is required by the Government of Nigeria. Salary £300-£15-£400 per annum. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, London, S.W. *See advertisement.*

The High Tension Co. require a man with experience of assembling sparking coils. *See advertisement.*

The University of London is about to appoint a principal officer at a salary of £2,000 a year. Names of those desirous that their names should be considered should reach the Secretary to the Senate, University of London, South Kensington, S.W., by Sept. 15.

An assistant lecturer and demonstrator, ineligible for military service, will be required in the engineering department of the Borough Polytechnic Institute, London, S.E., in September. Commencing salary £130, rising to £150. Applications by Aug. 9.

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply department. Salary £650, rising to £700 per annum. Applications to the town clerk (Mr. Thos. H. Nesbitt), by Sept. 13.

Mr. L. M. Jockell, charge engineer, York, has been appointed engineer of the Northern Counties Electricity Supply Co.'s station at Malton. Mr. Edwards, junior charge engineer, is recommended by the Electricity Committee to succeed Mr. Jockell at York.

Northampton Corporation are recommended by the Tramways Committee to appoint Mr. E. Jordan superintendent of their power station at £2 6s. per week, rising to £130 per annum.

EDUCATIONAL NOTES.

University of Manchester.—In the Faculty of Science complete courses of study (extending over three years) are arranged for the University Degrees in civil, mechanical and electrical engineering. Good facilities are provided for laboratory and research work, and the electrical engineering laboratory is housed in a new building. Complete theoretical and practical training is given to students preparing for the higher positions in the electrical engineering profession. Particulars of the courses can be obtained from the Registrar. The new session commences on Oct. 7.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses, giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

Liverpool University.—Mr. Heath Harrison, of the Harrison Line of steamships, has presented £10,000 to the University for the endowment of a Chair of Organic Chemistry. Some time ago Mr. Harrison, his late brother and Mr. J. W. Hughes presented £40,000 to the University for engineering laboratories.

City & Guilds Technical College, Finsbury.—The day courses at this college are adapted to the needs of various students, including pupils from secondary schools above the age of 15 who desire to receive a practical and scientific training, and young men who, having previously served a pupilage or apprenticeship, desire to go through a more systematic training. Programmes from the Registrar.

Imperial College of Science and Technology, South Kensington, London.—The City & Guilds (Engineering) College, the engineering section of the Imperial College, provides complete courses of instruction leading up to and including the highest specialised instruction for students, with the object of fitting them for leading positions as civil, mechanical or electrical engineers, scientific advisers, &c. The departments are: Mechanical engineering and motive power (under the direction of Prof. Dalby); civil engineering and surveying (Prof. Dixon); electrical engineering (Prof. Mather); mechanics and mathematics (Prof. Forsyth). Applications must be made by the first Monday in September for admission to the courses qualifying for the diploma of Associate of the City & Guilds of London Institute, and candidates must pass the entrance of matriculation examination of the College held in September or have passed the matriculation of the University of London in certain subjects. The diploma of the Imperial College is granted for advanced specialised or fourth year work. Prospectuses, &c., from the Registrar.

City and Guilds of London Institute.—The Council have awarded diplomas of Associate of the City and Guilds of London Institute (A.C.G.I.) to the following students who completed a full course of instruction at the close of the recent session:—

E. Ower (Bramwell Medal), R. G. Howard, S. A. Bremner, E. H. J. Stewart, A. S. Joffé, A. G. Smith, H. M. de Wittmann, G. W. Hogan, K. Singh, S. W. Luscher, E. W. Eglin, M. L. Bramson, F. E. Hobley, R. C. Bonnaud, B. E. Bartrum, F. E. Meyer, F. A. Sharp, R. V. Ramalho, H. F. Marles, H. E. Comben, J. Williams, F. A. Pucknell, H. P. Bloxam, C. E. M. de la Nougerede, and H. D. Heath (in civil and mechanical engineering); and B. Hague (Siemens Memorial and Henrici Medals), S. W. Messent, C. Jacoyou, C. G. Shaw, H. C. Gibson, W. H. Cable, D. Jacoyou, and F. F. H. Schroeder (in electrical engineering).

The diploma of associate of the City and Guilds of London Institute and Technical College, Finsbury (A.C.G.F.C.) has been granted to the following matriculated third year students of the City and Guilds Technical College, Finsbury: W. J. Jones (in electrical engineering); and E. C. Chitty, S. F. W. Crundall, A. T. Grisenthwaite, S. P. Kipping, F. J. Sharp, and A. W. H. Uffelmann (in technical chemistry).

ARRANGEMENTS FOR THE WEEK.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week ending August 1915:—

Wednesday and Friday: Drills 6.30 p.m. and 7.30 p.m.

There will be no drill Monday, August 2, 1915.

A 200-MILE ARTIFICIAL TRANSMISSION LINE.*

BY C. E. MAGNUSSON, J. GODERHAM AND R. RADER.

Summary.—In this article the authors give a full technical description of a 200-mile artificial power transmission line having adjustable constants, and give details of the construction and constants of the line. An interesting account of some tests made on the line is given, and this account is illustrated by oscillograph records.

In most engineering schools the instruction on electrical energy transmission lines is given by lectures, textbooks and problems. Practically no laboratory work is offered, for the simple reason that the instructors have no long transmission lines at their disposal. In the telephone field artificial lines are in common use both in the college laboratory and by the telephone engineer. It is, however, only within the past four years that any extended experiments have been made with artificial transmission lines in order to compare experimental observations with theoretical calculations. Investigations of great value have recently been made at Union College † under the direction of Dr. Steinmetz, and by Dr. Kennelly‡ at Harvard University. The results give conclusive evidence that the electrical phenomena of commercial transmission lines can readily be reproduced by artificial lines in the laboratory. Very little, if any, attention has been given to the problem of providing for the undergraduate adequate laboratory facilities for experimental work on transmission line phenomena. Both the lines referred to above were designed for special research work, whereas instructional work requires apparatus of a more general nature.

Some of the characteristics of the two lines referred to may be noted :

Artificial Line at Union College.—The line has 400 units. Each unit consists of No. 8 B. & S. copper wire, wound spirally on a glass cylinder, 6¼ in. (15·8 cm.) in diameter and 5 ft. (152 cm.) long. Each unit represents 0·325 mile (0·52 km.) of line. The inside of the glass cylinder is coated with tinfoil.

The line has a total reistance of 93·6 ohms, a total inductance of 0·394 henry, and a total capacity of 1·135 mfds. Equivalent length of line 130 miles (230 km.); equivalent size of wire, No. 1 B. & S. copper, and equivalent spacing, 72 in. (182 cm.). A very desirable feature of the design is the uniform distribution of resistance, inductance and capacity.

This line has the undesirable features of high first cost and maintenance cost. It is also limited to one size of wire and one spacing, as the resistance, inductance and capacity are fixed for each unit.

Artificial Line at Harvard.—This line has 30 units. Each unit consists of four induction coils and one condenser, the coils being wound with No. 19 B. & S. copper wire. Each unit represents 50 miles (80 km.) of line.

The line has a resistance of 726 ohms, a total inductance of 2·7 henries, and a total capacity of 2·25 mfd. Equivalent length of line, 1,500 miles (2,400 km.); equivalent size of wire, No. 3/0 B. & S. aluminium, and equivalent spacing, 90·5 in. (230 cm.).

The line is of the lumpy type, with resistance as the only adjustable line constant. This line has low first cost, and the maintenance is small. It was designed for special investigations under such conditions that the wave-length of the waves studied would be large in comparison with the equivalent length of each unit. For giving an accurate representation of present-day commercial transmission lines 50-mile units are too large.

Artificial Line at Massachusetts Institute of Technology.—This line has 30 units. Each unit has eight induction coils of No. 12 B. & S. copper and one condenser. Equivalent length of each unit, 80 miles (48 km.); equivalent size of wire, 500,000 circular-mils copper, and equivalent spacing 108 in. (275 cm.). The construction is similar to that of the Harvard line.

Artificial Line at the University of Washington.—The investigation described in this Paper was made for a two-fold purpose: First, to design and construct an artificial transmission line suitable for laboratory experiments for undergraduate students; and, second, to provide the first part of the apparatus required for research on long-distance transmission problems.

For instructional purposes it is desirable to have a line adjustable in length, spacing and size of wire, so as to be comparable with a large number of commercial transmission lines. [illegible] low first cost and minimum maintenance are met by the "lumpy" type of line. A 10-mile unit was decided [illegible]

* From the "Electrical World," July 24 [illegible]
Trans. A.I.E.E., Vol. XXX, p. 57, and [illegible]
† "Electrical World," Feb. 17, p. 359, and "Trans." A.I.E.E., Vol. XXXI., p. 1131.
‡ "Electrical World," May 2, and Aug. 8, 1914.

mation to the uniformly distributed inductance, capacity and resistance in practical lines, even at frequencies as high as 800 cycles per second. This line was designed to be adjustable for any spacing up to a minimum of 120 in., and for any size of wire up to No. 4/0 B. & S. hard-drawn copper. To comply with these assumptions each 10-mile unit should have a maximum inductance of 0·021 henry, a minimum resistance of 2·59 ohms, and an adjustable capacity from 0·1 to 1·0 mfd.

Inductance.—The general plan of the inductance coils was made similar to the Harvard line, using four short air-coil solenoids arranged in a square. As the mutual inductance could not be determined until both the dimensions of the coils and the relative positions of the four coils on the square were known, it was omitted while making the preliminary calculations of the coil dimensions. Corrections were later applied to the number of turns, so as to give the total required inductance with the coils in position. Each coil was designed for a resistance of 2·59 ÷ 4 = 0·65 ohm at 25°C., and an inductance of 0·021 ÷ 4 = 0·0525 henry. No. 14 B. & S. double cotton-covered copper wire was used; this, with the given resistance, fixes the length of wire in each coil at 257 ft.

For a given length of wire the inductance depends on the dimensions of the coil. For short air-core solenoids the inductance is given by Brooks' formula,* namely,

$$L = \frac{w^2}{l + r + 1{\cdot}5c} \cdot \frac{F' \cdot F''}{10^9} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

wherein w = length of wire in coil; l = length of coil; r = mean radius of coil; c = thickness of winding.

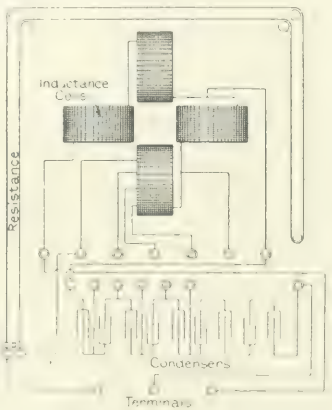


FIG. 1.—WIRING OF UNIT.

F′ and F″ are correction factors for very short coils, and have the values:

$$F' = \frac{10 \cdot 12 \cdot 2R}{10l + 10c + 1{\cdot}4R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and

$$F'' = 0{\cdot}5 \log_e \left(100 \cdot \frac{11R}{2l + 3c} \right) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where R = outside diameter of coil.

The formula (1) gives inductance in henries with the dimensions in centimetres. Where the dimensions are in inches, multiply the right-hand side of equation (1) by 2·54.

With the length of wire given the volume of the coils is a constant. The volume may be expressed in two ways, namely,

$$\text{Volume} = 2\pi rlc = \pi d^2 w/4, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where d = diameter of wire over insulation. Whence

$$l = \frac{d^2 w}{8rc} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

For the given size of wire (No. 14 B. & S. d.c.c., for which d = 0·072 in.) and length of wire (257 ft.), both d and w are fixed. The number of layers, l, is fixed by equation (5), and, therefore, $l + r$ is fixed by equation (4). Curves may, therefore, be plotted giving the relation between the mean radius of the coil and the inductance for various numbers of layers, and the proper number of layers and mean radius for the given value of L = 0·0525 henry) [illegible]

* "Bulletin" 31, University of Illinois.

By this method it was found that an 8 layer coil of approximately 2·2 in. (5·6 cm.) mean radius gives the required inductance of 5·25 millihenries. The corresponding length of coil is. then, from equation (5). 2·10 in. (5·34 cm.), and thickness of winding $8 \times 0{\cdot}072 = 0{\cdot}58$ in. (1·48 cm.).

Four test coils were wound to these dimensions and the inductance of each was measured. The four coils were then arranged in a square, as shown in Fig. 1, and connected in series. The mutual inductance was found to be approximately 8 per cent. of the total self-inductance. Compensation for the mutual inductance was secured by reducing the length of the wire 7 ft., thus reducing the [illegible] by 7·25 = 7·5 per cent.

The final dimensions of the coils as constructed were: Mean radius, 2·2 in. (5·59 cm.); length of coil, 2·15 in. (5·47 cm.); thickness of winding, 0·6 in. (1·52 cm.); number of turns, 216 (eight layers of 27 turns each); length of wire, 250 ft. (76·3 metres). The constants of the completed coil were: Inductance, computed, 0·00477 henry; measured, 0·00483 henry. Resistance, computed, 0·645 ohm; measured, 0·650 ohm at 25° C.

It may be noted that the measured inductance is 8 per cent. less than the 0·00525 henry required. This difference is supplied by the mutual inductance between the four coils in each unit. With the four coils in position the measured inductance closely approximates to the required amount.

After completing the winding, the coils were baked in "condensite enamel" to exclude moisture and to increase the insulation. The baking was done in a steam-jacketed cylinder in the following manner: After placing the coils in the cylinder, a vacuum of 8 lb. and a temperature of 112°C. was maintained for two hours. Sufficient enamel to cover the coils was then forced into the cylinder under atmospheric pressure. Next a pressure of 120 lb. per square inch was applied inside the cylinder and maintained for two hours with the temperature at 112°C. The free liquid was then removed

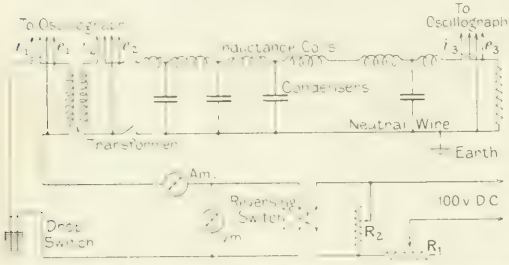


Fig. 2.—Diagram of Connections for Testing a 200-mile Artificial Transmission Line.

and the coils baked for 10 hours at 112°C., and at a pressure of 120 lb. per square inch. This process formed a hard and solid coil with a glossy surface.

Capacity.—Ordinary paraffin-paper telephone condensers, 1 in. by 2 in. by 4½ in. were used. Each condenser was tested at 500 volts, and had a capacity of 1 mfd. Nine of these condensers were provided for each unit, arranged as shown in Fig. 1. The receptacle for the condensers has space for four additional condensers.

Resistance.—An adjustable resistance was provided by a loop of No. 21 "Advance" resistance wire, shown in Fig. 1. Each unit was supplied with a 50-ohm manganin resistance to be inserted when it is desired to change the line into a telephone circuit.

The 10-mile Unit.—The right-hand coil, Fig. 1, is placed on a movable base, so that the coil can be turned 180 deg., thus varying the mutual inductance. Three taps are provided on the lower coil, dividing the number of turns into four equal parts. The average resistance of each of the 20 units is 2·581 ohms at 25°C., the resistance of each unit ranging from 2·467 to 2·630 ohms. The average inductance of the units (each arranged for maximum inductance) is 0·0213 henry, the inductance per unit ranging from 0·0197 to 0·0229 henry. The average capacity of the 20 units (eight condensers in series in a unit) is 0·147 mfd., the capacity ranging from 0·142 mfd. to [illegible]

The [illegible] of each unit can be obtained by [illegible] and by using the taps on the lower coil as shown in Table I.

[illegible] the 20 units are connected in series. In the [illegible] connected [illegible] other [illegible] of the [illegible] [illegible] The two [illegible] and the "T" connections to [illegible]

Table I.—*Inductance of 10-Mile Unit.*

Position of rotating coil.	Coils in Series.				
	4	3½	3½	3½	3
0 deg.	0·0214	0·0193	0·0176	0·0161	0·0154
45 ,,	0·0209	0·0186	0·0167	0·0156	...
90 ,,	0·0199	0·0178	0·0160	0·0149	...
135 ,,	0·0188	0·0171	0·0158	0·0145	...
180 ,,	0·0185	0·0168	0·0152	0·0142	...

Table II.—*Comparison of Calculated and Measured Constants.*

	Calculated for actual line.	Measured artificial line.
Total resistance	51·80 ohms.	51·80 ohms
Total inductance	0·42 henry.	0·42 henry.
Total capacity	2·86 mfds.	2·90 mfds.

tively. In the tests described below the "T" connection was used (*see* Fig. 2).

As a check on the design, the 20 units were connected in series and adjusted to represent 200 miles of No. 4/0 B. & S. copper 120 in.

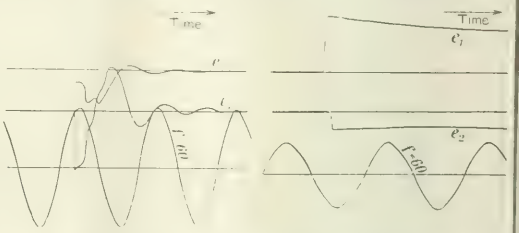


Fig. 3.—Receiver End Open. e_1 Voltage at generator end. i_1 Current at generator end. f Sixty-cycle wave.

Fig. 4.—Receiver End Connected Through a Resistance Equal to $\sqrt{L \div C}$ Ohms. e_1 Voltage at generator end. e_2 Voltage at receiver end.

spacing, one-phase, grounded, Y-connected transmission line. The calculated constants are compared in Table II. with the measured constants of the artificial line above described.

The apparatus can be adjusted so as to represent either aerial or cable, energy or telephone lines for a wide range of spacing and size of wire.

Travelling Wave and Length of Line.—Fig. 2 shows the connections used for taking oscillograms of travelling impulses. The impulse is produced by suddenly opening the drop switch, the arrangement being similar to that used by Cunningham and Davis * in the

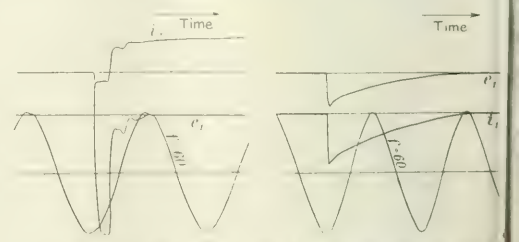


Fig. 5.—Receiver End Short-Circuited. e_1 Voltage at generator end. i_1 Current at generator end. f Sixty-cycle wave.

Fig. 6.—Receiver End Connected Through a Resistance Equal to $\sqrt{L \div C}$ Ohms. e_1 Voltage at receiver end. i_1 Current at receiver end.

experiments on the Union College line. Time was measured by taking an oscillogram of a 60-cycle voltage wave simultaneously with the oscillograms of the impulses.

The line constants were adjusted to the following values: Inductance, 0·47 henry; capacity, 2·92 mfds.; resistance, 51·7 ohms; quarter wave length frequency $= 1 \div 4\sqrt{LC} = 893$ cycles per second; equivalent length = 209 miles (336 km.) of single wire; equivalent [illegible] 120 [illegible] 336 km. No. 4/0 B. & S. copper.

Four oscillograms [illegible] shown in Figs. 3 to 6, the conditions [illegible]

* "Transients," A.I.E.E., Vol. XXX., p. 887.

Table III.—*Voltage and Current Values.*

	Voltage.	Current.	
Receiver end	651·5	Between	
Unit 20	650·5	20–19	0·063
Unit 19	649·5	19–18	0·124
Unit 18	647·0	18–17	0·184
Unit 17	644·0	17–16	0·244
Unit 16	640·0	16–15	0·305
Unit 15	635·0	15–14	0·362
Unit 14	630·0	14–13	0·420
Unit 13	625·0	13–12	0·480
Unit 12	618·5	12–11	0·542
Unit 11	613·0	11–10	0·598
Unit 10	609·0	10–9	0·650
Unit 9	604·0	9–8	0·704
Unit 8	596·0	8–7	0·754
Unit 7	586·0	7–6	0·802
Unit 6	576·0	6–5	0·856
Unit 5	564·0	5–4	0·910
Unit 4	551·0	4–3	0·953
Unit 3	539·0	3–2	0·99
Unit 2	525·0	2–1	1·03
Unit 1	511·0	1 (generator)	1·07
Generator end	500·0		

which each was taken being stated immediately beneath the oscillogram. These oscillograms are similar to those obtained on the Union College line, and need no extended description.

From measurements of the time elapsed between the beginnings of the two voltage waves in Fig. 4 and the time in Fig. 3 taken by

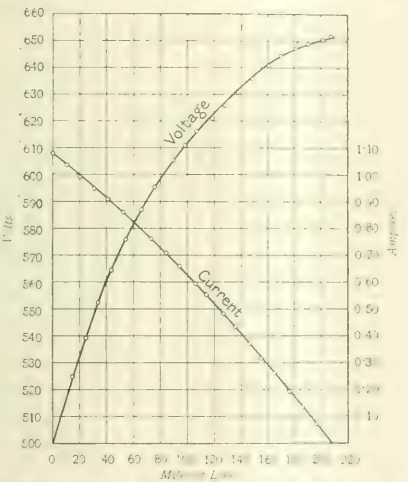


Fig. 7.—Voltage and Charging Current at No Load. Frequency 100 Cycles.

the impulse to travel out to the end of the line and back again, the length of the line was calculated and found to be 214 miles (344 km.). This differs by 2·4 per cent. from the value calculated from the line constants.

Voltage and Current Readings at 10-Mile Intervals.—To determine accurately the magnitude and phase relations of the voltage and current along such an artificial line as above described requires an alternating-current potentiometer. When this piece of apparatus is not available, approximate readings may be obtained by using ordinary alternating-current ammeters and voltmeters. The data given in Table III. were obtained by using Weston voltmeter with multiplier and Weston ammeters. The line was connected up [illegible] and the constants and equivalent lengths were the same as above, giving an equivalent of 209 miles of single wire. The receiver end was open and the voltage at the generator end was kept constant at 500 volts 100 cycles. The line was very sensitive to changes in frequency, and special care was necessary in order to obtain consistent readings. The [illegible] were taken at the middle point of each [illegible] were taken at the middle point of each [illegible] and current readings [illegible] the [illegible] plotted in Fig. 7.

As a check on the observed values the receiver voltage was calculated from the constants of the line, assuming a uniform distribution of resistance, inductance and capacity. Neglecting the load at the receiving end due to the voltmeter, this calculated value is 653 volts. When the load due to the voltmeter is taken into account the calculated receiver voltage becomes 656 volts. Comparing this value with the observed value of 651·5 volts shows a difference between the observed and calculated values of less than 1 per cent.

The above illustrations indicate the possibilities of this type of artificial transmission line, both for giving students an insight into well-known transmission-line phenomena and for use in research work on transmission-line problems.

INSULATOR DEPRECIATION AND EFFECT ON OPERATION.*

BY A. O. AUSTIN.

Summary.—The author discusses the various causes of the failure of insulators, showing that this is not due to fatigue, but rather to absorption of water, extremes of temperature or crystallisation in the cement. He then deals with the probability of failure due to one or more bad units in a string of insulators.

The growing investments dependent upon the transmission line make the study of factors governing reliability in the insulator of ever-increasing economic importance. In view of this, it is hoped

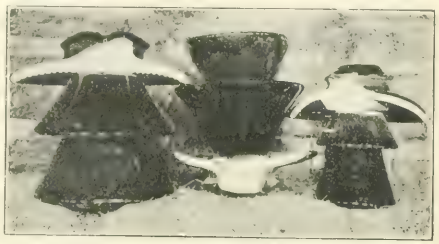


Fig. 1.

that this article will throw some light on insulator failures and be of assistance in deciding on the refinements and size of insulator necessary for a given system.

Where insulator trouble increases with time, it is only natural to attribute the trouble to fatigue in the insulator; but this is not necessarily the case, for the failures may be due to a number of entirely different causes.

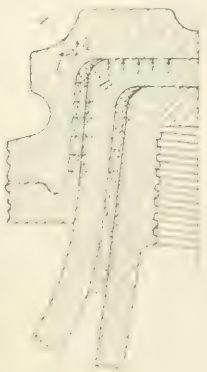


Fig. 2.

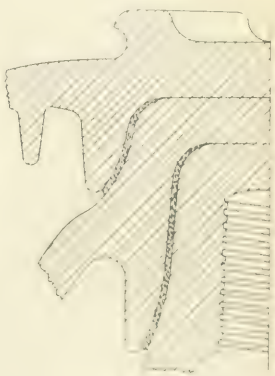


Fig. 3.

[illegible] years' [illegible] failure [illegible] the outer [illegible] the head of the cylinder from the side wall. This

* Abstract of Paper read before the American Institute of Electrical Engineers.

force can come from several sources, but as the porcelain does not seem to be appreciably affected either mechanically or electrically outside of the cracks, it would appear that the breakdown is due more to a rather high stress than to a low stress acting for a long time.

It is quite likely that the stress set up is that due to uneven expansion from varying temperature and from an expansion of the cement. Porcelain, like most dielectrics, is a very poor conductor of heat, so if the insulator has become hot in the sun or from surface leakage, and is then suddenly cooled by rain, there will be a considerable difference in temperature between the outer and inner parts. This difference in temperature may set up an average tensile stress of several hundred pounds in the outer members. This average stress is hardly high enough to cause any damage, but the shape of the dielectric may be such that a very high maximum stress is set

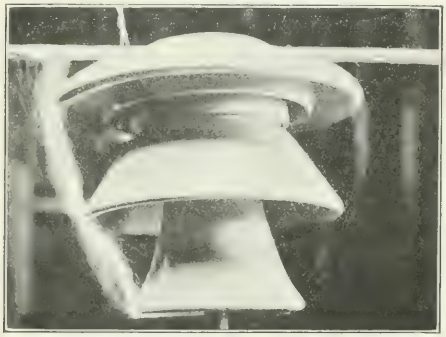


Fig. 4.

up, causing a crack, as along AB in Fig. 2. There is no doubt that the defect comes from internal stress, but as this stress may be set up by uneven temperature and expansion in the dielectric or by cement expansion it is not easy to determine the cause.

Cement expansion is caused by the growth of crystals, presumably of calcium sulphate, which is especially noticeable at railway crossings where the sulphur fumes attack the cement. Fig. 2 shows a section of an ordinary pin-type insulator, which usually cracks along the line AB. It is readily seen that a contraction of the outer part or expansion from the cement will set up a very high stress along AB. In Fig. 3 is shown one of the later designs of insulators which have proved to be practically proof against lightning, and it is evident that the stress set up by uneven heating or cement will not only be less, but the strength of the parts resisting these stresses will be



Fig. 5.

greater. In later types a shell protecting an path is provided between conductor and pin to act as a safety valve for surges.

Fig. 4 shows an improved insulator having the section shown in Fig. 3, flashed over at 270 kv. for a striking distance of 14 in. (dry arcing) and having a total puncture of over 300 kv.

[illegible] to show that anything would be gained by increasing the conductivity of the cement in insulators of this type or [illegible] to reduce heating from flow of charging current, but [illegible] although tests on the [illegible] show that this is beneficial in the [illegible]

[illegible] insulators. On the [illegible] crack in the [illegible] at the shoulder from combined expansion of the cap and cement exposed to weathering. The stress is concentrated by the shape of the insulator and the cement groove. The elimination of the cement next to the flange and the substitution of a sanded surface in place of the grooves for holding the cement greatly reduces the maximum stress.

To the right of Fig. 5 is shown a failure in an insulator of similar design but of different material. These insulators have transverse cracks in the bottom of the grooves, showing that the insulators would not withstand the elongation of the metal under the highest working temperature. A higher assembly temperature would improve this, or preferably a sanded surface in place of grooves, for the latter would be free from the objection of high shearing stresses in cold weather.

Vibratory stresses are most severe in dead-end insulators, and in such cases, if the maximum stress is very high and fluctuating with temperature, it will be only a matter of time before the molecular structure of the dielectric will be destroyed. Where this is combined with an increasing stress from cement expansion it is apparent that failures may be very serious in time, although there is little evidence of this during the early years of operation.

As for electrical strength, good porcelain will withstand considerable heat, so material which acts as a resister may pass electrical tests successfully, only to depreciate very rapidly in service owing to the absorption of water, which greatly lowers the resistance.

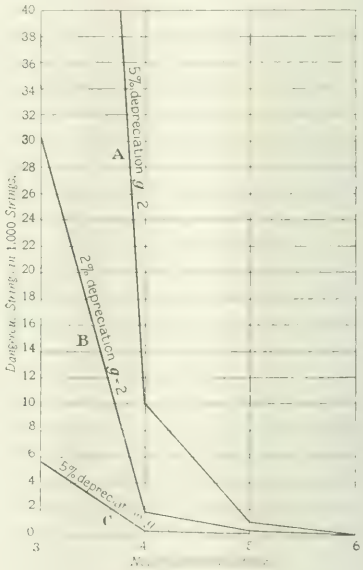


Fig. 6.

Porous material or that which lacks vitrification, while withstanding high voltages at time of installation, gradually loses its ability to carry electrical stress. An investigation of one of the large systems showed that out of 2 per cent. of insulators shown to be weak by the Megger, at least 1·4 per cent. were poor owing to lack of vitrification, and could be detected by the trained eye.

Failures from electrical stress may be gradual, for it is possible to puncture porcelain several times where the flow of current is extremely small before complete failure occurs. For this reason surges sometimes do considerable damage to a system, and their effect is not noticeable until the cumulative damage causes a complete breakdown. The success of some of the later types of insulators, however, shows that there is little to be feared from static puncture, as compared to some of the other defects in the insulator. In well-insulated lines trouble comes not by the depreciation of the insulators as a whole, but by the matching up of defective parts in a single insulator or string, such that the normal voltage or a switching surge causes the insulator to spill over or puncture.

The investigation of some of the systems shows that there is practically no successive breakdown in the insulator, and that faulty members are about equally distributed throughout the string. This shows that there is little danger of puncture from high-frequency surges where the insulator is made up of six or more closely spaced, well-tested sections. Lines of this class have also shown that the

much to line is practically lightning proof [illegible] systems have not averaged one kick-out in two years from the spilling of insulators, from lightning or any other cause.

The big problem in line insulation is not so much to design for high frequency, but first of all to prevent depreciation as far as possible, or at least to minimise the danger due to matching up of faulty parts in the insulator, for it is evident that if an insulator has a large number of parts which become [illegible] or cracking trouble is sure to follow, regardless of the fine showing of an insulator on high-frequency tests. It is well to consider the probability of trouble from this source and analyse the problem, in order that the relative importance of the factors governing the matching up of the faulty parts to the danger point may be obtained.

Let p = per cent. depreciation, or average number of parts bad in 100.

n = number of parts or discs in the insulator or string.

b = number of parts which may be bad in a single string when danger point is reached.

P = probability of a string being dangerous.

N = number of strings on the system.

Then, by the theory of probabilities, it can be proved that

$$NP = N\left(\frac{\quad}{1000}\right)$$

NP being the probable number of dangerous strings on the system.

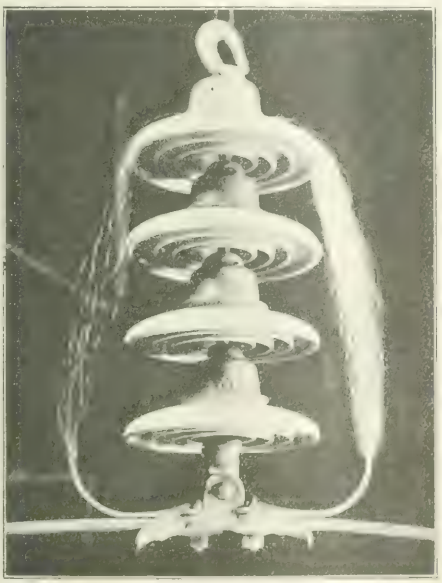


Fig. 7.

In Fig. 6 are shown some curves where the minimum insulation is maintained for various numbers of [illegible] The curves show that a line having only [illegible] and a switching surge that would spell [illegible] dangerous strings in 1000 strings, where there are [illegible] tions in the insulator. The addition of another part, however, reduces this hazard about 95 per cent., and the addition of still another part reduces the probable dangerous strings to 0·064 in 1,000 strings.

Operation bears out these curves [illegible] indeed be reduced very nearly indefinitely [illegible] insulation.

When the depreciation reduces the [illegible] of the line will weed out this material, and the operation will be greatly improved. If, however, the internal stress in the insulator is high, owing the insulator to fail [illegible] starting after several years' operation, it [illegible] become very difficult to maintain the line [illegible] line is gone over quite frequently. [illegible] covered by distributing the [illegible] different insulator strings.

The use of discharge horns and very closely spaced insulators improves the factor of safety for an insulator having only a few units. The insulator of this type is shown in Fig. 7. While the discharge points on the clamp greatly improve the factor of safety for a few units they do not materially improve the factor of safety for a long string. Since, however, depreciation is likely to reduce the total number of good units in a string, it is advisable to use the discharge points in order that the remaining sections will tend to flash over rather than puncture.

It becomes more apparent every day that a transmission line is like a chain, in that it is no stronger than its weakest links, and even a slight degree of insulator depreciation produces an operating hazard through the matching up of weak parts, and may cause trouble, whereas a much higher degree of depreciation on other parts or apparatus on the system may cause no interruption, nor give any direct evidence, and may be overlooked.

THE ELECTRIC CRANE APPLIED TO THE HANDLING OF COAL AND ORE.

BY H. H. BROUGHTON.

(Concluded from p. 578.)

Summary.—The author points out that none of the engineering firms in the country lay themselves out for the design and construction of electric overhead hoist equipments for the handling of coal and ore in considerable quantity. He briefly deals with the hydraulic and electric systems of power transmission for the working of dock machinery, and suggests a special period of the Papers devoted to the description of hydraulic coal hoists. The electric cranes used at the ports on the Great Lakes of America are described in considerable detail and particulars are given of two equipments, one for handling coal and the other for handling ore.

Electrically-operated coal and ore handling plants in great variety are to be found at the ports on the Great Lakes of America, and we propose to describe two of the most recent of these, one, on the Brown system, installed at Duluth-Superior Harbour for handling coal, and the other for handling iron ore, on the Hulett system, at the new dock of the Pennsylvania Company of Cleveland. In many respects these Lake Ports are remarkable, but, in our opinion, the most noteworthy feature is the phenomenal increase both in accommodation and tonnage handled in recent years. Thus at Duluth the receipts of coal increased from 2·6 million tons in 1900 to 9·5 million tons in 1914, and the storage capacity of all the docks was increased from a million tons in 1900 to over 9·5 million tons in 1910. In 1906 there were two docks equipped for the use of electrical energy and in 1911, 11 of the 21 coal docks were fully electrified. In 1909, 26 per cent. of the coal received was handled by electrical energy, and at the present time it is estimated that 70 per cent. of the total coal received is thus handled. Before the introduction of electrical energy the largest dock had a storage capacity of 250,000 tons, whereas several of the recent docks have storage capacities of 1,000,000 tons each, and another having an ultimate storage capacity of 2,000,000 tons is projected.

At Duluth the plant is designed for unloading coal from lake boats to the storage yards, and for loading on trucks for conveyance to various points in Minnesota and neighbouring States. Mr. W. Sykes† gave particulars of a test on one of the first electrical plants extending over a net period of four hours 11 minutes. The cranes made 356 trips, of which about 80 per cent. were to the pile to put in, about 20 per cent. to the hopper and 5 per cent. to the pile. The cranes average a speed of operation of 11 trips per hour, and the maximum rate of operation over one hour was 15 trips, the number being evenly divided between trips to the hopper and trips to the pile. The capacity of the bucket is 3 tons, and the total weight of coal handled during the test amounted to 2,000 tons.

The equipment described [illegible] put into service about three years ago by the Pittsburgh Coal Company at a dock having a storage capacity of 1,000,000 tons. Including the

† Proceedings, Am. Soc. Mech. Engineers, Vol. XXXI, Part I, p. 521.

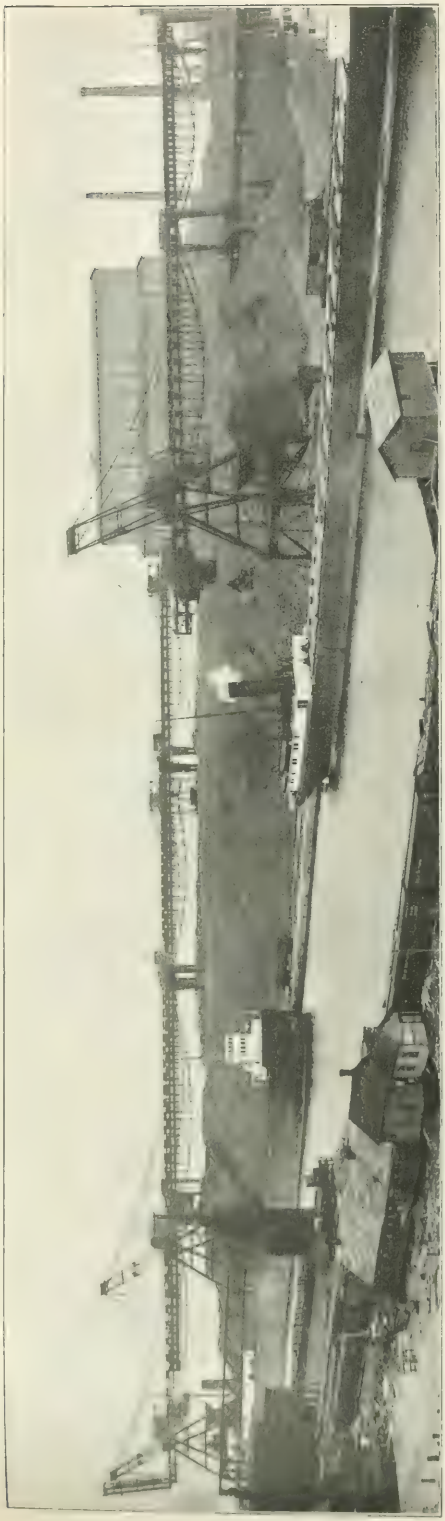


Fig. 8. General View of Brownhoist Coal Handling Plant at Pittsburgh Coal Company's Dock, Duluth, Minn.

delays in cleaning up the holds of vessels unloaded, the plant installed has a capacity of 900 tons per hour, and when working in free coal the capacity is some 50 to 60 per cent. greater.

From Fig. 8 it will be seen that there are three two-span bridges extending from the unloading dock and two single-span bridges at the rear. One of the single-span bridges is provided with a mechanical screening apparatus of novel design. Each span is 242 ft. in length, and the single-span bridges are arranged to register with any of the two-span bridges so as to make a three-span bridge, or a continuous runway for one of the trolleys of 726 ft. The travelling mechanism is arranged so that when a single-span bridge is connected to a two-span bridge the spans are operated as a unit. The single spans may also be operated as independent bridges. Each of the two-span bridges has a cantilever extension of 78 ft. out over the dock and there is a cantilever extension from the rear end of each of the single-span bridges. The storage yard is covered by the bridges which are movable on a runway of nearly one-quarter of a mile in length. With the exception of one of the single-span bridges each bridge is equipped with a man trolley and a two-rope grab-bucket of 5½ tons capacity. The single span not provided with a trolley is so operated by using one of the trolleys from a two-span bridge. Under the full load of 11·2 tons the lifting mechanism is designed to hoist at the rate of 250 ft. per minute. The traversing speed of the trolleys is 1,200 ft. per minute, and each bridge can propel itself along its own runway at a speed of 60 ft. per minute.

From the close view, Fig. 9, of the front or water end of two of the two-span bridges, it will be seen that the piers are equipped with bins for loading coal into trucks. The loaded bucket is seen to be just emerging from the hold of the boat, the apron of the near bridge being lowered to admit of the trolley taking up its position thereon. It will be noticed that the apron of the bridge in the background is raised. Numerous structural details both of the cranes and of the vessel are well shown. Each pier of the two-span bridges is mounted on two pairs of four-wheeled equalising trucks, one truck per leg, while the centre and rear end of each of these bridges and the forward end of the single-span bridges are carried on shear legs each mounted on a pair of four-wheeled mono-rail equalising trucks. The rear ends of the single-span bridges are carried on inverted piers, each pier being mounted on two eight-wheeled equalising trucks of about 2 ft. gauge. In addition, the pier that carries the screening apparatus has, for partially carrying that apparatus, an eight-wheeled idler truck.

With the exception of this truck and of the trucks supporting the rear pier of the other single-span bridge, all the truck wheels are positively driven, the respective travelling gear mechanisms being suitably housed on the bridge spans over the main piers. Only half the wheels under the rear pier mentioned are positively driven. The motor for the travelling mechanisms of each bridge is controlled from the operator's cab on the main trolley when the latter is brought immediately under the travelling mechanisms. Gear is provided on each trolley to enable the operator to slew the bucket through an angle of 90 deg.

As the mechanical screening apparatus possesses many novel features it is thought that a brief description of this apparatus will be of interest. In the portion of the rear pier of the single-span bridge containing the screening equipment, Figs. 10 and 11, is located a 30-ton bin for receiving the coal from the grab-bucket on the bridge span and for properly controlling the coal as it is fed into the screening plant. At the side of the main part of the pier is another bin divided into three compartments each of 40 tons capacity. Over this bin is arranged a rotary screen, operated by a 20 H.P. motor for grading the coal into three sizes, each size being discharged into separate compartments of the bin.

Beneath the 30-ton bin is a shaker screen 5 ft. in width and 15 ft. in length, operated by a 15 H.P. motor and designed to discharge the coal passing over it into a small hopper, which in turn discharges the coal to a pivoted scraper conveyor. This conveyor is driven by a 10 H.P. motor and delivers the coal into trucks. The coal passing through the shaker screen discharges

into a bin at the lower end of an inclined elevator and is carried to the rotary screen for distribution in the three compartments mentioned. The 20 H.P. motor used for the rotary screen also operates the elevator. Each of the 40-ton compartments of the large bin is provided with gates to discharge to a horizontal belt conveyor, driven by a 15 H.P. motor and arranged to run in either direction so that any of the different sizes of coal contained in the bins can be delivered on to the stock pile or into trucks on a siding. The 30-ton receiving bin has a large reciprocating gate, operated by the motor used for the shaker screen, and is provided with an auxiliary chute feeding into the lower end of the inclined elevator in order that coal from the screening stock pile may be re-screened. The screening plant has a capacity of 200 tons per hour.

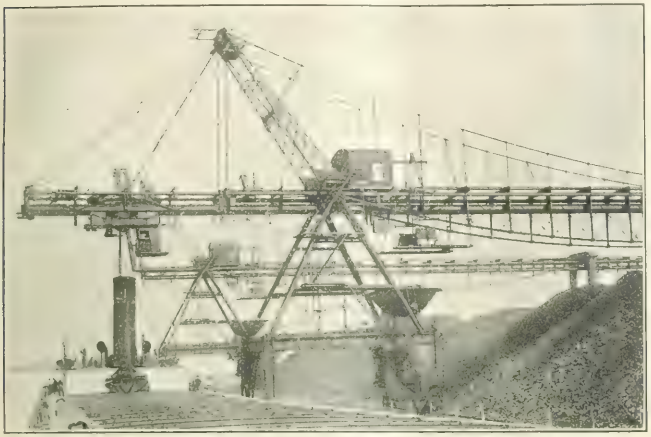


FIG. 9.—BROWNHOIST COAL HANDLING EQUIPMENT, PITTSBURGH COAL CO., DULUTH, MINN. (VIEW SHOWING TROLLEY HOISTING BUCKET FROM HOLD OF BOAT.)

The rear pier of the other single-span bridge is equipped with a 30-ton bin, gates and chute for loading coal into trucks, a screening bin and elevator for screenings, and chutes for screened coal. There is a bucket conveyor for raising the screenings to a point from where they are discharged by gravity to a screenings pile on the water side of the pier or carried by a belt conveyor and discharged into trucks on the other side of the pier. A continuous-running motor of 15 H.P. output is installed for operating the elevator and conveyor.

The electrical equipment, which was furnished by the General Electric Co., of Schenectady, is designed for the use of three-phase alternating currents at 440 volts and a frequency of 25 cycles per second. Master-type magnet-switch control is provided for the whole of the lifting and traversing motors of the trolleys, and drum-type controllers are used for the motors driving the travelling mechanisms on the several bridges. Each of the four trolleys has a 225 H.P. motor for hoisting, two 112 H.P. motors for traversing, one 5 H.P. motor for slewing the grab-bucket and a 2 H.P. motor for actuating the clutch which connects the dump-rope drum to the closing-rope drum mechanism. The travelling gear of the single-span bridge not containing the screening plant is driven by a 50 H.P. motor and each of the other bridges has a 112 H.P. travelling motor. Including the motors connected with the mechanical screening apparatus, the entire capacity of the motors installed amounts to 2,397 H.P.

Particulars of the rates charged for coal-dock service at Duluth have been given by Ryerson and Crane.* It appears that the maximum demand for one of the bridges described occurs during traversing and amounts to about 480 kw. With three bridges in operation peaks of 1,000 kw. to 1,200 kw. occur every few minutes, while on occasions the peak runs up to about 1,500 kw. The average load under these conditions seems to be 450 kw. to 600 kw. From the records of many of these unloaders it is found that the consumption for the actual unloading of coal from the boat varies from 0·35 to 0·6 kw.-hour per ton, depending on the distance the coal is taken back on the storage pile. The figures 1·09 to 1·76 kw.-hours per ton which were given by Ryerson and Crane were found by dividing the total kilowatt-hour consumption for the year by the number of tons of coal that were sent out from the dock during the year. They, therefore, include not only unloading, but re-handling and overhauling as well as the consumption of all the apparatus about the dock.

During the tests of the above plant a vessel containing 8,983 tons of lump coal was unloaded in 10 hours 15 minutes, and another cargo of 8,717 tons of the same grade was taken out in 10 hours 55 minutes actual working time. While working in free coal each bucket averaged nearly 6 tons to the lift.

In 1912 the Pennsylvania Company, of Cleveland, opened a new ore-dock having a yard of 40 acres in area and a storage capacity of 1,000,000 tons. The unloading equipment consists of four 17-ton Hulett unloaders and a 15-ton re-handling bridge, 606 ft. long overall. General arrangement drawings of one of the unloaders are given in Fig. 12, and the ore-bridge is shown in Fig. 13. From Fig. 12 it will be seen that the unloaders have a main span of 71 ft., spanning four railway tracks, and

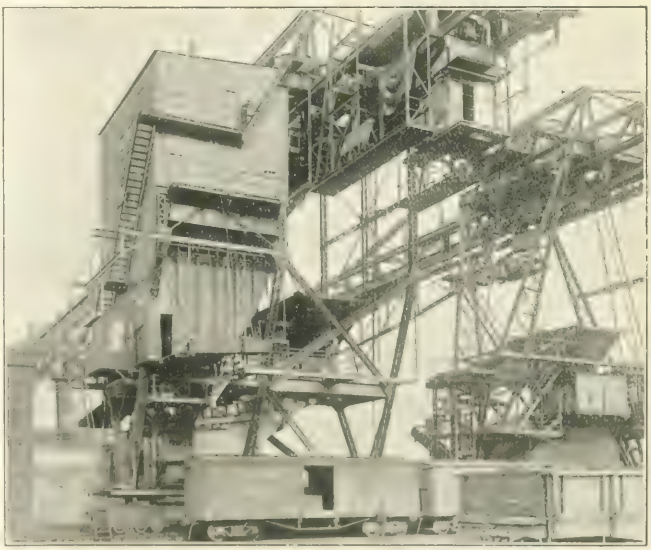


FIG. 10.—BROWNHOIST COAL HANDLING EQUIPMENT, PITTSBURGH COAL CO., DULUTH, MINN. (VIEW SHOWING SCREENING APPARATUS AND ELEVATOR.)

* "Notes on the Use of Alternating Current in Unloading Coal," "Transactions" Am. Inst. Electrical Engineers, Vol. XXXI., p. 709.

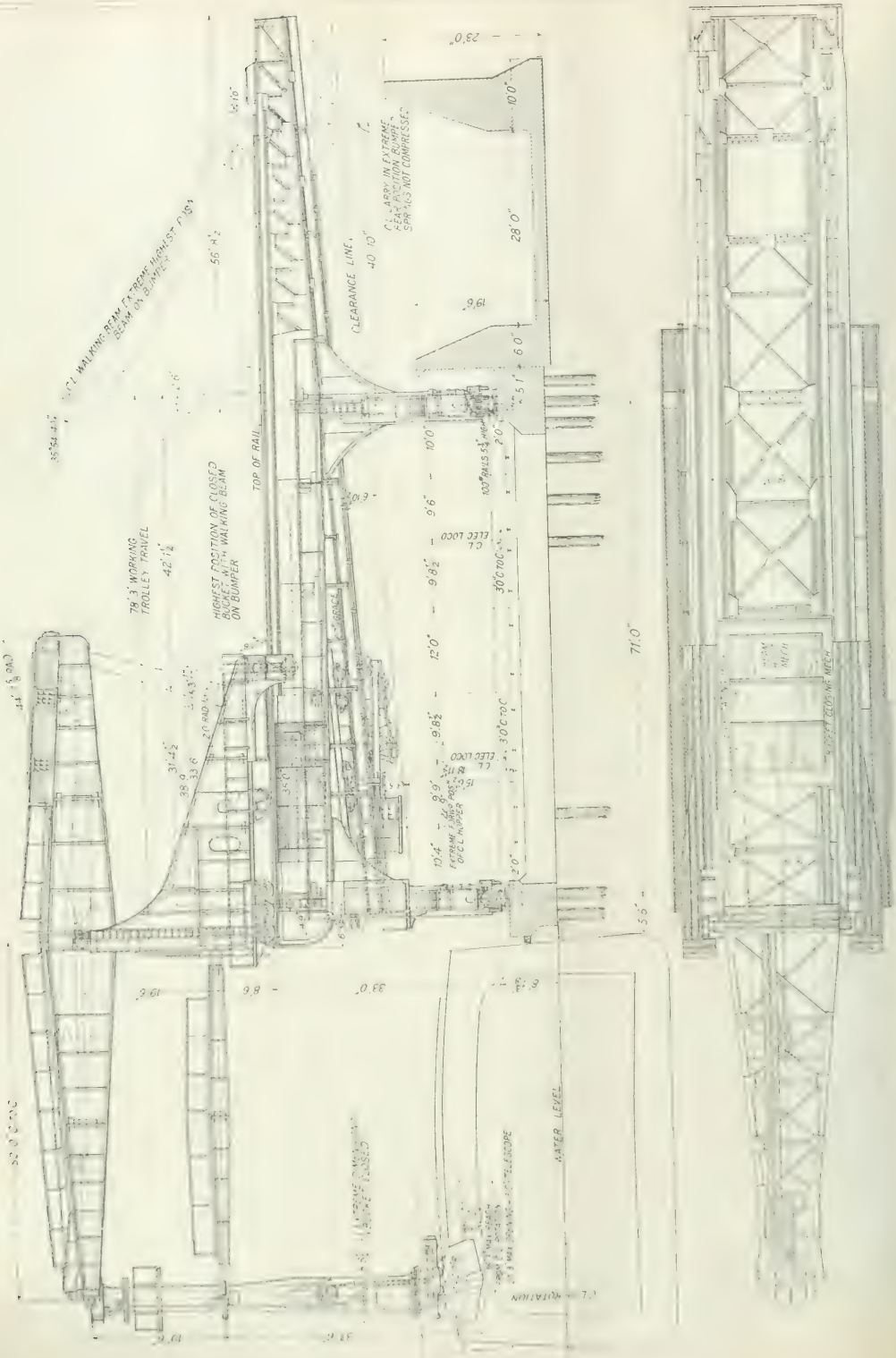


FIG. 12.—CLAYTON ATOMIC TEST DRAWINGS OF A 17-TON BUCKET DREDGER.

a cantilever extension at the rear end of 56 ft., which enables the unloaders to deliver ore 116 ft. from the face of the dock. At the water level the open bucket has a maximum reach of 65 ft. 2½ in. from the face of the dock. The total weight of each unloader is about 730 tons. The ore handling bridge, Fig. 13, has a main span of 266 ft., and a cantilever extension at each end of 170 ft. It is mounted on a pier and shear, and has a man-trolley fitted with the gear for operating the 15-ton

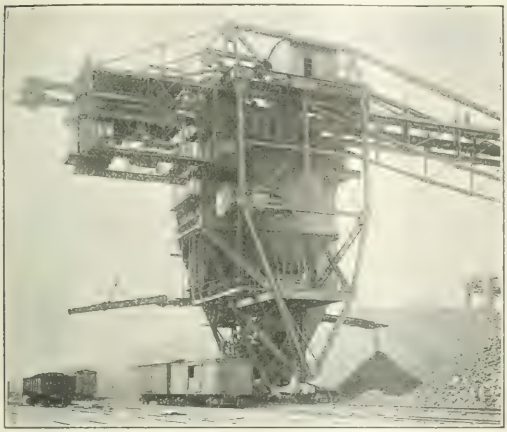


Fig. 11. Brownhoist Coal Handling Equipment, Pittsburgh Coal Co., Duluth, Minn. (View showing Screening Apparatus, Man Trolley and Bucket and Belt Conveyer and Elevator.

excavating bucket. A weighing hopper provided with a chute is housed in the pier.

In operation the ore is delivered by the 17-ton bucket to a 65-ton receiving hopper between the main girders of the unloader, from which it is drawn into a 50-ton Larry car equipped with scales for weighing the ore as it is discharged into the truck or on to the temporary stock pile. This Larry car can discharge the ore into trucks on any of the four tracks, or it can

down and limit switch. The motors are of the following capacities: Rocking beam hoist, 300 h.p.; trolley, 100 h.p.; bucket closing, 100 h.p.; bucket rotating, 35 h.p.; motor operating hopper gates and for moving the unloader along the dock, 150 h.p.; Larry travel, 150 h.p.; opening and closing Larry gates, 35 h.p. With these motors it is possible for the bucket to make a complete cycle in 50 seconds, and as the receiving hopper has a capacity of 65 tons it is unnecessary for the operator to wait for the Larry car operator to draw out each bucketful.

The crew for each unloader consists of one operator in the

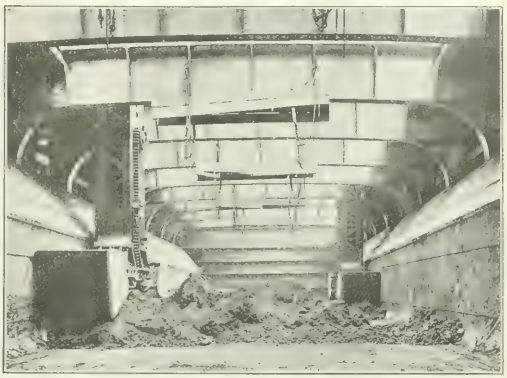


Fig. 14. Buckets of an Unloading Machine working in the Hold of a Modern Boat.

bucket leg for opening, closing and rotating the bucket, and operating the trolley; one operator in the Larry for filling, weighing and discharging; in addition, the railway company usually furnishes a check weighman in the Larry. There is also one oiler required for each machine and for the group of four machines there is a master mechanic and an electrician.

Each of the four unloaders on this dock discharges into trucks on the four tracks spanned by the machine. Between

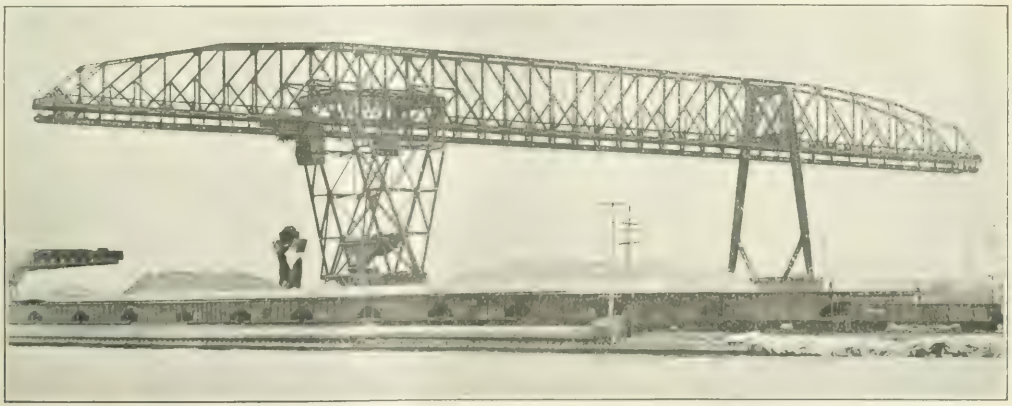


Fig. 13.—15-ton Ore Handling Bridge, [illegible] Railroad Co., Cleveland (the largest ore bridge in existence).

be run out on the cantilever extensions over the dock pile. The bucket is shown in the hold of one of the [illegible] in Fig. 14. When fully open the shells have a speed of 21 ft. 3 in. and in addition, a telescopic motion of 3 ft.

All the motions of the unloader and of the bridge are electrically operated, each motion being provided with a [illegible]

each pair of track, is a narrow gauge track on which runs an electric shunter especially designed for this work. The empties are delivered by locomotive within reach of this shunter, which takes [illegible] the tracks on each side of it, placing them under the two unloaders which [illegible]. As each car is filled the shunter moves the line of five trucks forward until

each truck has been filled; it then delivers the loads to the outgoing end of the yard, where a locomotive takes them for making up into trains, the shunter returning for another string of empties.

Although the Hulett unloader is the machine *par excellence* for service at tideless harbours it is manifestly suitable for places where there is little tide and where the vessels are constructed for its use. This is a question for the ship owner and naval architect. The problem has been solved in America by the close co-operation of the civil engineer, the shipper, the naval architect and the railway engineer, as well as the crane builder and electrical engineer. Without such co-operation the results which it has been our privilege to record could not have been obtained. In a later article the methods of loading will be considered.

The author desires to express his appreciation of the kindness of many American engineers for permission to make use of their Papers, and to thank the Brown Hoisting Co. and the Wellman-Seaver-Morgan Co. for particulars of the machines and equipments described in the article.

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ON SOME SOURCES OF DISTURBANCE OF THE NORMAL ATMOSPHERIC POTENTIAL GRADIENT.*

BY W. A. DOUGLAS RUDGE.

Summary.—The author has investigated some causes of disturbance of the normal atmospheric potential gradient, and shows the effect thereon of the presence of road and other dust and steam.

The author has made a study of some of the abnormal variations due to local circumstances and it appears that there are three main factors besides rain, hail and snow which may exert a disturbing influence, viz.: (1) The presence of dust raised by the wind sweeping over loose soil, &c., or by traffic passing along roads and streets; (2) the presence of dust produced during certain manufacturing operations; (3) the presence of clouds of steam.

THE EFFECTS DUE TO DUST.

In various communications† it has been shown that the presence of dust had a very marked influence on the atmospheric potential gradient. As far as Africa is concerned, the general result was that in nearly every case the presence of dust, whether raised by the wind or by trains, camels, horses or motor cars, caused the positive potential gradient to be diminished, and in extreme cases reversed. During a "dust" storm negative potential gradients of 10,000 volts (!) per metre were not infrequent, but the positive value was as a rule quickly restored after the dust had settled. In order to observe the effect of dust upon the potential gradient any form of electroscope furnished with a radium-coated wire to act as a collector will suffice. A small pocket electroscope, which can be attached to a walking stick, has been used for making qualitative tests, but for quantitative work the Wulf electrometer is very convenient. Perhaps a radium-coated wire is not the best form of collector if absolute values are required; but for comparative tests it is unsurpassable. The charge upon the dust is opposite in sign to that upon the air, and this has been seen in a most striking fashion. During a strong South African dust-storm it was observed that an electroscope placed near to a window occasionally showed a divergence of its gold leaves which at first was attributed to air currents, but the effect was really due to the air inside the room becoming charged, as the following experiment shows. The window was raised for some distance and a piece of wood fitted in to fill up the gap. A hole about 20 cm. in diameter was made in the wood and a tin tube fitted in, but well insulated by means of several layers of paraffined paper; the end of the tube projecting into the room was covered with a piece of wire gauze and several layers of fine chiffon. The dust blown in through the tube charged it so strongly with *positive* electricity that sparks could be obtained from it, and at the same time charged up the air of the room with [illegible] to such an extent that [illegible] electroscope

* Abstract of a Paper read before the Royal Society.

† "Roy. Soc. South Africa," Vol. II., Part V. (1912); "Nature," March, 13 1913; "Phil. Mag.," April, 1913; "South African Journ. of Science," February and March, 1912.

furnished with a radium collector indicated a charge in any part of the room, in some parts sending out the leaf to a right angle.

Observations have been taken at many places in Europe, in cities and along country roads, and the changes in the potential qualitatively observed. The effect of a dust composed entirely of siliceous materials, such as sand, weathered granite, basalt, fine clay, &c., is to diminish or, in extreme cases, to reverse the positive potential, whilst that of a calcareous material is to increase the positive potential. If there is a mixture of materials there is generally an increase of the positive potential; and on all old roads there is, in addition to the stony material, a large amount of organic matter, so that the general effect of dust is to cause the potential to increase. The actual change in the value of the gradient may be very large, say, from 100 to 500 volts per metre; the effect is, however, transient, and disappears with the settling of the dust. Upon freshly repaired sandy roads in Cambridgeshire and the New Forest, passing motor cars raised clouds of dust which gave a negative potential, but after a few days' use, sufficient organic matter accumulated to cause the normal positive potential to be increased. Since most roads are "metalled" with siliceous materials, the charge given to the air might have been expected to be negative,* but certainly on old roads the surface dust is a complex material, and what applies to pure silica, &c., in the laboratory does not do so to the mixture, and probably the much larger scale of the experiment led to different results. Specimens of road dust were collected from those places where observations had been made of the variations of the potential during the raising of dust clouds, either by the wind, or more generally by the passing of cars, and these were tested in the laboratory by the method already described,* which briefly is that a cloud of dust raised by a small bellows is projected against an insulated wire gauze screen connected to an electroscope, and the charge upon the latter tested. The air accompanying the dust is carried on, and its charge indicated by a radium collector attached to another electroscope. The charges thus obtained were found to be opposite in sign.

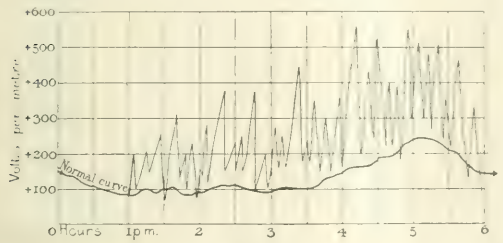


FIG. 1.

The curve (Fig. 1) shows how the presence of dust disturbs the normal gradient. The normal curve was obtained at some distance away from the town, the other was taken on Hills-road, Cambridge. Here every passing vehicle which raises dust makes its presence felt. Only a few of the points of change of potential are shown on the diagram, for even the passage of a bicycle along a dusty road produces some disturbance. The curve is a little diagrammatic, as it is the result of eye observations, but it well represents the extraordinary fluctuations due to the dust. A table in the Paper gives results of tests on a large number of roads in Glamorgan. In several instances it is seen that granitic and basaltic dusts give positive charges to the air instead of negative, as would have been anticipated from the nature of the material, but this was due to the dust really being composed of a mixture, as the following experiments show. A portion of the basaltic dust from the Ely and Cowbridge-road was treated with excess of HCl, and the insoluble residue washed and dried. This residue on spraying in the usual manner gave a — charge to air and + to gauze, showing that the opposite effect obtained with the untreated dust was due to the presence of calcium carbonate. A similar result was obtained with granite dust containing organic matter after the latter had been burnt off, so that it may be reasonably inferred that a purely siliceous dust would [illegible] to a negative charge in the air.

Manufacturing Operations, &c.—Several [illegible] cement works are situated near Cambridge, and these have a very marked influence upon the potential gradient in their neighbourhood. The gradient is enormously increased by the action of two causes: (1) steam escaping from the engine; (2) the cloud of cement dust which envelops the works. Both steam and cement dust render the atmosphere a positive charge and it does not seem possible to determine the amount due to each cause, but the local effects of the two together

* Roy. Soc. "Proc.," A., Vol. XC. (1914).

Table I.

Distance from works.	Potential gradient.	Distance from works.	Potential gradient.
Paces.	Volts per metre.	Paces.	Volts per metre.
100	880	700	180
150	540	800	130
200	420	900	90
300	360	1,000	75
400	300	1,100	70
500	250	1,200	70
600	210	—	—

is very great. The "Norman" cement works are about 1½ miles from the town and can be approached in one or two directions almost free from trees. A calm day after rain is a satisfactory one for making a set of determinations. Using a Wulf electrometer, readings were taken at different distances from the works until the potential indicated was the same as the average previously found for the neighbourhood. The distance was measured by pacing, and the electrometer had to be supported at different distances above the ground in order to meet the varying potential gradient. This was really very unsatisfactory, as the observer's body exerted a considerable influence, but a better arrangement could not readily be devised because the whole series of observations must be taken during a short interval of time when the normal potential gradient is steady. Table I. gives the record of the results obtained on February 12, 1913. Measurements were taken both going to and returning from the works, the whole time taken being about an hour. A rapid tour round Cambridge in a motor car just before and after the determination gave the average value for the potential gradient as about 75 volts per metre. Inside the factory itself the gradient was so high that it could not be found with the electometer used.

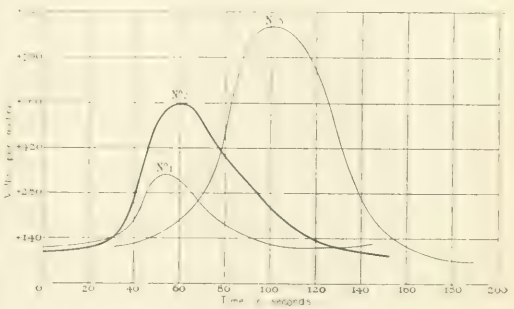


FIG. 2.

Influence of Steam.—Since the time when Armstrong devised his hydro-electric machine, it has been generally known that the escape of steam under pressure was accompanied by strong electrification, but as far as I know no one—with the exception of Lord Kelvin, with whose work* I have recently become acquainted—has called attention to the great increase in the normal atmospheric potential gradient produced by steam escaping from ordinary engines. Recently some work has been done at Cambridge on the influence exerted by the clouds of steam emitted by locomotive engines, the details of which are given below. The country round Cambridge is flat, and many spots may be chosen near to the railway where there are few trees to screen the effects and sufficiently far from roads to be out of the range of the dust influence. Observations were taken at stations at different distances from the line, and the magnitude of the potential gradient noted after the passage of a train under steam. The mere passing of a train had no influence, unless as sometimes happened in very dry weather a lot of dust was raised; for the potential to be largely increased it was necessary for steam to be escaping either in the usual way from the funnel, or even by blowing off from the safety valve. The observations were made with a Wulf electrometer furnished with a radium collector, and records were made of the potential indicated by that instrument at definite intervals of time. The recording was continued until the potential had fallen to its initial value, or until the passing of a second train produced another disturbance. The effect was thus noticeable for about [illegible] after the passing of the train. The curves (Fig. 2) show how the magnitude of the potential varies with the class of train; the curves giving the greatest values of [illegible]

* "Papers on Electrostatics and Magnetism," p. 397.

change in the potential. Curve No. 1 is a slow "stopping" train, No. 2 a goods train, and No. 3 a heavy "express." The last curve is displaced 25 seconds to the right for clearness. The time elapsing before the change in the potential due to the steam reached the recording instrument depended to some extent upon the direction and strength of the wind. In practically calm weather the disturbance extended uniformly a considerable distance from the place where the steam was emitted, but it was carried a greater distance with the wind. The distance from the line to which the influence of the steam extends may, in certain cases with the wind, reach a distance of nearly a mile, and the time taken before the electrometer indicates any change may be from four to five minutes. The curve (Fig. 3) gives the results obtained at a distance of nearly 1,000 yds., the potential changing from 100 volts per metre to about 200.

The influence of steam may be detected on a moving train. When a cloud of steam is trailing behind, an electroscope, furnished with a radium collector, will indicate a strong charge even inside the carriage, if the window is open. Inside a tunnel a very strong charge

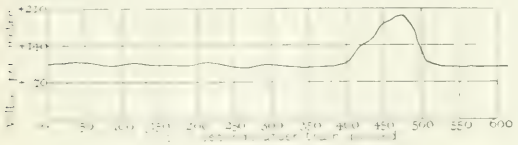


FIG. 3.

can be detected, sufficient to send the gold leaf out at right angles to its support. Inside a boiler-house the same thing is seen if the steam is escaping under pressure, and here, too, the charge persists in the air long after the cloud has disappeared.

A SHORT METHOD FOR CALCULATING STARTING RESISTANCE.*

BY B. W. JONES.

In commercial practice it is necessary to calculate a large number of starting rheostats for the shunt, induction, and series types of motors, and therefore it is essential that a short method be used. Of the methods available, the one described in the present article has been found in practice to give remarkable satisfaction.

First, either the maximum or the minimum accelerating current peak is assumed, together with the number of rheostat divisions and the internal motor resistance. If it is a series-motor resistance, then the speed characteristic curve of the motor is necessary. During acceleration the successive divisions of resistance are short-circuited as fast as the current decreases to a fixed assumed value, and all the current peaks are of equal value.

It should be noted that if all values are in percentages it will cause less confusion. Therefore, all of the series-motor formulæ will be expressed on that assumption.

Let

E = line volts.

I_1 = minimum acceleration current = E/R_1.

S_1 = (for series motors) speed corresponding to I_1.

I_2 = maximum acceleration current = E/R_2.

S_2 = (for series motors) speed corresponding to I_2.

S = speed corresponding to $1.5\,I_1$.

R_1 = total resistance to give minimum current = E/I_1.

R_2 = total resistance to give maximum current = E/I_2.

r = internal resistance of motor.

$r_1, r_2, r_3, r_4 \ldots r_n$ = resistance of the successive divisions of the rheostat.

n = number of rheostat divisions.

$X = \frac{\text{maximum acceleration current}}{\text{minimum acceleration current}} = I_2/I_1$.

$S_1 = S_2 + \ldots$

$100E - I_1 r$

$A_1 = S_1 I_1$

$100E - I_2 r$

$A_2 = S_2 I_2$

$Z = A_1/A_2$.

[illegible] $= 1.5\left(\frac{1}{n+2}\right)$ [illegible] $= 0.75\left(\frac{1}{n+2}\right)(S_1 - S_2)$.

[illegible] $I_2 = I_1 X$.

FOR SHUNT OR INDUCTION MOTORS.

(*a*) Assume that the minimum accelerating current, the number of rheo-tat divisions, and the internal resistance of the motor are known.

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{r}.$$

$r_1 = (X-1)r$.

$r_2 = Xr_1$.

$r_3 = Xr_2$.

$r_n = Xr_{n-1}$.

(*b*) Assume that the maximum accelerating current, the number of rheostat divisions, and the internal resistance of the motor are known.

$$\text{Log } X = \frac{1}{n} \log \frac{R_2}{r}.$$

$r_1 = (X-1)r$.

$r_2 = Xr_1$.

$r_3 = Xr_2$.

$r_n = Xr_{n-1}$.

It is apparent that if any three values are known, the fourth can be found.

FOR SERIES MOTORS.

(*c*) Assume that the minimum accelerating current, the number of rheostat divisions, and the internal resistance of the motor are known.

The following is an empirical formula:

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{1.5\left(\frac{n-1}{n-2}\right)Y}.*$$

Then we take†

$r_1 = A_1(S_1 - S_2)$.

$r_2 = Zr_1$.

$r_3 = Zr_2$.

$r_n = Zr_{n-1}$.

(*d*) Assume the same conditions as in (*c*), but that there are two motors to start in series-parallel.

For the series position:

$$\text{Log } X = \frac{1}{n+1} \log \frac{R}{r + 1.5\left(\frac{n-1}{n-2}\right)Y}.$$

$r_1 = r(Z-1) + A_1(S_1 - S_2)$.

$r_2 = Zr_1$.

$r_3 = Zr_2$.

$r_n = Zr_{n-1}$.

For the multiple position:

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{3\left(\frac{n+1}{n+2}\right)Y}.$$

$r_1 = A_1(S_1 - S_2)$.

$r_2 = Zr_1$.

$r_3 = Zr_2$.

$r_n = Zr_{n-1}$.

(*e*) Assume the same conditions as in (*c*), but that there are four motors to start in series-parallel. Four motors are to be in series at starting and two are to be in series for permanent running.

With this condition if r = internal resistance of two motors then the formulæ in (*e*) are to be applied.

THEORY.

(*a*) From geometrical progressions:

$$\text{Sum} = r + rX + rX^2 + \ldots rX^n = r + X^{n+1}.$$

(Where n equals two less than the number of terms which correspond to the number of rheostat divisions.)

Therefore the last term, R_1, which is the sum of all the previous terms, is:

$$R_1 = rX^{n+1}.$$

$$X = \sqrt[n+1]{\frac{R_1}{r}}.$$

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{r}.$$

* See footnote to previous column.

† G. E. Review, July, 1910.

(b) If n represents three less than the number of terms, then the next to the last term

$$R_2 = X \cdot \frac{R_1}{X}$$

$$\text{Log } X = \frac{1}{r} \log \frac{R_1}{r}.$$

(c) For series motors a modification of the above is necessary. Since there are already too many variables to solve the equation, it is necessary to resort to an empirical formula which is accurate enough for all practical purposes.

The motor field flux varies as a function of the current, and the current fluctuation is a function of the motor's internal resistance and the number of rheostat divisions. Therefore in place of

r there is placed $1{\cdot}5\left(\frac{n+1}{n+2}\right)Y$.*

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{1{\cdot}5\left(\frac{n+1}{n+2}\right)X}.$$

(*d*) The only difference between starting one motor from rest to full speed or two motors in series from rest to one-half speed is that an extra resistance, (r), is inserted in the circuit. Since the two motors in series attain only one-half speed, the sum of the two counter E.M.F. increments are the same as those of one motor running full speed when the current peaks in each case are the same. Therefore, the formula becomes

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{r+1{\cdot}5\left(\frac{n+1}{n+2}\right)Y}.$$

When the two motors are changed to the parallel connection and are accelerated from one-half to full speed, then the extra resistance (r), that was in the series connection, is eliminated and the average counter E.M.F. increment corresponding to each current peak is doubled. Therefore, the formula becomes

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{3\left(\frac{n+1}{n+2}\right)Y}.$$

(*e*) For the series-parallel operation of four motors, the motors are assumed to be connected as follows: During series operation all the motors are in series, and during parallel operation two sets each consisting of two motors connected in series are across the line. Then, if the internal resistance of two motors is considered as r, the same formulæ as given in (*e*) hold true.

Example 1.—Assume: A 25 H.P., 230-volt shunt motor. Minimum accelerating current = 100 amperes. Internal resistance of motor = 0·2 ohm. Number of rheostat divisions = 4.

Formula:

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{r}$$

$$= \frac{1}{5} \log \frac{2{\cdot}3}{0{\cdot}2} = \frac{1}{5} \log 11{\cdot}5 = \frac{1}{5}(1{\cdot}0614)$$

$$= 0{\cdot}212:$$

therefore $X = 1{\cdot}63$.

Then

$r_1 = (X-1)r$	0·126 ohm
$r_2 = Xr_1$	= 0·205 ohm
$r_3 = Xr_2$	= 0·334 ohm
$r_4 = Xr_3$	= 0·544 ohm
Total external resistance,	1·209 ohms
Internal motor resistance,	0·200 ohm
Total resistance,	1·409 ohms

Therefore as a check $\frac{230 \text{ volts}}{1{\cdot}409 \text{ ohms}} = 163$ amperes.

Example 2.—Assume: Same conditions as in Example 1, except that the maximum current is known (163 amperes) and the maximum current is to be found.

Formula:

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{r}$$

$$= \frac{1}{4} \log \frac{1{\cdot}409}{0{\cdot}20} = \frac{1}{4} \log 7{\cdot}045 = \frac{1}{4}(0{\cdot}848)$$

$$= 0{\cdot}212.$$

Therefore $X = 1{\cdot}63$ same as in Example 1. The results are the same as in Example 1.

* See equation (1) in paragraph 1, p. 624.

Example 3.—Assume: A 50-H.P., 230-volt series motor. Minimum accelerating current = 185 amperes. Internal resistance of motor = 0·087 ohm. Number of rheostat divisions = 4.

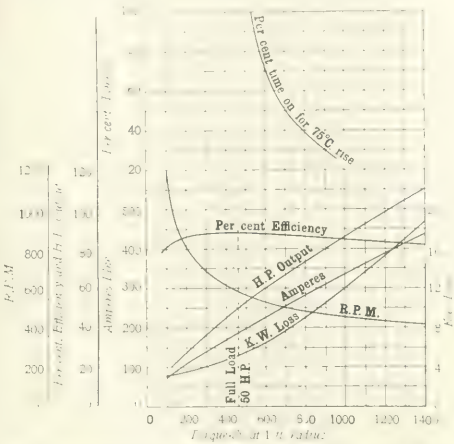


Fig. 1. Characteristic Curves of a 50-H.P., 230-volt Series Motor.

Referring to characteristic curves of this motor (Fig. 1), all values should be reduced to percentages. The speed and current for minimum accelerating values, together with line voltage, will always be considered 100 per cent.

Let

E = 230 volts = 100 per cent. volts.
I_1 = 185 amperes = 100 per cent. amperes.
S_1 = 578 revs. per min. = 100 per cent. speed corresponding to 100 per cent. amperes.
S_2 = 487 revs. per min. = 83 per cent. speed corresponding to 150 per cent. current.
$Y = (S_1 - S_2) = (100 - 83) = 17$ per cent.

Formula:

$$\text{Log } X = \frac{1}{n+1} \log \frac{R_1}{1{\cdot}5\left(\frac{n+1}{n+2}\right)Y}$$

$$= \frac{1}{5} \log \frac{100}{1{\cdot}5 \cdot 5 \cdot 6 \cdot 17} = \frac{1}{5} \log 4{\cdot}7 = 0{\cdot}674 \cdot 5$$

$$= 0{\cdot}135:$$

therefore $X = 1{\cdot}364$.

$$A_1 = \frac{100 \cdot 100 - 100 \cdot 6}{100 \cdot 100} = 0{\cdot}94$$

$$A_2 = \frac{100 \times 100 - 136{\cdot}4 \times 6}{87 \cdot 136{\cdot}4} = \frac{9{,}180}{11{,}850} = 0{\cdot}775.$$

$A_1 A_2 = Z = 1{\cdot}21$.

$r_1 = A_1(S_1 - S_2) = 0{\cdot}94(100-87) =$	12·20 per cent. ohms.
$r_2 = Zr_1$	= 14·80 per cent. ohms.
$r_3 = Zr_2$	= 17·95 per cent. ohms.
$r_4 = Zr_3$	= 21·75 per cent. ohms.
Total external resistance,	66·70 per cent. ohms.
Internal motor resistance,	6·00 per cent. ohms.
Total resistance in circuit,	72·70 per cent. ohms.

$R = \frac{E}{I_1} = \frac{230}{185} = 1{\cdot}24$ ohms.

Therefore, to reduce the percentages to actual values:

12·20 per cent. of 1·24 = 0·151 ohm.
14·80 per cent. of 1·24 = 0·184 ohm.
17·95 per cent. of 1·24 = 0·222 ohm.
21·75 per cent. of 1·24 = 0·270 ohm.

0·827 ohm.

Since the other resistances for two or four motors in parallel in per cent. volts, current, speed, and resistance, are similar to those just given it is not considered necessary to work out an example.

THE DEVELOPMENT OF ELECTRIC POWER FOR INDUSTRIAL PURPOSES IN INDIA.*

BY R. E. SELVER.

The author first calls attention to the development of electric power for industrial purposes in India. The mills aggregate 200,000 I.H.P., of which not even 10 per cent. is driven electrically. It must be realised that it is practically impossible to develop a remunerative market for any manufacture without incurring capital outlay. The measures so far adopted have been but half-hearted, agencies being purely commercial with perhaps a so-called engineering sub-department. A few British electrical manufacturers have gone further and have attached to such agencies their own technical representative, but it is necessary to so arrange matters that the manufacturer has a representative who is able to see the plant not only installed but worked for a certain time until the purchaser is able to take charge with confidence. Again, tenders are frequently given at f.o.b. and c.i.f. rates, but these are quite useless from the point of view of achieving serious business.

So far, Continental competition has been serious, and most of the plant has been put in by Swiss firms. Thus of 66,900 kw. of plant installed at certain stations, Switzerland has supplied 54,000 kw., England only 7,500 kw., while the United States have supplied 5,400 kw. of the prime movers. In the case of the electrical generating plant, Germany has supplied 32,000 kw., United States 17,000 kw., Switzerland 10,000 kw., and England only 7,500 kw.

Climatic Conditions.

It must be remembered that during the Indian "rainy" season, which lasts each year from June to October, the humidity reaches a figure of 95 per cent. with a temperature often of 98°F., and in the mills, factories and engine rooms, a temperature of 115-120°F. is often recorded. The temperature of water available for condensing purposes during the hot months, even when taken direct from the river or other sources of supply, often reaches 95°F., with the result that in the case of turbine plant, the economical steam consumption of which depends so largely on a good vacuum, it is essential to instal condensing plant of a much larger capacity than is usual at home.

The effect of these adverse climatic conditions on the insulation of electrical apparatus for high-tension plant recently led to a controversy as to whether it was advisable to instal 6,000-volt motors, at which pressure a supply of electricity for power purposes is available at cheap rates in two of the largest industrial centres in India, or whether it was preferable to interpose transforming plant, reducing the pressure to 500 volts for the supply to the motors. A large percentage of "burn-outs" on low-pressure motors (220-500 volts) has been directly traceable to the humidity, and it was thought by a number of engineers that the installation of high-pressure motors would be coupled with the risk of a still greater number of breakdowns due to this cause. It seems, however, to the author that the insulation on the average low-tension motor to prevent internal short-circuiting between successive turns due to the difference of potential between them is insufficient to prevent the percolation of moisture from an external source, whereas the insulation necessary on 6,000-volt mains to prevent internal short-circuiting due to the P.D. between successive layers is more than sufficient to prevent the percolation of moisture from an outside source. The author has in many cases supervised the installation of motors to run at 6,000 volts, and with one exception excellent results have been obtained.

Lack of Home Capital for Electrical Enterprises.

Another factor which has hampered the development of electricity for industrial purposes in India during recent years has been the lack of English capital for projected industrial enterprises for utilising either water power or coal near the pit's mouth for the generation of electric power for transmission at a cheap rate for mill and factory use. In the collieries of Bengal, which raise no less than 12,000,000 tons per annum, several projects of the kind were projected a few years ago for the construction of power houses for supplying electric power to [illegible] collieries, [illegible] owing to the lack of both capital and co-operation between colliery owners, [illegible] with the result that there are now scattered over the coalfields a number of small [illegible] power houses. The coal consumption at these stations [illegible] is about 850,000 tons per annum, while [illegible] 50,000 H.P. is awaiting electrical development. [illegible] Mundhum water power scheme, which [illegible] harnessing the water power available at Mundhum [illegible] transmission of electric energy to the mills and [illegible] about 45 miles.

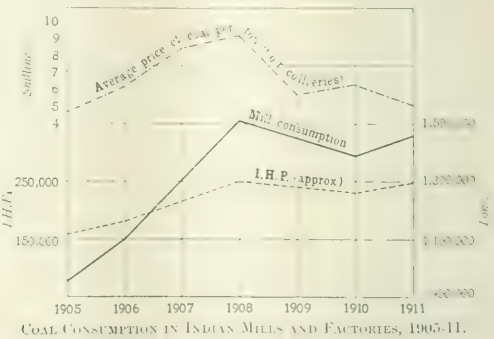
* Abstract of a Paper presented to the Council of the Institution of Electrical Engineers.

Antagonistic Attitude of Mill, Factory and Colliery Owners.

The fact of many of the pioneering electric power installations in India not proving so successful as anticipated, has in many cases turned the owners of mills, factories, and collieries against the use of electric power for industrial purposes, and although to-day this feeling has to a great extent been overcome, it is still a matter of considerable difficulty to convince owners and others that, apart from the saving in capital outlay and running expenses, inherent advantages appertain to the electrical drive which are not possible of achievement with steam.

In textile mills the steady and uniform speed results without doubt in a better quality texture, and the output over the same running hours is materially increased to an extent depending upon the careful layout of the machinery, but unfortunately in very few cases, if any, are manufacturers prepared to guarantee these results. Although they are convinced in their own minds that such is the case it is rarely that one is able to induce manufacturers to convert their beliefs into written guaranteed percentages, which is really the only basis on which it is possible for laymen to base the value of a conversion from steam, which may have done well for 25 years, to electric power. The adjoining figure represents the approximate coal consumption of the mills and factories in India, together with the cost of the same and the approximate horse-power available for electrification.

There is little doubt that the layout of a mill or factory to operate successfully in India cannot be designed to the best advantage at home, for in each case local conditions and the topographical position of the site must be taken into consideration. Experience has shown that many drives which have proved eminently successful at home have not given the best results in India, and for this reason it is not possible to lay down hard-and-fast rules, but each projected electri-



Coal Consumption in Indian Mills and Factories, 1905-11.

fication scheme should be laid out on site only after due regard has been paid to the local conditions under which the mill or factory may have to work.

One important point often lost sight of by home manufacturers is the fact that during the rainy season the average textile mill, after having been shut down on the Saturday afternoon, requires approximately double the amount of power to get under way on the following Monday morning, owing to the abnormal humidity causing the rope drives to tighten during the interval. It is therefore advisable when designing an electric drive with either ropes or belts to allow for the starting gear having an overload capacity of 80 to 100 per cent. This is a point which has frequently been lost sight of by British firms, and experience has shown that whilst in the majority of cases three-phase induction motors are quite capable of dealing with this temporary overload, the capacity of the starting gear has been quite inadequate.

Public Supply *versus* Privately Owned Generating Power.

Assuming for the moment that it is now possible for a thoroughly competent engineer to persuade mill owners and others of the advantage of the electric drive, one of the first points to be decided is the advisability or otherwise, viewed from the manufacturers' point of view, of taking a supply of electrical energy from a public company in preference to generating current on the premises. On this point a great deal of controversy has lately taken place, and as a matter of fact this point is being keenly contested at the present moment in one of the largest industrial centres of India, so that the views of engineers in charge of English supply companies would be of interest.

On the one hand, there is the mill owner wishing for a supply of current at an abnormally cheap rate, and on the other hand there is

the executive of the public supply company called upon by the shareholders to pay a handsome dividend on the capital of the company. There is, however, little doubt that for small outputs up to 1,000 H.P. it is far more economical for consumers to take a supply from a local company; but in the case of 15,000 H.P. or more for a 10-12-hour daily load throughout the year, manufacturers realise that with equal facilities for an adequate supply of water for condensing purposes and equal rates for coal, they are in a position to generate electric power as cheaply as a public supply company. The latter, however, are obliged to add to their generating costs a proportionate charge on the capital sunk in their whole undertaking and a similar charge to cover executive costs, as well as a reasonable percentage of profit. Whereas the manufacturer has only to add to his generating costs the standing charges on the capital outlay necessitated by his plant alone. It must be borne in mind that the keen competition in India to-day in the jute, cotton, flour and coal industries, increases the importance of a thorough grasp both by the manufacturer and the station engineer of all factors, both commercial and otherwise, which may reduce the mill or factory cost of the finished product to a minimum. Although the mill-owner's responsibility will be lessened by taking power from a public company, he cannot afford to do so until it is conclusively proved, apart from other advantages, that it will be more economical than generating power on the premises. The manufacturer does not seem to appreciate that the power he generates is more than he uses, nor that if he generates his own power it must take up some of his attention.

Desirability or otherwise of a Heavy Power Load for Supply Companies in India.

The conditions under which the electric supply companies operate in India do not form a true analogy with stations at home, in so far as in India during nine months of the year a heavy power load due to fans is maintained throughout the 24 hours. It is true that the peak lighting-load is superposed on the fan load, but the resultant station load-factor (defined as the ratio between the mean and the maximum load) may average as high as 65 per cent. It therefore becomes a matter of very serious consideration as to whether a very material advantage is to be gained by an Indian public supply company catering for heavy mill loads which will again be superposed on the fan and lighting peak-loads.

It must be remembered that the revenue per unit obtained from the two latter loads is far in excess of the price which it is possible to charge the mills and factories for a supply in bulk. Is it, therefore, worth while to put down additional plant for supplying current to mills and factories for which a comparatively small return can be asked when such a plant cannot be utilised for earning a bigger return per unit by supplying energy for lighting and fans?

There is also the question of distance which becomes vital in the case of transmission of power in bulk in a densely populated district from a station having a load factor of about 65 per cent. for the supply of current to small consumers for fans and lights.

Take, for instance, a concrete case where an application was received for the supply of electric power in bulk averaging 15,000 B.H.P. to a mill, equally well placed as regards the supply of water and coal, working 11 hours a day and situated approximately 10 miles distant from a power house generating current at 6,000 volts three-phase 50 cycles. Is it going to pay the power company to cater for such a load? In the first place the expenditure under the heading of cable alone would amount to approximately £30,000, as the district is too thickly populated to allow of overhead mains, and if the supply company deemed it necessary to lay down a duplicate cable to ensure reliability and immunity against breakdown this figure would be at once doubled. In addition, the power load will be superposed on the fan and lighting load, and with a station having a load factor of 60 to 65 per cent. additional plant would, therefore, be required. In the event of the mill doubling its plant and requiring twice as much power, additional cable and plant would again be required to be installed.

The earning capacity of such a load, viewed from the station point of view, would be almost negligible, [illegible] for such power would be limited to an extent depending on the figure for which the mill, instead of accepting the supply company, could generate its own power. [illegible] would tend to decrease the station [illegible] necessarily the standing charges which [illegible] entailed in providing for such a load, [illegible] the sale of power for such purposes [illegible] than it is possible to reduce the standing charges per unit generated by the introduction of such loads.

It appears, therefore, to the author that a point is reached when it will not pay a public supply company to [illegible] unless the rate charged for such power [illegible] charge on the total capital formerly expended for the sole benefit of the lighting and fan consumer.

It appears that a standing charge per kilowatt installed must be asked in addition to a charge per unit in order to safeguard the interests of the supply companies, as it may happen that through a shortage of raw materials or the excess of production over demand, a number of mills may be shut down two or three days per week over many months of the year. It must also be remembered that in the majority of cases it is of little use for the mill-owners to seek advice from the contractor, as he, as a rule, is only too anxious to supply not only the secondary motors but the complete primary plant, and, therefore, unless a project is likely to fall through owing to lack of capital, the contractor apparently cannot be relied upon to point out to the manufacturer that a greater economy, and in many cases greater immunity against breakdown, can be ensured by taking a supply from a public company.

Public Supply Companies in India.

The largest of the public supply companies in India is undoubtedly the Tata Hydro-Electric Power Supply Co., whose power station now under construction at Khopoli, in the Bombay Presidency, will when completed be in a position to supply 30,000 H.P. to the Bombay cotton mills, and at a later date 60,000 H.P.

The Cauvery Electric Power Supply Co. initiated by the Mysore Government is the next largest power supply company in India with a station capacity of 16,750 H.P. The head in this case is only 387 ft. and the generator pressure 2,170 volts three-phase 25 cycles. The bulk of the power is used on the Kolar Goldfields, some 92 miles distant from the falls. The transmission voltage is 35,000 and the distribution pressure for motor circuits 2,080 volts.

The Calcutta Electric Supply Corporation is next from the point of view of size, viz., 15,000 H.P., used almost exclusively in the largest presidency town of India for private lighting and fans. The generating pressure is 6,000 volts three-phase 50 cycles, and the transmission to sub-stations is carried out at this pressure, interconnected motor converters being used to transform to continuous current at 450 and 225 volts for general domestic purposes. A pressure of 6,000 volts is available for power.

The Bombay Tramways & Electric Supply Co. have a station of 12,000 H.P. capacity supplying power to the tramways and for private lighting and fans. The station voltage is three-phase 50 cycles, 5,500 volts, with continuous-current distribution to small consumers in the vicinity of the power house and three-phase distribution for large consumers and the outlying districts.

Another hydro-electric station of importance is that installed by the Government of Kashmir, where a station of 7,000 H.P. capacity has been erected for supplying power principally for dredging purposes.

The Madras Electric Supply Co. has been in existence some little time, but it is not possible to give any details in connection with this station as at the moment the whole system is being reconstructed with a view to its being in a position to meet the demands of the Presidency, which demand, however, for some time to come is only likely to consist of a lighting and fan load.

The first Electricity Act passed by the Indian Government came into force in 1903, but it was soon apparent that the Act was defective in many of its measures, and in 1910 a new Bill was drawn up by the Government of India with the assistance of eminent authorities. This Act became operative in January, 1911. It is not proposed to deal at any length here with the Act, but it may be mentioned that few, if any, irksome restrictions have been imposed on the general use of electrical power for factory, mill or colliery work. The interests of consumers taking a public supply have been well looked after, and the stipulations controlling the installation of high-tension plant are such that it is quite possible for British manufacturers to comply with the same without materially altering their standard plant designed for the home market.

Conclusions.

In conclusion, it may be said that the more important manufacturing centres of India to-day are fully alive to the advantages appertaining to the installation of electric plant, but if British manufacturers are desirous of obtaining a fair percentage of this trade it is essential that they should send out to the country their best men and [illegible] for the unfavourable climatic conditions and unskilled treatment to which the machinery is subjected.

[illegible] endeavour to grasp simple technical facts, whilst engineers must on the other hand be prepared to broaden their outlook to embrace not [illegible] the [illegible] with the [illegible] and British [illegible] manufacturers.

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ELECTRIC POWER IN INDIA.

The Paper by Mr. H. R. SPEYER on the "Development of Electric Power for Industrial Purposes in India," which is published in the "Journal" of the Institution of Electrical Engineers and which we give in abstract elsewhere, is important in that it gives an account of local conditions which have to be met in India, for local conditions are necessarily of essential interest to our manufacturers. In this Paper we find the remarkable statement that of 66,900 kw. of plant installed in Indian stations, only 7,500 kw. of prime movers has been supplied by Great Britiain and the same amount of electric generating plant, and this is to a British possession. On the other hand, Switzerland has supplied 54,000 kw. of prime movers and Germany has supplied 32,000 kw. of electric generating plant! If we wish to know the reason for this extraordinary and perplexing state of affairs we can turn to Mr. SPEYER'S Paper, from which it becomes apparent that it is the old story that the British manufacturer does not take sufficient trouble. Owing to greater standardisation, foreign manufacturers are often able to put forward standard plant, whereas the British manufacturer is obliged to quote higher prices to cover special construction. Also the time of delivery is generally longer in the case of the British firms. The question naturally arises: Are the British firms too busy to supply the plant? If that is so, let us accept the situation and cease to cry out about the encroachments of foreign traders. On the other hand, it seems worth while to consider whether it would not be to the advantage of the British manufacturer to put down more capital and thus to increase his business.

It seems to be clear from Mr. SPEYER'S Paper that the British method of doing business in India cannot be often productive or satisfactory. It should certainly be realised that capital is required to develop business abroad just as much as at home. The mere setting up of a selling agency is not sufficient; a purely commercial agency is a hopeless

sort of organisation for tackling technical problems. Even when an engineering sub-department has been established this seems to have generally been such as would not meet the case. It is necessary to have not merely a technical representative, but to have engineers who are capable of seeing the whole transaction through from start to finish, including the running of the plant for a certain period, so as to give confidence to the purchaser. It must be remembered that purchasers in India are not within such easy reach of engineering facilities as they are in this country; consequently, it is most important that the purchaser should have ample facilities to get his new plant into thorough running order and his staff fairly trained. A case is mentioned by Mr. SPEYER of a firm which had only one engineer with any real practical experience of electrical mill work in India. This engineer was naturally unable to give the individual attention that is necessary for each pioneering scheme. Thus the plant which was put down in one case, although by a leading British firm, was superseded by steam plant, owing simply to the lack of qualified supervision. This is unquestionably a short-sighted policy. Further, it is not encouraging to mill owners if they only receive tenders on the basis of f.o.b. and c.i.f. prices. There is not much doubt that our Continental and other rivals (the Germans, Americans, Belgians and Swiss especially) fully appreciate all these points, and it is for that reason they are able to obtain orders for plant which in the nature of things should come to this country.

The end of Mr. SPEYER's Paper deals with the question of power supply, and particularly with the relative merits of public supply and privately-owned generating stations. We do not quite agree with the author in his remarks on the subject when he states that a power company must "add to their generating costs a proportionate charge of capital sunk in their whole undertaking and a similar charge to cover executive costs as well as a reasonable percentage of profit, whereas the manufacturer has only to add to his generating costs the standing charges on the capital outlay necessitated by his plant alone." It appears to us, however, that in both cases the capital to be considered is simply the capital involved in the supply of a definite amount of power. In other words, assuming that the capital cost of the plant is the same in both cases, the capital charges should be the same, and there should be a reasonable percentage of profit in both cases. It would not be commercially sound for a mill owner to put down capital without getting a reasonable percentage of profit upon it. The only difference that may occur is in executive costs. These are often omitted by a private undertaking, but we do not think this is really legitimate finance. Generally speaking, the cost per kilowatt should be smaller for the supply company, owing to larger plant, and the cost of supply should also be less, owing to diversity factor. Further, in comparing costs, it should always be remembered that the costs of a power company tend to fall, whereas those of a private supply must remain stationary.

There are certain complications in the power position in India as compared with those in this country. Thus the fan load in India is very important, and has the effect of raising the load-factor of what would otherwise be an ordinary lighting load to the very satisfactory figure of 65 per cent. Consequently, there is not so much to be gained by the addition of a power load to a lighting load as there is in this country; and when it comes to the question of transmission, more particularly if underground cables are necessary, a point may very soon be reached where the transmission of electrical energy for power purposes is scarcely a paying proposition. The author comes to the conclusion that a point may be reached when it will not pay a public company to take on cheap power-loads unless the rate charged for such power includes a proportionate charge on the total capital formerly expended for the sole benefit of the lighting and fan consumer. Here, again, it seems to us that the basis of argument is wrong. The correct basis is to assume two separate stations for the two different characters of load, and then combine these to see what economy can be effected. Apart from economy in management, each load should bear its own costs, and it is clear that the combination of the loads must give an advantage. But to saddle one load with some of the costs of the other involves an economic fallacy, and should surely be ruled out of the question.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Alternating Current Electricity and its Application to Industry. By W. H. TIMBIE and H. H. HIGBIE. (London: Chapman & Hall, Ltd., 1914.) 1st edition. Pp. x + 534. 8s. 6d. net.

The great part which alternating-current machinery and phenomena play in modern practice makes it most necessary that every effort should be made to simplify the study of the fundamental principles of alternating-current working, so that they may be easily comprehended by the practical engineer. All the essential parts of the theory can be perfectly well and rigidly demonstrated without any more advanced mathematics than the solution of a right-angled triangle; and the use of dynamical analogies serves not only to elucidate the proofs, but to give a more correct physical interpretation of the phenomena than is done by the ordinary mathematical treatment of the subject. We must, therefore, congratulate Messrs. Timbie and Higbie upon their attempt to produce a book which, in their own words, is to be "simple enough to be readily understood by beginners, and, at the same time, complete enough to be a proper foundation for engineering practice or for later advanced study." For this purpose they have set about the work in the right way, by employing hydraulic analogues and by using a crank model to demonstrate the properties of simple harmonic motion. They have also kept the practical side of the question in view throughout, and have interspersed their work with numerous problems of a practical character.

All that is to the good, and there are very many practical engineers who will doubtless read this book with pleasure and profit. But just as the modern praiseworthy attempt to teach mathematics in relation to practical life has to some extent been set back by the want of a comprehensive logical scheme of such teaching, so does this book fail to do justice to the possibilities of accurate demonstration of alternating current phenomena by mechanical analogy. The logical sequence of the fundamentals—the comparison of resistance, inductance, and capacity with friction, inertia, and elasticity; and the explanation of the electrical analogies to displacement, velocity, and acceleration with illustrations of the phenomena

resulting upon sudden application or withdrawal of force. After this comes the establishment of the properties of simple harmonic motion and its vector representation, followed by the laws of series and parallel circuits containing resistance, inductance and capacity.

In the present work the first chapter is of an entirely practical character, and is devoted to modern systems of power transmission, with diagrams showing the essential features of the lay-out of such systems, with the devices required. Then we are given an introduction and fundamental ideas concerning the theory, in which a hydraulic circuit is operated by a pump actuated by a crank. The properties of simple harmonic motion are indicated, though without very rigid demonstration, and reference is made to the impedance of a circuit, without any explanation of the effects of inductance or capacity. Instead of introducing these in the following chapter, the authors apparently consider it more simple to deal with series and parallel circuits, with combinations of alternators and polyphase circuits as a means of showing the use of vector diagrams, although the reasons for employing such circuits are not explained. The next chapter deals with power and power factor and the use of wattmeters; but the explanation of any reason for difference of phase is not given before the fifth chapter, on inductive reactance. Capacity appears to be totally ignored, although the book draws attention to the importance of high voltage long-distance transmissions. The last four chapters return to practical matters, and deal in perhaps unnecessary detail with single-phase and polyphase alternators and armature windings, without coming to the important question of regulation. A good feature, however, is the treatment of windings and other methods for obtaining good wave forms.

The general impression left by a perusal of the book is that its two authors have not co-ordinated their respective rôles, and that neither of them has had an opportunity of developing his work properly. Two separate volumes for the theoretical and descriptive work would give better scope, and it is to be hoped that if this is arranged later, real justice will be done to the possibilities of the dynamical demonstration of alternating-current phenomena. C. V. DRYSDALE.

Elementary Electricity and Magnetism. By W. S. FRANKLIN and BARRY MACNUTT. (London: The Macmillan Co.) Pp. viii.—174.

This book has been written primarily as a text-book for colleges and technical schools. In it the student is presented with the more important facts of electro-magnetism, chiefly by means of comparisons with similar mechanical phenomena. The authors frequently impress these analogies on the mind of the reader by means of parallel statements and corresponding diagrams.

In the first chapter the important facts of magnetism and electro-magnetism are very briefly stated, and the principle of the d'Arsonval galvanometer and of the direct-current motor are included. The next chapter deals with the chemical effects of the current. It is the experience of many teachers that confusion is very likely to be introduced into the mind of a student by referring to the positive carbon pole of a cell as the cathode and the negative zinc pole as the anode, and it seems a pity that the authors have retained this nomenclature. Again, an obvious slip on p. 41, namely, "To deposit one *electro-chemical* equivalent of silver, *i.e.*, 108 gms. of silver, requires 26·82 ampere-hours," will lead the elementary student into difficulties.

The heating effect of the current is very clearly treated in Chapter III., and the ideas of E.M.F. and resistance are further explained. Ammeters and voltmeters and the various methods of using them with shunts and series resistances respectively are described. The subjects of induced E.M.F., motors, dynamos, resistance, alternating current transformers, [illegible] and telephones form the subject matter of Chapters IV. and the last chapter is devoted to condensers and inductances, electric charges and influence machines.

A specially good feature of the book is the exceptional clearness with which the text is illustrated, and the student will be able to test his progress by means of 120 problems to which answers are supplied. B. W. C.

Electrical Engineering. By T. C. BAILLIE. (Cambridge: University Press. 1915.) Vol. I. Pp. vii.+236. 5s. net.

The preface states that this book is intended to serve as a text-book for elementary courses in technical institutions. Examining the text from this point of view, it appears that not sufficient space has been given to the discussion of first principles to enable beginners to grasp these, whereas numerous excursions are made, particularly in footnotes, to niceties of the subject that need not trouble a student until he approaches the end of his course of study. In fact, the want of balance in standard of treatment in different parts of the book is most striking.

To illustrate this it may be pointed out that no mention is made of magnetic reluctance and the principles according to which magnetic circuits should be constructed, and the production of magnetic fields by currents in conductors and solenoids is passed over in about one and a-half pages of text. Notwithstanding the weakness of treatment of fundamentals in this part of the book, space is found to refer to magnetic properties of alloys, and a bare statement is introduced that the law of inverse squares can be proved from the inverse cube law experimentally obtainable for points on the axis of a bar magnet.

Turning to the question of dynamos, no explanation worthy of the name is given of the mode of action, and the elementary student will only be bewildered by the inclusion of three unexplained diagrams of complicated armature windings. The only reference to the functions of commutator and brushes is contained in the sentence: "Fig. 52 also shows the necessity for the so-called commutator which is simply provided to enable the fixed brushes to change their point of contact with the revolving armature winding, so as always to keep it at the appropriate place." The lack of explanation of such important subjects as are referred to above is not atoned for by the inclusion of data such as the atomic weights of dysprosium, lutecium, praseodymium and about 80 other elements, or the resistivities of numbers of alloys and solutions.

The book contains a number of blocks and tables taken from makers' catalogues showing nothing but external views of apparatus and giving purchasing data, and if these were removed much space would be gained for the inclusion of useful descriptive matter. A. J. M.

THE MEASUREMENT OF SELF-INDUCTION: AN ALTERNATE-CURRENT BRIDGE.

BY D. OWEN, B.A., B.SC.

Summary. The author considers the measurement of self-induction by a Wheatstone bridge arrangement. The necessary conditions are stated and actual results are given.

REMARKS ON THE THEORY.

Bridge methods for determining inductance or capacity in which a steady source of E.M.F. is employed possess only a moderate degree of accuracy, unless the sensibility of the bridge is multiplied by the aid of the revolving commutator. The advantage of great sensibility may, however, be attained without effort by applying an alternating E.M.F. to the bridge.

Let us consider the three electrical quantities, resistance, capacity and self-induction (R, K and L). The comparison of any one of these with a standard of the same kind would be a very simple matter if each of the four arms of the bridge contained one electrical quantity only. The current in any arm would be either exactly in phase or exactly in quadrature with the voltage across that arm. Only one condition would have to be satisfied to secure zero current in the galvanometer or detector at any frequency.

This simplicity is, of course, in effect fully attained in the determination of a resistance when direct current is used, as any inductance present is inoperative when the current is steady. In the comparison of two capacities using alternating current the condition is very nearly complied with, though for

accuracy it is in practice necessary to treat an absorptive condenser as a combination of capacity and resistance.

When we come to the measurement of inductance, however, we have in every case to reckon with the associated resistance of the coil under test. The electrically simple bridge is no longer possible. The simple relation of phases of current and voltage disappears. Two conditions of balance appear in place of one. This limits the choice of method, for to be practicable the bridge must be such that the two conditions of balance may be made without interfering one with the other. It is well known that this is impossible if we attempt to compare self-induction directly with a standard of self-induction.

Freedom from mutual interference of the two adjustments is secured in the bridge here described, in which a standard of capacity is employed. The self-induction to be measured is placed in the second arm of the bridge, in series with an adjustable resistance. The arms one and three are electrically simple, and arm four contains a combination of capacity and resistance in series. The current in the detector branch BD is zero at every instant provided

$$K_3 r_1 = K_4 r_2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$L = K_3 r_1 R. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In practice K_3, K_4 and r_1 are chosen. The two conditions of balance are then attained by the alternate adjustment of r_2 and R. The end-point is rapidly attained; indeed, once the bridge is connected up a measurement occupies only a few minutes. The required inductance is given by the formula,

$$L = K_3 r_1 R$$

The balance is independent of the frequency of the current used, and therefore of the wave-form of the applied voltage.

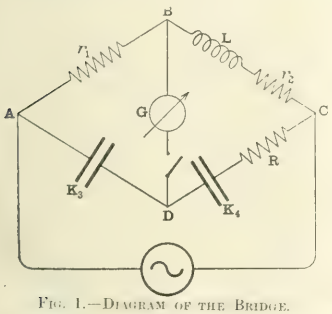


Fig. 1.—Diagram of the Bridge.

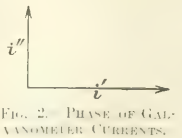


Fig. 2. Phase of Galvanometer Currents.

The sensibility of the bridge is very high over the range 100 ~ to 1,000 ~.

In all inductance or capacity bridges there are small residual effects of inductance in the resistance coils and of resistance in the condensers employed which may lead to error. The present bridge allows of these effects being eliminated. This may be seen from the form of the condition of balance $L = K_3 r_1 R$. Given K_3 and r_1, we see that L is proportional to R. If, then, the coil L be cut out of the bridge and its place be taken by a non-inductive resistance, a fresh balance may be obtained. Denoting by R_0 the new value of the series resistance in the fourth arm, a full examination shows that the true value of L is given by the formula,

$$L = K_3 r_1 (R - R_0).$$

This property of the bridge is of great importance in the accurate determination of low inductances when the unavoidable inductance of the leads employed becomes a sensible fraction of the inductance to be measured. This may be seen in the results quoted below.

It is interesting to note that, when the balance of the bridge is not quite complete, the slight departures from the equality required by conditions (1) and (2) lead to corresponding galvanometer currents which are in quadrature. For suppose i to be the current in arm two. An error of Δr_2 in the value of r_2 will correspond to the presence of an E.M.F. $i \cdot \Delta r_2$ in that arm; this will produce in the galvanometer (or detector) a current $ki \cdot \Delta r_2$, k being a constant depending on the resistances, &c., in the bridge. Similarly, an error ΔL in the value of L will cause a galvanometer current $k \cdot \Delta L \cdot \frac{di}{dt}$. Since i and $\frac{di}{dt}$ are in quadrature, the same must be true of the two components of the current in the galvanometer. This conclusion may evidently be extended to every inductance or capacity bridge employing alternating currents.

The Bridge in Practice.

K_3 should be a standard mica condenser, and it is advisable to use a mica condenser likewise for K_4, though its value is not used in the calculation. Two nominal $\frac{1}{3}$ mfd. mica condensers have been found quite suitable over the whole range of inductance from one microhenry upwards. As to r_1, this may be 1, 10, 100, . . . ohms, according to the value of L under test. For very accurate work R and r_2 must be adjustable to a hundredth of an ohm. In the case of r_2 this may conveniently be done by means of a carbon plate rheostat in series with an ordinary resistance box. In the case of R a loop of manganin or constantan wire about 40 cm. long fixed on a graduated scale, the two sides of the loop being about 0·5 cm. apart, serves to provide the fractional part of an ohm.

Either a telephone or a vibration galvanometer may be used to determine the balance point. Each instrument has its special advantages as well as disadvantages. For low inductances (say under 1 millihenry) the former has been found the more sensitive. If the coil under test contains iron, the vibration galvanometer alone is applicable; the harmonics introduced by the presence of the iron render silence in a telephone utterly impossible.

When the telephone is used a buzzer or small induction coil serves as a very satisfactory source, very high sensibility being obtained at about 500 ~. When the vibration galvanometer is employed it is best to use a tuning-fork interrupter in the primary circuit, and to work at a low frequency, say 100 ~

As examples, the data of three tests are given, one for a fairly high inductance, one for a very low inductance and one for a coil containing iron.

$K_3 = 0{\cdot}33200$ *m.f. at* 16°*C.*

No.	Coil.	r_1.	R.	R_0.	L = $K_3 r_1$ (R − R_0).	Detector and frequency
		Ohms.	Ohms.	Ohms.		
1	Copper coil of 500 turns	100	2397·42	0·25	0·079572 henry ± 0·000004	Telephone, 530 ~
*2	Helix, d.c., resis. 1·1 ohm, with core of soft iron wires	200	1539·5	0·2	0·10216 henry + 0·00006	Vibr. galv. 95 ~
†3	Single turn of copper wire, circum. 150 cm., diam. of wire 0·71 mm.	1·010	6·49	0·455	2·04 microhenry ± 0·01	Telephone, 530 ~.

It is to be noted that the bridge serves also for the determination of the effective resistance of the induction coil, a matter of considerable importance in telephonic and other work (*see* test No. 2).

The balance should, of course, hold either when the arrangement of source and detector is according to Fig. 1, or when these are interchanged. Which arrangement has the greater sensibility depends on the value of L and the conditions of the test. Thus, in test No. 2, the sensibility was over twice as great when the galvanometer was between B and D as when in the alternative position; in No. 3, on the other hand, the sensibility was about three times as great when the telephone was between A and C. Very careful measurements made with the two arrangements in succession have shown no appreciable difference in the calculated values of L. This result is of

* The effective resistance of the coil is also furnished by the data at balance. In this case it was 1·900 ohms.

† Inductance calculated by theory = 2·054 ± 0·005 microhenry.

importance as proving that there was no error present due to earth capacities. This immunity is to be expected in view of the comparatively large values of the capacities employed in the bridge.

Thus far the bridge has been regarded as serving for the determination of inductance in terms of a standard of capacity. The opposite procedure is, of course, equally possible; at balance $K = \frac{L}{r_1(R - R_1)}$. The determination of inductance, is probably the more often required. In point of permanence of value, however, a standard of self-induction is, if carefully constructed, superior to a mica condenser. The latter is subject to changes with time, and with frequency and temperature, which may amount to several parts in 10,000; the constancy of the former may be ensured to within a few parts in 100,000. The direct comparison of a self-induction with a self-induction being, unfortunately, impracticable, a standard of self-induction which has been tested against a primary standard at the National Physical Laboratory is of great value. It serves to determine the value of intermediary standard of capacity, namely, the mica condenser, its temperature coefficient, and to check it from time to time.

For proofs of formulæ and statements made here, and for further tests, reference may be made to "Proc. Phys. Soc.," London, 1914, No. 156, p. 39.

PRACTICAL RESULT OF THE POINT FIVE TARIFF.

It will be remembered that an animated discussion took place on this subject at the Convention of the Incorporated Municipal Electrical Association on June 17th (*see* THE ELECTRICIAN of June 18th, p. 403), and it was felt that the case of the Point Fives had not been supported as strongly as it should have been by some of the Point Fives themselves. Time did not permit of a detailed reply to the discussion by the authors (Messrs. A. S. Blackman and T. Roles). Mr. Roles has now favoured us with a copy of his written reply, and the substance of this we have pleasure in giving below:—

Mr. T. Roles first remarks that the rateable value basis naturally figures rather prominently in the report, because this happens to form part of the tariff at both Bradford and Sunderland. The Point Fives Association as a body holds the opinion that no great headway can be made in the supply of electricity for heating, cooking, and other domestic purposes, apart from lighting, at any price exceeding ½d. per unit in districts in which gas is sold at 2s. 6d. or under per 1,000 cubic ft. In Bradford and Sunderland the fixed charge arrived at on a rateable value basis has been so calculated that, plus a charge of ½d. per unit for current used for lighting purposes as registered by meter, it is on the average equal to the cost of lighting a house moderately well throughout at between 3½d. and 4d. per unit. It follows, therefore, that on the average all units sold for heating and cooking purposes, and any increase of illumination above the ordinary, are obtained by the consumer at a flat rate of ½d., and it was to the results of selling current for these purposes at a flat rate of ½d. that the attention of the members of the Incorporated Municipal Electrical Association was primarily intended to be drawn, whereas by most of the speakers these results have only been given a secondary place, if mentioned at all, and the pros and cons of the rateable value system have provided the main theme of the discussion.

In opening the discussion Mr. Wilkinson called attention to one of the Tables, and deduced from the same that although a Point Five Tariff causes a very healthy increase in the number of units sold, the effect upon the revenue of the undertaking is anything but healthy. As several other speakers emphasised this point, the authors think it as well to clear up a misunderstanding which has arisen in respect to these figures. In putting forward this Table and a similar Table applying to the Sunderland undertaking, the authors wished to show the effect of a Point Five Tariff on consumers who had previously been supplied under the tariffs existing prior to the adoption of the new method of charging. It is stated that, "Owing to changes of tenancy and alterations in other conditions, the comparison given below relates to only 138 of the consumers changed over, the periods covered being the year prior to the introduction of the Point Five Tariff and the year ended Dec. 31, 1914." As the consumptions of these consumers increased by 94·9 per cent. under the new tariff, it is very clear that the tariff encourages consumers [illegible] heating apparatus. With regard to the falling off in the revenue derived [illegible] Mr. Wilkinson [illegible]

advantage of it. It is hardly likely that the 138 consumers in question, having the option of remaining on the flat rate of 4d. or of changing over to the domestic rate of 15 per cent. on the rateable value and ½d. per unit, would have changed over to the latter without they saw some definite advantage would be gained by so doing. In some cases the only advantage was that they could obtain current for heating purposes at a low rate, but in the majority of cases a direct reduction was effected in the cost of their lighting supply. The Table, however, makes it very apparent that, in the case of Bradford at any rate, there is no foundation for the suggestion that a Point Five Tariff under the rateable value system is a means of deluding the undertaking's consumers into believing that they are getting a substantial reduction and current for heating and cooking purposes at a low rate, whereas in reality they are not.

It should also be pointed out that when the domestic tariff was instituted at Bradford, it was fully realised by the Electricity Committee that the time had arrived for a reduction to be made in the charges to domestic consumers who had wired their houses throughout or practically so, and consideration was given to the lines upon which such reduction should be made. By adopting the rateable value system, the good consumers were put into a position to obtain the necessary reduction, and little or no reduction was allowed to consumers with poor load factors. The result as regards the 138 consumers was almost identical with what it would have been had the flat rate for lighting purposes been reduced from 4d. to 3d. per unit and these consumers used exactly the same amount of current for lighting purposes, and the 94·9 per cent. increase in their consumprions—equal to 88,992 units—had been sold them for heating and cooking purposes at ½d. per unit.

The revenue of the undertaking has, in addition, not suffered to the extent it would have done under flat rates of 3d. for lighting and ½d. for heating and cooking purposes, as the consumers whose residences are only partially wired and/or the load factors of whose installations are low have not received an undeserved reduction of 25 per cent. on their accounts.

The other Table gives a better idea of the difference. In this case the comparison applies to all domestic consumers connected for the complete 12 months ended Dec. 31, 1914, and shows that the average number of units consumed per house in the case of consumers on the flat rate was 367 and the average revenue £5. 18s., as against an average number of units per house of 1,082 and an average revenue of £7. 12s. 4d. in the case of the consumers on the Point Five Tariff. There is little doubt that consumers on the flat rate are using electricity for lighting purposes only, and, therefore, those on the Point Five Tariff are consuming on the average 715 additional units per house either for increased lighting or for heating and cooking purposes. The average revenue obtained for the additional 715 units is £1. 14s. 1d., so that the average price per unit obtained for the additional current sold is 0·575d. Taking into consideration the very small additional capital outlay involved, and the fact that the total running costs and expenses due to management are but slightly increased, in the writer's opinion the result is very satisfactory. Had there been no desire to give a reduction to consumers with good load factors, but simply to give these consumers an opportunity of increasing the amount of illumination in their houses and to use heating and cooking apparatus, it would have been an easy matter to have met these conditions by making the fixed charge a higher percentage of the rateable values of the premises. The figures given by Mr. Wilkinson showing what would be the likely effect of the adoption by Harrogate of a Point Five Tariff, based on 15 per cent. of the rateable value, are very interesting It is necessary, however, for Mr. Wilkinson to consider carefully as to whether 15 per cent. on the rateable value is a reasonable fixed charge to make in his town.

Mr. Wilkinson's remarks with regard to the heating of water by electricity are well worth careful consideration, as in the writer's opinion the possibilities of electricity in this direction are far from generally realised.

Councillor Dymond's comments as to large supplies of electricity being immediately demanded by upper-class residential houses for heating and cooking purposes in the event of a Point Five Tariff being adopted, with consequent overloading of the mains, were ably dealt with in the contribution to the discussion made by Alderman Smith, of Barrow. The following figures as applying to Bradford will show that the experience in that city is similar to that at Barrow. The 566 Point Five consumers supplied throughout the complete year ended Dec. 31, 1914, may be divided up in accordance with the rateable values of their residences as follows:—

Rateable Values.	No. of Consumers.
Exceeding £10, but not exceeding £20	124
.. £20, ... £30	190
.. £30, ... £40	92
.. £40, ... £50	62
.. £50, ... £60	46
.. £60, ... £70	19
.. £70, ...	33

From this it is clear that well over 50 per cent. of such consumers reside in premises having rateable values of £30 or less, which are naturally those of middle-class consumers.

The writer agrees that the supply of electricity for heating and cooking purposes presents a difficult problem in a small residential town. It must, however, be remembered that if a satisfactory half watt lamp of moderate candle-power makes its appearance, as is likely to be the case, the revenue received by all undertakings for current supplied for lighting

purposes will be considerably reduced, and the undertakings in residential districts will be far more badly hit than those which depend chiefly upon power supplies for their incomes. The only way in which such districts can make up this loss in revenue appears to be in the direction of increasing their outputs for other domestic purposes. The problem has, therefore, to be tackled sooner or later, and in the opinion of the writer it is better to face it now and obtain some very necessary experience, rather than to wait until the reduction in the lighting output is an accomplished fact. A unit of 1d. or ½d. per unit for heating and cooking purposes, in accordance with the price charged for gas in the district, could be adopted, and the results of such a tariff would no doubt form a valuable basis on which to decide whether still further reductions could usefully be made. As far as his experience goes, however, even were a Point Five Tariff to be instituted at once, no such rush of applications for supplies for heating and cooking purposes would be experienced as many persons seem to anticipate.

There are several Point Five undertakings which do not depend on rateable value, and this basis is not in any way bound up in the Point Fives.

The author is in total disagreement with Mr. Wordingham's dictum that the figures given in the Paper clearly showed that a system could not be right which nearly doubled the consumption and yet reduced the revenue. The Paper certainly showed that in the case of 138 consumers, in the aggregate the effect of the tariff was increased consumption and reduced revenue, but the result, taking all residential consumers into account, is that the undertaking has very considerably increased its revenue, and the revenue per house received from consumers on the Point Five rate is nearly 30 per cent. more than that received from the flat rate consumers. Any substantial reduction in a tariff is almost certain largely to decrease the revenue derived from and to increase the consumption of existing consumers, but the loss in income in respect to such consumers is usually more than made good by additional revenue obtained from new consumers gained.

Mr. Wordingham also stated that he did not believe for one moment it was possible to heat water by electricity economically in sufficient quantities for ordinary domestic supply, and that it was a great mistake to try to do it or to say that it could be done. Whatever he may believe, it is a fact that a number of electric water heating installations are at present in use, are giving satisfaction, and are proving economical. Even if this were not the case, the writer is at a loss to know why it is a great mistake to try to do it. Had the pioneers of the electrical industry been imbued with similar ideas, instead of faith in the future of electricity and courage to tackle the apparently impossible, electricity supply undertakings would probably be non existent to-day.

With regard to the opinion expressed that it is wrong to increase the capacity of radiators in order to heat the air of the room in which they are installed, and that it is essential to keep the air cool, and warm the individual, this, though it may be scientifically correct, is not the opinion of the great body of consumers who have to be catered for. Whatever form of heating is adopted, the usual practice is to warm the air of the room until it reaches a temperature of about 60° F., and one finds it very difficult to persuade a person that he should sit in a room having a temperature somewhere near freezing point—as is the case on many winter days—and toast a portion of his anatomy by the rays of a 1 kw. radiator, leaving the other portions to freeze, it being usually difficult, if not impossible to arrange for such a person to be surrounded by radiators.

Mr. Lackie pointed out that before fixing the Glasgow tariff his main endeavour had been to see that the revenue per house was increased and not diminished. This was also the endeavour of the writer, providing that the increase was due to the installation of additional lights or of heating and cooking apparatus, and the Paper shows that this endeavour has met with success. With regard to lighting supplies only to residences wired throughout and with good load-factors, there was a definite intention to reduce the revenue obtained. An example was given by the speaker of a charge made under the double flat rate in operation in Glasgow, with the object of showing that the same compared favourably with the examples of the Point Five Tariff given on page 6 of the Paper. These latter examples were, however, not intended to represent fair average consumptions of houses of £40 rateable value, but were purely hypothetical cases put forward to show an advantage the rateable value system of charging possesses in respect of the facility for closely estimating the probable cost of electricity supply for any house. Mr. Lackie's example of what the bill of a domestic consumer living in a £40 house in Glasgow would probably be goes to indicate that while the lighting consumers at Glasgow are supplied at an exceedingly cheap rate, the heating and cooking tariff is not sufficiently low to induce consumers to use such apparatus to any great extent. It would tend to make a house the number of units used for heating and cooking purposes would only be 400. The writer presumes that the house would be inhabited by at least three persons, and, on a very moderate basis, if electricity was used for cooking, the consumption for the purposes would amount to at least six units a day. One might, therefore, expect a consumption of over 2,000 units for cooking purposes alone. This is entirely out of the question.

The following figures relating to consumers' accounts in the Bradford supply may usefully be compared with the [illegible] showing the advantage of the Point Five Tariff:

House Rated at £30.

On Flat Rate. Year ended June 30, 1910

244 units at 4d.	£4	1	4
Meter rent	0	8	0
Total	£4	9	4

Average price, 4·39d. per unit.

On Point Five Tariff. Year ended December 31, 1914.

15 per cent. on rateable value of £30	£4	10	0
4,757 units at ½d.	9	18	2½
Total	£14	8	2½

Average price, 0·73d. per unit.

It will be noted that in the second case the consumer pays for the consumption for all purposes, including heating, cooking, and the [illegible] domestic heating and cooking supply only. It is the object of the Point Five Tariff to get the consumer to pay for the consumption in connection with the house, whether the fixed charge is a very suitable one in this case, as the meter rent is included in it, but is an additional charge in respect of the flat rate.

The figures given by Mr. Lackie with regard to his own house would seem to indicate that he himself finds ¾d. per unit too high a price to pay for electricity used for heating and cooking, as his consumption for these purposes is only 1,200 units per annum.

The information as to houses in Glasgow which have been electrically equipped throughout is very interesting and useful as giving some idea of what the future outputs of electricity undertakings may be when the domestic load has been developed. Considering, however, that the houses have only five apartments, the revenue received—viz., £51. 8s.—is extraordinary. Houses with five apartments in Bradford would have an average rateable value of not more than £15, and if the occupants were found to pay on the average £10 per year for coal and gas, the writer would be surprised. The radiators used in the Glasgow houses appear to be of very small capacity, as does also the cooker.

Mr. Cooke appears to have obtained the impression from the returns given in the Paper that the units sold for domestic purposes in Bradford are about 185,000 per annum; this, however, is not the case. For the year ended March 31, 1915, the total number of units supplied to domestic consumers under the Point Five Tariff was 797,303. The writer quite agrees with Mr. Cooke that there is a vast field for heating supply in connection with business premises, and hopes that before long a Point Five Tariff will be available for such premises in Bradford.

Mr. Nichols Moore maintained that progress in the supply of current for heating and cooking purposes could be made with a tariff of 1d. per unit. The writer does not think that any member of the Point Fives Association will disagree with him, as practically all have had experience with a 1d. or ¾d. rate prior to adopting a Point Five Tariff. To compete seriously with other methods of heating and cooking, however, they are of the opinion that the tariff must be reduced to ½d. His remarks regarding the Bradford results have been replied to earlier. As to the results of the working of the tariff in the other Point Five towns mentioned, the writer is not in possession of the necessary statistics concerning these undertakings to enable him to meet Mr. Moore's arguments, but he has no doubt that the engineers of the undertakings referred to could show very good cases for the policy adopted by them.

Mr. Long asks how a Point Five Tariff can be justified in the case of towns in which the cost of coal per unit is in the neighbourhood of ½d. This question can only be satisfactorily answered by the engineers of the towns concerned. The writer would, however, remark that when fixing the amount to be allocated to standing and running costs under any tariff it is usual for at least 25 per cent. of the coal costs, and considerably higher percentages of other items making up the works costs, to be debited to standing costs (*see* Report of Joint Committee of M.T.A. and I.M.E.A. on Charges for Electrical Energy supplied for Traction Purposes from Combined Stations). If only 25 per cent. is taken off the figures given with regard to the average cost of coal per unit in the towns mentioned the charge of ½d. per unit will compare much better with the coal costs. It must also be remembered that the coal costs quoted are average costs, and that the cost of generating units during the hours of light load is very much higher than during the heavy load periods. In works supplying residential districts the number of hours of light load is very high compared with the number of hours during which a moderately good load is sustained. The supply during the hours of light load is usually provided by small inefficient generating sets or by large generating sets run at an uneconomical load. If, therefore, by selling electricity at a cheap rate for heating and cooking purposes, a good day load can be obtained, not only is the cost of generation reduced during the hours of light load, but the average figures per unit in respect of each item of works costs may also be appreciably lowered.

In concluding his reply, the writer would say that if the preparation and discussion of this report lead to increased efforts being made by electricity supply undertakings to cope with the problem of electricity supply for heating and cooking purposes, the result will be a cause of gratification to the members of the Point Fives Association.

Electromagnet for Removing Splinters. An interesting application of electricity to surgery is the removal of steel or iron splinters from the hand or eye by an electromagnet. Such surgical aid is used in hospitals, and a very powerful one has been installed by the Westinghouse Company at their works in East Pittsburgh, U.S.A. The coil weighs 50 pounds and requires 1,000 watts for full excitation.

CORRESPONDENCE.

TESTING ELECTRICAL PORCELAIN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the article entitled "A Comparison on Different Methods of Testing Porcelain," in your issue of July 16, the authors have not made clear as to just what classes of porcelain their comparative tests are supposed to cover, and to what voltage limits it is intended to apply the tests. From their conclusions, however, it would seem that this was intended for the ordinary line of standard insulators up to about 33,000 volts. Testing of insulators is one of the most difficult problems before the porcelain manufacturer at the present time, as the usual tests only give comparative values. As a rule we can only apply a definite voltage in commercial lines of insulators, and those which do not survive such definite voltage are rejected. It may be that some of the accepted insulators are but slightly better than some that failed, but for commercial purposes a definite line must be drawn at some determined voltage. In commercial tests it is inadmissible either to apply impulses of too high a voltage or to continue the test for too long a time for fear of damaging the insulators.

In "Conclusion 6" the authors state that porcelain appears to be fatigued by the application of potentials above a certain unit stress. While from their test the authors would perhaps not be justified in drawing a definite conclusion on this subject, yet it is now a well-known fact that insulators are fatigued, depending upon the stress imposed upon them. Several companies operating high-voltage transmission lines in America have given this problem considerable study, and have found that line insulators which stood the most severe tests before

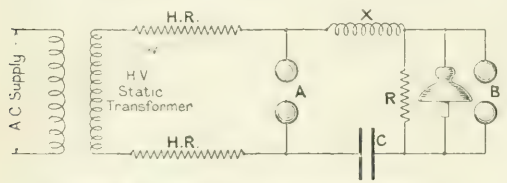


DIAGRAM OF CONNECTIONS OF IMPULSE GENERATOR.

being placed in position, became worn-out after a few years' service. In "Conclusion 3" it is stated that the breakdown of porcelain is due to the electrostatic effect and not to heating. This is not quite correct, as if a high-frequency impulse is allowed to discharge over the surface of an insulator for any length of time hot points are very liable to occur on some spot which was slightly weaker than the rest of the porcelain, and in time the insulator will be punctured at this spot. It is also stated that there is little to be gained by giving insulators a test under oil, but I would like to point out that the strength of porcelain is most accurately determined by this method.

As to the attempt to obtain a test which would give a similar result to a lightning stroke, I cannot see from the data given by the authors that they have succeeded in this. The frequency of lightning is estimated at from 300,000 to 500,000 cycles, and to obtain a test giving a similar result we must be able to predetermine the voltage, frequency, and steepness of the wave-front which are to be impressed upon the insulator under test. The wave-front of an impulse may be steep or sloping, the former giving rise to greater disturbance on the line on account of the suddenness of the impact.

Mr. F. W. Peek, Junr., has devised an impulse generator (the connections of which are shown herewith) which gives a nearer approach to any desired conditions than any other test known to the writer. An ordinary transformer steps up to the voltage required. The two high resistances marked "H. R." limit the current to a safe value. The spheres "A" are set so as to give an arc-over at any predetermined value, and the spheres "B" are merely for checking the measurement of the high voltage impulses produced by the insulator under test.

A single impulse may be obtained varying in voltage up to the limit of the transformer and from 1,000 to 1,000,000 cycles. The inductance "S," capacity "C," and resistance "R" are variables upon which depend the values of the impulse to be obtained, and from the values of which the frequency, wave-shape and voltage impressed upon the insulator may be determined. With arc-over at "A" there is transmitted to the insulator under test a single impulse of the required value.—I am, &c.,

London, July 19. O. E. GRIGSBY, M.Sc.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I find myself quite unconvinced by the experiment described by your correspondent Mr. Carl Hering in THE ELECTRICIAN of the 16th inst. The galvanometer is shunted

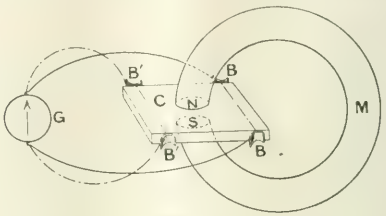


FIG. 1.

by an almost negligible resistance, and must therefore be so extremely insensitive as to be incapable of indicating the presence of the small E.M.F. that would be induced should such induction take place. To illustrate my point, let the apparatus be arranged as in Fig. 2. In this case, when the bar B is moved from B to B', an E.M.F. is undoubtedly induced in it, but one would hardly expect to obtain an indication on the galvanometer G.

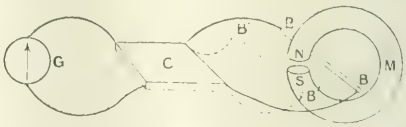


FIG. 2.

It would appear to make no difference where the copper block is placed in Fig. 2. It may be placed between the poles, as in Fig. 1 (Mr. Hering's arrangement), and the conducting bar may be moved above or below it, or the copper block may be replaced by a bath of mercury through which the bar may be moved. In each case there is, presumably, an E.M.F. induced and the galvanometer is shunted. It does not necessarily follow from this that an E.M.F. is induced in the case of Fig. 1; but this point can be easily settled by experiment. Let me suggest one way of dealing with the problem. If an E.M.F. is induced when the two sliders B B (Fig. 1) are moved from B to B', and *vice versa* there will be a current set up in

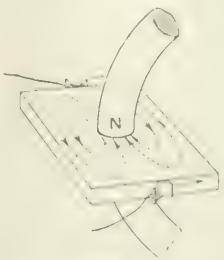


FIG. 3.

the block more or less in the nature of an eddy current, as indicated in Fig. 3. Let the sliders, therefore, be driven backwards and forwards at an acoustic frequency, and *listen* for the induced currents by means of a pair of good telephone receivers connected to two flat coils of wire which are laid on the block so as to form secondaries to the supposed eddy-current circuits.

Such an experiment might well be carried out in the laboratory of one of our technical colleges, and no doubt the students who may take the matter up will find other methods of checking their results and throwing light upon the point in question.—I am, &c.,

Chelmsford, July 25. HUMPHRY MACCALLUM.

SHOP WINDOW LIGHTING IN WAR TIME.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In December last I sent a letter to your paper in regard to shop window lighting in war time dealing with the amateurish attempts made by shopkeepers to conform to regulations. I drew attention to the much-favoured method of wrapping tissue paper around bare lamps and pointed out that not only was this very ineffective but was a distinct source of danger, as witnessed by the large amount of badly scorched tissue paper seen.

The note of warning which I struck in that letter was amply justified in the Press this week, where it was stated that the L.C.C. Fire Brigade was recently called to an outbreak of fire caused by crinkled paper round electric lamp bulbs in a shop window. One is led to wonder how many small outbreaks not necessitating the attendance of the fire brigade have been caused by this highly dangerous practice.—I am, &c.,

London, July 24. F. W. WILLCOX.

ELECTRIC VEHICLES FOR TRAMWAY SERVICES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In response to your invitation for an expression of opinion on "Electric Vehicles" as to the uses they could be put to in tramway services (notwithstanding the attitude which one of your contemporaries has adopted towards a few remarks I made at the discussion on these vehicles at the Conference of the Tramways and Light Railways Association in London), I think there is quite a field of usefulness for these vehicles, but not, I venture to say at present, in the omnibus field for passenger transit until the weight of these vehicles can be reduced by subsequent improvements, and the speed correspondingly increased.

Mr. Watson in his Paper stated that we had accustomed the travelling public to too high a rate of speed. Be this as it may, the public are now used to these rates of travel, and I think will not be content to go back to slower means of transit. Further is it not one of the desirable features to be attained by road authorities, inasmuch as the greater average speed (not excessive speed) that can be maintained the more traffic the road can deal with in a given time, without resorting to expensive road widenings.

Prior to the establishment of motor omnibus services in this area I investigated the merits of self-propelled vehicles for the purposes in view, and having regard to the condition of the roads in county areas in the North, and to the heavy gradients on the roads, it was essential that the weight of the vehicle should be kept down to a minimum. We therefore started with omnibuses of the then latest London type weighing 5 tons 10 cwts. empty, and equipped with 30 H.P. engines. On the heavy gradients it was soon demonstrated that 30 H.P. engines were not sufficiently powerful and consequently all our later vehicles were equipped with 40 H.P. engines, and the unloaded weight of these vehicles (double deck) is approximately 4 tons 10 cwts.

It is not essential that the vehicle should be equipped with powerful engines for operating on the level, but we must maintain an average speed of not less than 8 miles an hour, and as the gradients over which we operate are severe, the length of time occupied on the gradients determining the time of the journey. We do not encourage and never have encouraged excessive speed with these vehicles; in fact we do everything to prohibit it, as they operate over rough roads, and the cost of maintenance runs up if the speed is not kept down to reasonable limits.

If battery vehicles were substituted for these petrol machines I cannot see from my experience in what way we could reduce the weight of the present vehicle, as the petrol engine would be replaced by a motor or motors, so that there would be no saving in this respect, and as the chassis would have to carry an additional 2 tons, say, of batteries, it would bring the unloaded weight to something approaching 6 tons.

I have previously pointed out the principal item in maintenance of our vehicles occurs through bad roads, and if battery vehicles weighing considerably more than our present vehicles were substituted, this trouble would be accentuated. We would rather, on the other hand, if we could, reduce the weight of our existing vehicles by a ton or more, but one does not see where such a reduction in weight could be made, and retain the lasting properties of the chassis. The weight therefore in our case became one of the deciding factors. Had we beautiful pavements to run on, such as you have in London and your main roads generally in the south, the position might be somewhat different, and therefore every case must be treated on its own merits, and not as your contemporary would have it "one vehicle for all purposes whether suitable or not."

For the "odd jobs" outlined in your editorial these vehicles will undoubtedly have a considerable field, and I fail to see that in speaking of a vehicle which will perform many services, which may be described as "odd jobs," that any slur is cast upon the vehicle, as there have been fortunes made out of performing what may be termed "odd jobs," and I shall not have any hesitation whatever in adopting electric vehicles to such uses as I may ultimately find they are better fitted than either petrol or steam vehicles.

Another most important point to bear in mind is the heavier the vehicle the more difficult it is to control on descending heavy gradients, and light weight combined with the necessary strength and powerful braking equipment should be the deciding factor in these cases.—I am, &c.,

Corporation Tramways, Newcastle-upon-Tyne, July 26. ERNEST HATTON, Engineer and General Manager.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am glad to see the interest you have taken in "Electric Vehicles," as one who experimented more than a quarter of a century ago with this type of vehicle, and who has watched its progress during the intervening years, often with disappointing results. I believe that it is now emerging successfully from the various difficulties which beset its earlier developments.

So far as I can see, the one difficulty in the immediate future is the question of initial cost, which is considerably higher than that of the ordinary petrol vehicle. If manufacturers could reduce the cost to a figure nearly equal to that of the petrol vehicle, there can be no doubt that the success of the electric vehicle would be assured.

I may say that I am, at the moment, looking very carefully into this method of traction, and may possibly be able to give a more useful opinion on the subject later on.—I am, &c.,

Corporation Tramways, Liverpool, July 26. C. W. MALLINS, General Manager.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is to be regretted that the interesting Paper on the subject of "Electric Battery Vehicles," submitted by Mr. W. H. L. Watson, at the recent meeting of the Tramways & Light Railways Association, was read at the end of the meeting, otherwise it would have been debated at greater length. I trust the author will have a further and early opportunity of giving results of developments which are proceeding for the advancement of the electric battery vehicle. With regard to the authors' remarks, that the scheme at Morecambe, if adopted, will be the first of its kind in the country, he has, most

probably, overlooked the fact that electric battery cars were in service on the Bristol Road Route, Birmingham, some 20 or 25 years ago. Since that time, of course, a great deal has been done to improve the electric battery, from the transit point of view, and it is interesting to know that the battery omnibuses working at Southend, South Shields, and some other places are affording such satisfactory results as to be likely to encourage their further development. The results obtained by Mr. Harvey, of Ilford, with his battery tower wagon are apparently also encouraging. Generally we may, I think, look forward to a further and extended use of the battery vehicle, and in its performance doing something more than the "odd jobs" which Mr. Hatton had in view.—I am, &c.,

Corporation Tramways, Croydon, July 26. T. B. GOODYER, Tramways Manager, Croydon.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with great interest the leading article in your issue of the 23rd inst. on "Tramways and Electric Vehicles."

I quite admit that the Paper read by Mr. W. H. L. Watson at the Conference of the Tramways and Light Railways Association last week was not discussed as fully as the merits of the Paper demanded, but, as your representative who was present will know, the time allotted to the Papers was far too short, and this undoubtedly militated against a full discussion.

There is no doubt whatever that electric vehicles of all kinds can be most usefully and economically employed in conjunction with tramways and light railways, and personally I anticipate a very big extension of the use of such vehicles in the future. The great point in their favour is that the mechanism of the vehicles is in all respects similar to that of a tramcar; therefore the same class of labour capable of efficiently maintaining a tramways system will equally well maintain electric battery 'buses or electric vehicles of all kinds. I know that difficulty has been experienced in many instances where a small number of vehicles with internal combustion engines have been run in conjunction with tramways, simply because it was not practicable to employ economically a skilled staff to look after the maintenance and upkeep of such vehicles.

I do not attach much importance to the objections raised on account of low speeds of electric battery 'buses on long rising gradients, because in my opinion reliability of service is far more important than speed.—I am, &c.,

Yorkshire (West Riding) Electric Tramways Co., Wakefield, July 27. H. ENGLAND, General Manager.

ENGINEERING STANDARDS COMMITTEE.

PROGRESS OF WORK OF ELECTRICAL SECTION.

The last annual meeting, since its reconstitution of the Sectional Electrical Committee, of which Sir John Snell is the chairman, was recently held to approve such work as was completed during the year and to receive the report of the work in progress.

As a result of the meeting, it is understood that the following reports, which have been presented to the Main Standards Committee for publication, will shortly be available to the public:

1. British Standardisation Rules for Electrical Machinery.
2. British Standard Specification for Electricity Meters.
3. British Standard Specification for Charging Plug and Socket for Vehicles propelled by Electric Secondary Batteries.
4. British Standard Specification for Wall Plugs and Sockets. Five-ampere two-pin without earthing device.

As will be remembered by those in touch, it may be briefly stated that the sub-committee dealing with electric power cables, of which Mr. C. P. Sparks is the convener, has under consideration the revision of the Report on Copper Conductors (Report No. 7 revised March, 1910). The sub-committee on electrical accessories, of which Mr. C. H. [illegible] is the convener, is in co-operation with the Tungsten Lamp Association, Limited, and are considering the drafting of a [illegible] for incandescent lamps and the question of minimum [illegible] of the sub-committee.

The sub-committee on electrical accessories, of which Mr. C. H. [illegible] is the convener, is in co-operation with the Tungsten Lamp Association, Limited, and are considering the drafting of a [illegible] for incandescent lamps and the question of minimum [illegible] of the sub-committee.

A panel has also been formed to revise the Standard Specification for ammeters and voltmeters (Report No. 49 issued in September, 1909), and on this panel the British Electrical and Allied Manufacturers' Association will be represented by Mr. E. B. Vignoles and Mr. Patrick Hamilton.

Lastly, the sub-committee on electrical symbols, presided over by Dr. A. Russell, has appointed two panels, one to draw up a British list of graphical symbols for use in [illegible] installation and power work, and the other to deal with telegraphic and wireless symbols.

The extremely important questions of standards for distributing pressures for new systems, which has been brought forward by Mr. C. H. Merz, is to occupy the attention of a sub-committee under the chairmanship of Dr. R. T. Glazebrook, C.B., upon which all interests will be represented.

As a rough gauge of the activities of the committee it is noted that during the past year more than 90 meetings have been held, and from the above record of work accomplished and in hand, it will be appreciated that the electrical section of the committee is engaged on work of the highest importance to the industry at large.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

[illegible]

24,577 [illegible] or by electric current or steam. (Patent of addition not granted.)

25,072 SIEMENS BROS. DYNAMO WORKS, JOETTGEN & BOLTON. Arrangement and connections of electric switchgear and switches therefor.

25,362 MENZEL.—Method and machine for making tubing for conducting fluids and for electrical insulation purposes.

25,479 SIEMENS SCHUCKERT-WERKE GES. Cooling arrangements for electric locomotives. (26/5/13.)

1914 SPECIFICATIONS.

313 WADE. (Kaisser.) Electric switches.

683 ROUTIN. Means for collectively actuating and controlling alternating-current motors. (Patent of addition not granted.)

953 GREEN. Electric switchboards.

1,871 SIEMENS & HALSKE AKT.-GES. Circuit arrangements for telephone systems. (25/1/13. Addition to 28,751/12.)

3,912 ALLGEMEINE ELEKTRICITATS-GES. Arrangement for regulating the phase displacement between the main current and voltage fields of a Ferraris meter. (5/2/13.)

Relates to Ferraris meters, in which the phase displacement between the magnetic fluxes of the voltage and main current fields, produced by magnetic shunt members is regulated by a bridge of paramagnetic material connecting the outer arms and forming an additional shunt to the magnetic flux of the circuit.

3,986 MASCHINENBAU ANSTALT HUMBOLDT. Electromagnetic shaking feeds or jiggers for electromagnetic separators. (18/2/13.)

4,101 HELFENSTEIN-ELEKTRO-OFEN-GES. Production and condensation of metallic vapours. (18/2/13.)

7,589 STONE & CO. & DARKER. Dynamo-electric generators.

7,590 STONE & CO. & DARKER. Dynamo-electric machines.

7,922 SYKES. Microphones, relays and the like, especially suitable for use in radio-telephony.

8,280 ARNO. Electric distributing systems.

8,504 DRESLA. Electric time switches. (3/4/13.)

8,794 DRUMAUX. Reciprocal connection for two telephone lines connected with a relay for reinforcing telephone currents. (23/10/13.)

Reciprocal connection for two telephone lines connected with a relay for annulling or impairing the tendency to produce disturbing oscillations characterised in that the relay is connected with the telephone lines by the interposition of artificial lines having inductance and capacity with comparatively small resistance and leakance, and being tuned and calculated in such a manner that the telephone currents propagate in same in an undulating (wave) manner with comparatively low speed, small damping effect and small distortion.

9,686 KUHR & BRIDGES. Wave detector for wireless telegraphy of a mercury and crystal type using carborundum or other crystals.

10,253 GILL. (United States Light & Heating Co.) Variable-speed generator and storage battery systems.

11,[illegible] Commutating [illegible]

12,941 B.T.-H. CO. (G.E. Co.) Motor control systems.

15,270 HART. Apparatus for transmitting pictures of moving objects and the like to a distance electrically.

15,338 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.) Telephone systems.

15,485 PLANIAWERKE AKT.-GES. FUR KOHLENFABRIKATION. Electric arc lamps. (6/4/14.)

16,007 KNIGHT & CLERK. Incandescent electric lamps.

16,027 MICANITE & INSULATORS CO. & ALLAN. Insulation of dynamo-electric machinery.

16,126 ALLGEMEINE ELEKTRICITATS-GES. Apparatus for the electric soldering of thin objects by means of indirect heating. (12/8/13.)

16,327 B.T.-H. CO. (G.E. Co.) Electric circuit controlling devices.

16,[illegible] [illegible] & [illegible] [illegible] arrangements for wireless telegraphy.

An oscillatory circuit containing an oscillation detector is connected to a microphone relay, the vibrations of the microphonic contact of which are under the direct control of both the detector circuit and the local microphone circuit, the latter circuit being connected either directly or through the intermediary of a second microphone relay to a contact relay or like receiving apparatus having movable parts, such as a syphon recorder or Wheatstone receiver, through a second oscillation detector arranged in series or in parallel with the contact relay or its equivalent.

16,[illegible] [illegible] Apparatus for calling attendants.

16,575 RAILING & GARRARD. Electric relays.

17,399 BLOXAM. (Telegraphone Ges.) Telautographic apparatus.

18,405 WACKER. Bell-ringing apparatus. (25/8/13.)

18,761 WOODHOUSE, & CALLENDER'S CABLE & CONSTRUCTION CO. Terminal boxes for electric cables.

19,254 THOMPSON & DAVIES. Devices for separating magnetic materials from materials in which they may be present as impurities or foreign matter.

19,[illegible] [illegible]

20,[illegible] [illegible]

20,580 COLLIE. [illegible] & Patents Act, [illegible] telephone installations.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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ELECTRICAL APPLIANCES IN THE CANADIAN MARKET.

An interesting report has been published by Mr. H. P. STARRETT, the consul stationed at Fort William, Ontario, Canada, regarding the uses of electricity for domestic purposes in the cities of Fort William and Port Arthur. We gather from the abstract of this report recently published in the "Electrical World" that electrical energy is to be obtained in certain sections of the Province of Ontario and in Western Canada at the rate of 0·5d. per unit, on a special meter, for heating and cooking purposes. No reference is made to the charge for electrical energy for lighting, but presumably this is somewhat in proportion, and is a figure which would preclude the use of gas, because the cost of coal is in the neighbourhood of £2 a ton. Mr. STARRETT states that cooking by electricity costs less than half that of cooking by wood or coal. We gather from the report that there are approximately 8,000 dwelling houses in Fort William and Port Arthur, and upwards of 5,000 of these are wired for the use of electricity, and the occupants own the apparatus of which they make use for cooking and heating purposes. The average expenditure per tenant is said to be between £4 and £5, and that in a number of cases the amount reaches £40. There still exists a demand for hot-plates, warming cupboards, toasters and flat-irons; electric washing machines and vacuum cleaners are in some demand, and also radiators and small fires. Mr. STARRETT anticipates that there is an immediate prospect of a market for electrical goods to the value of over £20,000.

The proximity of the American electrical factories probably accounts for the high percentage of subsidiary electrical apparatus used in Canada. Mr. STARRETT puts this as high as 65 per cent. We ourselves have experienced something of an influx of American appliances, such as irons, toasters and kettles, but there is no reason why the English makers of such apparatus should not make a bid for business in the Canadian market. The records of the expansion of the hydro-electric undertakings throughout the country indicate that there is no falling off in the demand for electrical energy, and although in the initial stages this demand is principally associated with power supply in bulk for industrial purposes, the domestic consumer who fits out his premises for the use of energy for lighting, heating and cooking is by no means to be despised. With the flattening out of the demand for the electric service for industrial power purposes there will come a greater appreciation on the part of the power supply undertakings of the domestic load. In the near future this load will reach substantial proportions, and it foreshadows a considerable amount of activity among the manufacturers of subsidiary electrical appliances. By comparison with steam-electric generating plants in this country, colonial and foreign hydro-electric stations are unable to offer such favourable rates for electrical energy. It must not, however, be presumed from this fact that the comparison is a true one. As a fact, the cost of fuel in these countries is so high that although electrical energy may be offered at prices two and three times those that obtain in Great Britain, they are extremely low and favourable of acceptance amongst the industries in which the hydro-electric stations give a service. Many makers of subsidiary electrical appliances in this country overlook the market abroad because they believe that the charges for domestic electricity supply are on the high side. Could they but realise the amount of business which the American makers of these appliances are able to do in Canada and the United States they would change their views on the subject and take steps to plan their production for an Imperial rather than for a purely home demand. We know that British electrical appliances compare favourably with those turned out by American factories, and we know that they would be appreciated in the colonies if an organised attempt were made to put them forward amongst the factors and distributors.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week July 19, 1915, to July 24, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible] candles. £364; telephone materials, £999; lamp parts, £520; elec. wire and cable, £26; unenumerated, £1,315. *Switzerland:* Unenumerated, £11. *Holland:* Elec. lamps, £1,271—10 pkgs. *Sweden:* Elec. lamp parts, £145; telephone material, £88; unenumerated, £854. *France:* Elec. carbon candles, £411; lamp parts, £70; unenumerated, 8 pkgs. *Canada:* Telephone materials, £125; unenumerated, £194. *Denmark:* Telegraph apparatus, 9 pkgs.; telegraph instruments, £537. *Java:* Telephone material, 24 pkgs.

EXPORTS.

To Australasia.—*Auckland:* Elec. machinery, £119; unenumerated, £15. *Melbourne:* Elec. machinery, £34; wire and cable, £3,432; telegraph cable, £1,704; unenumerated, £1,092. *Sydney:* Elec. machinery, £333; wire and cable, £2,317; unenumerated, £1,239. *Wellington:* Elec. machinery, £475; unenumerated, £1,406. *Brisbane:* Wire and cable, £2,002; unenumerated, £500. *Dunedin:* Elec. machinery, £11; wire and cable, £15; unenumerated, £127. *Lyttelton:* Elec machinery, £31; unenumerated, £173. *Adelaide:* Wire and cable, £127. *Townsville:* Wire and cable, £700. *Christchurch:* Wire and cable, £231. *Otago:* Unenumerated, £134. *Perth:* Unenumerated, £232.

Africa.—*Durban:* Wire and cable, £26; elec. machinery, £1,029; unenumerated, [illegible] machinery, £78; wire and cable, £137; unenumerated, £516. *East London:* Elec. machinery, £24; unenumerated, £95. *Sierra Leone:* Unenumerated, £57. *Mauritius:* Unenumerated, £19. *Sekondi:* Wire and cable, £162; unenumerated, £18. *Mombasa:* Unenumerated, £109.

Egypt.—*Port Sudan:* Unenumerated, £127. *Port Said:* Unenumerated, £162. *Alexandria:* Wire and cable, £26; unenumerated, £519.

Spain.—*Barcelona:* Elec. machinery, £130.

[illegible] material, £221; unenumerated, £4,199. *Rio de Janeiro:* Unenumerated, £642. *Pernambuco:* Unenumerated, £37. *Barbados:* Unenumerated, £57. *Punta Arenas:* Unenumerated, £38. *Pelotas:* Elec. tram cars, £4,500.

Japan.—*Yokohama:* Unenumerated, £18,318.

China.—*Shanghai:* Elec. machinery, £19; unenumerated, £1,343. *Canton:* Unenumerated, £23. *Honkong:* Unenumerated, £52.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Elec. machinery, £1,326; wire and cable, £1,249; telegraph material, £35; unenumerated, £880. *Calcutta:* Wire and cable, £507; elec. machinery, £315; unenumerated, £1,829. *Colombo:* Unenumerated, £58. *Madras:* Wire and cable, £87; unenumerated, £483. *Singapore:* Elec. machinery, £310; wire and cable, £110; unenumerated, £897. *Karachi:* Unenumerated, £763. *Kilindini:* Unenumerated, £215. *Rangoon:* Wire and cable, £224. *Bankok:* Unenumerated, £41.

Canada.—*Montreal:* Elec. machinery, £139. *Quebec:* Unenumerated, £13.

France.—*Paris:* Elec. machinery, £390; unenumerated, £383.

Norway.—*Christiana:* Unenumerated, £213.

Malta.—Unenumerated, £36.

FOREIGN GOODS (duty paid and free).

Sydney: Unenumerated, £19. *Barcelona:* Unenumerated, £83. *Durban:* Unenumerated, £57. *Karachi:* Unenumerated, £109. *Madras:* Unenumerated, £50. *Melbourne:* Unenumerated, £46. *New York:* Unenumerated, £210. *Petrograd:* Unenumerated, £20. *Wellington:* Unenumerated, £70.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Hamilton v. Marconi's Wireless Telegraph Co. (Ltd.

[illegible] hearing [illegible] resumed on Thursday last week.

Mr. Pollock [illegible] that they had had to get certain letter from the Admiralty and to be sure as the public interest they should not be made public. He now [illegible] a report of the case was appearing in the electrical papers. It was a matter of some importance that these things should be treated as confidential.

Mr. Gordon Hewart, K.C., agreed.

[illegible]

Mr. Pollock [illegible] templated had been built. The only way in which it could be material was that it fell under the branch of the claim as to whether there was a sale effected within the plaintiff's territory, and the defendants said that [illegible] term of three years. That which came under the agreement of July 13 [illegible] material to the case. The plaintiff [illegible] to make no claim in respect [illegible] Mr. Pollock [illegible] Company [illegible] matter. He felt that they were sitting as a public court where reports were being made of what was taking place, and there were matters which should not be brought into publicity at the instance of a man who had no right to have the documents produced.

Mr. Gordon Hewart said his answer to that was twofold. In the first place Mr. Pollock had put in a certain letter, and there was an answer to that letter. Having put the letter in he could not say that the answer to it was not relevant. The letter without the answer might be misleading.

The Referee: You want more than this one reply.

Mr. Gordon Hewart said he wanted to see that one reply before he knew. In the second place Mr. Pollock suggested that the plaintiff's claim in respect of that document depended upon his submission that the commission was for the life of Mr. Hamilton. There was a contract made, which, if it had been performed by the defendant company would have undoubtedly yielded a large commission to Mr. Hamilton. Mr. Hamilton said that so far as he was concerned he did all his part, and if the matter did not go on, the fault was with the Company.

The Referee: Nothing has been done—nothing has been put up. Does not the claim depend upon whether or not he is entitled for life?

Mr. Gordon Hewart said he submitted that it did not, because Mr. Hamilton had done his part. The second contract had come to something.

The Referee: Was that within the time of his agreement?

Mr. Gordon Hewart: I should say—

The Referee: There was [illegible] upon whether he was entitled for life?

Mr. Gordon Hewart: I submit not because Mr. Hamilton had done his part and another contract was [illegible] from which the company derives considerable benefit.

Mr. Pollock suggested that if after considering the matter the Referee thought he ought to produce the correspondence he would do so; they might have a further sitting in order to discuss the matter.

Mr. Gordon Hewart said that Mr. Pollock's anxiety not to disclose what followed after the letter was significant.

Mr. W. W. Bradfield, the manager of defendant company, said the Admiralty sent orders to the company, and all of them passed through his hands. From time to time they ordered supplies of apparatus to be sent to the naval stores at different places, but he had never known the orders to specify the particular ships in which the apparatus was to be fitted, nor was it possible for the company to ascertain the place at which the apparatus was to be used. He had no documents beyond those disclosed in reference to the battleship "New Zealand." With regard to the Malay States battleship, that ship had not been completed, and he had no documents relating to her. His company had never, to his knowledge, supplied apparatus to be fitted in the Australian battleships, but it was quite possible that some of the apparatus supplied to the Admiralty had been fitted to those ships. All orders passed through his hands or were brought to his notice before they passed into the company's books. Orders for field sets for Australia came from the War Office. In those orders there was an indication that they would be paid for by the Commonwealth of Australia. They had not paid the plaintiff in respect of those. He had never had any communication with the Admiralty with regard to supplying apparatus for the Australian ships.

A letter and a reply which followed it from Mr. Godfrey Isaacs were submitted to witness, and he was asked by Mr. Gordon Hewart whether, after having read them, he had any doubt that the apparatus installed in the Australian ships were [illegible] Witness replied that he should think it very unlikely that any considerable portion would be manufactured by the company. The proportion would be very small. Some [illegible] supplied particular portions of the apparatus. The cost of a set of apparatus would depend upon the size of the installation. A small one would be from £400 to £500, and for larger ships the cost would go up to and beyond £1,000.

Supposing it were held that Mr. Hamilton was entitled to commission upon the apparatus supplied by [illegible] you could ascertain from your books and inquiries at the Admiralty the price of the [illegible] Our books would not tell us, and I do not think the Admiralty would give us any information on the subject. No doubt it would be possible to find what was the total amount of business done with the Admiralty during the year, but there were no records of the names of the ships. He had a conversation with Mr. Hamilton before he went to Australia as to calling upon certain shipping agents in London, and he understood that he was already in touch with the shipping houses in Australia, but he (Mr. Hamilton) was not largely interested in rising the subsidy from £200 to £250 per annum.

Mr. Pollock [illegible]

The Referee then read certain letters handed in, and said he was of opinion that he ought not to call for any further discovery.

Mr. Pollock, in summing up defendants' case, said the dismissal took place on Jan. 13, 1913, and the contract of May, 1910, between plaintiff and defendant company ran for the definite period of three years, and so would have continued until May, 1913. The agreement was, according to the verdict of the jury, improperly broken by defendants in January, 1913, and they were asked by the judge to give damages in respect of the pecuniary profit which Mr. Hamilton would have received if he had not been improperly dismissed, and they gave him in respect of the first period £640. There was evidence before the jury, and it was admitted that in respect of that period there was certainly a sum of £140 payable to him, but by reason of an order that had been made and an agreement between Sir Edward Carson and Mr. Duke, it was contemplated that there would have to be a further inquiry as to damages. Therefore, it

was known to the jury and all persons at the time that at the time £140 was put forward it might not be the full sum which would be payable in respect of the broken period. It was fair to say that no jury could have at that time believed or supposed that there was finality in the £140. Mr. Justice Avory at the time directed the jury that the plaintiff was entitled to damages for loss sustained by breach of the agreement and for the pecuniary benefit which he might have derived from the agreement, and further that he was entitled to such sums as they thought he might have earned up to May, 1913. The jury estimated that at an additional £300, and he submitted that that closed the matter as regards the period from January to May. Plaintiff could not be given any further sum unless it could be shown that the business done during that period stopped that amount. The inquiry had, on the contrary, shown that he was not really entitled to the £300. The award to plaintiff was a round figure in the matter, and in addition to that he had got the sum of £700 as payment for the value of the chance that the agreement should have continued for another three years down to 1916. The value of that chance had been measured by the jury. He asked the Court to find that over the two periods the plaintiff had been compensated, and that for the further three years he had also been compensated by the sum awarded by the jury, and if the plaintiff asked for commission on sales effected between the periods of January and May, 1913, he was asking to be paid his commission twice over. The agreement was determined by a period of three years and the plaintiff was to be paid 5 per cent. on the gross value of the sales in return for services rendered and his giving exclusive attention to the business of the company. Therefore, the agreement could not be for the period of his natural life. He was only entitled to be paid for the period during which the agreement was running. The claim in relation to the high power stations, or the Imperial wireless exchange (said counsel), rather startled him, because, when he looked at the agreement it appeared he was to be paid on the sales effected by the company and when such payments became due and payable, and when the amounts were received by the company. The fact was that no money had been received in respect of those stations. The plaintiff then said he was entitled to be paid because, if the contract had not been abandoned, there would have been a prospect of his being paid. What they had done, said the plaintiff, was to prevent the receiving of the money, and so deprive him of his commission. It was impossible, however, to say that there was any sale effected on anything which came within the agreement. The agreement had to be ratified by the House of Commons, by the Governments of Egypt, South Africa and India, so it could not be said to have been an agreement which would necessarily go through. It was impossible for an agent to charge his principals with a breach of agreement if they found it necessary to withdraw an order to get better terms. It was estimated that the contract would have produced royalties to the amount of something between £4,000 and £30,000 a year, but there was no proof of that and no actual damages had been proved. As to the claim in relation to the sale of the Amalgamated Wireless Australasian (Ltd.), he said that it was a claim prompted by an over-sanguine spirit, which did not really know what the true facts were. There was a rivalry existing between the Berlin Co. and the Marconi Co., and the German Co. worked in Australia through the Australian Wireless Co. The rivalry became acute, and it was determined to try to put an end to it. The agreement of March 6, 1913, was accordingly entered into, an agreement which contemplated taking over the German Co. and the Australian Co. by a new company to be formed. It [illegible] was to take over the business from October, 1912, which was before the agreement of the plaintiff had lapsed. That sale to the Australasian Co. was not the sale which was contemplated by the plaintiff's agreement. As to the shipping contracts with the British India and Shaw Saville lines, he contended that the plaintiff had no claim which could be substantiated.

Mr. Gordon Hewart, K.C., in summing up the whole case for plaintiff, repudiated the suggestion that the plaintiff was seeking to recover damages to which he was not entitled. In estimating the position of the plaintiff in the matter it was important to see what the real agreement of the case had been. The plaintiff was acting [illegible] those he produced and in spite of there being [illegible] and in addition certain sums to which he believed [illegible] agreement moneys earned. But the books and documents were in the possession of his employers. He had no access to them, and when he came to close quarters he was hemmed in [illegible] information could be had which necessary steps could be completed. On Sept. 1, 1913, he issued his writ, and certain interlocutory proceedings took place. On March 26, 1914, there was made, at the instigation of defendants, an order which reserved all questions of account and postponed discovery of documents [illegible] Mr. Hamilton's account. Accordingly [illegible] Mr. Hamilton's appointment he tried at the [illegible] plaintiff's solicitors [illegible] Then came the end of the long trial [illegible] with in what he could not help thinking was an unsatisfactory fashion. Upon that document, which was not handed to the jury, the defendants admitted that they owed Mr. Hamilton a further £140, bringing the total up to £257. Then came the verdict of the jury, and the reference upon the question of account. Plaintiff, again, in the [illegible] counsel, objected [illegible] that the total [illegible] £442 [illegible] that up to that point the [illegible] that the company owed Mr. Hamilton £960 and [illegible] appeared that they had [illegible] very good grace from defendants to speak of plaintiff approaching the question of damages in too sanguine a mood, or that he was asking for damages which existed only in his imagination. As to the claim for commission on the three Australian destroyers under the agreement of May 19, 1910, if the defendants were liable it was not denied that the amount of their liability would be £103. 15s. But it was said on behalf of the defendants that they were not liable at all. Then, as to the field sets, it was common ground that if defendants were liable in the case of the sales of Jan. 25, 1913, they were liable to pay £120, and the contention he had to meet was the contention as to the broken period between the time plaintiff was dismissed and the time his agreement for three years was to come to an end. They knew from Mr. Cappalare that it was impossible to state as a fact that the sum mentioned of £140, and no more, was what was due to the plaintiff in respect of this broken period. That figure was before the jury at the time, and was no doubt taken into account by them. The question of what was really the total due to the plaintiff was never before the jury. On the question of royalties, counsel said, the facts were not in dispute. He did not care whether it was called "royalty" or anything else, but submitted that there was actually a sale to the Government of the right to use the apparatus if not a sale of the apparatus itself. The Australian ships were installed before Jan. 9, 1913, and he submitted that the royalties were part of the price. The plaintiff undoubtedly did much work in connection with the Australian business, and that high-power stations were part of the work was not disputed. It was, therefore, important to realise what services plaintiff had rendered. The evidence was that in 1910 he went to South Africa and Australia, and put the question of the wireless chain before the authorities, and had otherwise taken an important part in connection with it. When the contract was made between the Marconi Co. and the British Government the Pretoria and Singapore stations were included, and were to cost £60,000 each. They were expected to yield royalties of from £5,000 to £30,000 a year. The plaintiff's submission was that he, acting as agent on behalf of the principals, had done his part fully in the matter and had succeeded. The contract was made and in Feb., 1913, it was repudiated by the defendants themselves, after which they made another contract in July, 1913, which was more beneficial to them. They repudiated the first contract of their own choice. The claim against the principals was, therefore, a good one. They could not after repudiation say, as against their agent, that they had never received the money. The contract was entered into between the defendants and the War Office, and by an act of the defendants was afterwards abandoned for reasons based upon self-interest. He submitted that under those circumstances the plaintiff was entitled to the commission which he would have received had the contract been carried out.

The Referee: Had he gone so far that they were certain to get the money. They had a contract which was subject to the approval of the House of Commons and the contract was not completed until it had been approved.

Mr. Gordon Hewart said it could be no part of the plaintiff's duty to secure the approval of the House of Commons. It was the act of defendants, and by their own resolution that the House of Commons was never asked to approve the contract. There was no provision in the contract for the withdrawal, nor was there any time limit during which the approval of the House of Commons might be sought. Before they had even sought approval the defendants repudiated the contract, and, therefore, the plaintiff was in the same position as if they had received the money. As to the claim to the British India, Burma and Malay States stations, counsel said the contract was that in consideration of plaintiff devoting his whole services to the company he would receive commission on all sales effected within the territory mentioned, the "all," he contended, covered any limitation as to time.

The Referee: The agreement says that he shall give the whole of his services exclusively, and that points to the fact that it was intended to limit it to such time as he remained giving his services, and that was for a period of three or six years.

Mr. Gordon Hewart said what was contemplated at the time the agreement was made was that the Marconi Co. was to absorb the Pacific Radio Telegraph Co. (Ltd.), when plaintiff would be offered the post of managing director. What was intended was that Mr. Hamilton should be [illegible] commission. In arriving at a decision the Referee would have to consider the [illegible]

The Official Referee reserved judgment.

Consulting Engineers' Fees.

[illegible] was given last week in the Court of Session, Edinburgh, in an action brought by Mr. [illegible], consulting engineer, Central Chambers, Dundee, against [illegible] for £216. 14. 5d. for professional services rendered. Pursuer's case appeared briefly to be as follows: In April, 1913, defender [illegible] Dundee, and Mr. Hamilton was [illegible] amount. Pursuer had been paid the £155, and the sum for which he now sued was alleged to be due for extra work for which he was entitled to special remuneration. Defenders pleaded that the pursuer, not having performed any duties for them except those of consulting engineer under [illegible] with the Local Authority [illegible] him £40.

The Lord Ordinary [illegible] to £40, and [illegible] to the date of tender, March 9, 1914. Defenders were found entitled to expenses since that date.

PARLIAMENTARY INTELLIGENCE.

Price of Coal (Limitation) Bill.—In the House of Commons on Tuesday Mr. Runciman moved to insert provisions at the end of Clause 4 that where any contract has been made on or after April 1, 1915, and before the commencement of the Act, for the sale of coal by the owner thereof at the pit's mouth, coal delivered under that contract after the expiration of the period fixed under the provision, and shown to be excepted coal within the meaning of this provision, shall, if the other party to the contract within two months after the commencement of this Act gives notice in writing to that effect to the owner of the coal at the pit's mouth, be deemed for the purposes of this Act to be sold at the time of the delivery thereof; if in consequence of this provision the price to be paid by any person to whom coal is delivered is reduced by any amount, the price to be paid by any person to whom the coal is delivered in pursuance of any subsidiary contract shall be reduced by an equivalent amount. Excepted coal means coal supplied for domestic or household purposes to any person and coal supplied for any purpose to any local authority, or to any undertakers supplying gas, water, or electricity in any locality in pursuance of authority given by an Act of Parliament, or an Order confirmed by, or having the effect of, an Act; the period fixed under this provision shall be three months after the commencement of the Act, but the owner of the coal at the pit's mouth may apply to the Board of Trade for an extension of that period and the Board of Trade may extend the period for such time as they think just.

An amendment proposed by Mr. Mackinder, giving any purchaser under a subsidiary contract the same right to give notice to the owners of coal at the pit's mouth as the person who had made the original contract, together with provision for communicating to the purchaser the name of the person from whom the coal was bought, was accepted and the clause, as amended, was added to the Bill, which was read a third time.

BUSINESS NOTICES.

Robt. Redman and Herbt. A. Passmore, electrical engineers and contractors, 12, Union-street, Newton Abbot, and 32, Torwood-street, Torquay, have dissolved partnership. Debts by Mr. Passmore, who continues the business.

Plant Wanted.—The Northampton Electric Light & Power Co., Bridge-street, Northampton, want for immediate delivery a 500 kw. to 750 kw. three-phase turbo-generator, 50 cycles, 6,600 volts through step up transformer.

Plant for Sale.—Two horizontal Cornish boilers at Victoria Park Hospital, Manchester, advertised for sale.

Tenders are invited for the purchase and removal from the Head Post Office, Manchester, of certain plant and machinery which is no longer required. Specification and forms of tender from the Controller of Stores, Accounts Section, Studd-street Depot, London, N. Tenders by Monday, Aug. 11. *See also our advertisement.*

ELECTRICITY SUPPLY.

EXTENSIONS.

Birmingham.—In a report presented to the Council on Tuesday the Finance Committee stated that they have ascertained from the several committees what loans are required during the current year which would fall within the limits imposed by the control authorities, and have authorised the Corporation to borrow £399,844, including £253,444 for the electric supply department and £76,652 for the tramways.

In the case of electricity undertaking, the expenditure was absolutely necessary in consequence of the large demand recently made upon the department for electric current, chiefly by manufacturers of war material. The amount asked for in connection with the tramways undertaking includes balances of various accounts for construction work which is in progress. The attention of the Treasury was given to the applications. The committee had called the attention of the Treasury to the fact that the following works for which they had Parliamentary or departmental sanction had been deferred: Electric lighting undertaking, £255,667; tramways, £90; 331

Bury Lancs.—The Corporation are considered by the Electricity Committee to apply to the Treasury to borrow £7,500 for electricity works extensions.

Coventry.—At Tuesday's meeting the Council decided that application be made to the Ministry of Munitions, Whitehall Gardens, London, S.W., under Clause 9 of the Munitions of War Act, 1915, for permission to borrow £21,417 for the Electricity Department.

The manager (Mr. Lea) had reported that further large applications have been received from firms engaged upon the manufacture of munitions for additional supply of power, and that, in order to accede to the applications, it is necessary for further extensions to be undertaken without delay.

On Thursday last the Town Clerk informed the Electric Light Committee that he had written to the Minister of Munitions with regard to the possibility of the money being difficult to obtain except upon unfavourable terms, and asking, as to a Government guarantee against loss on capital account in the event of a cessation of the additional demand for power. He had received no definite reply, but had received a telegram stating that the committee's inquiry was receiving careful consideration.

The Manager has been authorised to obtain provisional tenders for the plant required.

Edinburgh.—The estimated amount of capital expenditure by the Corporation electricity department for the year ended May 16, 1916, is £37,000, including the cost of a new power station at Portobello.

Mexborough.—An inquiry is to be held into the application of the Council for a loan of £4,000 for electricity works extensions.

GENERAL

Bispham.—The Council have granted an increase of £20 a year in the salary of their electrical engineer, Mr. S. J. Hollinrake.

Bradford.—The city electrical engineer, Mr. T. Roles, is preparing a report on the question of sinking wells to obtain water for the Valley-road generating station.

Buckhurst Hill (Essex).—Mr. Sydney Morse has given notice, on behalf of a company, of intention to apply for a provisional electric lighting order for this district.

Coniston.—The directors of the Coniston & District Electric Supply Co. have recently accepted tenders for the supply and erection of electric generating plant, laying of cables, &c. Water turbine plant will be employed.

Increased Charges for Current.—Ilford Electricity and Lighting Committee has decided to increase the charges for electricity supply by 12½ per cent., and to continue the present discount of 5 per cent. for prompt payment.

Huddersfield Electricity Committee have also decided upon an all-round 12½ per cent. increase.

Bath Electricity Committee are making a 10 per cent. increase.

Worksop Council are increasing their charges by ½d. per unit for lighting and ½d. for power.

Leicester Corporation are recommended by the Electricity & Tramways Committee to increase the charges for current for lighting by ½d. per unit, and for power by 20 per cent.

Chislehurst Electric Supply Co. have given notice that their charges for current are increased by 10 per cent. as from the end of the June quarter.

Southampton Electricity Committee recommend that the charge per unit to private consumers for lighting up to 50 units per quarter be increased from 3d. to 3½d., for business premises from 3d. to 3½d., the back lighting to remain at 2½d.; that certain specified large consumers have their charge increased by ½d. per unit, that all charges for supplied other than heating and cooking, outside the borough be increased to 3½d. per unit; that the charge for heating and cooking units be increased from ½d. to ¾d.

Leicester.—On Thursday last the members of the Corporation inspected the buildings and plant at the new Lero power station and the tramway car depot.

The power station is equipped with three 1,000 H.P. and one 2,000 H.P. sets, consisting of slow-speed reciprocating engines with generators producing direct current at 550 volts, a 1,500 H.P. motor-alternator taking 2,000-volt single-phase current from the Aylestone station, and converting it to 550 volts d.c., two turbine sets of 6,000 H.P. each generating three-phase current at 6,600 volts (which is converted by rotary converters to d.c. 550 volts), and a 1,500 H.P. turbine driven by the exhaust steam from one of the reciprocating engines and a small percentage of live steam from the boilers. In the old boilerhouse there are eight Lancashire boilers, with mechanical stokers, and two new water-tube boilers capable of evaporating 2,500 lb. of water per hour. The tramcar body shop is 362 ft. long by 43 ft. wide, and the paint shop 296 ft. by 43 ft. The machine tools in the car-body shop are belt-driven by motors in the basement.

After the inspection Ald. Flint, chairman of the Tramways and Electricity Committee, entertained the visitors at tea, and said the extensions had cost £68,000. The buildings were designed by the borough engineer, Mr. E. G. Mawbey, and the erection of the plant was supervised by the engineer and manager, Mr. T. R. Smith. The present capacity of the Lero station was 20,000 H.P., compared with 3,000 H.P. in 1905, and the total capacity of the Lero and Aylestone stations was 28,800 H.P. The gross revenue of the electricity undertaking for 1914 was £81,810, and the net profit £9,549. The number of employés of the department who had joined H.M. Forces was 377.

Several members praised Ald. Flint's ability as chairman of the committee, and a vote of thanks to him and the other members of the committee was passed.

Redditch.—On Tuesday the Council considered a report by the Electric Supply Committee, which stated that the manager (Mr.

R. N. Mayne) had made an application for an increase of £150 a year in his salary.

The Committee recommended the Council not to grant the increase, but a member moved that the part of the report referring to Mr. Mayne's salary be referred back to the committee, and that Mr. Mayne be urged, in view of the critical nature of the circumstances, to defer his application until the completion of the reconstruction scheme, when it would be favourably considered.

On a vote the amendment was lost and the report adopted.

London Linking-up Scheme.—In connection with the proposal to link up the electricity undertakings of Battersea, Fulham and Hammersmith, the Board's Electricity Committee report:

That so far as can be ascertained, no difficulty will be experienced in obtaining approval to the scheme, but, in view of the Treasury requirements as to capital expenditure, it would appear that sanction will only be given, at the present time, to the borrowing of an amount sufficient to connect the Battersea and Fulham undertakings. In that case, the connection with Hammersmith would have to be postponed until the Treasury are prepared to sanction the additional expenditure.

It is suggested that the three Councils should enter into an agreement, and also a supplemental agreement, which would modify the terms of the principal agreement so far as may be necessary until Hammersmith join up.

Tenders have been obtained by Fulham Council for carrying out the work of linking up the Battersea and Fulham undertakings.

Market Weighton.—Pocklington Rural Council have decided to adhere to their proviso that the contractor who is promoting an electric supply scheme for Market Weighton must have subscribed capital of £1,000 before commencing the work of equipping the station.

St. Pancras (London).—The Finance & Electricity Committees' recommendations regarding the postponement of the work of installing two of the four boilers on order for Kingsnorth station have been adopted by the Council.

Stoke-on-Trent.—The Electricity Committee recently resolved:—

That this committee cannot recommend any particular firm of contractors, and that it be an instruction to the engineer that when information respecting wiring contractors is asked for by consumers a list giving all the contractors in the district be supplied.

Street (Somerset).—Messrs. Christy Bros. & Co. have notified the Council that electricity supply will be available by Aug. 10.

Wanstead.—The County of London Electric Supply Co. and the Peninsular Syndicate have notified the Council of their intention to apply for provisional electric lighting orders.

Wirral.—Messrs. Johnson & Phillips are applying for a provisional electric lighting order.

Worksop.—The Council have decided to increase their charges for electric energy by ½d. per unit for lighting and ¼d. for power.

York.—In sanctioning the borrowing by the Corporation of £15,936 for the electricity department, the L.G. Board write that they have decided, though not without much hesitation, to sanction loans in respect of the expenditure already incurred, or to which the Town Council are committed. "The Board view with great dissatisfaction the incurring of expenditure in anticipation of sanction. It will not be possible for the Board to be satisfied with repeating their warning in any similar case in future."

LIGHTING, POWER & HEATING NOTES.

Restricted Street Lighting.—Gedelming Lighting Committee recommend the Council to approve an offer made on their behalf to the Urban Electric Supply Co. to share to some extent the loss sustained by the company by the non-lighting of the street lamps.

School Lighting.—In Oct., 1913, the London Education Committee accepted the tender of Arthur Newman (Ltd.) at £460 for electric light wiring and fitting at Middle-row school, Kensington. The first section of the school has been rebuilt and wired, and the rebuilding of the second section is proceeding, but the Committee are informed by Newman & Co. that they have purchased the business of Arthur Newman (Ltd.), and they ask for 33⅓ per cent. on the contract price. The Committee favour the completion of the work by the L.C.C. Lighting Department at a cost of £290.

Cillingham Education Committee have agreed to the proposal of the borough electrical engineer to have all new work including hire of installation and fittings) for electric lighting in non-provided schools, subject to the approval of the managers and of the Board of Education.

TRACTION NOTES.

Bury (Lancs.).—The Board of Trade have approved the extension of the tramway into Lancashire and Lumb.

The chairman of the Tramways Committee (Alderman Lunge), the deputy chairman (Councillor Hargreaves) and the manager (Mr. Clough) have been deputed to attend the annual meeting of the Municipal Tramways Association, which will be held in London in September.

Light Railway Inquiry.—The Light Railway Commissioners (Mr. Hardy, Mr. Stewart and Col. Boughey) held an inquiry into the application of the Lancashire & Yorkshire Railway Co. for an order authorising the construction of an electric railway to Formby Headland.

For the promoters, it was stated that the proposed line would be a loop from the existing Liverpool–Southport line, branching from the latter line at Hightown, and (after running out to Formby Point) rejoining it about midway between Freshfield and Ainsdale. The length of new line is nearly 7 miles, and it will cost about £62,650. It would be a single line with passing places. Formby Urban and West Lancashire Rural Councils supported the scheme, and Southport Corporation appeared to secure a clause prohibiting any greater interruption of highway traffic over the Ainsdale level crossing than that which occurred at the present time.

London County Council.—At Tuesday's meeting the Highways Committee submitted a report recommending that, with a view to avoiding the waste in men, materials and money, due to unnecessary transit services in London, the Council should participate in a conference to be held with the representatives of other traffic authorities and undertakings; and that the Highways Committee be authorised to take all necessary steps in connection with matters arising out of such conference, provided that any arrangement come to be limited to the period of the duration of the war.

The committee further recommended that grants of special duty pay, not exceeding £1,189 in all, be authorised to certain officers and employés in the tramways department for special services rendered during the strike of motormen, conductors, &c., and that members of the operative staff of the tramways department who will not receive during the year 1915-16 the holidays to which they are entitled, be paid at the rate of pay they were receiving when the holidays became due a day's wages in respect of each day's leave which they should have received.

Pay of Electrical Fitters in the Tramways Department.—The committee also recommended that fitters in the electrical section of the tramways department should be placed, as regards minimum rate of pay, on the same basis as fitters in the rolling-stock section—*i.e.*, 10d. an hour minimum.

Retention of Services of Consulting Engineers.—The Council on April 7, 1914, decided that an agreement should be entered into for a period of one year certain with Messrs. Kennedy & Donkin, providing for Sir Alexander Kennedy to advise and report on the extension of the Greenwich generating station, at a retaining fee of £500 a year. As regards new constructive work, a commission ranging from 3 to 5 per cent. was to be paid on the certified cost of the plant dealt with. The agreement expired on May 31, 1915. In view of the fact that the work connected with the installation of additional turbo-generators is still proceeding, and that it is not proposed for the present to appoint a successor to Mr. J. Shepherd, the electrical assistant, whose resignation was reported on May 4, 1915, the committee are of opinion that the services of Messrs. Kennedy & Donkin should be retained, and as Messrs. Kennedy & Donkin are prepared to agree to the extension of the arrangement, the committee advise that their services be retained for one year, and thereafter subject to three months' notice of determination of their engagement, to advise and report as to matters relating to the extension of the Greenwich generating station and the questions arising out of the tramways undertaking, and generally to afford the Council whatever consultative assistance may be desired; that they supervise and superintend such new plant or work as may be placed in their hands, including inspection during construction (if in the United Kingdom), and provide a resident engineer during the erection of plant or apparatus at the generating station or elsewhere at a retaining fee of £600 a year; and that, as regards new constructive work, a commission of 5 per cent. be paid to them on the certified cost of plant, &c., up to £50,000 a year, and 4 per cent. on any expenditure exceeding that amount, except that the commission on new constructive work connected with the second stage of the extension at the Greenwich generating station shall be 3 per cent.

Loans to Borough Councils.—The Council sanctioned the following loans to Borough Councils for electricity purposes: Battersea, £2,618; Fulham, £4,168; Poplar, £10,188; St. Pancras, £15,000; Stepney, £1,153; Woolwich, £2,172 and £1,700.

L. & S.W. Electrification.—The trains on this company's suburban lines are expected to be operated electrically by the end of August.

Trolley Omnibus Scheme for London Suburbs. Metropolitan Electric Tramways (Ltd.) have notified Tottenham Council of their intention to promote a Bill in the next session of Parliament to revive their powers under their Light Railways Act, 1913.

TELEGRAPH AND TELEPHONE NOTES.

Radiotelegraph Notes.—A report from Admiralty to the effect that the Commander-in-Chief, Portsmouth, offers a reward of £400 for information concerning the ownership of a yacht, described as "may be known as the Kom," said to be making a passage between the Solent and Falmouth, and which has been detained by the Navy for a period of nine months.

It is announced that a committee has been formed in Sweden to establish a radio-telegraphic connection between the Swedish capital and the

United States by means of a station built at Karlsborg, Sweden. The [illegible] of the U.S. station is not stated. It is said that the chairman of the committee is the general manager of the Swedish "State" Telegraph Co.

Senatore Marconi, in discussing recently the use of radiotelegraphic communication by the Italian military authorities, stated that this method of communication is in more general use in the Italian Army than in any other army of the Allies, for the correction of faulty artillery sighting, in the disposition of troops and in communication between various commands. Senatore Marconi, at the same time, said he was unaware of any of the arrangements that are alleged to be in progress for the erection of a great radio station in Sweden. He was aware, however, of a large Marconi station in course of erection in Norway.

EMPIRE NOTES.

Australasia. It was recently stated that the electrification of the Melbourne suburban railways is still being blocked by delays in delivery of equipment. The probable date for commencing to run the first electrified section is now given as Dec., 1916.

Melbourne Council has arranged for the supply of power to operate the Melbourne Burwood electric tramway (1¼ mile) within the Council's area, to be taken by the Melbourne Electric Supply Co., which has the contract for the remaining 7½ miles. It has been agreed that the Council shall receive an annual payment from the company of about £78, the [illegible] to be increased in proportion to subsequent increases of plant or length of lines.

India. "Indian Industries and Power" says the Government of Madras has under investigation a hydroelectric scheme for the Coimbatore district. The Government hope to get a satisfactory water supply for Coimbatore from the Siruvani river by combining the hydroelectric power scheme. If the scheme is adopted, the South Indian Railway Co. will probably build a workshop at Podanur and obtain power from the Siruvani works. There will also be a demand for power for the mills in Coimbatore. A project for hydroelectric works at Pykara Falls is also being considered. Schemes for the lighting of Ootacamund are under consideration. One proposal is to obtain water-power from Lovedale Lake, another is to use the Kalhatty Falls, and a third contemplates the utilisation of the water-power of the Coonoor river, either alone or in conjunction with the Karteri stream.

MISCELLANEOUS NOTES.

Classification of Merchandise Traffic. The Board of Trade have [illegible] Carriages for Motors (packed) to Class 3 of the Classification of Merchandise Traffic on British Railways.

Electricity and the Drama.—There is being played at the London Garrick Theatre two of the Grand Guignol plays that have been popular in France for some time. In English the play is entitled "Striking Home," in France it is known as "Sabotage." The plot represents a fanatical trade unionist who incites his fellows on strike to cut off the supply of electricity, with the result that the light goes out in his own home just as a doctor is operating upon his child, and the child dies. Thus do the "chickens come home to roost."

Government Assistance for Traders.—At its meeting on Thursday last Bristol Chamber of Commerce decided to support proposals that representations be made to the Government suggesting that all possible assistance should be rendered to exporters on the following lines:—

[illegible] Department of Commerce with a permanent [illegible] (2) Consular Representatives should have a commercial department. (3) That all Consular representatives should be British born. (4) That [illegible] United Kingdom for foreign boats should as to [illegible] (5) That [illegible] support of trade in the United [illegible]

Inquest. An inquest was held on Thursday last into the cause of [illegible] between Lowood Dundee and York, who died as the result of injuries received at York Electricity Works on the [illegible]

[illegible] was employed at the London Garage, [illegible] Underwood engaged on work [illegible] months. [illegible] and was driving No. 4 bus on Tuesday and [illegible] 5.40 p.m. He had had no difficulty in [illegible] After work started and the brakes were [illegible] [illegible] at about [illegible] [illegible] [illegible]

motor cars and cycles, £317,634, and electrical machinery unenumerated, £317,231) (decrease £610,974); telegraph and telephone cables, submarine, (*a*) £35,725 (decrease £19,698), (*b*) £185,379 (decrease £108,774); other than submarine, (*a*) £42,989 (increase £17,009), (*b*) £227,254 (increase £37,864); telegraph and telephone apparatus, (*a*) £12,266 (decrease £5,567), (*b*) £99,407 (decrease £45,068); other electrical wires and cables, rubber insulated, (*a*) £24,026 (decrease £6,397 (*b*) £141,109 (decrease £47,267); with other insulation, (*a*) £47,582 (increase £15,945), (*b*) £205,642 (decrease £21,812); carbons, (*a*) £831 (decrease £534), (*b*) £3,370 (decrease £2,135); glow lamps, (*a*) £14,007 (increase £3,195), (*b*) £60,415 (increase £601); arc lamps and searchlights, (*a*) £315 (decrease £1,183), (*b*) £2,041 (decrease £6,230); parts of arc lamps and searchlights (other than carbons), (*a*) £655 (decrease £639), (*b*) £8,172 (decrease £9,088); primary and secondary batteries, (*a*) £20,488 (increase £9,129), (*b*) £102,931 (increase £13,757); meters and measuring implements,* (*a*) £12,672, (*b*) £77,057; transformers,* (*a*) £17,042, (*b*) £39,288; switchboards,* (*a*) £8,132, (*b*) £30,762; electrical goods and apparatus unenumerated, (*a*) £57,046 (decrease £26,580), (*b*) £296,171 (decrease £176,186). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £293,806 (increase £22,526), (*b*) £1,486,998 (decrease £217,231).

* Not enumerated separately in previous years.

TENDERS INVITED.

Telephone and Telegraph Material, Wire, Instruments, &c.

The Deputy Postmaster-General, Perth (W. Australia), requires tenders by Aug. 25 for supply of c.b. Telephones to specifications 431 and 409 (320); and by Sept. 29 for Telephone Switchboards and Parts (schedule 470). Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *See advertisement.*

Tenders are required by Aug. 25, for the supply of Salammoniac (Specification 305), and Steel Galvanised Wire (Specification 414), and by 2 p.m. Sept. 1 for Condensers, Resistance Testing Sets, Relays, Rheostats, Sounders and Wheatstone Transmitters, for the Australian Commonwealth Postmaster-General's Dept. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Adelaide (South Australia) will receive tenders until 2 p.m. Aug. 18 for Battery Material (schedule 385) and Magneto and Trembling Bells (schedule 386) for the Australian Commonwealth Postmaster-General's Dept.

The Postmaster-General, Adelaide (S. Australia), will receive tenders until 2 p.m. Sept. 1 for Condensers, Insulation Resistance Testing Sets, Relays, Rheostats, Morse Senders and Wheatstone Transmitters (schedule 384) for the Australian Commonwealth Postmaster-General's Department. Forms of tender, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

New Zealand Public Service Stores Tender Board, Wellington, N.Z., require tenders by 4 p.m. Aug. 11 for 1,500 red and 2,000 white three-conductor Cords and 3 tons Bichromate of Potash. Particulars from the Post and Telegraph Dept., Wellington, Christchurch, Auckland and Dunedin.

The Deputy Postmaster-General, Melbourne, invite tenders until 3 p.m. Aug. 17 for Electric Lamps, Caps and Sockets (schedule 1214) and Telephone Instruments, &c. (schedule 1222), until 3 p.m. Aug. 24 for Telephone Instruments (schedule 1218), and until 3 p.m. Aug. 31 for Switchboard parts (schedule 1239) for the Australian Commonwealth Postmaster-General's Dept. Specifications, &c., from the Deputy Postmaster-General.

The Deputy Postmaster-General, Perth (W. Australia), invite tenders until 3 p.m. Aug. 25 for 320 c.b. Telephones (schedule 462 W.A.), for the Australian Commonwealth Postmaster-General's Dept. Specifications, &c., from the Deputy Postmaster-General.

Turbo-Alternators, &c.

Bristol Corporation Electrical Committee invite tenders for a 6,000 kw. Three-phase Steam Turbo-alternator, with Condensing Plant. Specifications and forms of tender from the chief engineer and general manager, Mr. H. Faraday Proctor, to whom tenders by noon Monday, Aug. 23.

Cables.

Rochdale Electricity Committee are prepared to let 12 months' supply of Paper-insulated Cables. Specification, &c., from the Borough Electrical Engineer and Manager.

Dynamo, Battery, Wiring, &c.

Ealing Urban Council require tenders by noon Aug. 16 for supply of a Dynamo, Battery, Wiring, &c., for the proposed works. Specification, &c., from the Electrical Engineer's Office, Ealing.

Motors, &c.

Sydney (N.S.W.) Council require tenders by Sept. 13 for supply of a.c. and d.c. Motors during two years (contract 382). Specification from the City Electrical Engineer.

Motor Generators, &c.

Tenders are invited for the supply and delivery in Melbourne of one 1,000-kw. direct-current Generator with Field Regulator and accessories, one Liquid Starter with accessories, &c. Tender forms, &c., from the agents for City Council (Messrs. McIlwraith, McEacharn & Co. Ppty., Ltd.), Billiter-square-bldgs., London E.C. Tenders to Chairman of Electric Supply Committee, Town Hall, Melbourne, by 10 a.m. Aug. 11.

Fire Alarms.

Rangoon (Burma) Municipality require tenders by Aug. 11 for the installation of a system of Fire Alarms for the town of Rangoon. Specification, &c., from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, London, E.C.

Electric Light Wire, &c.

The Victorian Railway Commissioners require tenders by 11 a.m. Aug. 11 for supply of 100 tons c.i. Scrap (contract No. 28,924), 20 miles v.r. Electric Light Wire (No. 28,925), and 270 lengths of Seamless Copper Tubes (No. 28,936). Specifications from the Commissioners, Spencer-street, Melbourne.

Pump and Motor.

The Metropolitan Board of Water Supply, &c., Sydney (N.S.W.), want tenders by 2 p.m. Sept. 6 for Centrifugal Pump and Electric Motor for Richmond pumping station. Specification, &c., from 341, Pitt street, Sydney.

Traction Lamps, &c.

Johannesburg Council require tenders by noon Aug. 25 for 8,600 Drawn-wire Spiral Filament Traction Lamps; and spare parts for tramcars. Specifications, &c., from the Municipal Offices, Johannesburg.

TENDERS RECEIVED AND ACCEPTED.

Doncaster (Victoria).—In connection with the equipment of the Shire Council's electricity works contracts have been placed with the following firms:—

Australian General Electric Co. (contract No. 1, £289 9s.); Gent & Vincent (£170 1s. 8d.); Australian General Electric Co. (£76 5s.); and British Insulated & Helsby Cables (£391 16s.). (No. 2).—Mark W. Connell (No. 3) £200, 15s. and (No. 4) £295, 13s., and Box Hill Electric Installation Co. (No. 4) £26.

Nuneaton.—The following tenders have been accepted by the Electricity Committee:—

Nuneaton Engineering Co., house-service joint boxes, &c., £3 3s. 6d. each and 4 9d. each; C. M. Ayres & Co., wood plugs for [illegible] boxes, 24s., 23s., 22s. 6d. and 21s. per 100.

Bristol.—The Electrical Committee have accepted the following tenders:—

City Laundry Co., boiler and [illegible] £233; [illegible] & Sanderson, steel and [illegible] £108 [illegible]; British Westinghouse Co., motors; W. Lees & Co., [illegible], £118 12s. 6d.; [illegible] £24 [illegible] motors; Ohio Ac. Lamp, Ltd., arc lamps, [illegible].

Eastbourne.—[illegible] The Electrical Committee have accepted the tender of the [illegible] of L. Gordon & Sons for [illegible] contract [illegible] £12.

Blackpool.—The Corporation have accepted the tender of [illegible] Engineering Co., Ltd., for [illegible].

Tantalum Lamps.—Messrs. Siemens Bros. Dynamo Works, Ltd., have been awarded the contract for supply of Tantalum [illegible] lamps to Leith Corporation for the ensuing 12 months.

EDINBURGH.—For fouldron work for the Corporation's new Portobello electric generating station the tender of G. & R. Cousin, amounting to about £5,000, has been accepted.

CONISTON.—The Coniston & District Electric Supply Co. has placed an order with James Gordon & Co. for the supply and erection of a water turbine, electric generator, &c.

Commonwealth Contracts. The following orders have been accepted by the Australian Government Departments :—

Postmaster-General's Dept., Melbourne.—Western Electric Co., telephone transformers, £250 ; W. T. Henley's Telegraph Works Co., cable, £1,092 ; J. R. W. Gardam, accumulator battery (for Perth Radio-telegraph station), £322 ; British Insulated & Helsby Cables, cable, £1,845.

Postmaster-General's Dept., Brisbane.—British Insulated & Helsby Cables, 100-line test board, £24. 10s. ; J. C. Fuller & Son, wire, £259.17s.9d. ; Synchronome Electrical Co., of Australia, motor-generator, £73 ; Siemens Bros. Dynamo Works, Wheatstone receivers, £129. 1s., ditto transmitters, £126. 5s. ; W. G. Watson & Co., accumulators, £212.

Postmaster-General's Dept., Sydney.—British Insulated & Helsby Cables, wire, £589.

Postmaster-General's Dept., Adelaide.—India Rubber, Gutta Percha & Telegraph Works Co., galvanometer, £4. 4s. 6d. ; Siemens Bros. Dynamo Works, voltmeter, £10 ; F. Kanematsu, insulators, £581. 6s. 8d.

Victorian Railway Commissioners.—British Pneumatic Railway Signal Co., impedance bonds, £8,000, relays, £3,060 ; Herbert Morris (Ltd.), overhead cranes, &c., £1,898. 9s. ; McKenzie Holland & Westinghouse Power Signal Co., track resistances, £1,547. 19s. 2d. ; British Insulated & Helsby Cables, cables, overhead equipment of permanent way and overhead transmission mains, at rates ; Allgemaine Elektricitäts Gesellschaft track bonds, £5,962 ; Austral Otis Engineering Co., street railway and tramway crossing, £180 ; British Insulated & Helsby Cables, copper wire, £86. 17s. per ton.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bristol.—The accounts of the electricity department for the year ended March 25 show gross capital expenditure £933,280, of which £548,921 is outstanding.

Revenue was £116,626 (compared with £105,940 in previous year) and total costs were £53,574 (£48,105), leaving gross profit £63,559 (£58,437). Interest and stock dividends required £20,545 (£21,017) and redemption £29,419 (£28,027), leaving net profit £13,594 (£8,516, plus £875 for depreciation of stores, &c.), of which £1,234 (£1,719) has been transferred to capital account, £2,289 (£893) devoted to other purposes, *i.e.*, substitution of three-phase alternator, &c., £6,010 (£6,000) placed to reserve, the unappropriated balance being £6,374 (£2,314). Coal cost 0·273d. (0·266d.) per unit sold, total works costs were 0·503d. (0·518d.) and total costs 0·668d. (0·702d.). Redemption required 0·381d. (0·425d.) and interest 0·271d. (0·321d.). Units generated were 22,156,500 and sold 18,202,156 (15,488,638). Maximum load on station was 8,478 kw. (8,354 kw.) and load factor was 24·5 (21·16) per cent. The capacity of the generating plant is 15,050 kw. (as in previous year). Consumers number 5,270 (4,768) and total connections are equal to 796,301 (714,956) 30-watt lamps. Cooking stoves on circuit are 67 (59). Motors on consumers' premises are 2,057 (1,822) and the aggregate horse-power of motors and heating apparatus is 19,542 (16,956). The total mileage of cable laid is 377 (363). Of the total connections (=796,301 30-watt lamps) 485,974 are for power, heating and cooking.

Mr. H. FARADAY PROCTOR (chief engineer and general manager) says in his report there is a large influx of power demands at the present time, applications having been received for some thousands of additional horse-power. Revenue per unit fell to just under 1½d. and total cost to 0·668d. (a reduction of about 5 per cent.), both figures being the lowest on record. The cost of production is only half what it was 10 years ago. Many half-watt lamps have been installed for street lighting in place of arc lamps and the result is eminently satisfactory, there being a better distribution of light and no variation in intensity. A list is given of 63 of the staff who have joined H.M. Forces. At the time of its compilation there had been [illegible] casualties.

Eastbourne. The [illegible] expenditure on the electricity department at March 31 was £203,701 (increase £10,219). Loans repaid and [illegible] amount to £88,824.

Last year's revenue was £30,474 (against £30,608 in 1913-14), working and general expenses were £15,231 (£15,579), leaving gross profit £15,244 (£15,029), out of which, after meeting loan charges, £1,404 (£892) has been transferred to meter, mechanical stokers, &c., suspense account, and the net profit is £2,228 (£2,697). Total revenue per unit sold was 3·86d. [illegible] and total costs were 1·85d. (1·82d.), exclusive of redemption capital 1d. (0·90d.) and interest 0·71d. (0·71d.). [illegible] generated were 2,100,700 (1,816,667) and sold 1,816,667 (1,835,960). Total connections are equal to 5,194 kw. (4,778 kw.), [illegible] 1,112 kw. (1,116 kw.) and load factor 14·69 (14·89). [illegible] engineer says in his report the [illegible] 772 units. Since the commencement of the [illegible] the output for private lighting has decreased, and only a very [illegible] has been made for public lighting, but the [illegible] more than made up by the [illegible] power and heating, from 11·318 to 503,597). [illegible] increased from £2,040 to £2,194, an increase of [illegible] and that from heating from [illegible] compared with 20 per cent.) [illegible] 0·83d. to 0·78d. per unit, [illegible] 0·83d. to 0·78d. per unit, [illegible] at a higher price for the [illegible] months during the pre- [illegible] to recommencing [illegible] the slack period, which could not be done [illegible] good [illegible] being avoided.

[illegible] to the [illegible] account, which [illegible] income £342 [illegible] £1,021, this also covers the cost of the town [illegible] office of the department, of which increasing use is made by the public. The number of persons calling during the past year was 5,214. The erection of the new main switchboard is well in hand, and it should be ready for use by the autumn. The installation of the new boiler and additional water-cooling plant for the condensers has been postponed owing to the war. All the new high-pressure feeder and ring mains have been laid and connected up to new disconnecting and inspection boxes and pillars in the streets and switchboards in the sub-stations. The most important connection to the main has been the lighting of the camp at Summerdown-road, to which a special high-tension main was laid and sub-station constructed on the site.

Hammersmith (London).—The accounts of the electric supply undertaking for the year to March 31 show gross capital expenditure £376,181 (increase £18,691), of which £132,806 has been repaid.

Revenue was £63,280 (compared with £62,148 in previous year), working and general expenses were £34,772 (£32,357) and special expenditure was £1,512 (£1,162), leaving gross profit £26,994 (£28,629). Interest required £8,521 (£8,283), and redemption of capital £14,345 (£13,876), and the net profit was £3,717 (£6,386). Average price obtained per unit for all purposes was 1·44d. (1·49d.). Coal cost 0·323d. (0·334d.), and total costs, other than capital charges, were 0·776d. (0·748d.). Units generated were 11,497,932, and purchased 244,458 (11,302,277 and 30,286), and sold 9,717,252 (9,306,651). Maximum load was 4,646 kw. (6,162 kw.).

The engineer and manager (Mr. G. G. Bell) reports : The war has affected the electricity department in many ways. It has been customary to receive the mechanical stoker coal per rail to Chelsea Basin, and thence by barge alongside the Council's river wharf, whilst the bulk of the Welsh coal has been brought from Cardiff by steamer and delivered at the wharf by barges. Chelsea Basin has become so congested that it has been necessary to take large quantities of coal at Shepherd's Bush depot, and, although by this means the cost of barging is saved, carting from Shepherd's Bush depot costs about 1s. 9d. per ton, and as a saving of 8d. per ton is effected on the barging, the net cost is 1s. 1d. per ton, compared with 1d. per ton, the cost of transporting from Chancellors wharf to the works by the new coal handling scheme. Cost of carting coal has increased from £590 to £824. The Welsh coal is delivered by rail at Hammersmith Grove station, at an extra cost to the department of 1s. 6d. per ton compared with sea borne coal. A heavy decrease in sale of current for lighting purposes is also due to the war. There is now practically no outside lighting supplied from the department's circuits. The net result is a decrease of about 413,000 lighting units at 3d., which equals £5,162, compared with the previous year. Rental for outside lanterns and arc lamps has decreased nearly £300.

Employes in H.M. Forces have their Government pay increased by the Council to the same amount that they receive whilst working for the Council. This represents a further expenditure of £788. The present cost is about £23 per week. The Council's men in H.M. Forces number 33, representing 28 per cent. of the number engaged prior to the war. Coal and cartage cost £12,827, compared with £12,917, a reduction of £90, but coal alone shows a saving of £325, the balance being increased cost of carting. The policy of replacing the old switchgear in sub-stations by new up-to-date switchboards has been continued, and cost during the year £210. Works costs show a decrease from 0·531d. to 0·526d. per unit sold. The items included in these figures are the only ones over which the engineers have direct control. Total costs show an increase of 0·02sd. per unit sold, but rates and taxes and war allowances account for 0·032d. The reserve fund amounts to £16,774, of which £13,751 has been invested. £12,031 has been spent during the year on the coal storage and transportation scheme. The whole of the plant is now working with the exception of a few details, with the result that between 7,000 and 8,000 tons of coal can now be stored. Now, however, it is extremely difficult to get deliveries of coal and prices are very high, so that it is unwise to store huge quantities. The reduction in maximum demand from 6,162 kw. to 4,646 kw. was due to the fact that the Olympia Motor Show was not held, and consequently the maximum load consisted of the demand of ordinary consumers. There are 3,985 consumers (increase 409).

St. Pancras (London).—The accounts of the electricity department which were adopted by the Council last week show their total capital expenditure, after writing down value of machinery taken out of use, is £571,380 (increase £5,349), and on standing as paid £427,188.

Income during the year to March 31 was £87,052 (compared with £93,483 in the previous year), and working expenses were £51,979 (£51,901), leaving gross profit £35,072 (£41,581), and after providing for capital charges the net profit was £6,619 (£12,413). Units generated were 1,806,945 (1,921,639), and sold 10,649,038 (11,102,664). The total maximum supply demanded was 5,150 kw. (5,684 kw.) Consumers were 4,456 (against 4,284 at March, 1914), and lamps, &c., connected or applied for, included 16 c.p. incandescents 180,824 (164,066), arcs 2,244 (2,193), motors 2,026 (1,868), and heating and cooking apparatus equal to 5,608 (4,968) amperes at 220 volts.

Coun. Jobson, in submitting the accounts, said the reduction in the income was wholly consequent upon the war.

West Ham. The electricity department's account for the year to March 31 show gross capital expenditure £656,552 (increase £26,416), of which £399,353 is outstanding.

Revenue was £128,738 (compared with £128,825 in previous year), and gross profit £37,818 (£42,854). Interest and special charges absorbed £23,093 (£19,252), and sinking fund £23,577 (£22,850), leaving net deficit £8,852 (against a profit of £751). The special charges included £1,411 allowed to men on active service. Average price obtained for all purposes was 0·858d. (0·891d.) per unit. Coal cost 0·328d. (0·316d.) per unit sold, total works costs were 0·612d. (0·599d.) and capital charges 0·314d. (0·294d.). The gross profit on the sales department (including hiring schemes) was £1,397 (£2,421).

Mr. J. W. Beauchamp (engineer and manager) says in his report the consumers number 4,198 (increase 310), with connections equal to 22,664 kw. (increase 944 kw.). Motors connected are 1,815 (20,627 H.P.), increase 112 (497 H.P.). Maximum load was 12,160 kw. (against 12,225 kw.). Units generated were 42,595,281 (40,969,428) and sold 35,641,945 (34,404,791), of which 25,391,931 (23,096,919) were for power and 356,877 (237,996) for heating and cooking. Load factor was 33·46 (32·13) per cent. The reduction of maximum load was due to the lighting restrictions, which more than counterbalanced the new connections. It is found easier to sell motors outright than to let them on hire. The arc lamp hiring scheme has suffered heavily, as a result of the reduction of shop lighting. 80 of the staff and employés have joined H.M. Forces.

Wolverhampton.—The past year's accounts of the tramways department, which were adopted by the Council last week, show capital expenditure £292,361. The total sinking fund is £58,688, and the amount of sinking fund applied in reduction of debt £33,508.

Revenue was £55,323 (compared with £57,204 in previous year), working expenses were £34,605 (£33,126), to which is added £461, war service allowance to employés, leaving gross profit £20,257 (£24,078). Interest required £6,779, repayment of capital £5,669, and income tax £203, leaving net balance £9,160 (£12,117) (trams, £7,606; motor char-à-bancs, £1,554), of which £5,416 (£6,563) is placed to reserve and renewals and £3,744 (£5,554) devoted to relief of rates. The reserve and renewal fund amounts to £53,987. Total revenue per car-mile was 11·239d. (11·485d.), working expenses, including power, were 7·03d. (6·651d.), and including renewals 9·774d. Average fare charged per mile was 0·879d. Passengers carried were 12,236,785, car-miles run 1,181,309, and units used 1,712,796.

Worcester. The account of the electricity department for the year ended March 31 show total capital expenditure £174,128 (increase £2,570). Stock cancelled, debt discharged and redemption of sinking fund amount to £88,158.

Total revenue was £20,860 (against £21,523 in previous year), and working and general expenses were £9,226 (£10,643), leaving gross profit £11,635 (£10,879), and after providing £10,674 for dividends on stock, interest and contributions for redemption of stock and loans, the net profit (after payment of £880 for improvements) was £81 (compared with £505, after paying £968 for improvements). Coal cost 0·32d. (0·36d.) per unit, and total working expenses were 0·84d. (0·92d.). Total cost, including capital charges, &c., was 1·990d., and total mean price obtained 1·998d. Units generated were 2,915,814 (against 2,935,490), and sold 2,506,875 (2,569,996). Total maximum supply demanded was 1,188 kw.

The city electrical engineer (Mr. C. M. Shaw) says in his report the policy of effecting improvements and works of a capital nature out of revenue which has been pursued during the past 10 years, makes it practically impossible to show any net profits. An examination of the capital account and costs of production during this period will demonstrate the value of replacing obsolete plant. In fact, if such had not been done there is no question that the position of the undertaking would now have been most serious owing to the increased costs of labour, fuel and other material. Sixty new consumers were connected, and 161 extensions made on existing installations, the total increase of demand being equal to 7,162 30-watt lamps, compared with 13,632 lamps last year. Twenty four additional motors of an aggregate horse-power of 101 and 69 heating devices with a total of 112 H.P. capacity were connected.

Units generated by water power were 509,422, a decrease of 120,671, mainly due to shortage of water during last summer and extensive floods in November, December and January. The water plant was laid down from these causes for the equivalent of 132 days 11 hours during the year. Coal cost £3,417 (against £3,857). Having regard to the conditions under which the works have operated during the latter half year, which has not tended to economical working, and that latent costs are much heavier, through payment of wages to men absent at the front, Mr. Shaw says the results show such improvement that he considers the committee are to be congratulated on the surplus on the year's working.

COMPANIES' MEETINGS AND REPORTS.

Electric & General Investment Co. (Ltd.)

The twenty-sixth ordinary general meeting was held on Tuesday, under the presidency of Mr. J. B. BRAITHWAITE.

The SECRETARY (Mr. S. R. Shaw) having read the notice convening the meeting and the certificate of the auditor,

The CHAIRMAN said: This is the first time in the course of the 25 years' existence of this Company that our ordinary shareholders have had to go without a dividend, but, of course, the conditions are quite exceptional. I think when they look back over their record of 25 years they will probably agree that they have not done so badly, for I see that during that period we have paid them the equivalent of £6 for each £1 share they hold, or an average of 24 per cent. For 10 months we have had a state of war, which has naturally put a stop to financial business of almost every kind; and, as we are largely a financial company, that has naturally greatly affected our earnings. The net result is that we have earned a dividend on our preference shares, we have transferred £2,409 odd from profit and loss to our contingencies fund, we have paid, of course, a little bit on account of the preference dividend for the year—£497. 10s.—and we carry forward to next year £5,222. 5s. 7d., which is within £100 or £200 of the balance of the preference dividend for the past year. As you know, the dividend is cumulative on the preference shares, and we hope to make a distribution on account of that dividend as soon as financial conditions improve. We did not consider that it was wise to borrow for the purpose of paying the dividend on this occasion, but we are carrying forward sufficient to pay the balance of last year's dividend, and we shall make a distribution as soon as financial conditions permit. There is little to say about the balance-sheet. The investments have risen from £316,000 to £338,000. Sundry debtors have decreased from £20,305 to £6,777. Sundry creditors and open accounts show a decrease from £26,322 to £24,773. The debenture stock outstanding is the same as it was last year—£17,863—and the capital also remains the same. We have slightly altered the form of making up the balance-sheet. Instead of carrying provision for contingencies on the debit side, we are showing it as deducted from the investments, and it is our intention from year to year to show that figure on that side of the balance-sheet instead of on the other side. There is nothing else I can say. I now move the adoption of the balance-sheet and report.

Mr. EMILE GARCKE seconded the motion, which was carried unanimously.

The retiring director (Mr. Emile Garcke) was re-elected, as was the retiring auditor, and the proceedings then terminated.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The ordinary general meeting was held on Monday, Senatore G. MARCONI presiding.

The CHAIRMAN said he had little doubt that the accounts (abstracted in our issue of July 16) would be regarded, in all the circumstances, as satisfactory. The figures in the accounts excluded any payment by the Government for the use of the company's high-power stations since the beginning of the war, and for numerous other services rendered. No basis for remuneration had yet been settled, and the Board thought it better to leave the whole item to be dealt with in the accounts of the present year. At the beginning of the war wireless telegraph apparatus was promptly declared contraband of war, and for the time being, therefore, their work in many parts of the world practically came to a standstill. Their programme had consequently undergone complete dislocation, and it was impossible at the moment to say to what extent or in what way it would be affected eventually. On the other hand, their factory had been kept very fully occupied both by home and foreign orders. Naturally, the businesses of their associated companies in some cases had also been much disturbed. The American company had been deprived of the use of their Transatlantic station owing to the stations on this side being required for other purposes. Their high-power stations at San Francisco and Hawaii had been completed, and a service was being conducted with satisfactory results. They were daily awaiting information with regard to the opening of that service through to Japan. The Canadian company had continued to make progress, but the changes contemplated had not yet been carried out, owing to the war. The Argentine company had to defer work upon their high-power station. The Belgian company continued to conduct its business from Marconi House. The French company had continued to do a satisfactory business, and had paid, for 1914, a dividend similar to that of 1913. The Marconi International Marine Communication Co. had continued to show satisfactory progress, although it has not benefited to any extent directly arising from the war. Their Italian company had paid a dividend of 15 per cent., compared with 6 per cent. for 1913. The Spanish company's negotiations with the Spanish Government were not terminated by the outbreak of war, but they were carried forward actively and satisfactory termination.

The development of the Automatic Telephone Co. had made much commercial progress in the course of the year. The name of the company has been changed to the Relay Automatic Telephone Co., as the Swedish name under which it traded was held to be misleading, which

were not by any means [illegible]. They had signed an important contract with the Italian Government, which they contemplated would be put into operation in the early future. With regard to the Imperial [illegible] the Postmaster-General informed the company that, owing to the altered circumstances resulting from the war, the Government had decided not to proceed with these Imperial stations. They were further informed that the governing factors in determining the Imperial scheme would be better met by means other than the construction of stations of the character and in the situations contemplated by the contract, and that the amounts disbursed by the company in respect of the contract would be refunded. Subsequently, in February, negotiations were entered into with the Government for the erection of certain stations on conditions differing from those contained in the original scheme. Negotiations were proceeding on a basis which, if agreed to, would represent to the company a reasonable equivalent of the terms of the 1913 contract. Nothing, however, had yet been definitely [illegible];

There had been important developments in the art of wireless telegraphy, and they had applied for several new patents.

Mr. GODFREY C. ISAACS (managing director) seconded the resolution for the adoption of the report and said that when he joined the Company on Jan. 25, 1910, it had an issued capital of £547,299, and had practically no cash resources and no credit. It had been extremely difficult to find money in this country for wireless telegraphy. But for Mr. Marconi being successful in obtaining money in Italy there was little doubt, he thought, that the Marconi Company would have then come to an end. Mr. Marconi had personally advanced £12,000. To-day they had an [illegible] capital of nearly £1,500,000. They were in a very sound financial position, and their assets were very sound. They had nearly £1,000,000 to the credit of general reserve. Their securities were first-class, and their properties could be realised at a handsome profit. With regard to the reasons why the business did not prosper in its first years, after Mr. Marconi provided the Company with his valuable invention, was because the valuable patents, which were then this company's property alone, were imitated in Germany; a big German company was created by the German Government. It had the advantage of the financial aid of some of the principal German banks, and a very large subsidy from the German Government. It was against this State-aided opposition that the Marconi Company had to contend for many years. Notwithstanding this very powerful opposition of the German company, and largely due to the magnificent support given to Mr. Marconi personally by the Italian Government, and this notwithstanding that Italy was the ally of the German company's Government, the Marconi Company was successfully carried on. The German company, aided always by the German Government, created powerful agencies in nearly every country in the world, and made great headway. With the exception of Italy, France and Great Britain, these Germans had obtained a preponderating position in practically every part of the world. They had not only to contend with the German agents, but also with the German Ambassadors, and their position was so impossible under such conditions that, immediately on joining the Company he (Mr. Isaacs) made an appeal to Sir Edward Grey and placed the whole of the facts before him; from that time forward he obtained the support of the British Ministers abroad in their negotiations with foreign Governments, and from that time also they commenced to make substantial progress, until they had now reached the preponderating position in the industry. This was a great victory in view of the methods adopted by the Germans. Within three months of his joining the Company it was evident that their future lay in a commercial wireless telegraph service, and they applied in April, 1910, to the British Government for the right to erect high-power stations in all British possessions. [illegible] them that night, although they had asked for no money. When the British Imperial chain was suggested it met with severe opposition on the ground that unduly favourable terms were demanded. But the German Government at once resolved to build a chain of wireless stations in all the German Colonies. The matter was not discussed in the German Parliament, but the stations were immediately proceeded with and were built. He was informed that the price the German Government paid for each of those stations was three times the price their Company had asked from the British Government, and there was a subsidy which represented far more than the Marconi Company ever contemplated getting in any year from the royalty which they were to receive upon the Imperial stations. Those stations he [illegible] the German Government £2,000,000, and it was not a bad investment at all. For instance, this country declared war on Germany at midnight on Aug. 4 last. At 5 in the afternoon of Aug. 4 Germany [illegible] which proved that no stations [illegible] could transmit messages, covering a radius of 2,000 miles or more, to this effect: "War declared upon [illegible] a neutral port. By that [illegible] the greater part of the mercantile marine. If it had but saved one of its big ships the wireless investment would have been amply justified. They contemplated that after the war there would be a considerable business to be done with many foreign countries, but owing to the financial stress which might reign for a period it was possible that many foreign Governments would defer entering into the engagements which they otherwise would be only too willing to do if they were not able to some extent, and for some little period, to finance the work which they were prepared to undertake for those governments. The Board contemplated so husbanding their [illegible] that when the time comes they will be able to [illegible] their associated companies. If those companies [illegible] the shareholders would agree that they were adopting a wise policy in paying a smaller dividend and in making all the provision which the future might require.

Mr. LANHAM asked what they had to receive from the British Government. He did not know whether anything had been received on account. If it were a large sum it would be a very useful thing to know in the nick of time. He thought the Chairman should, if possible, give the amount. He wished he had known as much in February, 1914, as he knew to-day. He was speaking to a certain extent as a Stock Exchange man, and he had discovered that inside knowledge was rather useful.

Ald. J. FORDE suggested that when the money was paid to the Company by the Government the information should be communicated at once to the shareholders.

Mr. GODFREY ISAACS said he did not know that he could give the sum with any assurance, and if he could he did not think he would. The services which the Company was rendering to the Government still continued. As regards publishing the sum which they might receive directly the matter was settled, if it were possible it should be done immediately. With regard to the question of the information getting through to some before it got to others, to the advantage of some, so far as the Company was concerned they did their utmost to prevent any information going out of the office until it was sent out by circular to shareholders; but in a business like theirs he wanted everybody to bear in mind, before he allowed himself to listen to wild charges thrown at the Company and its officials, that there were a large number of persons, not in the Marconi office, who knew what was going on, and who, perhaps, knew sooner what was going to happen than the Marconi officials themselves.

The resolution was then carried, and the dividends proposed in the report were approved.

The CHAIRMAN proposed a resolution altering the articles of association which was carried, and will come up at an extraordinary meeting on Aug. 18 for confirmation.

A cordial vote of thanks to the chairman and his colleagues concluded the proceedings.

BRITISH ELECTRIC TRACTION CO. (LTD.) At an extraordinary meeting of this company on Friday the scheme of reduction (set out in our issue of July 16, p. 569) was approved with four dissentients. Mr. Emile Garcke presided, and said the directors proposed to write off net £908,000, which the directors estimated that their assets were short of, or 3s. 7d. in the £. The two debenture stocks amounting to £1,800,000 were not affected. The capital of the preference stocks was not to be reduced, but it would be rearranged. The reduction of capital fell entirely on the ordinary stocks—50 per cent. was written off the preferred ordinary stock. Then there were the income certificates (£266,000) which had no capital rights. These would be cancelled, and the holders would receive capital stock to the extent of 35 per cent. of the nominal amount of the certificates. It was proposed to convert the four classes of stock and the income certificates into two classes of stock—preference and ordinary. The new 6 per cent. cumulative preference stock would have priority of capital over the new ordinary stock. The ordinary stock would rank after the preference stock as regarded capital and dividends. Preference stock would be allotted as follows: To holders of the existing 6 per cent. preference stock, an amount equal to their present holdings; to the holders of the existing 7 per cent. non-cumulative stock, 35 per cent. of their holdings; and to the holders of income certificates, 10 per cent of their holdings. The new ordinary stock would be allotted: To holders of existing 7 per cent. non-cumulative preference stock, 65 per cent. of their holdings; to holders of existing preferred ordinary stock, 50 per cent. of their holdings; to holders of existing deferred ordinary stock, 30 per cent. of their holdings; and to holders of income certificates, 35 per cent. of their holdings. The matter was not completed that day by carrying the resolution. Separate meetings would have to be held at which the scheme as it affected each class could be discussed. If all the class meetings approved the scheme by the necessary three-fourths majority a confirmatory meeting of all the stockholders would be called, and the scheme would finally be submitted to the Courts for approval. The great merit of the scheme (said Mr. Garcke) was that by a reduction of capital by £900,000 the directors hoped, in course of time, to remove the whole of the market depreciation, which amounted to about £2,000,000. He believed if the scheme were carried out it would place the company in a stronger position to meet the difficulties with which they would be confronted as a result of the war, and would, he hoped, enable them, when the war was over, to start on a new career of prosperity, with its optimism tempered by past adversity. The directors had received proxies from stockholders representing between £8,000 and £9,000 against the scheme, and from stockholders representing something like £1,200,000 in its favour.

The meetings of the several classes of stockholders to consider and, if thought fit to approve the proposed scheme, will take place on Aug. 9 at the Holborn Restaurant, London.

KARACHI ELECTRIC SUPPLY CORPN. (LTD.) The annual meeting was held recently at Karachi. The chairman (the Hon. M. de P. Webb, C.I.E.) said supply was commenced at the end of March to 39 consumers, and since then the number had risen to 64, and nearly 200 houses and premises were being or about to be wired. Karachi municipality had placed a five years' contract with the company for public lighting, whilst the Karachi Cantonment authorities were negotiating for lighting the cantonments. The industrial development of Karachi had been hindered in the past by the difficulty and expense of providing adequate supplies of cheap power, but fortunately they had large oil fields not far away, and by the aid of oil fuel they could generate electrical energy at a cost that would enable many new industries to be started in Karachi.

METROPOLITAN RAILWAY CO.—The half-year's working to June 30 admits of the payment of the dividends on the preference and an interim dividend at the rate of 1 per cent. per annum on the ordinary stock. The latter compares with 1½ per cent. for the first half of 1914. The decrease is due to the company receiving from the Government only the same net receipts from traffic as in 1913, although the company has to provide interest on the cost of new lines and works. An interim dividend on the surplus lands stock at the rate of 2¾ per cent. per annum is to be paid for the half year.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

BEACON CARBONS (LTD.) (140,966).—Reg. July 14, capital £5,000 in £1 shares, to carry on business of manufacturers of and dealers in electric carbons, electrical equipment, fittings and machinery, appliances for electric lighting and electric cables, &c. Private company. First directors: C. W. Webster and Mrs. A. M. Webster. Reg. office: Whitley-street, Bingley.

COMPARRI WIRELESS CONTROL SYND. (LTD.) (141,009).—Reg. July 17, capital £5,000 in £1 shares, to take over inventions and patents relating to wireless control systems, electric apparatus for operating and controlling musical instruments &c., and to adopt an agreement with Manrico Compare. Private company.

F. HUSBAND (LTD.) (140,919.)—Reg. July 8, capital £1,000 in 10s. shares (1,000 7 per cent. preference), to acquire the business connection of an electrical engineer belonging to F. Husband, and the benefit of his British patent rights in connection therewith. Private company. First directors are F. Husband and J. A. Fraser. Reg. office, Craven House, Kingsway, W.C.

PERKINS ENGINEERS (LTD.) (140,847).—Reg. July 1, capital £100 in £1 shares, to carry on the business of mechanical, electrical, consulting and other engineers, makers of ovens, machinery and appliances for baking, kneading, &c. First directors are F. C. Ihlee, W. Pelmore, K. Pelmore, J. E. Pointon, J. H. Booth and J. Newman.

TALBOT ENGINEERING CO. (LTD.) (140,894).—Reg. July 6, capital £1,000 in £1 shares, to take over the business carried on as the Talbot Engineering Co., and to carry on the business of electrical, mechanical, motor, aerial and general engineers, manufacturers and factors of metal appliances, &c. First directors are M. Thomas, D. J. Evans and W. H. Hughes. Reg. Office: Commercial-buildings, Talbot-road, Port Talbot.

WILSONS & BERRY (LTD.) (140,898).—Reg. July 6, capital £15,000 in £1 shares (5,000 preference), to take over the business of Wilson Bros., to carry on the business of mechanical and electrical engineers, manufacturers of, agents for and dealers in motors, motor cars, &c. Private company. First directors are E. H. Fletcher, R. Wilson, F. Wilson and A. J. Berry.

MORTGAGES AND CHARGES.

BRITISH & COLONIAL INSULATING CO. (LTD.)—A memorandum of satisfaction in full on July 13, 1915, of debentures dated May 18, 1909, securing £10,000, has been filed.

JULIUS SAX & CO. (LTD.)—Mortgage debenture dated July 9, 1915, to secure £1,000 (ranking pari passu with £2,500 issued in 1908), charged on company's undertaking. Holder, P. C. Rowe, Newlands, Leatherhead, Surrey.

NATIONAL ALLOYS (LTD.)—Debenture dated July 2, 1915, to secure £5,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holders, Edward Le Bas, Dock House, Billiter-street, London, E.C.

NAYLORGRAPH (LTD.)—Debenture dated June 24, 1915, to secure £350, charged on the company's undertaking and property, present and future, including uncalled capital. Holder, J. M. Hunt, Fairlawn Park-road, Southborough.

PORLOCK & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Debenture and as further security thereto, a mortgage, both dated June 24, 1915, to secure £250, charged on Higher Mill, at Hawkcombe, Porlock, Somerset, water rights and company's other assets, present and future, including uncalled capital. Holder, C. Blackford, Porlock, Somerset.

RECEIVERSHIPS.

BRITISH ELECTRIC AUTOMATIC MACHINES (LTD.)—Notice of appointment of D. Johnston, 1, Broad-street place, E.C., as receiver or manager on July 19 under powers contained in debenture dated April 12, 1915, filed.

CITY NOTES.

MEMORANDA (July 28).—Bank rate 5 per cent. (since Aug. 8, 1914.) Consols 65¾. Consols Pay Day Aug. 5. Stocks and Shares Ticket Days Aug. 11 and 26. Pay Days Aug. 12 and 27. Price of silver, 22¾d.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO.—An interim dividend on the ordinary shares at the rate of 5 per cent. (less tax) for the half-year ended June 30 has been declared.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—An interim dividend at the rate of 4 per cent. per annum for the half-year ended June 30 has been declared.

CENTRAL LONDON RAILWAY CO.—Interim dividends for the first half of 1915 on the undivided ordinary stock at the rate of 3 per cent and on the preferred ordinary stock at the rate of 4 per cent. have been declared.

CITY AND SOUTH LONDON RAILWAY CO.—An interim dividend for the first half of 1915 on the 5 per cent. preference stocks at the rate of 2½ per cent. have been declared.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—An interim dividend on the preference shares at the rate of 6 per cent. per annum, less tax, for the half-year to June 30 and an interim dividend on the ordinary shares for the same period at the rate of 5 per cent. per annum, less tax, have been declared, both payable Sep. 15.

CROMPTON & CO. (LTD.)—Mr. Thomas Britten (the company's manager at Chelmsford) has been elected to a seat on the board.

LONDON ELECTRIC RAILWAY CO.—Interim dividends for the first half of 1915 on the 4 per cent. preference stock at the rate of 4 per cent. and on the ordinary shares at the rate of 1 per cent. have been declared.

METROPOLITAN DISTRICT RAILWAY CO.—Interim dividends for the first half of 1915 on the 4 per cent. guaranteed stock at the rate of 4 per cent., on the first preference stock at the rate of 4½ per cent. and on the second preference stock at the rate of 3 per cent. have been declared.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Interest on the 6 per cent. first cumulative income debenture stock will be paid on Sept. 1, less tax, at the rate of 6 per cent., and coupon No. 15 of the 6 per cent. income bonds will be paid, free of British tax, at the rate of 6 per cent. on the same date.

WAR LOAN AND ELECTRICAL UNDERTAKINGS. Money on loan to Falkirk Council has been withdrawn by the lenders for the purpose of being invested in the War Loan. The Town Council decided to raise their interest on short period loans from 3½ per cent. tax free to 4 per cent. less tax.

Grangemouth Council have agreed to endeavour to arrange loans at 4 per cent., and in the meantime the Burgh Chamberlain is authorised to arrange for small loans at 4½ per cent.

Greenock and Port Glasgow Tramways Co. have undertaken to subscribe the last 10s. of each £5 War Loan bond taken out by their employés.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, July 28. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Wed. July 28.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 2 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 5	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref	10½	5 13 1	Feb, Aug
5	10½	Brompton & Kensington Ord.	3⅝	6 - 2	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	90¾	4 8 5	..
St.	4%	Charing Cross West End & City Debs...	85	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	4⅛	5 10 10	..
5	5%	Do. Ord.	4	6 5 0	Aug, Feb
10	9%	City of London Elec. Lt. Ord.	13½	6 14 6	Feb, Aug
10	6/0	Do. 6% Pref.	12¼	4 17 0	Mar, Jly
St.	5%	Do. 5% Deb. St.	110	4 10 11	Jun, Dec
10	7%	County of London Ord.	10½	6 10 2	Mar, Sept
10	6%	Do. 6% Pref.	10⅛	5 18 7	Feb, Aug
St.	4½%	Do. 2nd Deb.	97	4 12 1	Mar, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs...	7¼	5 16 2	July
5	9%	Kensington and Knightsbridge Ord. ..	7½	6 4 2	Feb, Aug
St.	4%	Do. Deb. St.	89	4 13 0	Jan, Jly
5	3/0	London Elec. Supp. 6% Pref.	5⅜	5 12 -	..
St.	4%	Do. 4% Mort. Debs.	86½	4 11 11	Jan, Jly
5	3½%	Metropolitan E. Supp. Ord.	7	6 7 3	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	95½	4 14 -	Jan, Jly
St.	5%	Midland Elec. Corp. 1st Mort. Deb. St.	97	5 1 -	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs ..	10½	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 - -	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1⅛	5 11 -	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs. ..	95	5 5 3	Jan, Jly.
St.	4½%	Urban Electric Supply 4½% Deb. St.	90½	5 - 2	Apl, Oct
1	9%	Waste Heat & Gas Elec. Gen. Stations.	1½	7 - -	May, Aug
1	9%	Westminster E.S. Corp. Ord.	1⅞	6 - -	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4½	4 14 -	Jan, Jly.
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.....	79	- - -	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	68†	5 17 6	Feb, Aug
St.	4%	Central London Guar. Assented Ord...	7	5 4 11	..
St.	4%	Do. do. Assented Def. Ord. ..	5½	5 4 3	..
..	..	..	100†	- - -	..
..	..	St.	93½†	- - -	..
St.	..	City & S. London Deb.	91	4 15 3	May, Nov
..	..	Do. Pref. Ord.	80	- - -	Feb, Aug
10	5½%	Lanarkshire Tramways	77½	7 17 6	Feb, Aug
10	4%	London Electric Ry. Ord.	11	- - 9	Jan, July
St.	4%	Do. 4% Pref.	62½	- - 6	Mar, Sept.
St.	4%	Do. 4% Debs.	89	4 14 1	Jan, Jly.
St.	4½%	Metropolitan Ry. Con. Ord.	43	4 18 7	Feb, Aug
St.	4½%	Do. 3½% Pref.	37	4 10 -	Feb, Aug
St.	4½%	Do. 4½% Pref.	43½	4 14 -	Feb, Aug
St.	4½%	Do. 4½% A Deb.	94½	4 15 6	Jan, Jly.
St.	4½%	Do. 4½% B Deb.	94½	4 15 6	Jan, Jly.
St.	4½%	Metropolitan Dist. Ry. Ord.	14	- - -	Apl
St.	4%	Do. 4% Pref. Ord.	92	4 7 3	May, Nov

†Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name.	Price, Wed., July 28.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	cont.	£ s. d.	
St.	4½%	Metropolitan Dist. Ry. 4½% First Pref.	69¾	6 9 4	Feb. Aug
St.	6%	Do. 6% Perm. Debs.	122½	4 12 8	Jan. July
St.	4%	Do. 4% Guar.	89¼	4 10 8	Jan. July
St.	4%	Do. 4% Deferred 3-5	87½	4 11 7	Jan. July
St.	4%	Do. 4% Guar. Stock	75½	5 6 0	Mar. Sept
10	..	Underground E. Rys. : London Shares	1½	.. ..	..
1/0	..	Do. A Def.	9	.. ..	..
St.	6%	Do. 6% Debs.	104½	5 14 5	Mar. Sept
..	6%	Do. 6% Inst. Bds. with Coup. 15	75¼	7 19 10	Mar. Sept
..	4½%	Do. 4½% Bds.	96	4 12 0	Jan. July
5	..	Yorkshire W. Riding Ord.	½	.. ..	March
5	6%	Do. Pref.	4	7 1 8	Jan. July
		Electric Manufacturing, &c.			
1	1/2	Babcock & Wilcox Ord.	2	6 3 0	Apl. Oct
1	1/0	Brit. Aluminium Ord.	1	5 0 0	Mar
100	5%	Do. Prior Lien Debs.	93½	5 5 6	Jan. July.
1	£5	Do. 6% Pref.	6	6 13 4	Jan. July
5	15%	Brit. Insulated & Helsby Ord.	11½	6 14 10	Aug. Feb
5	3/0	Do. 6% Cum. Pref.	6⅝	4 15 5	Jan. July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	½	9 6 4	Mar. Sep
2	7½	Brit. Westinghouse Pref.	1	8 13 11	Acrii
100	6%	Do. 6% Prior Lien Debs.	100½	5 19 8	Apl. Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11½	6 16 4	Jan. July
5	2 %	Do. 5% Pref.	5	5 0 0	Feb, Aug
1	15%	Castner Kellner	2½	5 2 2	May. Nov
1	6%	Dick, Kerr & Co. 6% Pref.	½	7 13 7	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅞	.. ..	Feb. Aug
1	6%	Elec. Construction Ord.	½	9 3 11	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan. July
St.	4%	Do. 4% Debs.	69½	5 15 4	Jan. July
10	6%	General Electric 6% Pref.	7⅛	6 5 6	Jun. Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 8 2	Feb. Aug
5	2/3	Do. 4½% Cum. Pref.	4½	5 0 0	..
St.	4½%	Do. 4½% Deb.	98	4 11 10	Jun. Dec
10	5%	India Rubber, G. P. &c., Ord.	8½	5 17 8	Feb. Aug
10	5%	Do. Pref.	8¾	5 16 6	Apl. Oct
100	4%	Do. 4% Debs.	98	4 1 8	Apl. Oct
10	12	Tesegn Com. & Main. Co.	32½	7 10 8	Mar. July
100	4%	Do. 4% Debs.	93	4 6 0	Jan. July
1	7½%	Vickers Ord.	1⅜	4 10 4	May. Aug
1	6d.	Do. 5% Pref.	¾	5 6 8	May. Aug
St.	4%	Do. 1st Debs.	80	5 0 0	Jun. Dec
100	4½%	Do. 4½% 2nd Debs.	100	4 10 0	Jan. Dec
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	97½†	6 2 6	Feb.May.Aug.N
St.	1/1	Do. Def. Ord.	21½	7 1 2	Feb.May.Aug.N
St.	4%	Commercial Cable 4% Debs.	72⅝	5 10 4	Ja.Ap.Jly.O
10	5%	Cuba Submarine Ord.	8⅛	5 13 6	May. Nov.
10	10	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6¾	5 16 10	Ja.Ap.Jly.O
St.	25/0	Eastern Tel. Co. Ord.	120½†	5 16 4	Ja.My.Jly.O
St.	17/6	Do. 3½% Pref.	72†	4 17 3	Ja.My.Jly.O
St.	4%	Do. 4% Debs.	81½†	4 18 4	May. Nov
St.	4%	Eastern Extension Tel. Co. 4% Debs.	78½	5 1 9	Feb. Aug
10	7%	Do. Ord.	118†	5 18 8	Ja. Ap. Jly.O
10	22½	Gt. Northern Tel. Co. with Coup. d	33	6 13 4	Ja. My. Jly
25	13%	Indo-European	5¼	6 0 4	May. Nov
1	10%	Marconi's Wireless Tel. Co.	1⅜	5 7 7	April
1	7%	Do. 7% Pref.	1½	4 3 6	July
10	9d.	West India & Panama Od.	1⅜	8 13 11	May. Nov
10	6%	Do. 1st Pref.	6¾	7 3 4	May. Nov
10	3/0	Western Telegh. Co.	11⅛	5 14 3	Mr. Jn.O.Dec
St.	4%	Do. 4% Deb. St.	83	4 16 5	Jan. Dec
..	4½%	Western U. 5% Pf. Bd.	96	4 14 9	May. Nov.
		Telephones.			
..	$2	American Telephone & Telegh. $100 Cap	123½	6 7 10	Ja.Ap.Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	77½	6 9 0	Jan. July
1	7½d.	Monte Video Telephn. Ord.	6⅞	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	99⅛	4 13 1	May. Nov
100	5%	Oriental Telephone Ord. (ex bonus)	1⅛	5 5 1	Apl. Oct
St.	4%	Do. Db. St.	85¾	4 12 6	Jan. July
St.	4½%	Telephn. Co. of Egypt Db. St.	88	5 2 3	Jan. July
..	8%	United River Plate Ord.	5⅛	6 16 2	Apl. Oct
5	..	Do. 5% Cum. Pref.	4½	5 3 3	Jan. July
St.	4½	Do. Deb. St.	90	5 0 0	Jan. July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	⅞	6 5 6	St.Db.Mr.Jn
12	..	Do. 6% Pf.	10⅜	5 15 6	St. Db. Mr. Jn
100	..	Marconi Investments Syndicate	99	6 5 0	Ja. Ap. Jly. O
..	9d.	Universal Stock Exchange	6¾	5 15 7	Ja. Ap. Jly. O
100	6%	Submarine Cable Trust Certs.	125¾	4 15 7	Apl. Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	6%	Anglo Argentine Trams. 5% Debs.	77	6 13 4	Jun. Dec
St.	4½%	Do. 4½% Debs.	60	5 12 6	Jan. July
St.	4%	Do. 4% Debs.	⅞	7 4	Jan. July
		Do. 5% 1st Pref.	4	6 17 6	Jan. July
		Do. 5% 2nd Pref.	3½	7 11 6	Jan. July
100	$1½	Brazilian Traction Ord.	4⅛	12 1 3	Fb.M.Au.N
100	$1½	Do. 6% Pref.	⅝	9 12 2	Ja.Ap.Jly.O
5	..	Buenos Ayres Tramways	7	5 14 3	May.
		Do. 5% Cum. Pref.	4½	5 7	May. Nov
St.	4½	British Columbia 4½% Con. Debs.	⅛	6 1 4	..
5	..	Calcutta Elec. Trams. Ord.	⅝	7 17	Mar. Sep
		Do. 6% Cum. Pref.	⅛	7 13	Feb. Aug
5	..	Mexican Electric Tramways Cum. Pref.	6	6 0 0	..
100	..	Mexico Trams Debs.	3½	7 4 11	Jan. July
..	..	Mexico Trams Common St.	3	.. ..	Fb.M.Au.N.
		Do. 5% Pref.	⅝	8 15 5	Mar. Sep
St.	4½	Montreal Street Ry. 4½% Deb.	77½	5 16 3	Feb. Aug
100	..	Rio de Janeiro Tram L. & P. Co. Bds.	70	6 8 6	Jan. Dec
100	4½	Do. Ord.	77½	5 14 3	Feb. Aug
		Colonial and Foreign Electric Supply, &c.			
		Anglo-Mexican Elec. Prof.	5½	5 13 7	Mar. Sept
St.		Do. 5% Deb.	⅝	5 3	Jun. Dec
		Do. 5% 1st Pref.	1½	5 14	..
		Do. 5% 2nd Pref.	1½	5 14	..
		Do. 5% 3rd Pref.	1½	5 14 10	May. Nov
		Do. Ord.	⅝	6 12 3	May. Nov
		Do. Def.	⅝	7 7	Ja.Ap.Jly.O
St.		Mexican Light & Power Co. Deb. St.	77½	5 7 6	Jun. Dec
		Do. 5% 1st Pref.	1½	7 1	Jan. July
St.	4½	Rio de Janeiro Tramway, Light & Power Co.	97⅛	4 12 1	Jan. July
St.	4½	Do. 4½% Debs.	88½	5 4 2	May. Nov
		Victoria Falls & Transvaal P. Co., 6% Pf	8½	.. ..	Jan. July
..	4%	Do. 4% 1st Mort. Deb.	83½	6 6 7	Jan. July

† Has dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date July 28, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	14½d.	English Lead	£25 10 0
Solid Drawn Copper Tubes	14d.	Antimony	nominal
Brazed Copper Tubes	14½.		
Brazed Brass Tubes	16½d.	Old Metals.	per ton.
Brass Wire	14d.	Clean Scrap Copper	£66 0 0
Copper Wire	14½d.	Brazlery Copper Scrap	£60 0 0
Rolled Brass	13½d.	Clean Scrap Brass	£55 0 0
Brass Sheets	14½d.	Old Lead	£20 10 0
		Old Zinc	£45 0 0
	per ton.	Hollow Pewter	£120 0 0
Copper Sheets	£102 0 0	Black Pewter	£85 0 0
Spelter	£100 0 0	Gun Metal	£62 0 0

Mr A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date July 28, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£75 0 0	Old Lead	£20 10 0
Clean Mixed Brass	£56 0 0	Tea Lead	£18 10 0
Clean Copper	£66 0 0	Hollow Pewter	£120 0 0
Brazlery Copper	£60 0 0	Shaped Black Pewter	£85 0 0
Gun Metal	£63 0 0		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.		Amount	Inc. or dec. (a)	Aggregates. No. of weeks.	Amount	Inc. or dec (a)
			£	£		£	£
Aberdeen Corporation	July	21	2,583	— 195	7	13,614	— 237
Anglo-Argentine	,,	22	4[illegible]	— 3,[illegible]	27	1,484,478	— 133,340
Ashton-under-Lyne	,,	24	871	+ 70	17	8,256	+ 182
Ayr Corporation	,,	24	1,051	147	10	4,768	— 321
Bath Electric Trams, Ltd	..	..	..	..	..	..	..
Birkenhead Corporation	,,	25	1,438	+ 191	17	22,768	+ 1,107
† Birmingham Corporation	,,	24	14,154	+ 1 847	17	217,903	+ 5,411
Blackburn Corporation	,,	23	1,420	6	17	22,265	— 1,194
Blackpool Corporation	,,	22	2,064	987	16	83,237	— 8,103
Blackpool and Fleetwood	,,	24	1,346	— 213	29	16,257	— 3,581
Bolton Corporation	,,	25	2,902	+ 85	17	44,893	— 3,455
Bournemouth ... { Trams	,,	21	2,064	— 237	16	33,423	— 911
Bournemouth ... { Buses	,,	21	33	— 40	16	407	— 101
Bradford Corporation	,,	24	6,642	— 435	17	109,578	+ 1,096
Brighton Corporation	,,	25	1,253	— 15	17§	18,051	— 1,437
Bristol Trams { Trams	,,	24	4,753	— 11	29	134,270	— 2,154
Bristol Trams { Buses, &c.	,,	23	5,070	+ 384	29	136,453	+ 23,139
Burmah E. Trams & Ltg.	,,	24	R4,900	+ R330	29	..	+ R46,626
Burnley Corporation	,,	24	1,610	— 30	17	41,588	— 1,755
Burton Corporation	,,	22	300	— 25	17	4,800	— 360
Bury Corporation	,,	25	1,440	+ 84	17§	23,217	— 607
Calcutta Tramways Co.	,,	28	R67,[illegible]	— R3,066	29	R1,924,394	— R91,087
Camborne-Redruth	,,	17	135	— 14	28	3,797	— 143
Cardiff Corporation	..	..	..	..	..	..	..
Cork Electric Trams Co.	,,	22	314	— 56	29	14,278	— 333
Coventry Corporation	,,	26	919	+ 92	17	16,046	+ 1,537
Croydon Corporation	,,	16	1,894	+ 47	15	28,895	+ 436
*Derby Corporation	,,	24	1,086	+ 42	16§	17,430	— 234
Dover Corporation	,,	17	343	+ 23	15	4,767	+ 806
Dublin & Lucan Railway	,,	23	165	— 21	3	520	— 78
Dublin United	,,	26	6,530	— 65	29	175,987	+ 5,425
Dundee Corporation	,,	24	1,[illegible]	— 37	10§	13,113	— 163
East Ham Council	,,	24	1,353	+ 244	16	21,993	+ 4,046
Exeter Corporation	,,	26	413	+ 25	16	6,293	+ 108
Glasgow Corporation	,,	24	12,842	+ 2,716	8§	169,495	+ 6,517
Glossop Trams	,,	24	138	+ 12	30	3,597	— 140
Gloucester Corpn. { Trams	,,	24	314	+ 6	16	5,377	— 173
Gloucester Corpn. { Buses	,,	24	1[illegible]	+ 4	16	810	— 16
Halifax Corpn. { Trams	,,	24	2,279	+ 22	16	36,400	— 347
Halifax Corpn. { Buses	,,	24	1[illegible]	+ 200	29	25,072	— 1,847
Hastings Elec. Trams Co.	..	..	..	..	..	..	..
Huddersfield Corpn.	,,	24	1,[illegible]	— 58	16	30,425	— 3,473
Hull Corporation	..	..	..	..	..	..	..
Ilford District Council	,,	20	112	+ 6	16	2,094	— 94
Ilkeston Corporation	,,	24	647	+ 112	16	8,852	+ 633
Isle of Thanet Co.	,,	24	877	+ 861	42§	14,477	— 7,885
Kilmarnock Corporation	,,	24	204	+ 12	10	1,749	— 58
Lanarkshire Trams Co.	,,	23	2,627	+ 588	29	51,925	— 1,119
Lancashire United	,,	24	1,849	+ 111	29	49,043	+ 1,154
Leeds Corporation	,,	24	9,286	+ 251	17	148,931	+ 5,158
Leicester Corporation	,,	24	3,244	+ 127	30	87,576	+ 1,388
Leith Corporation	,,	24	855	— 37	13	8,094	+ 59
Lincoln Corporation	,,	24	217	+ 3	13	2,286	— 59
‡ Liverpool Corporation	,,	24	14,164	+ 454	29§	385,474	— 1,966
Llandudno&Colwyn BayR	,,	23	538	— 99	34	9,489	+ 472
London County Council	,,	14	46,405	+ 1,632	15	624,097	— 43,675
Lowestoft Corporation	,,	24	208	— 11	17§	7,173	— 1,199
Maidstone Corporation	,,	22	224	— 27	16	3,570	— 132
Manchester Corporation	,,	24	18,218	+ 881	16	299,811	+ 1,532
Nelson Corporation	,,	24	217	— 16	16§	3,234	— 411
Newcastle-on-Tyne Corpn	,,	24	6,642	+ 1,420	16§	103,738	+ 12,210
Newport (Mon.) Corpn.	..	..	..	..	..	..	..
Northampton Corporation	,,	24	1[illegible]	— 19	16§	12,569	+ 2,545
Nottingham Corporation	,,	24	3,8[illegible]	— 11	16	61,118	+ 1,920
Oldham Corporation	,,	24	1,[illegible]	— 27	13	43,792	— 818
Portsmouth Corporation	..	..	..	..	..	..	..
Preston Corporation	..	..	..	..	..	..	..
Rawtenstall	,,	24	1,838	— 167	16§	28,923	+ 1,012
Rotherham Corporation	,,	24	1,165	+ 111	16	17,997	+ 1,356
Salford Corporation	,,	24	5,413	+ 449	17§	88,614	— 369
† Sheffield Corporation	,,	24	9,[illegible]	+ 1,[illegible]	12§	151,331	+ 12,135
Southampton Corpn.	,,	24	1,554	+ 1	16	23,615	+ 885
Southend Corporation	,,	24	837	— 69	16	13,039	— 4,875
Southport Corporation	,,	17	961	— 61	13	12,309	— 210
St'lyr'dge, Hyde, &c., Jt. B.	..	..	..	..	..	..	..
Sunderland Corporation	,,	24	1,[illegible]	— 33	17	21,[illegible]	— 1,113
Sunderland District	,,	24	2,[illegible]	— 1	28	39,[illegible]	— 1,320
Swindon Corporation	..	..	..	..	..	..	..
Tynemouth Tram Co.	,,	24	1[illegible]	+ 1	28	1,[illegible]	+ 53
Wallasey Corporation	,,	24	1,[illegible]	— 7	16	21,[illegible]	— 1,068
Walsall Corporation	,,	24	1,[illegible]	+ 179	30	23,885	+ 2,311
West Bromwich Corporation	,,	24	1,[illegible]	+ 146	17	15,668	+ 1,449
Warrington Corporation	..	..	..	..	..	..	..
West Ham Corporation	,,	24	3,175	— 212	16	50,813	+ 3,613
Wigan Corporation	,,	24	1,642	— 178	16	25,004	+ 187
Wolverhampton Corpn.	,,	24	1,160	+ 4	16	17,710	— 305
Yorkshire W.R. Trams	,,	24	1,[illegible]	— 117	30	46,[illegible]	— 2,699

(a) Those comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ‖ Plus 3 days.
¶ Plus 2 days. ** Compared with one week more last year.

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NOTES.

Technological Museums.

PRACTICALLY every town in the country worthy of the name has a museum, and we cannot believe that idle curiosity accounts for the fact that during the course of the year hundreds of thousands of people visit these institutions. For no apparent reason the products of bygone ages figure largely in the contents of the average museum. Indeed, into such prominence are the antiquities brought that there is seldom accommodation in the building for the display of present-day materials and manufactures. We admit our reverence for old things; especially do we admire old buildings, old books, china, furniture and the like. We glory in the antique, but, at the same time, we recognise that since we are what we are, namely, a commercial nation engaged in the manufacture of a very varied assortment of goods, and depending, as we do, upon such manufactures for the means of livelihood, it would be well for us, and it would benefit our successors, if we devoted some attention to the things of to-day in our museums. As long as a nation enjoys prosperity there is little inclination on the part of the authorities to embark on new ventures, but when in normal times our trade is threatened on every side it is necessary that steps be taken to checkmate what may become a catastrophe. When our trade is threatened we must at once determine what is wanted, what our rivals are offering, what our manufacturers are producing to meet the threatened rivalry, and what they can produce. Documents, books and statistics are of themselves of little real service in such a situation. What is wanted is a technological museum and library in every industrial centre throughout the country. The museum and library in a particular district should represent, to the fullest possible extent, all that is known concerning the industries of the district.

A RESEARCH department controlled by a representative local committee should undertake to keep the museum and library fully up to date, and in addition should be prepared to advise manufacturers both as to new markets and new processes. Under present conditions each manufacturer, in a manner infinitely laborious and wasteful, has to conduct his own research in his own way, and very often this means that it is done badly, expensively and, consequently, wastefully. With relatively few exceptions, there is no need for secrecy, and we are strongly of the opinion that goods of foreign manufacture can be better examined and criticised by a body of men working earnestly and in concert than by an individual behind locked doors and drawn blinds. The need for technological museums is not peculiar to electrical engineering, but for every branch of industry and for every profession. At the outbreak of war we were treated to the absurd spectacle of Boards of Trade and Chambers of Commerce hurriedly organising exhibitions of goods of enemy manufacture in order that home firms might inspect them. To-day we are told on every hand to organise, and in organising it behoves us to know, above all, what the other man is doing. We know of no way, other than through the medium of trade museums, of imparting this knowledge to those it directly concerns. When we have vindicated our honour and when our men return to us by the million, let us show them that in their absence we have endeavoured so to order affairs that a greater victory awaits them at home and that part of the fruits of such victory shall be theirs.

Thermal Insulation of Ovens.

THERE is no doubt that the thermal insulation of electric ovens is important from the point of view of obtaining economical results, more particularly if an oven is required for prolonged operation. Further, if the thermal insulation is poor, the rapidity with which an oven heats-up is low; therefore, the electrical input must be greater if the cooking temperature is to be reached in a given time. From every point of view it is desirable that this time should be short. The cook has no wish to wait longer than is necessary, and if the oven is very slow in heating-up this merely means that the cost of running is higher than is necessary. But,

notwithstanding the importance of thermal insulation, it has not been given the extensive study which it deserves. We are, therefore, glad to reprint an account of tests carried out by Messrs. A. E. KENNELLY, F. D. EVERETT and A. A. PRIOR dealing with this subject. The tests were carried out on ovens the walls of which were constructed of asbestos board. Commercial ovens are not made in this way, as the asbestos would not be a suitable material for keeping clean; consequently iron is used almost exclusively. The use of asbestos board, varying in thickness from $\frac{1}{4}$ in. to $\frac{1}{2}$ in., modifies the conditions, the temperature gradient being smaller than it would be with metal. For this reason we would rather that the authors had tested their insulating materials between metal sheets.

NEVERTHELESS, the results are instructive. It is noticeable that whereas a single shell gave a thermal resistance of 0·0254 thermal ohm, a double shell only raised this to the figure of 0·0410. It would have been interesting to have seen whether simply a double layer of the asbestos board would have given as good a result as the double shell enclosing an air space. Air is an excellent thermal insulator, but if air is to be effective it is essential to do away with convection currents. This is shown clearly by a test in which the space in the double shell was divided up so as to make a cellular construction; but the cells were large, with the result that no improvement was effected. Packing the space with cotton waste caused a marked improvement, the thermal resistance rising to 0·0605, and when metallic wool, which is a specially prepared mineral wool, was substituted for the cotton waste, the figure rose to 0·0779. We are not acquainted with this last-named material, so that we cannot compare it with cotton waste in its general properties; but it is obvious that to some extent the result must depend upon the thermal conductivity of the material used, as well as upon its cellular nature. The best result is probably obtained by using material whose thermal conductivity is low and which at the same time imprisons a large amount of air.

The Design of Induction Motors.

Of the books dealing with the design of induction motors, many are ultra-theoretical and several are ultra-practical. That both classes serve a useful purpose is not for us to deny; but we formed the opinion long ago that in the engineer's office a happy combination of the two is desirable. The practitioner is generally too busy to devote much time to an advanced theoretical study of the subject, and the young designer lacks the experience to enable him to decide which sections of the theoretical treatment have to be considered in order to secure a satisfactory commercial design. During the past session, Mr. H. L. SMITH read a Paper before the Rugby Engineering Society on "The Electrical Design of Induction Motors," and in our present issue we publish the first part of Mr. SMITH's most interesting and lucid Paper. The author shows that the design of an induction motor is not so much a question of advanced mathematical knowledge as a thorough grounding in fundamental principles combined with ability to interpret and apply a few elementary formulæ common to many problems in alternate-current working. We venture to think that the author's treatment of the subject will make a strong appeal to, and be appreciated by, many of our readers.

Past and Present.

MANY of our readers will call to mind that about 14 years ago eight 7,000 kw. reciprocating units were installed in the 74th-street Station of the Interborough Rapid Transit Co., of New York. The guaranteed steam consumption of these engines for a normal rating of 8,000 H.P., when operating at 150 lb. steam pressure and 26 in. vacuum, was approximately 17·3 lb. per kilowatt-hour. At the time, both engines and generators were unique examples as regards design, construction and performance, and they were looked upon as the last word in the art. These sets are probably as good to-day as when they were installed; but four of them are, nevertheless, being broken up and sold as scrap, and three 30,000 kw. turbine units of Westinghouse manufacture are being installed in the same space. Striking figures in support of this drastic measure were given in a recent number of the "Electric Journal." With coal at 12s. per ton and an evaporation of 8·7 lb. of water per pound of coal, and assuming that the turbines are operated three-fourths of the time at a load of 25,000 kw., the annual saving in fuel alone for each unit will amount to over £40,000, and it is estimated that the labour charges per kilowatt of output will be less than one-fourth of that required with the reciprocating engines. These units will be operated for the greater part of the time at their most efficient load, namely, 25,000 kw. At this load the makers guarantee a steam consumption of 11·27 lb. per kilowatt-hour and a Rankine-cycle efficiency of 75·76 per cent. Assuming that the turbine sets operate three-fourths of the time, and that steam is worth 6d. per 1,000 lb, with six per cent. interest and a 15-year life, one-tenth of a pound of steam per kilowatt-hour represents a capitalisation per machine of £3,800. Comparison shows that when both turbines and engines are working at maximum efficiency, the steam consumption of the turbine unit per kilowatt-hour is approximately 65 per cent. of that of the steam engine.

Triple Frequency Currents in Delta Winding. The "Electrical World" has reported a curious case of injurious harmonics in a 750 kw. generator. The machine was originally star-connected, and when changed to the delta arrangement it was found that it overheated even on open circuit. Investigation revealed the fact that there was a current equal to 125 per cent. of full load current flowing round the delta and that its frequency was 180, or three times the normal frequency of the machine.

Trams Replace Horses in Vienna.—The Director of the Vienna Municipal Tramways, writing in the "Electric Railway Journal" gives an account of how their cars performed the work of horses and motor lorries commandeered for military use. The haulage of coal and coke from railway warehouses and gas works to the large city depots and retail dealers is now largely carried out by attaching the horse wagons behind the electric cars. Two wagons can be towed by one car at a speed of about 4 miles per hour, suitable resistances being fitted to deal with the slow speeds. Most of the traffic is carried on at night to avoid delaying the passenger service.

Restriction of Coal Exports.—The Board of Trade has now announced that, by an Order of Council, the exportation of coal and coke to all countries except British possessions and protectorates will be prohibited after August 13th. The object of the restriction is to prevent merchants from obtaining a higher price abroad than that permitted in England, there being no intention of withholding from our Allies the coal necessary for their railways or industries. Licences to export coal or coke to prohibited destinations in Allied countries will be granted in certain cases, as they have been for neutral countries. Applications for these must be made on a special form to the War Trade Department, 4, Central-buildings, Westminster, London, S.W.

Electric Resistance Furnaces.—In a Paper read by Mr. C. W. Bartlett, before the National Electric Light Association of America, the author divided commercial applications of electric resistance furnaces into four classes, each having a definite temperature range. The limits of temperature and a few of the typical operations specified in each class are as follows :

Class 1. From 1,000° C. to 1,400° C. (*a*) Hardening high speed steel ; (*b*) heating steel bars for forging and welding ; (*c*) melting copper and gold.

Class 2.—From 450°C. to 1,000°C. (*a*) Annealing ; (*b*) heating copper, brass and Monel forging bars ; (*c*) melting zinc, silver and aluminium.

Class 3.—From 250°C. to 450°C. (*a*) Sherardising ; (*b*) melting tin, lead and babbit ; (*c*) boiling varnishes.

Class 4.—From 100°C. to 250°C. (*a*) Baking japan, enamels, lacquers and insulating compounds ; (*b*) vulcanising ; (*c*) heating moulds.

Electroplating with Cobalt.—Commercial plating with nickel is an industry of very great magnitude, but although it has been known for a long time that the closely related metal cobalt is capable of yielding similar results, there has been heretofore no practical application of this metal in this way, doubtless on account of its greater value due to its use in producing the blue colour of glazes used in the ceramic industry, &c. From an article in the " Journal of Industrial and Engineering Chemistry " it appears that, on account of an increased production of cobalt in recent years in the province of Ontario, there is probably a need of a more extensive utilisation of this metal. Messrs. H. T. Kalmus, C. H. Harper and W. L. Savell, of the Canadian Department of Mines, have made extensive experiments with cobalt plating, and have found that this metal has some advantages over nickel which in practice may overcome its higher cost. One of the best cobalt plating solutions, used with metallic cobalt anodes, is made as follows : Cobalt sulphate (anhydrous) 312 grams, sodium chloride 19·6 grams, boric acid nearly to saturation, and water 1,000 c.c. The cobalt may be deposited on various metals and alloys, and the platings are firm, hard and uniform. They may be buffed to a satisfactorily finished surface, which, although brilliantly white, has a slightly bluish cast. An advantage of the solution that has been mentioned is that it is capable of plating at least 15 times as fast as the fastest satisfactory nickel solution. It appears that the cobalt plating rapidly deposited is harder than nickel plate, so that less cobalt is required to give the same protection. As the present price of cobalt is about four times that of nickel it may seem doubtful whether the former can replace the latter in practice. The authors, however, claim this to be probable.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Prof. G. W. O. Howe contributes an article on " Coupled Oscillatory Circuits and the System ' A Grade Unique ' " (p. 662).

We publish an article on " Thermal Insulation Tests of Electric Ovens," by Messrs. A. E. Kennelly, F. D. Everett and A. A. Prior (p. 668).

We give in full a Paper on the " Electrical Design of Induction Motors," by Mr. H. L. Smith (p. 653).

An article on " Industrial Research," by Mr. L. V. Hawkins, appears on p. 660. This subject is also discussed editorially in our Leading Article (p. 666).

An abstract is given of an original communication on the " Journal " of the Institution of Electrical Engineers, by Mr. A. Still, on " The Inherent Regulation of Synchronous Alternating-current Generators " (p. 658).

We also give an abstract of a Paper on " The Insulating Properties of Solid Dielectrics," by Mr. H. L. Curtis (p. 656).

Mr. J. Sayers has kindly sent us a report (reproduced on p. 670) on " The Magnetic Storm of June 17th."

An account of a discussion on the " Lighting of Rifle Ranges " at a recent meeting of the Illuminating Engineering Society appears on p. 673.

Companies' Meetings and Reports.—Bombay Electric Supply and Tramways Co., British Columbia Electric Railway Co., County of Dorset Electric Supply Co., Electric Supply Corporation, North Berwick & District Electric Light and Power Co., Yorkshire Electric Power Co. (pp. 683-685).

OBITUARY.

ROBERT HAMMOND.—We deeply regret to have to record the death of Mr. Robert Hammond, M.Inst.C.E., M.I.E.E., which occurred yesterday (Thursday) morning. Mr. Hammond was one of the best known pioneers of electric lighting in this country, having taken up electrical engineering in 1878 in connection with the engineering business established by him in Middlesbrough and London. He was the first concessionaire of the Brush Company, and he was largely instrumental in popularising the Brush arc machine in this country. On the invention of the Swan incandescent lamp, Mr. Hammond turned his attention to central station lighting, and laid down the first works in this country—viz., those at Brighton, Eastbourne and Hastings. In 1883 he published the first book written on the subject of private house electric lighting, entitled " Electric Light in Our Homes," and Mr. Hammond claimed that his house at Highgate was the first house in Europe lighted from top to bottom with the incandescent electric light. Between 1883 and 1903 he paid several visits to the United States in order to study the developments in electric traction. Mr. Hammond acted as consulting engineer for many electricity supply undertakings in this country, and he laid down several supply works in England, Scotland and Ireland, as well as in the Colonies, Spain, &c. In conjunction with many of the undertakings, refuse destructors were installed under his supervision. Mr. Hammond has also acted as electrical engineer to many municipal electric tramways in the United Kingdom and the Colonies. Mr. Hammond was a recognised authority in rating appeals and arbitrations. In 1910 he acted as arbitrator to fix the price to be paid by the Paisley District Tramways Co. to Paisley Corporation for a supply of electrical energy for the tramways, and in 1911 between the Gravesend Corporation and the Gravesend & Northfleet Electric Tramways (Ltd.) for the same purpose. He was also a familiar figure as an " expert witness " in Parliamentary Committee rooms, and he acted in a professional capacity in nearly all the inquiries relating to the electrical power distribution bills. He acted for the London County Council in their bulk supply bills of 1906 and 1907, and in the latter part of 1907, he, in conjunction with Mr. H. F. Parshall, prepared a scheme for the supply of electricity in bulk for Greater London, involving an expenditure of £4,500,000. He was one of the advisers of the Postmaster-General in the case for the acquisition of the telephones. Mr. Hammond was the author of many Papers which appeared in THE ELECTRICIAN and other technical journals and in the " Transactions " of societies. In 1905, at Johannesburg, before the Engineering Section of the British Association, Mr. Hammond read an important Paper on " Electric Power Distribution for the Rand." For the purpose of providing for the training of electrical engineers, Mr. Hammond founded in 1884 the Hammond Electrical Engineering College, and later (in 1890) the Electrical Standardising, Testing and Training Institution, of the Board of Governors of which he has continuously been a member. In 1902 he succeeded the late Prof. Ayrton as the hon. treasurer of the Institution of Electrical Engineers. Mr. Hammond, whose death is a great loss to the electrical industry, was 65 years of age.

J. C. GILL.—We regret to record the death of Mr. John Chas. Gill, city electrical engineer, Peterborough.

KILLED IN ACTION.—We regret to announce that Major Gordon Stewart Drummond Forbes, C.M.G., D.S.O., King's Own Scottish Borderers, 7th Battalion, has died from wounds received in action. Deceased, who was the sixth son of the late General Sir John Forbes, G.C.B., of Inverernan, Aberdeenshire, was electrical mining engineer, and was 48 years of age. For some considerable time he was identified with the mining industry on the Rand, and subsequently took a prominent part in the development of Rhodesia.

We also regret to announce the death of Major Gardiner, Royal Engineers. The deceased officer, who was reported missing at the end of last year, is now stated to have been killed before Givenchy on December 20. Major Gardiner was prominently associated with Indian Railway administration for many years, and he went straight from India to the front. In the English railway world Major Gardiner was known as having in 1908 brought forward a system of cab signals and the automatic electric control of moving trains as a safeguard against the failure of the human machine. He was a member of the Institutions of Civil Engineers and Electrical Engineers.

In the "Staff War Bulletin" of the County of London Electric Supply Co. and associated companies, it is announced that the following members of the staff have been killed in action:

G. Beast (employed at the Streatham local office), P. G. M. Brown (of the development department at the head office), Sergeant W. B. Featherstonhaugh (mains department at head office), and A. Haydock (switchboard attendant at Bournemouth).

APPOINTMENTS VACANT AND FILLED.

A switchboard attendant is required for the Stepney (London) electricity undertaking with experience of a.c. and d.c. switchboards. Applications to the engineer and manager, Mr. W. C. P. Tapper, 27, Osborn-street, Whitechapel, E., by Tuesday, Aug. 10. *See advertisement.*

Sutton Coldfield Corporation require an electrical engineer and manager. Commencing salary will not exceed £250. Applications to the Town Clerk (Mr. R. A. Reay Nadin) by Sept. 1.

An all-time instructor of experimental physics and mechanics, applied mechanics, electrical engineering, machine drawing and workshop practice is required by the Wimbledon District Higher Education Committee. Salary £150 per annum. Forms of application from the Principal, Mr. W. A. Harwood.

The High Tension Co. require a man with experience of assembling sparking coils. *See advertisement.*

An electrician is wanted for permanent position in London, to take charge of electric power and lighting equipment, &c. *See an advertisement.*

The University of London is about to appoint a principal officer at a salary of £2,000 a year. Names of those desirous that their names should be considered should reach the Secretary to the Senate, University of London, South Kensington, S.W., by Sept. 15.

The Victorian Railway Commissioners require a circuit designer and draughtsman. Particulars from the Agent-General for Victoria, Melbourne-place, Strand, London, W.C. Salary £350. Applications by 11 a.m. Aug. 11.

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply department. Salary £650, rising to £700 per annum. Applications to the town clerk (Mr. Thos. H. Nesbitt), by Sept. 13.

Mr. R. H. Fox, of Sunderland, has been appointed resident electrical engineer of the Musselburgh & District Electric Light & Traction Co.

Mr. F. A. Nicholls has been appointed assistant engineer of Leek Urban Council's electricity works.

The City of London Corporation have appointed Mr. E. E. Finch (chief assistant) as City Engineer, in succession to the late Mr. Frank Sumner, at a salary of £800 per annum.

Mr. E. J. Cochrane, assistant electrical engineer to Sydney (N.S.W.) Council, has been appointed chief engineer and general manager of the City Electric Light Co. of Brisbane.

Mr. A. V. Baldwin has been appointed electrical engineer to Hopetown (Victoria) Municipality.

Mr. E. Coade, having resigned the position of chief engineer of the Rutherglen (Victoria) Council's electricity department, Mr. H. W. Wilyatt has been appointed as his successor.

INSTITUTIONS AND SOCIETIES.

Institute of Chemistry. The results of the examinations recently held in London, Glasgow and Dublin have been published.

Of 11 candidates for the Intermediate examination, seven passed: C. E. Cornell, A. Harrison, T. Hopkins, B.Sc., J. Mcleod, J. Ogilvie, B.Sc., Agnes Slee, and A. Stewart, B.Sc. In the examination in General Chemistry for the Associateship A.I.C., E. R. Taylor, A.R.S.M. (Lond.), passed. Of 24 candidates who presented themselves for the final A.I.C. examination 16 passed. In the branch of Mineral Chemistry E. Arnold, B.Sc., in Organic Chemistry G. M. Bennett, B.A. (Cantab.), A. J. Boyd, B.Sc. (Birmingham), H. Hepworth, B.Sc., I. Hopper, A.R.C.S.I., C. A. Hutchinson, B.Sc., C. H. Lumsden, B.Sc., J. W. Porter, A.R.C.S.I., and S. H. Tucker, B.Sc., A.R.C.S. (Lond.); in chemistry (and microscopy) of food and drugs, fetilisers and feeding stuffs, soils and water: G. A. Bracewell, P. Cheng, B.Sc., A. O. Jones, C. H. Manley, B.A., C. C. Roberts, M.A., and S. Emsley, B.Sc.

EDUCATIONAL NOTES.

University of Manchester.—In the Faculty of Science complete courses of study (extending over three years) are arranged for the University Degrees in civil, mechanical and electrical engineering. Good facilities are provided for laboratory and research work, and the electrical engineering laboratory is housed in a new building. Complete theoretical and practical training is given to students preparing for the higher positions in the electrical engineering profession. Particulars of the courses can be obtained from the Registrar. The new session commences on Oct. 7.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

University of Bristol.—The Session in the Faculty of Engineering will commence on Sept. 14 and in the Faculties of Arts, Science and Medicine on Oct. 1. There are complete courses of instruction in civil, mechanical, electrical and automobile engineering. There are well-equipped laboratories and good facilities for practical and research work. Prospectuses and full particulars may be obtained from the Registrar, Mr. James Rafter, M.A.

University of Birmingham.—The new session commences on Tuesday, Oct. 5. At this university there are full courses of instruction in mechanical, civil and electrical engineering. The courses extend over four years, and students who enter after matriculation, and pass successfully the examinations at the end of each year will be entitled to the degree of Bachelor of Science in the branch of engineering to which they devote themselves. There are good facilities for practical and research work. Syllabus, giving particulars of university regulations, lecture and laboratory courses, fees, &c., may be obtained from the secretary.

Imperial College of Science and Technology, South Kensington, London. The City & Guilds (Engineering) College, the engineering section of the Imperial College, provides complete courses of instruction leading up to and including the highest specialised instruction for students, with the object of fitting them for leading positions as civil, mechanical or electrical engineers, scientific advisers, &c. The departments are: Mechanical engineering and motive power (under the direction of Prof. Dalby); civil engineering and surveying (Prof. Dixon); electrical engineering (Prof. Maurice); mechanics and mathematics (Prof. Forsyth). Applications must be made by the first Monday in September for admission to the courses qualifying for the diploma of Associate of the City & Guilds of London Institute, and candidates must pass the entrance or matriculation examination of the College held in September or have passed the matriculation of the University of London in certain subjects. The diploma of the Imperial College is granted for advanced specialised or fourth year work. Prospectuses, &c., from the Registrar.

City & Guilds Technical College, Finsbury.—The day courses at this college are adapted to the needs of various students, including pupils from secondary schools above the age of 15 who desire to receive a practical and scientific training, and young men who, having previously served a pupilage or apprenticeship, desire to go through a more systematic training. Programmes from the Registrar.

Crystal Palace School of Engineering.—The distribution of certificates was made by Commodore Sir Richard Williams-Bulkeley, Commanding Officer of the Royal Naval Division Depot at the Crystal Palace, on the 29th ult.

Sir Richard pointed out that engineering was playing a very prominent part in the destiny of this country. If 20 or 30 years ago we had been told that the next war would be waged by means of earthworks, trenches and saps to within 20 or 30 yards of one another, most of us would have laughed; but it had come about on account of the simple fact that modern weapons were such that nobody could live above ground. All this was due to a certain branch of engineering and there were hundreds of other branches connected with military movements.

ARRANGEMENTS FOR THE WEEK.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Cray, V.D.

The following orders have been issued for the week ending Aug. 14, 1915:

Monday, Wednesday and Friday.—Drills, 6:30 p.m. and 7:30 p.m.

THE ELECTRICAL DESIGN OF INDUCTION MOTORS.*

BY H. L. SMITH, A.M.INST.C.E.

Summary.—In the present Paper the author briefly considers the designing required on induction motors from the time of receiving the customer's inquiry down to the sending of drawings to the shops.

The Nature of the Demand.- By far the commonest frequency, especially for small machines, is 50 cycles per second. The next commonest frequency is 25 cycles, with an occasional sprinkling of 40 cycles and 60 cycles, and sometimes 33⅓ cycles.

The commonest voltage is 400 or 440 volts for all sizes of machine from 1 H.P. to 500 H.P. For the smaller motors 200 or 220 volts is fairly common, and for the larger motors, 500, 2,000 or 3,000 volts. For very large machines, of 1,000 H.P. or 2,000 H.P., 3,000 volts is perhaps the commonest voltage, with an occasional 5,000 or 6,000-volt machine. The commonest numbers of poles, all for 50 cycles, are as follows: 1 H.P. to 5 H.P., 4 poles; 5 H.P. to 15 H.P., 6 poles; 15 H.P., to 60 H.P., 8 poles; 60 H.P. to 150 H.P., 10 poles; 150 H.P. to to 350 H.P., 12 poles; 400 H.P., 16 poles; 1,000 H.P., 20 poles; and

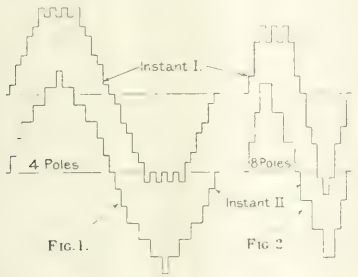


FIG. 1. FIG. 2

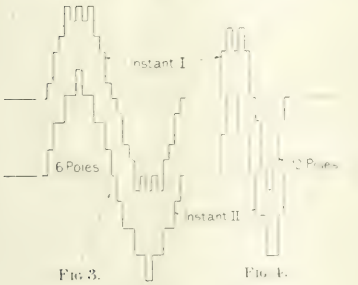


FIG. 3. FIG. 4.

Machine D.

2,000 H.P., 24 poles. These figures are, however, only a rough guide, as there is a wide range in the frequencies, voltages and numbers of poles called for.

The following machines are referred to in the Paper:

Machine A: Three-phase slip-ring type 8 poles 750 revs. per min. 50 cycles 3,000 volts 50 H.P.

Machine B: Three-phase squirrel cage 2 poles 3,000 revs. per min. 50 cycles 500 volts 140 H.P.

Machine C: Three-phase squirrel-cage 6 poles 1,000 revs. per min. 50 cycles 400 volts 20 H.P.

Machine D: Three phase squirrel-cage 4, 6, 8, 12 poles; 1,500, 1,000, 750, 500 revs. per min. 50 cycles 400 volts 15 H.P., 10 H.P., 7·5 H.P. and 5 H.P.

Machine E: Three-phase squirrel-cage 4 poles 1,500 revs. per min. 50 cycles 220 volts ¼ H.P.

The Equilibrium of E.M.F.s.—It is apparent that, if there were no back E.M.F., the switching of the motor on to the mains would at once be the signal for a destructive rush of stator current.

This condition of the stator back E.M.F. being of necessity approximately equal and opposite to the stator impressed E.M.F., and, therefore, fixed in magnitude and phase, is the outstanding feature of the induction motor problem and dominates all the interactions that subsequently may be called into play.

When, as is usually the case, the winding diagram repeats itself after every pole, we have only to add up the ampere-turns embracing each pair of homologous teeth, and place them side by side to obtain the shape of the revolving field. If we take as instant I. the instant when the currents in the three phases are proportional respectively to 1, $-\frac{1}{2}$, $-\frac{1}{2}$, and as instant II. the instant when they are proportional to 0·867, 0, −0·867, then for each phase, multiplying the amperes by the turns, we obtain a table of figures proportional to the ampere-turns of M.M.F., and, therefore, to the flux passing down each tooth.

If we plot these fluxes flowing down each tooth side by side, as shown for machine D in Fig. 1, we obtain a curve the shape of which gives the flux distribution round the periphery and the area represents the flux per pole. It will be seen that the shape of the curve is different for instants I. and II., but the area is the same in each case, thus showing that, although there is a pulsation of M.M.F., there is no pulsation of flux due to this cause.

Fig. 2 gives the flux curve for the same winding when connected to give 8 poles, and Figs. 3 and 4 give corresponding curves for the second stator winding when connected to give 6 and 12 poles respectively, the scale being kept the same throughout by referring to the flux per pole as calculated.

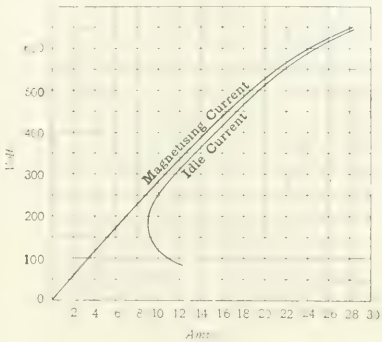


FIG. 5.

The total stator flux per pole is determined from a consideration of the fundamental principle of electromagnetic induction—viz., that, if the flux interlinking with a circuit is altered at the rate of one line per second, one C.G.S. unit of E.M.F. is set up. The whole flux per pole is changed from zero to a maximum in one-fourth of a complete cycle—*i.e.*, in 1/4*f* second, where *f* is the frequency.

∴ Mean rate of change of flux per turn $= N \times 10^8 \times 4f$ lines per second, where N = the flux per pole in megalines.

∴ Mean E.M.F. per turn $= N \times 10^8 \times 4f / 10^{-8}$ volts.

But for machine D running as 4 poles E.M.F. per phase $= 400/\sqrt{3}$ volts (R.M.S.).

$$\therefore \text{Mean E.M.F. per turn} = \frac{400}{\sqrt{3}} \cdot \frac{1}{108} \cdot \frac{2\sqrt{2}}{\pi} \times 1{\cdot}087 \times 1{\cdot}22 \text{ volts.}$$

$$\therefore N = \frac{10^8 \times 231 \times 1{\cdot}087 \times 1{\cdot}22}{\pi\sqrt{2} \cdot 50 \times 108} \text{ megalines.}$$

$$= 1{\cdot}275 \text{ megalines.}$$

The factor 1·087 is a "breadth factor," and is introduced because the 108 turns in series per phase are distributed in slots, so that the E.M.F.s per turn are not all exactly in phase, and the factor 1·22 is a "fractional pitch factor," and is introduced because the flux interlinking is not the whole flux per pole.

Proceeding in the same manner, the flux per pole for the same winding when connected to give 8 poles was 0·555 megaline, and for the second stator winding, when connected to give 6 poles and 12 poles respectively, 0·875 megaline and 0·361 megaline.

For any particular machine the magnetising current would be proportional to the voltage applied if the permeability were constant. As about 80 per cent. of the M.M.F. is expended on the air gap and only about 20 per cent. on the iron, the permeability is, in fact, more or less constant. Fig. 5 gives the results of a test running light on machine B. From this it will be seen that the curve of magnetising current is very nearly a straight line up to the normal voltage of 500, and that it is only after the voltage is raised above the normal that the curve begins to bend over, thus justifying the practice of neglecting tentatively saturation. The exciting current curve

* Paper read before the Rugby Engineering Society.

comes between the idle current and the magnetising current, and is scarcely distinguishable from the latter. The drooping down of the idle current curve is due to the fact that the friction watts are constant, and that, therefore, with reduced voltage the friction current C_f goes up.

The friction losses are obtained by reducing the voltage low enough, until the hysteresis and eddy losses become negligible. Thus, with 100 volts of impressed E.M.F., the loss was 2.940 watts and the speed 2,930 revs. per min. Taking the hysteresis and eddy losses as 100 watts this leaves 2.840 watts as the friction loss at 2,930 revs. per min., or, say, 1,000 watts per phase at 3,000 revs. per min.

With 500 volts of impressed E.M.F. the loss was 6,230 watts. Deducting the constant 3,000 watts friction loss, we get the hysteresis and eddy loss as 3,230 watts or 1,077 watts per phase.

There are two E.M.F.s in the circuit, impressed and induced, which partially oppose one another, so that the effective E.M.F. is only E cos φ, in phase with the current, and the effective resistance is E cos φ/C.

We may take as the vector of reference either the current or the impressed E.M.F., the ore course being adopted for resistances and reactances, and the other for conductances and susceptances, a mode of procedure which involves that the conductance should be, not 1/R, as in the case of direct-current work, but $\text{Cos}^2\varphi$/R.

Thus, taking the current as the vector of reference, we have :—

Effective E.M.F. = E cos φ,
Effective resistance = E cos φ/C,
Wattless E.M.F. = E sin φ,
Reactance = E sin φ/C,

and taking the impressed E.M.F. as the vector of reference, we have

Effective current = C cos φ,
Effective conductance = C cos φ/E,
Wattless current = C sin φ,
Susceptance = C sin φ/E.

The Equilibrium of M.M.F.s.—The stator current produces one M.M.F., the rotor current produces another. The resultant of these

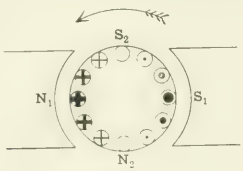


Fig. 6.

two is that which drives the flux round the mutual path. The current which, when flowing through the stator winding, would produce this resultant M.M.F. is the exciting current.

In the case of the induction motor, where the number of turns on the rotor is considered the same as that on the stator, the condition of the equilibrium of M.M.F.s reduces down to the equilibrium of currents. The tendency of the rotor current in the first instance is to convert the rotor itself into an electromagnet with the polarity shown in Fig. 6. This cross-magnetising rotor current is balanced by an equal and opposite cross-compensating component of the stator current. If there were no such thing as magnetic leakage the matter would end here. The diameter of Heyland's circle would become infinite, and there would be no breaking-down point.*

The induction motor on no load can be represented as a single resistance and a single reactance (Fig. 7), or as a single conductance and a single susceptance (Fig. 8).

The single resistance can be separated into that which is a property of the circuit, or the ohmic resistance, and that which is not a property of the circuit or the extra resistance due to magnetic friction, &c. The single reactance can be separated into that which is due to the stator leakage inductance, and that which is due to the mutual inductance (Fig. 9).

Or we can separate the single conductance into two portions, one corresponding to the power current due to the stator ohmic resistance, and the other to the power current due to hysteresis and eddies ; and we can separate the single susceptance into two portions corresponding respectively to the wattless current due to the stator leakage inductance and to the wattless current due to the mutual inductance (Fig. 10).

Finally, we can combine the two methods, when we get Fig. 11.

* Heyland gave the method of establishing the circle diagram in The Electrician, Vol. XXXVI., pp. 505, 578, 650, 719, 795 (1896).

The Complete Solution of the Induction Motor.—In the induction motor there are a magnetic field, a sheet of stator current and a sheet of rotor current, all revolving in synchronism together. The rotor itself may slip, or even come to rest, but the sheet of rotor current does not slip. The only connecting link between stator and rotor is the revolving field. Hence, in order that the stator current may remain unaltered, all that is necessary to ensure, as we slow the rotor up, is that the revolving field and therefore also the sheet of rotor current should remain unaltered. Now, the rotor copper loss being proportional to the slip, it so happens that, if an induction motor be running at any particular slip, s, and its speed be reduced by inserting external resistance in the rotor circuit, the sheet of rotor current does remain unaltered, because, although the whole rotor resistance goes up in proportion to the slip, the rotor reactance goes up in the same ratio, the former from r_2 to r_2/s, where r_2 is the ohmic resistance, and the latter from sx_2 to x_2, where x_2 is the rotor leakage reactance for primary frequency.



Fig. 7. Fig. 8. Fig. 9. Fig. 10. Fig. 11.

Methods of Representing an Induction Motor on No Load.

Hence, in order to determine the characteristics of an induction motor, all that is necessary is to suppose it as running at several different values of the slip and to bring it to rest successively by inserting external resistance in the rotor circuit.

Thus, each phase may be shown as Fig. 12, where r_1 is the stator ohmic resistance ; x_1 is the stator leakage reactance ; g is the exciting conductance ; b is the exciting susceptance ; x_2 is the rotor leakage reactance ; and r_2 is the ohmic resistance of the equivalent rotor winding.

Also, if K_2 and T_2 are the cosine and tangent respectively of the

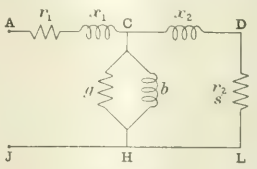


Fig. 12.

rotor angle of lag, and R_2 the resistance per phase when reduced to rest, then for secondary circuit CDL

$R_2 = r_2 \div s$,
$T_2 = x_2 \div R_2$,
K_2 = the cosine corresponding to T_2,
G_2 (conductance) $= K_2 \div R_2$.

For the secondary circuit CDL in parallel with the exciting circuit CH,

$G = G_2 + g$,
$T = (G_2 T_2 + b)/G$,
K = the cosine corresponding to T,
$R = K \div G$.

For the complete circuit,

$R_1 = R + r_1$,
$T_1 = (RT + x_1) \div R_1$.

Then power-factor K_1 = the cosine corresponding to T_1.

stator current, $C_1 = E_1 K_1 \div R_1$.
internal E.M.F., $E = C_1 Z = C_1 K \div G$,
rotor current, $C_2 = G_2 E / K_2$
primary watts, $W_1 = \text{phases} \times R_1 C_1^2$.
secondary watts, $W_2 = \text{phases} \times R_2 C_2^2$.

mechanical output watts $= (1-s)(W_2 - F)$, where s = fractional slip and F = friction watts,

efficiency = output ÷ input,
horse-power output = output watts ÷ 746.

For instance, in machine D when running as six poles the constants were as follows :—

$r_1 = 0.696$, $r_2 = 0.199$, $x_1 = 1.34$, $x_2 = 0.382$, $g = 0.00403$, $b = 0.0443$.

The calculation for the characteristics would then be proceeded with in tabular form, and would appear as follows :—

Slip	0·01	0·02	0·04	0·06
$R_1 - r_2/s$	19·9	9·95	4·97	3·32
$T_2 = x_2/R_2$	0·0192	0·0385	0·077	0·115
K_2 from T_2	1·0	1·0	0·997	0·995
$G_2 = K_2^2/R_2$	0·0503	0·1006	0·2000	0·3000
$G_2 + g$	0·05433	0·10463	0·20403	0·30403
$T = (G_2 T_2 + b)\ G$	0·835	0·461	0·293	0·259
K from T	0·766	0·908	0·96	0·968
$R = K^2/G$	10·4	7·87	4·51	3·08
$R_1 = R + r_1$	11·096	8·566	5·206	3·776
$T_1 = (RT + x_1)/R_1$	0·904	0·58	0·51	0·567
K_1 from T_1	0·742	0·86	0·89	0·87
$C_1 = E_1 K_1/R_1$	15·43	23·1	39·5	53·3
$E - C_1 K\ G$	218	201	186	170
$C_2 = G_2 E/K_2$	10·93	20·15	37·2	51·1
W_1 = phases $\times R_1 C_1^2$	7,900	13,700	24,300	29,500
W_2 = phases $\times R_2 C_2^2$	7,150	12,100	20,600	26,000
$(1-s)(W_2 - F)$	6,890	11,650	19,600	24,300
$(1-s)(W_2 - F)\ W_1$	0·87	0·85	0·807	0·823
$(1-s)(W_2 - F)/746$	9·23	15·6	26·3	32·5

The Power Equation.—Since action and reaction are equal and opposite, the drag of the rotor on the field is equal to the drag of the field on the rotor. The whole mechanical power imparted to the rotor, including that required to overcome friction, is proportional to the torque × the speed of the rotor in revs. per min. The whole power of any sort imparted by the revolving field is proportional to the torque × the speed of synchronism in revs. per min.; therefore the difference—*i.e.*, the torque × the slip in revs. per min—must equal the rotor copper watts.

The only connecting link between stator and rotor is the revolving field, and the power equation is obtained by equating the power delivered *to* the motor less stator copper and iron watts to the power delivered *by* the motor + rotor copper and friction watts.

For instance, in machine B, with 146 amperes line current, the stator copper loss was 1·91 kw., the iron loss 3·1 kw., so that the whole stator losses were 5·01 kw. The input was 115·6 kw. Hence, the whole power imparted to the rotor was 110·59 kw. The slip was 2·2 per cent. of synchronism, so that the rotor copper loss was 2·2 per cent. of 110·59 kw.—*i.e.*, 2·43 kw. The friction loss was 3 kw., so that the output was 105·16 kw. (140 H.P.), and therefore the efficiency was 91 per cent.

The fact of the slip being a measure of the rotor copper loss may be used as a means of determining the characteristics of a motor. For instance, the following table gives the results of a test on machine D when running as a six-pole motor :—

—	Line volts.	Amperes.	Watts.	Per cent. Slip.
Running light	400	10·1	920	1·0
Belt only	400	10·2	1,428	1·2
Three-quarter load	400	11·7	4,312	2·1
Full-load	400	15·5	7,930	3·0
25 per cent. overload	400	19·3	10,200	3·5
50 per cent. overload	400	22·7	13,600	4·8

From this test we can calculate as follows :

Amperes per phase	10·1	10·2	11·7	15·5	19·3	22·7
C^2R stator	187	...	287	500	650	910
Core loss	513	513	513	513	513	513
Total stator loss	...	...	800	1,013	1,163	1,423
Input to machine	...	...	4,312	7,930	10,200	13,600
Rotor input	...	...	3,512	6,917	9,037	12,177
Slip, per cent.	1·0	1·2	2·1	3·0	3·5	4·8
C^2R rotor	...	...	74	207	316	585
Friction	220	220	220	220	220	220
Total rotor loss	...	...	294	427	536	805
Total loss in machine	...	...	1,094	1,440	1,699	2,228
Output in watts	...	...	3,218	6,490	8,501	11,372
Output in H.P.	...	...	4·3	8·7	11·4	15·2
Efficiency	...	...	74·7	81·8	82·2	83·6
Power-factor	...	...	0·53	0·74	0·81	0·85

Curves of efficiency and power factor can then be plotted as in Fig. 13.

The Torque Equation.—The torque exerted by the rotor teeth is proportional to the whole power input to the rotor. From the torque exerted by the teeth has to be deducted the torque required to overcome friction, and the remainder gives the torque available at the shaft extension. In the case of a squirrel-cage rotor, both at full-load and at starting, the iron loss is negligible, in the one case because the frequency is small, and in the other because the mutual flux is small. Thus, at all load, full load or overload the torque = K times the whole input to the rotor in watts, where K is a constant, then at starting the torque of a squirrel-cage rotor = K times the rotor copper watts.

The torque is proportional to the mutual flux × the rotor current × the sine of the angle between them. Hence, there are two points at which under ideal conditions, there is no torque—viz., at synchronism because then there is no rotor current, and at standstill because then there is no mutual field.

For squirrel-cage motors the starting may be done either (*a*) in the case of small machines by switching direct on to the mains or (*b*) in the case of larger machines by a Y—Δ switch for three-phase or a series-parallel for two-phase or (*c*) in the case of still larger machines by a compensator.

In the case of Y—Δ starting for three-phase and series-parallel for two-phase the proportions are as follows :—

THREE PHASE.

	Y	Δ
Connection of phases	Y	Δ
Voltage per phase	$1/\sqrt{3}$	1
Flux per pole	$1/\sqrt{3}$	1
Current per phase	$1/3$	$1/\sqrt{3}$
Current in line wires	$1/3$	1
Starting torque	$1/3$	1

TWO-PHASE.

	Series.	Parallel.
Voltage across each half of each phase	1/2	1
Turns in series per phase	1	1/2
Flux per pole	1/2	1
Current in each half of each phase	1/4	1/2
Current in line wires	1/4	1
Starting torque	1/4	1

The Squirrel-cage Rotor.—If Fig. 14 represents the developed plan of a squirrel-cage rotor then the revolving sheet of rotor current appears as an alternating current in the bars and as a revolving sheet of electrification in the end rings.

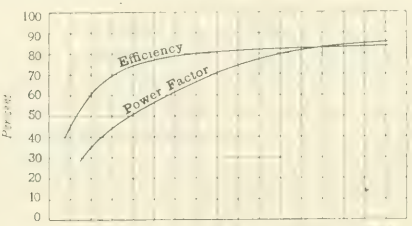


FIG. 13.—MACHINE D AS A SIX-POLE MOTOR.

From Fig. 14 it is apparent that the cross-section of the end rings should be some function of the cross-section of the bars per pole. What this function is depends to a certain extent upon the style of design—*i.e.*, whether the end rings are in the form of a single solid ring at each end or of a number of discs. In the latter case the ratio of the cross-section of the end rings at one end to the cross-section of the bars included under one pole is from 0·25 to 0·2.

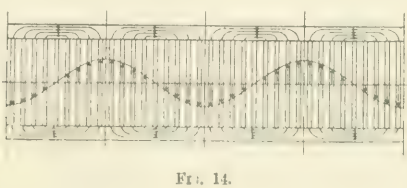


FIG. 14.

For instance, in machine C the rotor had 41 slots, 6 poles.

Then, slots per pole = 7 approximately; size of bar = 0·64 cm. × 1·25 cm., and cross-section of copper per pole = 7 × 0·8 = 5·6 sq. cm.

There were three discs each end, 19 cm. inside diameter, 25·4 cm. outside diameter and 0·16 cm. thick.

∴ Cross-section each end = 1·55 sq. cm.

Then function required = 1·55/5·6 = 1/4 nearly.

It should be noted that the "cogging" of squirrel-cage motors is due to the zig-zag leakage, and, therefore, may be expected to be

greatest in motors with short pole-pitches and small numbers of slots per pole—*i.e.*, in slow-speed motors; and least in motors with long pole-pitches and large numbers of slots per pole—*i.e.*, in high-speed motors. From this it follows that the rotor slots for machines with small numbers of poles can be larger and fewer in number than for machines with large numbers of poles without deleterious results. The practice of making the rotor slots an incommensurable number is effective so long as the rotor is central. But when the bearings wear the bulk of the zig-zag flux is on one side and the stator develops a "governing tooth" and slot. As every rotor tooth passes the governing slot it makes it alternately easier and more difficult for the zig-zag leakage to pass, and the rotor tends to stick in the position of minimum reluctance. But the flux in the governing tooth is zero twice in a cycle and at each of these two instants the rotor is free to move forward one rotor slot-pitch. If the zig-zag leakage is bad enough the machine will continue to run at this peripheral speed of two rotor slot-pitches per cycle.

Machine E is a case in point. The magnetic qualities of this machine are poor from a commercial point of view, but good for experimental purposes. The number of slots is 12 on the stator—*i.e.*, one slot per pole per phase, and 23 on the rotor, the dispersion coefficient being about 17 per cent. Owing to the short-circuit current being smaller relative to the normal current than is the case with any ordinary motor the rotor may be held stationary with full volts on the stator for quite a length of time without the machine getting unduly hot, or the applied voltage may even be transformed up when all these cogging effects are exaggerated.

This machine having four poles, the peripheral speed at synchronism is 11½ rotor slot-pitches per cycle, and the speed of zero cogging is two rotor slot-pitches per cycle or 4/23 of synchronism—*i.e.*, 260 revs. per min.

(To be concluded.)

INSULATING PROPERTIES OF SOLID DIELECTRICS.*

BY HARVEY L. CURTIS.

Summary.—Methods of measuring very high resistances are discussed, and diagrams given showing how they may be applied to the measurement of volume resistivity and surface resistivity. The effect of the humidity of the surrounding air, of the temperature of the specimen, and of the magnitude and length of application of the impressed voltage is discussed. The surface resistivity is shown to be due to a surface film, usually of water or oil on the insulator. This is generally the important factor in determining the leakage between two conductors insulated by a solid dielectric. The surface resistivity of most materials changes through wide limits when the humidity of the surrounding air is varied. The effects of temperature and of exposure to light are also treated.

There are several electrical properties of insulators between no two of which is there a known relationship. The most important of these are (1) the volume resistivity of the material, (2) the leakage over the surface, (3) the dielectric absorption, (4) the dielectric strength, and (5) the dielectric constant. All of these properties are functions of the temperature, and some may also be affected by other physical conditions, such as applied voltage, humidity, pressure, &c. This Paper presents results upon the volume resistivity and surface leakage of a number of insulating materials. The aim has been to cover all the conditions that will normally be found in a physical laboratory.

Methods.

The methods employed may naturally be classed under two heads: (1) The methods of measuring the resistance; (2) methods of preparing the specimen. Under the latter will fall the methods of maintaining the specimen under the desired conditions.

Methods of Measuring the Resistance.—In measuring the resistance high accuracy was not required. An accuracy of 10 per cent. was considered sufficient. As a large number of samples were measured, and each sample measured several times, it was necessary to arrange the apparatus so that it could be worked rapidly. Measurements were made from 10^4 ohms to 10^{15} ohms, the upper limit being fixed by the sensibility of the apparatus. It was found impossible to measure with one method a range of resistance much greater than 10^{11} ohms. Hence, two different methods were employed: (*a*) The galvanometer method; (*b*) the electrometer method.

[illegible] the galvanometer method as arranged for measuring the volume resistivity of the specimen. The terminal [illegible] is connected to the metal on which the specimen [illegible]. The current flows through the specimen to the mercury contained in an open cylinder of known area which is connected to D. The megohm in series serves to protect the galvanometer, and is usually negligible relative to the resistance of the specimen. To prevent the current which flows over the surface of the specimen from reaching D, a guard ring of mercury surrounds the inner cylinder, but is insulated from it. This guard ring is connected directly to the opposite terminal of the battery. In measuring a surface resistance or any resistance in which a guard ring is unnecessary the unknown resistance is connected directly between D and F.

For supplying the voltage, trays of small storage cells are used. This battery and the other apparatus are placed on metal plates

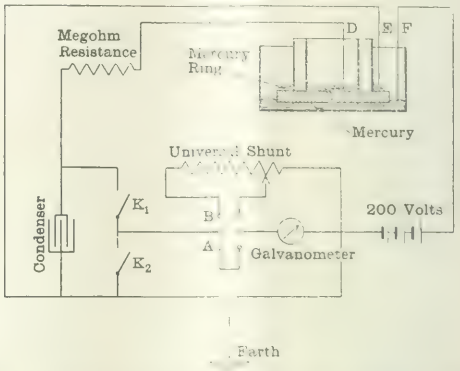


Fig. 1.—Connections for Measuring Volume Resistivity by the Galvanometer Method.

which are grounded. One terminal of the battery is also connected to the same ground. The key K_2 is for short-circuiting the galvanometer, while the key K_1 closes the circuit through the galvanometer. When the double throw switch is in the direction B, the galvanometer is connected in parallel with a universal shunt. This can be readily adjusted, so that 1, 1/10, 1/100, 1/1,000, or 1/10,000 of the total current passes through the galvanometer. The Sullivan galvanometer had a current sensitiveness of 2,000 mm. per microampere, with a scale distance of 2 metres. Using a battery of 200 volts, as was done in almost all cases, resistances from 10^4 to 10^{11} ohms can be measured to an accuracy of 10 per cent. When

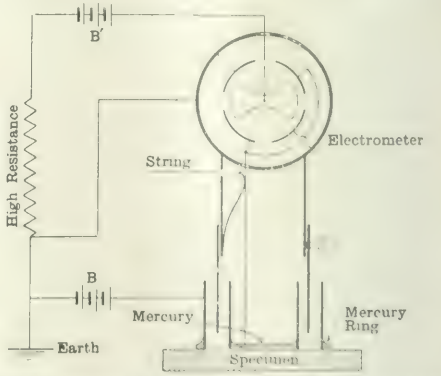


Fig. 2.—Connections for Measuring Surface Resistivity by the Electrometer Method.

the double throw switch is thrown to A, the galvanometer is connected directly in series with the specimen without the damping resistance which is contained in the universal shunt. If the current is so small that it does not produce an appreciable deflection upon closing the key K_1, the key is opened and the current allowed flowing through the specimen will charge the condenser. At the end of a time *t*, the key K_1 is again closed, and the charge which has accumulated is discharged through the galvanometer. From the ballistic constant of the galvanometer, the resistance of the specimen can be

* Abstract of a Paper from the Bulletin of the Bureau of Standards, Washington, U.S.A.

computed. Resistances up to 10^{17} ohms were measured by this method.

For measuring resistances higher than 10^{17} ohms a Dolezalek quadrant electrometer of a capacity of 1.5 mf. was employed. By means of it resistances as high as 10^{19} ohms could be measured. The diagram of Fig. 2 shows the connections for measuring the surface resistivity. The lead to one pair of quadrants is entirely surrounded by an earthed shield, while the other pair of quadrants is connected to earth. The surface leakage current flows between the inner and outer cylinders which rest on the insulator. To measure the volume resistivity of the material the battery B is disconnected from the outer ring and connected to the mercury in which the specimen is floated (*see* Fig. 1). The outer ring is then connected to earth. The current which flows on to the inner quadrant must now flow through the specimen. If the needle of the electrometer is maintained at a constant potential, the deflection of the needle will depend on the quantity of electricity on the inner quadrant. If the external E.M.F. E is high relative to the counter E.M.F. due to the charge on the quadrants, then the current through the insulator may be considered constant, and equal to

$$\frac{E}{R} = \frac{Q}{t} = \frac{Kd}{t}$$

where E is the applied E.M.F., t the time necessary to produce a deflection d, and K is the quantity of electricity necessary to produce unit deflection. This is similar to the method using a ballistic galvanometer, but differs in that the quantity can be determined at any instant. To determine the constant of the instrument, a sample whose resistance could be measured by both the galvanometer and electrometer methods was employed.

Methods of Preparing the Specimens.—To prevent the surface leakage, the material was obtained, whenever possible, in plates 10 cm. square by 1 cm. thick. Metal strips 1 cm. wide were clamped to this with their adjacent edges 1 cm. apart. The resistance was measured between the strips. The surface resistivity is assumed to be 20 times the resistance measured. While this is not strictly true, since there is leakage over the edges as well as over the face of the specimen, yet the correction is too small to take account of in the present work. To ensure good contact tinfoil was wrapped around the metal strips and carefully pressed against the surface of the insulator along the whole edge of contact. In some cases tubes of the material were used. In such cases wires were tightly twisted around the tube at a distance of 1 cm. apart and the resistance between these wires measured.

For determining the effect of temperature and humidity it was necessary to place the samples in a case, the temperature and humidity of which could be maintained constant. The temperature was maintained constant by a vapour pressure thermostat. The humidity was regulated by placing in the case an open vessel containing a sulphuric acid solution of the proper strength to give the desired humidity.

Volume Resistivity.

Effect of Humidity.—In certain cases results taken at different times did not agree satisfactorily. In seeking a cause for this, the question naturally arose as to whether the humidity of the air in which the sample had been kept before being measured could affect the volume resistivity. In order to test this, samples which had been maintained for some time in air of one humidity were surrounded by air of another humidity and maintained in this condition for several weeks. The volume resistivity was measured at frequent intervals during this time. The results show that, in certain cases, the volume resistivity decreases with increasing humidity, but that an equilibrium is reached after a few days. The samples tested were maintained at a high humidity (about 90 per cent.) for more than a month when the humidity of the tank was decreased to 25 per cent. and maintained at this humidity and a temperature of 25° C. for 10 days. Measurements were made at intervals. In many cases there was a progressive increase in the resistance, and in most of the samples the resistance was greater at the end of 10 days than at the end of 30 days. Ebonite, Bakelite No. 140, and Bakelite No. C 5,074 showed the largest. The celluloid had five times the resistance when it was dried than when it was in equilibrium with air of 90 per cent. humidity. It is well known that celluloid loses camphor when it is kept in a dry atmosphere. The change in resistivity may be due to the loss of camphor. Ebonite absorbs water very slowly. The indefiniteness of the volume resistivity of materials which absorb water is apparent. Many figures have been given for the volume resistivity of ebonite, but these values are of little value unless the history of the sample is known. The resistivity of ebonite depends upon the length of time it has been in contact with water. Ebonite which has been in contact with water for a long time has a resistivity which is only a few per cent. of that of ebonite which has been dried for a long time. Paraffined wood and boiled paper are very sensitive to humidity, but it is too small to announce with certainty. Some of the moulding compounds—electrose, gummon and moulded mica—showed no measurable change.

Table I. *Volume Resistivity at Various Temperatures.*

Volume resistivity at 20° C. Volume resistivity at 30° C.

Sample.			Sample.		
Sealing wax	1.9×10^{16}	0.9	Gummon electrose	2.6×10^{16}	2.6
Mica Indian ruby, slightly spotted)	1.0×10^{17}	1.0	Red fibre	7.8×10^{16}	2.6
Mouldoid	2.0×10^{15}	1.2	Mica Indian ruby, stamped	2.3×10^{17}	2.7
Mica (brown Alsatian, cleaved)	1.7×10^{17}	1.2	Dark mica	2.2×10^{17}	3.0
Shellac	1.2×10^{17}	1.5	Hard rubber	1.0×10^{17}	3.2
Ivory	1.5×10^{17}	1.6	Plate glass	4.0×10^{17}	3.2
Vulcabestos	1.2×10^{17}	1.6	Bakelite No. 150	1.3×10^{17}	3.3
Unglazed porcelain	2.2×10^{17}	1.6	Paraffined maple	1.9×10^{17}	3.6
Muscovite, N. 200	3.2×10^{17}	1.8	Boron	1.7×10^{17}	3.6
Mica (clear)	1.1×10^{17}	2.0	Sulphur	3.5×10^{17}	4.0
Paraffin	2.6×10^{15}	2.0	Bakelite No. 3,200	1.2×10^{17}	4.3
Black electrose	6.0×10^{16}	2.0	R.G.R.	1.2×10^{17}	4.3
Yellow electrose (L)	4.7×10^{15}	2.3	Khotinsky cement	2.1×10^{17}	11.0
Bakelite No. 140	7.5×10^{16}	2.4	Yellow beeswax	1.0×10^{17}	16.0

NOTE.—Values are for individual samples.

With regard to the effect of voltage on the change of the volume resistivity of insulators with voltage the results of the many observers on the subject show a wide variation that the author attempts no review of it. He refers briefly to the results of Evershed. The author's results upon a number of materials are given in the Paper, from which he states that only in one-third of the specimens was there any appreciable change in going from 50 to 500 volts, and of these the majority were known to be porous. In the case of opal glass there was an increase in resistance with increasing voltage, and while this was confirmed by several measurements, no other material was found which gave a similar result.

In Table I. are given some of the values found on the effect of temperature on volume resistivity. The range of temperature has been from 20°C. to 30°C. in every case.

Effect of Dielectric Absorption.—The system of two opposite electrodes separated by a dielectric such as that used in measuring the volume resistivity of insulators may also be considered as a condenser. Hence, at the instant of closing the circuit the current will be largely due to the displacement through the dielectric, but this will become negligible in a few thousandths of a second. Also, as in the case of all condensers using solid dielectrics, there will continue to flow for some time a current which is absorbed by the dielectric. While accurate data are not as yet available concerning the absorption current, it is possible to get some idea of its magnitude, and hence to estimate at what point the absorption becomes an important factor. It is shown that where the volume resistivity is less than about 10^{13} ohms, the absorption current gives no error greater than 10 per cent., provided the resistance is measured at the end of a minute. However, if the resistivity is above 10^{15} ohms, measurements must be made with different time intervals in order to determine when the absorption current becomes negligible. If the resistivity is greater than 10^{16} ohms, the absorption current at the end of one minute will probably equal the conduction current and may be much larger. In such cases it is necessary to apply the voltage for a much longer time before the true conduction current can be obtained. Curves are given showing the change of the apparent resistivity with time for two insulators having a resistivity greater than 10^{17} ohm-cm. In the case of hard rubber it is shown that even at the end of half-an-hour the absorption current is more than 10 times the conduction current. Even at the end of 18 hours we are not certain that the absorption current is negligible. For fused quartz the change in the apparent resistivity continues for a long time. At the end of 1 hour the resistivity was 5×10^{17}. At the end of 18 hours the resistivity was too high to measure, certainly more than 5×10^{18}.

The change of the apparent resistivity with time for a material at two different temperatures was also investigated. The shape of the curves obtained was somewhat different, showing that temperature modified the absorption curves. At 30 deg. the resistance had reached its permanent value in about 20 hours, the curve having an appreciable tendency to the axis of time.

Temperature Coefficient.—The values of the volume resistivity of a large number of insulators are given in order of their temperature coefficients in Table II. The values have been taken in the laboratory during the winter months, when fluctuations

Table II.—*Volume Resistivity of Solid Dielectrics.*
(Materials arranged in order of decreasing resistivity.)

Material.	Resistivity.	Material.	Resistivity.
	Ohm-cm.		Ohm-cm.
Special paraffin	Over $5{,}000 \times 10^{15}$	German glass	50×10^{12}
Ceresin	Over $5{,}000 \times 10^{15}$	Paraffined mahogany	40×10^{12}
Fused quartz	Over $5{,}000 \times 10^{15}$	Stabalite	30×10^{12}
Hard rubber	$1{,}000 \times 10^{15}$	Plate glass	20×10^{12}
Gutta-percha	200×10^{15}	Halowax No. 1001	20×10^{12}
*Sulphur	100×10^{15}	Dielectrite	5×10^{12}
*Amberite	50×10^{15}	Bakelite No. 5199 RGRB	5×10^{12}
*Rosin	50×10^{15}	Bakelite No. 150	4×10^{12}
*Mica, India ruby slightly stained	50×10^{15}	Common	3×10^{12}
G. E. No. 55 R	40×10^{15}	Tegit	2×10^{12}
Halowax No. 5055 B	20×10^{15}	Opal glass	1×10^{12}
Bakelite No. 1.558	20×10^{15}	Paraffined poplar	500×10^{9}
*Electrose No. 8	20×10^{15}	Bakelite No. G 5200 RGR	400×10^{9}
*Parowax, paraffin	10×10^{15}	Bakelite No. 1	200×10^{9}
Glyptol	10×10^{15}	Bakelite No. 190	100×10^{9}
*Shellac	10×10^{15}	Italian marble	100×10^{9}
Lavadier glass	8×10^{15}	Bakelite macarta	50×10^{9}
*Insulate No. 2	8×10^{15}	Bakelite No. G 5074	40×10^{9}
*Sealing wax	8×10^{15}	Black condensite	40×10^{9}
*Yellow electrose	5×10^{15}	Yellow condensite	40×10^{9}
*Diamond	3×10^{15}	Paraffined maple	30×10^{9}
*Murdock No. 100	3×10^{15}	White celluloid	20×10^{9}
*Yellow beeswax	2×10^{15}	Vulcabeston	20×10^{9}
Klebitsky cement	2×10^{15}	Hard fibre	20×10^{9}
Mica, brown African clear	2×10^{15}	Black galalith	20×10^{9}
G. E. No. 40	1×10^{15}	Lavite	20×10^{9}
*G. E. No. 55 A	1×10^{15}	White galalith	10×10^{9}
*Moulded mica	1×10^{15}	Hemit	10×10^{9}
Unglazed porcelain	500×10^{12}	Red fibre	5×10^{9}
Redmonite No. 157, 4	200×10^{12}	Pink Tennessee marble	5×10^{9}
Black electrose	100×10^{12}	Blue Vermont marble	1×10^{9}
Tornadic molybdenite	50×10^{12}	Ivory	200×10^{6}
Mica, India ruby stained	50×10^{12}	Slate	100×10^{6}
		Bakelite No. 140	20×10^{6}

and as the humidity of heated rooms is always low, the amount of moisture in those materials which absorb water was as low as will normally be found. The determinations were made at room temperature, 22° C. Except in the case of some of the insulators having very high resistivity, the voltage was applied for a sufficiently long time to make the absorption current negligible. As time did not permit the determination of the resistivity for all materials, the apparent resistivity after the voltage has been applied for 15 minutes is given in certain cases. These are indicated by an asterisk. Very few of the materials are so uniform that two samples will give values of the resistivity as close as 10 per cent., while a factor of 10 or even more is not infrequent.

(To be concluded.)

THE INHERENT REGULATION OF SYNCHRONOUS ALTERNATING-CURRENT GENERATORS.†

BY ALFRED STILL.

Summary.—This Paper is written from the designer's point of view, the type of machine considered being principally the synchronous polyphase generator with salient poles. The same considerations will apply, with rare exceptions, to high-speed machines with distributed field windings, and also to single-phase generators.

The usual methods of predetermining the regulation of alternators involve almost invariably the use of vectors or vector algebra. This is convenient and helpful, because the problem is thus presented in its simplest aspect. The very fact that vectors are used assumes the sinusoidal variation of the alternating quantities, or the sub-[illegible] and [illegible] allowance for the actual wave shapes, thus eliminating the less easily calculated effects caused by cross-magnetisation, and the consequent distortion of wave shapes. On the other hand, the exclusion of these factors, especially when [illegible] from standard types, may lead to incorrect conclusions; and, in any case, the plotting of the actual flux and E.M.F. curves [illegible] to the designer. It is therefore proposed to consider in the first place what is the best that can be [illegible] and then to [illegible] a greater [illegible] by using vectors representing the actual flux distribution in the air-gap corresponding to the required load conditions.

By enumerating all the factors which influence the terminal voltage of a generator driven at constant speed with constant field excitation, it will be possible to judge how nearly the methods about to be considered approximate to the ideal solution of the problem. These factors are :—

(*a*) The total or resultant flux actually cut by the armature windings (this involves the flux linkages producing armature reactance).

(*b*) The ohmic resistance of the armature windings.

(*c*) The alteration in wave-shape of the generated E.M.F., due to changes in air-gap flux distribution.

By far the most important items are included under (*a*).

Approximate Method of Predetermining Regulation.

Let curve A of Fig. 1 represent the open-circuit characteristic of the machine; it can be drawn [illegible] accurately from design data after the whole magnetic circuit has been designed, excepting that the flux leakage from pole to pole is not very easily estimated in new types of machines. It is assumed that the quantities required for the construction of the vector diagrams are known; but a means of estimating the probable quantitative effects of the slot and end fluxes will be considered later.

Load Saturation Curve for Zero Power Factor.—Any power factor below 20 per cent. is usually considered to be equivalent to zero. On these low power factors with lagging current the phase displacement of the armature current causes the armature magnetomotive force to be almost wholly demagnetising. Its maximum value per pole is easily calculated, and its effect in reducing the flux in the air-gap is readily compensated (on zero power factor) by increasing the field excitation so that the resultant ampere-turns remain unchanged. This statement is not strictly correct, because the increased ampere-turns on the field poles give rise to a greater leakage flux, and this alteration should not be overlooked, especially when working with high flux densities.

Knowing the increase of flux in pole and frame, the magnetomotive force required to overcome the increased reluctance of these parts can be calculated, and in this way the dotted curve A′ of Fig. 1 can be drawn. This is merely the open-circuit saturation curve corrected for increased leakage flux due to the additional field current required to balance the demagnetising effect of a given armature current.

In the vector diagram Fig. 2, let OE_r represent the required terminal voltage if the machine is mesh connected, or the corresponding P.D. per phase winding if the machine is star connected. The vector OI, drawn 90 deg. behind OE_r, is the armature current on zero power factor. The impedance-drop triangle is now constructed by drawing E_rP parallel to OI, of such a length as to represent the IR drop per phase, and PE_σ at right angles to OI to represent the reactive pressure drop per phase in the end connections. OE_σ is, therefore, the voltage actually developed in the slot conductors, because it contains the component PE_σ to balance the voltage generated by the cutting of the end flux, and the component E_rP to overcome the ohmic resistance of the windings. Now produce PE_σ to E_σ' so that $E_\sigma E_\sigma'$ represents the voltage that would be developed by the slot flux if this were cut by the conductors. OE_σ', which may be called the apparent developed voltage, is then the E.M.F. that would have been developed in the armature windings if the slot flux had actually entered the core instead of being diverted from tooth to tooth by the action of the current in the conductors. It is, therefore, also a measure of the total flux passing through the air-gap into the armature teeth, and the magnetising ampere-turns necessary to produce this flux would, on open circuit, actually develop this E.M.F. in the armature. Thus, when the resultant magnetomotive force in the magnetic circuit is such that E_σ' volts would be developed on open circuit, the terminal voltage under the assumed load conditions would be E_r. It is usual, when the power factor is zero, to consider this loss of pressure as equal to the total reactive drop (E_rP), because, owing to the relative smallness of PE, and the fact that its direction is such as to have little effect on the pressure drop, the error introduced by this assumption is negligible.

Again, the apparent developed voltage E_σ' obtained from Fig. 2 gives the point M on the corrected no-load saturation curve A′ in Fig. 1, and the distance OM′ shows what exciting ampere-turns are required to develop this E.M.F. The terminal voltage is, however, only E_r, which gives the point N of the triangle MNR. Now draw NR parallel to the horizontal axis so as to represent the total number of ampere-turns per pole due to the armature current, which, as previously explained, will be entirely demagnetising, and must, therefore, be compensated by an equal number of ampere-turns on the field poles. Thus, OR is the field excitation necessary to produce E_r volts at the terminals of the machine. If the load is now thrown

* Apparent resistivity taken after the voltage had been applied for 15 minutes.

† Abridged from a communication to the "Journal" of the Institution of Electrical Engineers.

off, the terminal pressure will rise to E_0, and the percentage regulation for this particular current output on zero power factor will therefore be 100 (SR/RR′). The difference of pressure SR, corresponding to any particular value, OR′, of field excitation (Fig. 1) is called the synchronous reactance drop, because, although it is made up partly of real reactance drop and partly of armature reaction, it may conveniently be treated as if it were due to an equivalent or fictitious reactance capable of producing the same total loss of pressure if the magnetomotive force of the armature had no demagnetising or distortional effect. Thus, by producing the line PE_g' to E_0 in Fig. 2, so that PE_0 is equal to SR of Fig. 1, the vector diagram shows the difference between the open-circuit pressure OE_0 and the terminal pressure OE_t under load conditions at zero power factor when the field excitation is maintained constant. The additional (fictitious) reactance drop E_0E_g' is correctly drawn at right angles to the current vector, because on zero power factor the effect of the armature magnetomotive force is wholly demagnetising. It should be realised

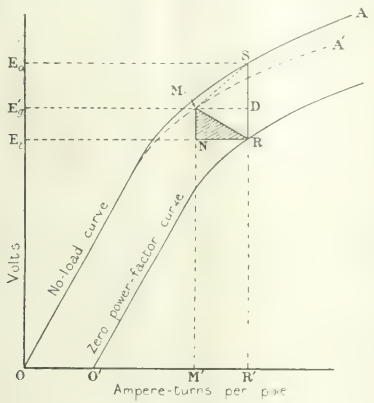


Fig. 1.

that the fictitious reactance drop E_0E_g' of Fig. 2 cannot be predetermined until the whole of the magnetic circuit of the machine has been designed. The distance DR in Fig. 1 is the loss of voltage corresponding to $E_g'P$ of Fig. 2, and is approximately constant for a given armature current. The portion SD, however, of the total difference of voltage depends on the slope of the line MS, and is thus some function of the degree of saturation of the iron in the magnetic circuit.

Short-circuit Current.—The value of the short-circuit current is intimately connected with the regulating qualities of a machine, and in large generators becomes a matter of importance.

The maximum value of the armature current at the instant a short-circuit occurs depends mainly on the true inductance of the armature windings; but when the armature magnetomotive force has had time to react on the field and has actually reduced the flux of induction in the air-gap, the resulting current may be fairly

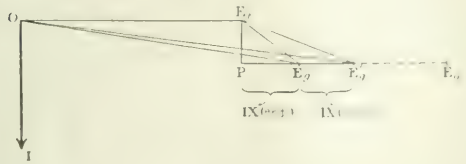


Fig. 2.

accurately calculated by using the construction indicated in Figs. 3 and 4.

The vector triangle in Fig. 3 is constructed for any assumed value, I, of the armature current. It shows the value of the terminal voltage is zero, the machine being short-circuited, the flux in the air gap must be such that the pressure OE_g' is developed in the armature conductors on open circuit. The value OF, Fig. 4, of the ampere-turns necessary to produce this flux in the air-gap is thus determined, the ordinate OE_g' being the generated voltage determined by the vector diagram. Now, since the magnetomotive force of the armature windings will be almost wholly demagnetising, it is correct to assume that the field excitation must be increased by an amount equal to the maximum armature ampere-turns per pole in order that the resultant excitation may be OE. Thus, FG in Fig. 4 is made equal to the maximum armature ampere-turns,* and by drawing to a suitable scale the ordinate GJ equal to the assumed armature current I_c the point J on the short-circuit current curve is obtained. By repeating the construction for any other assumed value of the current it will be seen that so long as E_g' lies on the linear portion of the no-load characteristic the relation between the short-circuit current and the field-pole excitation is also linear. When the field excitation is OL, giving a pressure OE_0 on open circuit, the short-circuit current will be LK.

Regulation on any Power Factor.

Unless the effects of cross-magnetisation are taken into account it is impossible to predetermine the regulation accurately when the power factor differs appreciably from zero, but by the intelligent use

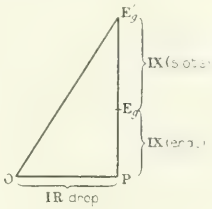


Fig. 3.

of vector quantities (involving as they do the assumption of simple harmonic curves) very satisfactory results can be obtained. The best method known to the author by which the load saturation curve for any power factor may be drawn, without resorting to flux distribution and wave-shape analysis, is that given by Prof. Alexander Gray.† A similar method has also been suggested by A. E. Clayton.‡

Calculation of Armature Inductance.

End Connections.—The flux cut by the conductors which project beyond the ends of the armature slots is very difficult to calculate, and empirical formula based on experimental data are generally used for predicting the probable value of the inductance of the

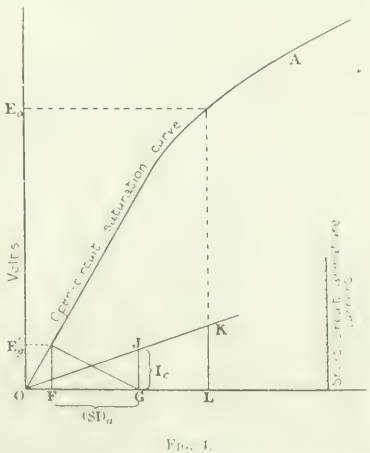


Fig. 4.

armature end connections. Without attempting to go into the details of mathematical analysis, it can be shown that the flux produced by each pole-face [illegible] the end connections of the armature conductors per pole [illegible] the armature current, the total number of ampere-turns per pole [illegible] and the number of conductors per pole [illegible] may be taken as

$$= \frac{3Z}{2p} \times 2I,$$

where Z is the number of conductors per phase and p is the number of poles.

* See the author's paper on "The Calculation of Armature Reactance," THE ELECTRICIAN, Vol. LXXIII., p. 99, 1914.

† A. Gray, "Electrical Machine Design."

‡ THE ELECTRICIAN, Vol. LXXIII., p. 99, 1914.

of the slot conductors will depend mainly upon the number of ampere-conductors per pole on the armature, and on the average axial extension l' of the coils beyond the ends of the armature core. For the calculation of this flux in the case of a three-phase generator the author suggests the empirical formula

$$\varphi_s = kT_s I_c l' \left(\frac{6}{n_s + 5}\right) \log_{10}(12 n_s l'), \quad . \quad . \quad . \quad . \quad (1)$$

where T_s = the number of inductors in each slot ;
n_s = the number of slots per pole per phase ;
l' = the projection of coil ends beyond end of slots in cms. ;
$l_c = (2\tau + 4l')$ = approximately the total length in cms. per turn of wire in a coil, less the slot portion ;
I_c = the R.M.S. armature current per conductor ;
k = constant, approximately unity, depending upon the design of the machine, the arrangement of the windings, and the proximity of masses of iron tending to increase the induction.

If p is the number of poles of the machine, and assuming the form factor to be 1·11, the voltage component developed per phase winding by the cutting of the end flux is

$$E_e = (2{\cdot}22k) f p T_s^2 l_e \left(\frac{6 n_s}{n_s + 5}\right) \log_{10}(12 n_s l') \times I_c \times 10^{-8}. \quad . \quad (2)$$

This quantity is usually referred to as the reactive voltage drop per phase due to the inductance of the end connections ; it appears as the vector PE_e in Fig. 2. If the multiplier $(2{\cdot}22k)$ be taken as 2·4, the formula agrees well with the average of tests on machines of normal design.

Slots.—The effect of slot inductance being generally to reduce* the amount of the total air-gap flux which is actually cut by the conductors, the simplest way to obtain a quantitative value for the slot reactance is to calculate the total flux which leaks from tooth to tooth in the neutral zone. The amount of flux diverted from the armature core into the leakage paths referred to may be calculated by assuming the current in the slot conductors to be acting independently of the field magnetomotive force. The total slot flux is the sum of three component fluxes : φ_1 passing through the space occupied by the copper, a portion of which will be cut by some of the conductors ; φ_2 crossing the space above the windings, usually occupied by the wedge ; and φ_3 which leaks from tooth top to tooth top. The portion φ_1 being cut by some of the conductors requires the calculations to be based on an equivalent slot flux, which, if cut by all the conductors, would develop an E.M.F. equal to the actual loss of pressure. This flux is

$$\varphi_1 \text{ (equivalent)} = \frac{0{\cdot}4\pi d_1}{3S} T_s I_s,$$

where T_s is the number of conductors per slot ; I_s is the current per conductor in amperes ; d_1 is the depth of copper in the slot ; and S the width of the slot in cms.

The permeances P_2 and P_3 of the air paths of the component fluxes φ_2 and φ_3 respectively can be calculated fairly accurately, and if l_a is the axial length of the armature coil in cms., the total "equivalent" slot flux in the neutral zone is

$$\varphi_s = 0{\cdot}4\pi T_s I_s l' \left(\frac{d_1}{3S} + P_2 + P_3\right). \quad . \quad . \quad . \quad . \quad (3)$$

If φ_a is the flux per pole actually cut by the conductors, the total flux per pole in the air-gap under load conditions will be $\varphi_p = \varphi_a' + 2\varphi_s$.

This total flux, if actually cut by the armature conductors, would generate the E.M.F. referred to as the "apparent" developed voltage, and represented by OE_g' in Fig. 2.

The flux $2\varphi_s$ maxwells is the portion of the total air-gap flux which, under load conditions, is no longer cut by the armature conductors. The R.M.S. value of the voltage lost per phase winding is therefore

$$E_s = \frac{2\pi \varphi_s T_s n_s p}{2 \times 10^8} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The slot flux in the neutral zone will be a maximum on zero power factor when the current I_s producing it is approximately equal to the maximum value of the armature current, or to $\sqrt{2} I_c$. Inserting this value of I_s in formula (3) and substituting in formula (4) we get

$$E_s = 0{\cdot}4\pi I_c l' \left(\frac{d_1}{3S} + P_2 + P_3\right) 10^{-8} \quad . \quad . \quad . \quad . \quad (5)$$

[illegible] voltage drop per phase due to the slot inductance ; it appears as the vector $E_g E_s'$ in Fig. 2.

[illegible]

* [illegible] load and leading current, in which case the tendency would be to increase the total useful flux.

INDUSTRIAL RESEARCH.*

BY L. A. HAWKINS.

Industrial research is a relatively new thing. It means the co-operation of business and science for their mutual advantage. Not so very many years ago such co-operation would have been unthinkable. To the average business man, the scientist seemed a rather futile fellow whose putterings with test tubes had little more practical value than the researches of a classical scholar in the Greek Dative, while the man of science, like his classical brother, looked with some contempt on the sordidness of trade, talked of "pure" science, as something nobler than "applied" science, and felt that he was losing caste if he permitted his work to suffer contact with "commercialism."

Happily for both business and science, those ideas are now dead—as dead as witchcraft, or as the divine right of kings. Repeated object lessons have taught the business man that nearly every marked advance in science has resulted, sooner or later, directly or indirectly, in important effects on industry, while the increasing dependence of modern life on its complex industrial organisation has forced the scientist to realise that in benefiting industry he is contributing efficiently to the welfare of mankind, which is, and always must be, the chief aim of all work that is worth while.

The result of this awakening was that business resolved to domesticate science, and that science graciously accepted the home, with all modern improvements, which was offered her. Thus arose the research laboratory of the large industrial corporation. Though such laboratories have been in existence relatively few years, they have already proved their value. They have been a potent factor in Germany's wonderful commercial development.

The extent to which research has permeated, and made itself an essential part of, German industry is clearly revealed in the address delivered by Dr. Carl Duisberg before the Eighth International Congress of Applied Chemistry, entitled "The Latest Achievements and Problems of the Chemical Industry." The scope of the Paper is almost co-extensive with industry itself. Production of power, refrigeration, the manufacture of quartz, steel, special alloys of most diverse properties, acids and other reagents, tin, rare metals and coal-tar products, including explosives, dyestuffs and medicinal drugs, chemotherapy, or the treatment of infectious diseases by chemical means, the production of synthetic perfumes, artificial silk, cinematograph films, non-inflammable celluloid and its applications, including patent leather, artificial leather, insulation, enamels and synthetic rubber—each of these is cited to illustrate notable recent achievements of chemical research.

The coal-tar dye industry is built entirely on chemical research. Dr. B. C. Hesse, in the "Journal of Industrial Chemistry," December, 1914, estimates the annual production of dyes in Germany at $68,222,846, more than 11 times the production in Great Britain and about 18 times the production in the United States. In explanation of this fact he quotes a prominent German chemist as saying, in part, "In no country on earth are those branches of the chemical industry which demand versatility of thought, and particularly a large body of scientifically trained employees, so well developed as with us."

Germany was the first country to perceive the enormous monetary value of organised industrial research, and great have been the rewards of her foresight.

We, in this country (U.S.A.), were late in starting, but progress has been rapid and the results important. An article by Mr. A. D. Little in the "Journal of Industrial and Engineering Chemistry," October; 1913, entitled "Industrial Research in America," is an impressive exposition of the extent to which organised science has already become a business asset in the United States. For instances, he cites the Du Pont Powder Co., employing 250 trained chemists, with a laboratory comprising 76 buildings spread over 60 acres, which estimates that its laboratory yields an annual profit of $1,000,000, the world-famous Edison laboratories with their multifarious important products; the automobile industry, in which one tyre manufacturer spends $100,000 a year on his laboratory, the Bausch & Lomb Optical Co. ; the Eastman Kodak Co. ; the electrochemical industries at Niagara Falls ; and the metallurgical industries, all investing largely in organised research and all reaping profits from their investments.

In all this work, the public benefits, whether by new devices capable of new results, by more efficient apparatus, by better materials, by cheaper goods, or by increase of scientific knowledge. Indeed one of the important advantages the public derives from the existence of the big industrial corporation is the result of industrial research, made possible only by large aggregations of capital, con-

* From the "General Electric Review" (of America), slightly abbreviated.

trolled by far-sighted, broad-minded men; for the maintenance of a well-equipped laboratory with a capable staff is an expensive matter, and the financial returns are seldom immediate. Years of costly failure must often precede success, and not even then is success always possible. But in the end, industrial research, if wisely organised and efficiently conducted, does pay, and both the corporation and the public benefit.

The extent and quality of the equipment required by an industrial laboratory, and the character of the work that may profitably be undertaken, of course, vary considerably in different branches of manufacture, but, in a general way, the part that such a laboratory may play in a modern manufacturing plant may be illustrated by a description of one such institution.

The research laboratory of the General Electric Co. (of America) started on a small scale 14 years ago, has grown to be one of the largest of its kind, and its work has given it a wide reputation.

Its present staff of 150 employees is now located in a modern seven-storey building and occupies the greater part of four floors and the basement, a floor space of 66,500 sq. ft. In the basement are the laboratory power plant and chemical storeroom. Power is supplied from outside at 250 volts, continuous current on the three-wire system, and at 40 cycles, three-phase, 120 volts. In the laboratory power plant are 16 machines which deliver power at different voltages and at frequencies ranging from 25 up to 2,000 cycles. Through transformers, currents as high as 12,000 amperes and voltages up to 200,000 may be obtained. A switchboard comprising 28 transfer sections makes it possible to connect any machine to any one of the 118 delivery panels distributed through the laboratory. In the power plant there are also a liquid air machine, an air compressor and two vacuum pumps, one two-cylinder, 12 in. by 12 in. and the other three-cylinder, 8 in. by 10 in.

All wiring and piping are carried in horizontal ducts 8 ft. by 5 ft. running above the corridors through the laboratory. There are 35 miles of wire, ranging in size from No. 6 up to 2,000 circular mils. The building is piped throughout with city water, river water, illuminating gas, compressed air, vacuum, high-pressure hydrogen, low-pressure hydrogen, oxygen, high-pressure steam, and for vacuum cleaning. Distilled water may be delivered by gravity to any room, and 250 motors, 80 transformers and 60 vacuum pumps are distributed through the building.

In a one-story addition are located a number of furnaces, including a porcelain kiln, a frit furnace, two pot furnaces, three calorising furnaces, two brush firing furnaces, all gas heated, and two large vacuum furnaces, electrically heated. There is also a furnace for argon purification. Disc grinders, crushers, a pulveriser, two large sets of rolls, 5 in. by 8 in., and four smaller sets, eight swaging machines, 10 punches and a 60-ton hydraulic press are installed. The larger electric furnaces of the laboratory, including a 2-ton arc furnace, are in a separate building. The calorising furnaces, just mentioned, are used for giving to metal parts the heat-proofing treatment, and the argon furnace purifies argon gas for use in experimental incandescent lamps.

On the first floor of the laboratory are offices, the library of 1,400 volumes, three experimental rooms used for X-ray investigations, and the machine shop. The equipment of this shop includes a milling machine, a lathe, 20 in. by 16 in., two smaller engine lathes, four bench lathes, a shaper, a radial drill, two drill presses, a sensitive drill, a forge, a band saw and sharpener, and 100 linear feet of bench space.

The second floor is occupied by research work on insulation, by production work on the Coolidge X-ray tube and by the carpenter's shop. The equipment for the insulation work includes a paint grinder, barrel mixers, compound mixers, electric drying ovens, a vacuum impregnating machine, a hydraulic press with steam attachment, a 60,000-volt set for testing dielectric strength and apparatus for measuring insulation resistance hot and cold.

Because of the importance of insulation in electrical apparatus, the laboratory continuously devotes much time to it. Many new moulded compounds have been produced, improving and reducing the cost of countless devices. Improvements have been made in varnished cloth, enamels and other standard insulations, and new types of insulation have been developed, such as the mineral insulation used in the sheath wire now in production for heating devices.

So much has been published lately on the Coolidge X-ray tube that it needs no description here. It is manufactured entirely in the laboratory. The equipment for production and experimental work comprises a Wappler and Bartlett [illegible] machine, a Scheidel Western machine, a [illegible] machine, a Wappler and Bartlett table for fluoroscope work, [illegible] fluoroscope display frame, a Scheidel X-ray coil, a Kelley Koett table stand, two Kny-Scheerer interrupters, six exhaust ovens, equipped with Gaede molecular pumps, two Arsem vacuum furnaces, and a tungsten tube furnace.

In addition to the Coolidge tubes, the laboratory manufactures targets for the standard type of tube, comprising a tungsten disc embedded in a copper block.

The analytical laboratory is on the third floor. On this same floor is the work on transformer steel and other alloys, with an equipment comprising a set of small electric furnaces for making alloys, eight small electric annealing furnaces, two vacuum furnaces, three melting furnaces, a set of rolls, a potentiometer and Wheatstone bridge, a Burrows permeability apparatus, storage batteries, a photomicrography outfit and chemical balances. Even a slight decrease in transformer core loss is of great importance because of the enormous aggregate of transformers in use, most of which have their supply voltage on them 24 hours a day, so that their core loss is a continuous waste. For this reason continuous research on transformer steel seems justified, even though the results seem small. As for the other work on alloys, there are always demands for new characteristics, mechanical, electrical or chemical, so that hundreds of special alloys have been made and tested in the laboratory. Also composite metals have been developed, such as "Binel metal," that is, steel coated with a thin layer of Monel, the natural copper-nickel alloy which stands high temperatures with very little oxidation, and composite wire for special purposes, such as gold-coated tungsten and molybdenum as a substitute for platinum in dental work.

On the same floor are diamond drilling and jewel polishing machines and apparatus for testing motor and generator brushes. The quality of the brush has so great an effect on the operation of continuous-current motors and generators that the laboratory has given much time to the development of new grades of brushes better suited to the various machines than any grade formerly on the market. In this way they have made it possible to clear up a number of complaints on motor operation, and in other cases to improve the operation or to lower maintenance costs.

The lamp work is located on the fourth floor. From its beginning the laboratory has devoted a large part of its efforts to the improvement of incandescent lamps, and has originated the metallised carbon filament lamp, the drawn wire tungsten lamp and the gas-filled lamp, thereby gradually sextupling incandescent lamp efficiency. If one stops to compare the status of incandescent lighting 15 years ago with what it is to-day and considers how much of the phenomenal advance has been due to those three developments, he will need no argument to convince him that the research laboratory in the electrical industry has justified its existence.

The laboratory equipment for lamp work comprises a small factory for lamp manufacture with a maximum capacity of about 100 lamps per day. There are four large and four smaller exhaust ovens of standard type, three special ovens for special exhaust, a Thomson welding machine, three sets of apparatus for making arced joints, one for pinched joints, two filament winding machines, two different types of apparatus for making pure nitrogen, from air and hydrogen, and from tank nitrogen and ammonium carbonate, respectively, apparatus for purifying argon and a gas density balance. For testing lamps there are three Lummer-Brodhun prism photometers, two portable photometers, one flicker photometer, one Lummer-Brodhun precision photometer and an optical pyrometer for filament temperatures calibrated up to the melting point of tungsten, 3,450°K. A storage battery, 30 amperes, 170 volts, is used for the photometric work. The life test has a capacity of 60 kw. and facilities are provided for obtaining voltages from 0 to 250 in $\frac{1}{4}$-volt steps. A Tirrell regulator maintains constant voltage on the bus bars. Additional circuits are provided for "shop tests" of 120 volts alternating current and 125 and 250 volts continuous current, and also an outdoor series circuit of 6·6 amperes equipped with compensators for the high current series lamps.

A colour booth for studying colour values of glasses, apparatus for studying residual gases in vacuum lamps and apparatus for photographing filaments while burning, are included in the equipment. There is also a photographic dark room on this floor.

Part of the floor is devoted to production work, including a room for chemical purification of tungsten oxide, a battery of electrically heated hydrogen furnaces for oxide reduction, with a capacity of 50 lb. of metal a day, and a room for the assembly and grinding of tungsten [illegible] for use in spark coils, magnetos and relays. One large room is devoted to the study of phenomena in very high vacuum. This work has thrown much light on the characteristics of the electron [illegible] under various conditions, and the results have been published in recent Papers by Dr. Langmuir. The phenomena of pure electron emission, resulting from operating a hot tungsten filament in a vacuum so high that there is not sufficient residual gas to produce ionization, have been utilized in the Coolidge X-ray tube and in the high voltage rectifier known as the Kenotron.

A number of improvements in wireless transmission also have been made possible by this investigation. For this wireless work a smaller room has been fitted up as a sending and receiving station, and an antenna, over 800 ft. long, composed of two wires spaced 16 ft. apart, has been strung between steel towers on the roofs of the laboratory and another building. Before this large antenna had been erected, wireless telephonic communication between the Schenectady and Pittsfield plants had been successfully obtained, and wireless messages received from Berlin, San Francisco and Honolulu.

The laboratory is continually conducting researches of a purely scientific nature and publishing the results in an endeavour to contribute its share to the progress of scientific thought, which is rapidly enlarging, modifying and clarifying our conceptions of the fundamental things underlying all physical sciences. These investigations may be initiated because of their scientific interest, without any definite practical object in view, but it has been already said that every marked advance in science has resulted sooner or later, directly or indirectly, in important effects on industry, and these laboratory investigations have certainly nearly always had these practical results. The study of electron emission, and the various practical utilisations of the principles discovered is a case in point. The gas-filled lamp, now known as the Mazda C, had its origin in the results of an academic study of the laws governing the loss of heat in small wires, coupled with the results of an investigation of the evaporation of tungsten. The metallised filament lamp resulted from experiments with a high-temperature vacuum furnace. In none of these cases was the practical result foreseen when the research that made them possible was started.

It should not be supposed, however, that all the important achievements of the laboratory have been thus brought about. Many of them, of which drawn tungsten wire is a notable example, were the result of persistent and resourceful effort directed from the beginning toward a perfectly definite goal. Other examples are the sheath wire, with mineral insulation, now in production for heating devices, the magnetite electrode for luminous arcs, and the commercial development of the mercury arc rectifier.

Of course, even in those cases where unforeseen practical results are made possible by the new insight into fundamentals, gained from purely scientific research, they seldom first appear in fully developed form, like Athena sprung from the brain of Zeus, but much work, inventive and experimental, specifically directed to the end in view, is usually necessary before that end is reached.

A third kind of work which constantly requires the attention of the laboratory and occasionally demands the full application of its resources, is that which arises from the specific problems of factory production, such as the improvement of processes, the location of hidden troubles, and the development of new or better materials. Much of the work on insulations and alloys falls within this class, together with countless special investigations, each of which may be the work of a few hours or may extend over months or even years.

The General Electric Co. maintains other laboratories than the one described. There are laboratories at the Lynn and Pittsfield plants, which specialise on the production problems of those works. There are lamp development laboratories at Harrison and Cleveland which develop and standardise new processes, materials and lamp designs, for the lamp factories. There is the physical laboratory at Cleveland, which conducts researches of a highly scientific order in the physical and physiological aspects of light and illumination. There is the illuminating laboratory at Schenectady, devoted to illuminating engineering, the selection of the best lighting unit and the best method of utilising it for a given lighting system. There is the consulting engineering department laboratory devoted to general and special engineering problems and particularly to the investigation of high-tension phenomena. There is the testing laboratory, investigating and testing the physical and chemical properties of materials. There is the standardising laboratory, in charge of the standardisation of all instruments, developing new instruments, like the oscillograph, and investigating and developing test methods. In addition to the activities of all these laboratories, the various engineering departments conduct many special tests which they are specially equipped for handling and investigations which sometimes amount to research work of a higher order. Research in general,

[illegible]

tory, we have tried to indicate the nature and function of industrial research, to show how science and industry may mutually profit by close co-operation. We believe the subject is timely. The great [illegible] extent we are prepared to take advantage of the new markets, cut off from their past source of supply and turning naturally to us to fill their wants. Our introspection shows us lacking in two essentials, financial and technical. The financial difficulties, our lack of the necessary banking facilities and system of commercial credits in foreign lands, will surely not be beyond the ability of our banking houses and business men to handle, now that they have been brought face to face with the necessity for action, for neither in wealth nor in business ability need we feel incompetent to accomplish what other nations have done.

COUPLED OSCILLATORY CIRCUITS AND THE SYSTEM "À ONDE UNIQUE."

BY PROF. G. W. O. HOWE, D.Sc.

Summary.—In the first part of this article the author deals with the theory of coupled circuits and the conditions under which a single wave would be emitted, following the lines of investigation taken by M. Girardeau. In the second part of the article the author discusses the system "À Onde Unique," and compares the arrangements adopted with the usual and simpler Tesla and Oudin connections.

Part I.—Coupled Oscillatory Circuits.

When an oscillatory circuit consisting of an inductance, a capacity and a spark-gap is coupled to another oscillatory circuit, such as the aerial system of a radio-telegraph station, it is well known that, in general, although the circuits may be tuned to have the same natural frequency, the transfer of energy between them is of such a character that the oscillation produced in the aerial has not a single definite frequency, but may be analysed into two damped oscillations of different frequencies. It is also well known that the two separate frequencies cannot be detected if the coupling is weak, but that the secondary oscillation then appears to be a damped oscillation of a single definite frequency. The physical reason for this apparent superposition of two oscillations of different frequencies when the coupling is tight is as follows: Initially, all the energy is stored in the primary condensers, but when the spark-gap breaks down it is gradually transferred from the primary to the secondary circuit, the transfer not stopping when the energy is equally shared by the two circuits, but going on until it is all oscillating in the secondary circuit. The process then reverses, until the energy—less what has been lost in the interval—is again oscillating in the primary circuit, when the whole cycle recommences. This surging of the energy to and fro between the two circuits goes on until the energy is all dissipated or the spark-gap quenches and becomes non-conducting. The pulsations of the amplitude in each circuit are referred to as "beats," the name given to the analogous phenomenon in acoustics.

Oscillograms have been published by the author showing this phenomenon under various conditions* of coupling and damping. In these oscillograms it is clearly shown that, although with the circuits very slightly damped the "beats" are strongly marked even with a coupling of less than 5 per cent., the coupling can be made much tighter (13·2 per cent. in Figs. 10 and 12, Plate I.) without producing "beats" if the damping of either circuit be greatly increased. The antenna current will not exhibit two different frequencies, even with tight coupling, if the damping of the spark-gap circuit is sufficiently increased, and this quite apart from any quenching of the spark-gap. The high resistance of the circuit prevents the rapid transfer of energy to it from the oscillations in the antenna, although not so effectually as quenching.

This question has recently been considered mathematically by M. Girardeau† of the Société Française Radio Electrique, and his results are worthy of further consideration.

If L_1, C_1, R_1 and L_2, C_2, R_2 be the inductances, capacities and resistances respectively of the two circuits, we have

$$L_1 \frac{d^2 i_1}{dt^2} + M \frac{d^2 i_2}{dt^2} + \frac{i_1}{C_1} + R_1 \frac{di_1}{dt} = 0 \quad . \quad . \quad . \quad (1A)$$

$$L_2 \frac{d^2 i_2}{dt^2} + M \frac{d^2 i_1}{dt^2} + \frac{i_2}{C_2} + R_2 \frac{di_2}{dt} = 0 \quad . \quad . \quad . \quad (1B)$$

* "Proc. of the Physical Society of London," XXIII., 1911, p. 240.

† "La Lumière Électrique," June 11 and 18, 1914.

where M is the mutual inductance of the two circuits. By differentiating these equations three times and substituting for i_2 in (1B) its value in terms of i_1 from (1A), and putting

$$\frac{R}{2L}=d, \quad \frac{1}{LC}=\Omega \text{ and } \frac{M}{\sqrt{L_1L_2}}=k,$$

we get

$$(1-k^2)\frac{d^3i_1}{dt^3}+2(d_1+d_2)\frac{d^2i_1}{dt^2}+(\Omega_1^2+\Omega_2^2+4d_1d_2)\frac{di_1}{dt}$$
$$+2(d_1\Omega_2^2+d_2\Omega_1^2)i_1=0. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

with an exactly similar equation for i_2.

A solution of this equation is $i_1=Ae^{mt}$, which we may substitute in (2), giving

$$(1-k^2)m^3+2(d_1+d_2)m^2+(\Omega_1^2+\Omega_2^2+4d_1d_2)m$$
$$+2(d_1\Omega_2^2+d_2\Omega_1^2)=0. \quad . \quad . \quad (3)$$

which may also be written thus

$$(m^2+2d_1m+\Omega_1^2)(m^2+2d_2m+\Omega_2^2)-k^2m^4=0. \quad . \quad . \quad (4)$$

This equation of the 4th degree in m has four roots of the form $-\alpha-j\omega$, where $j=\sqrt{-1}$. If $-\alpha-j\omega$ is one root, then $-\alpha+j\omega$ must also be a root; hence the four roots may be written

$$-\alpha_1-j\omega_1,$$
$$-\alpha_1+j\omega_1,$$
$$-\alpha_2-j\omega_2,$$
$$-\alpha_2+j\omega_2.$$

If these are the four values of m, then

$$(m+\alpha_1-j\omega_1)(m+\alpha_1+j\omega_1)(m+\alpha_2-j\omega_2)(m+\alpha_2+j\omega_2)=0. \quad (5)$$

Up to this point the treatment of the problem has followed the usual lines, but M. Girardeau here raises the important question: What are the conditions under which the two damped sine waves, represented respectively by $-\alpha_1\pm j\omega_1$ and $-\alpha_2+j\omega_2$, merge into one, which could be represented by $-\alpha+j\omega$, where $\alpha_1=\alpha_2=\alpha$, and $\omega_1=\omega_2=\omega$? Equation (5) would now become

$$(m+\alpha-j\omega)^2(m+\alpha+j\omega)^2=0 \quad . \quad . \quad . \quad . \quad (6)$$

On multiplying this out and comparing the various powers of m in equations (3) and (6), we find that

$$2(1-k^2)\alpha=d_1+d_2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7A)$$
$$2(1-k^2)(3\alpha^2-\omega^2)=\Omega_1^2+\Omega_2^2+4d_1d_2. \quad . \quad . \quad (7B)$$
$$2(1-k^2)(\alpha^2-\omega^2)\alpha=d_1\Omega_2^2+d_2\Omega_1^2. \quad . \quad . \quad (7C)$$
$$(1-k^2)(\alpha^2-\omega^2)^2=\Omega_1^2\Omega_2^2. \quad . \quad . \quad . \quad . \quad (7D)$$

By eliminating α and ω, first from a, c and d, and then from a, b and c, we get the two equations of condition

$$\frac{d_1\Omega_2^2+d_2\Omega_1^2}{\Omega_1\Omega_2}=\frac{d_1+d_2}{\sqrt{1-k^2}} \quad . \quad . \quad . \quad . \quad (8)$$

$$\frac{\Omega_1^2+\Omega_2^2+4d_1d_2}{2(1-k^2)}-\frac{d_1\Omega_2^2+d_2\Omega_1^2}{d_1+d_2}=\frac{d_1+d_2}{2(1-k^2)} \quad . \quad (9)$$

These are the conditions which must be fulfilled to give an oscillation of a single frequency with the given coupling k.

From (7A) we have

$$\alpha=\frac{d_1+d_2}{2(1-k^2)} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

for the damping constant of the resultant oscillation, and from (7A) and (7C)

$$\omega^2=\frac{d_1\Omega_2^2+d_2\Omega_1^2}{d_1+d_2}-\left(\frac{d_1+d_2}{2(1-k^2)}\right)^2 \quad . \quad (11)$$

where $\omega=2\pi f$ and f is the frequency of the oscillation.

Having established these equations, M. Girardeau considers two special cases: (1) when $d_1=\frac{R_1}{2L_1}$ is so small as when the damping of the spark-gap circuit is negligibly small, and (2) when $d_1=d_2=d$, say, when $\frac{R_1}{2L_1}=\frac{R_2}{2L_2}$. The first case is obviously quite outside the range of practical radio-telegraphy, since the primary circuit contains the spark-gap, and never has a decrement which is negligible in comparison with that of the aerial system. Taking it, however, as an extreme limiting case, we find

$$\alpha=\frac{d}{2(1-k^2)}$$
$$\frac{\Omega_2}{\Omega_1}=\sqrt{1-k^2}$$
$$d_2=k\Omega_2 \text{ or } \frac{R_2}{2L_2}=k\frac{\Omega_2}{2}.$$

The second equation gives the amount by which it is necessary to detune the circuits, while the third gives the damping constant which the antenna must be given for any given coupling. The first equation gives the damping constant of the resultant oscillation. Ω_1 and Ω_2 refer to the resonant, and not to the natural frequencies. Damping causes a circuit to have a natural frequency less than its resonant frequency. If Ω_n and Ω_r are the natural and resonant frequencies ($x2\pi$), it is easy to show that $\Omega_n=\sqrt{\Omega_r^2-d^2}$. In the case just considered, $\frac{d}{\Omega_1}=k$ and $\frac{\Omega_2}{\Omega_1}=\sqrt{1-k^2}$. The primary is assumed to have no resistance, so that its resonant and natural frequencies coincide. Hence, although the resonant frequency of the secondary has to be reduced to $\sqrt{1-k^2}$ of that of the primary, its natural frequency being less than its resonant in the same proportion, has to be reduced to $1-k^2$ of that of the primary. The frequency determined by means of a wave-meter is, of course, the natural frequency. Even in the case of relatively tight coupling, however, say 10 per cent., the frequencies would only have to differ by 1 per cent. Such refinements are impossible with an ordinary wave-meter. M. Girardeau, however, does not give any numerical examples, such as the point we have just mentioned, but simply gives the formulæ as found above. We shall test the various formulæ on practical examples, and see their practicability or otherwise. As an example, consider a station for a wave-length of 1,885 metres, with an antenna capacity C_2 of 0·005 microfarad and $L_2=200$ microhenries; if

$k=0·05$	$R_2=20$ ohms	and $\delta_2=0·3$
$k=0·1$	$R_2=40$ ohms	and $\delta_2=0·6$
$k=0·2$	$R_2=80$ ohms	and $\delta_2=1·25$

Such high values for the logarithmic decrement of the antenna could only be obtained by inserting resistance, which is hardly a practical solution of the problem.

Returning now to M. Girardeau's Paper, let us consider his second case, where $d_1=d_2=d$. The formulæ become

$$\alpha=\frac{d}{1-k^2}$$
$$\frac{\Omega_1^2-\Omega_2^2}{\Omega_1\Omega_2}=\frac{2}{\sqrt{1-k^2}},$$
$$d^2=\frac{\Omega_1^2+\Omega_2^2}{4}(1-k^2).$$

With regard to this last equation, M. Girardeau says: "Elle conduit évidemment à un couplage extrêmement serré pour des amortissements faibles et il est évident qu'entre les deux cas limites $d_1/d_2=0$ and $d_1/d_2=1$ il existe toute une gamme de valeurs admissables pour k."

Let us look into this a little more closely. It will be convenient to represent the ratio Ω_1/Ω_2 by x; then the second of these three equations may be written

$$x-\frac{1}{x}=\frac{2}{\sqrt{1-k^2}},$$

which is a quadratic equation, giving as its solution

$$x=\frac{\Omega_1}{\Omega_2}=\frac{1}{\sqrt{1-k^2}}+\sqrt{\frac{1}{1-k^2}+1}=\frac{1+\sqrt{1-k^2}}{\sqrt{1-k^2}}.$$

This gives the detuning necessary with any degree of coupling. Substituting $x\Omega_2$ for Ω_1 in the last of the three formulæ, we have

$$d=\frac{\Omega_2}{2}\sqrt{1-k^2}.$$

This gives the value of $\frac{R}{2L}$ which each circuit must have in order to obtain an oscillation of one frequency; the positive sign is to be used if $\Omega_1>\Omega_2$, the negative if $\Omega_1<\Omega_2$.

To see how absolutely impracticable this case is we need only consider a single example. Let $\Omega_2 = 10^6$, corresponding to a wave-length of 1,885 metres, and let $k = 0{\cdot}1$; then $\gamma = 0{\cdot}995$, $\Omega_1 = 0{\cdot}995 \times 10^6$, and $\delta_1 = 0{\cdot}67 \times 10^6$, giving a logarithmic decrement of 4·2 for the aerial system and 4·65 for the spark-gap circuit. If the coupling be increased to 0·6, which is an almost impossibly large value, the decrement of the aerial goes down to 2·81, while that of the primary circuit goes up to 5·62. In this case $\Omega_1 = 0{\cdot}85\ \Omega_2$.

The writer has also worked out the conditions for singleness of frequency for a station with a wave-length of 1,885 metres and a logarithmic decrement of the aerial system of 0·1 per period, but with different values of the coupling; for each coupling one finds the necessary decrement of the spark-gap circuit. The result is as follows:

δ_1	0·5	1·0	2·0	
k	5	13	30	per cent.
$\Omega_2\ \Omega_1$	1·002	1·01	1·05	

It will be noticed that the necessary detuning is so small in any practical case as to be well within the unavoidable errors of any wave-meter. As M. Girardeau says: "il existe toute une gamme de valeurs admissable pour k," but they are only to be obtained by inserting resistance in the primary circuit.

It should be pointed out that M. Girardeau's mathematical treatment of the problem ignores entirely the initial conditions. Since the aerial current has an initial amplitude of zero, it cannot be represented by a damped sine-wave, as he assumes. The oscillation in the aerial has to be built up by the transfer of energy from the spark-gap circuit, whether the coupling be great or small, and it is only after this initial period is past and the aerial oscillation is beginning to die away that M. Girardeau's solution is applicable. It is also obvious that the primary decrement is greater during this initial period than during the later stages, when the secondary oscillation has been established.

Apart from this objection, however, and the more obvious objection that the peculiar characteristics of the spark will cause a wide divergence between theory and practice, it is very questionable whether any increase of the coupling would be advantageous if it necessitated artificially increasing the decrement of the circuits. The mere fact that the coupling is tighter is no advantage whatever unless the radiation from the antenna is thereby improved, either in quantity or quality.

Equations (8), (9), (10) and (11) are important, however, since they enable one to calculate the permissible coupling between any two circuits of given decrements, if the spark-gap be considered as a constant resistance. They can, however, be put into a more general form. The phenomena cannot depend on the absolute values of the frequencies, &c., but merely on the four variables

$$x = \frac{\Omega_1}{\Omega_2}; \quad \gamma = \sqrt{1-k^2}; \quad \delta_1 = \frac{R_1}{2f_1 L_1}; \quad \delta_2 = \frac{R_2}{2f_2 L_2}.$$

Then equation (8) may be written

$$x = \frac{\delta_2}{\delta_2'} \frac{\delta_1'}{\delta_1}. \qquad (8')$$

Similarly, for equation (9), we have

$$\gamma^2 = 1 - \frac{\delta_1 \delta_2}{\delta_1' \delta_2'} \frac{\omega_1^2 + \delta_2^2}{\omega_1^2 + \delta_1^2} \frac{\omega_2^2 + \delta_1^2}{\omega_2^2 + \delta_2^2} \frac{\omega_1 \omega_2}{8\pi^2 \gamma^4}. \qquad (9')$$

δ_1 and δ_2 being known, these two equations enable us to determine x and γ. (In the numerical examples quoted, the author solved the equations graphically.)

Equations (10) and (11) may be transformed in the same way.

In THE ELECTRICIAN of July 25, 1913, the author published an article with the above title, in which he adversely criticised the claims made in the British patent specification [illegible] May 16, 1912, [illegible] stated that, by the use of an intermediate [illegible] circuit between the antenna and the oscillation circuit containing the spark-gap it is "possible to operate with as close couplings as desired," and that "it is demonstrable that the complete system always presents a single natural velocity of pulsation which is given by the formula $\omega = \Omega \sqrt{\frac{1}{1-k_1^2-k_2^2}}$."

The author pointed out that this definite claim of being able to tighten the coupling to any extent without the production of beats would, if substantiated, constitute a revolutionary advance in the art of radio-telegraphy. He showed, however, that the claim was based on a fallacy. Correspondence ensued between M. Béthenod, the chief engineer to the company, and the author.* In his final letter of October 3rd the author showed that the three-circuit system could be reduced to an equivalent arrangement with two coupled circuits, the equivalent inductances, resistances and coupling being easily calculable from those of the three circuits, so that, whatever could be done with the three circuits could also be done with two, without any intermediate circuit.

The article and correspondence was discussed editorially in the "Jahrbuch der Drahtlosen Telegraphie," p. 535, 1913, and the conclusion arrived at was that "there is no doubt that the criticism of Prof. Howe appears to be thoroughly justified, and we can only understand the sharp tone of M. Béthenod's letter on the assumption that he is compelled to defend an untenable position because the business interests of his firm demand it."

After this the author anticipated that the system "à onde unique" would drop quietly out of sight. In the second part of M. Girardeau's Paper, however, the system is again described, but in a very different manner to that originally adopted. The extravagant claims made in the patent specification are not even mentioned, and the mathematical methods of M. Béthenod are discarded in favour of those given by the author. M. Girardeau gives exactly the same formulæ to prove the equivalence of the three-circuit arrangement and the ordinary two-circuit arrangement; he derives the same expression for the equivalent coupling, which is quite different to that given by Béthenod; and he gives the frequencies of the two oscillations produced without attempting, as Béthenod did, to treat one of them as negligible. All this would have been very satisfactory, especially to the writer, were it not for the fact that, instead of expressing his indebtedness or referring his readers to the page of THE ELECTRICIAN where the formulæ were given, M. Girardeau states that: "Un avis contraire a cependant été émis par M. le professeur Howe." It should be pointed out, however, that the adverse criticism was directed against claims quite different to those made in M. Girardeau's present article, and that, far from questioning the validity of M. Girardeau's present mathematical treatment of his system, the writer feels flattered by its official adoption by the company.

The extreme modesty of the present claim is evident from the concluding paragraph of the article, viz.: "Le montage avec circuit apériodique nous apparait donc comme un moyen pratique de réaliser les conditions nécessaires pour l'obtention d'une onde unique, conditions peu réalisables pratiquement avec le montage à deux circuits Oudin ou Tesla." In other words, having shown in the first part of his article that the coupling can be made tighter if the decrement be increased, and that for every value of the coupling there is a minimum allowable decrement, M. Girardeau maintains that the necessary adjustment can be more conveniently made by using the intermediate aperiodic circuit. This is a matter of opinion, which will be better understood by comparing the connections and the equations of the two-circuit and three-circuit arrangements.

The equations (1A) and (1B) for the ordinary arrangement may be written

$$L_1 \frac{di_1}{dt} + M \frac{di_2}{dt} + \eta_1 i_1 + R_1 \int i_1 dt = 0,$$
$$L_2 \frac{di_2}{dt} + M \frac{di_1}{dt} + \eta_2 i_2 + R_2 \int i_2 dt = 0.$$

* See THE ELECTRICIAN, July 25, August 22, October 3, 1913.

whereas, with an intermediate circuit of inductance L_3 and mutual inductances of M_1 and M_2 with the two oscillatory circuits

$$\frac{di_1}{dt}-\frac{M_1M_2}{L_1L_3-M_1^2}\cdot\frac{di_2}{dt}-\frac{L_3}{L_1L_3-M_1^2}\cdot\frac{q_1}{C_1}-\frac{R_1L_3}{L_1L_3-M_1^2}\cdot i_1=0,$$

$$\frac{di_2}{dt}-\frac{M_1M_2}{L_2L_3-M_2^2}\cdot\frac{di_1}{dt}-\frac{L_3}{L_2L_3-M_2^2}\cdot\frac{q_2}{C_2}-\frac{R_2L_3}{L_2L_3-M_2^2}i_2=0.$$

The second pair of equations is identical with the first if we put

$$(L_1L_3-M_1^2)/L_3 \text{ for } L_1,$$
$$(L_2L_3-M_2^2)\ L_3 \text{ for } L_2,$$

and $M_1M_2\ L_3$ for M.

Instead of

$$d_1=R_1\ 2L_1 \text{ and } d_2=R_2\ 2L_2,$$

we now have

$$d_1\ \frac{R_1L_3}{2(L_1L_3-M_1^2)} \text{ and } d_2\ \frac{R_2L_3}{2(L_2L_3-M_2^2)},$$

and instead of

$$k=\frac{M}{\sqrt{L_1L_2}} \text{ we have } k\ \frac{k_1k_2}{\sqrt{(1-k_1^2)(1-k_2^2)}},$$

where $k_1=\frac{M_1}{\sqrt{L_1L_3}}$ and $k_2=\frac{M_2}{\sqrt{L_2L_3}}$.

Fig. 1 (*a*) and Fig. 2 (*a*) represent the two-circuit arrangements in common use, referred to by M. Girardeau under the

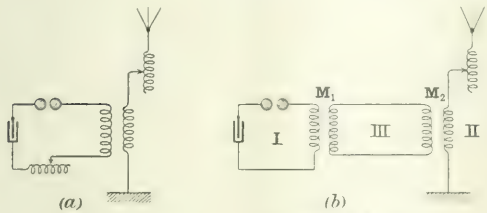


Fig. 1.

names of Tesla and Oudin respectively, while Fig. 2 (*a*) and Fig. 2 (*b*) show the corresponding connections of the system "à onde unique." In Fig. 1 (*a*), once the two circuits are tuned, one can adjust the coupling very finely by moving one of the coils, without in any way affecting the damping or

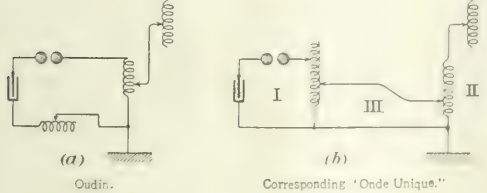


Fig. 2.

tuning of either circuit. In Fig. 2 (*a*), adjustment of coupling necessitates the movement of a contact, which also alters the tuning of the aerial, and this must then be corrected on the aerial tuning inductance. Since this is done by trial, any detuning which would improve matters would be unconsciously done. If one thought that the transmission could be improved by increasing the decrement of the circuit, it would be a very simple matter to introduce a resistance, although in the system "à onde unique" no resistance is varied, but the value of $d=R/2L$ is merely changed by variation of the effective values of L_1 or L_2, due to variation of k_1 and k_2. In Fig. 1 (*b*) any change in M_1 or M_2 affects both the coupling and the tuning, while in Fig. 2 (*b*) any movement of the coupling contacts causes also a variation of L_3, which affects every variable concerned, as may be seen from the equations above. Fig. 2 (*b*) represents diagrammatically the connections actually employed by the company, and, in the writer's opinion, it is the most complicated and difficult of adjustment of the four arrangements shown; it is difficult to see what advantage has been gained, since, whatever opinion one may hold as to the convenience of adjustment, one can certainly do nothing with this arrangement which could not be done with the ordinary two-circuit arrangement.

Some official tests are recorded by M. Girardeau to show the superiority of the system "à onde unique," but these results are certainly not explicable on the basis of his mathematical treatment of the problem. In fact, the only claim now really made for the system is that the conditions necessary to get the best results can be more easily realised, which forces one to the conclusion that they were not realised in the tests carried out with the ordinary two-circuit arrangement; why, he does not say.

LARGE AMERICAN GENERATING SYSTEMS.

The accompanying table, which is taken from the "Electrical World," gives statistics for 1914 on the outputs, peak load and load factor of the largest generating systems of America. The combined output of the 36 companies listed, one being estimated, is approximately 12,000,000,000 kw.-hours. Three of the companies in the list—the Ontario Power Company, the Toronto Power Company and the Shawinigan Water & Power Company—are in Canada, although a large part of the output of the first two companies is exported across the border into the United States. Of the total output, approximately two-thirds was generated from water-power. In the last report issued by the Bureau of the Census, that of 1912, the total output of the 5,221 central stations of the United States was 11,532,963,000 kw.-hours. Two items of particular note in the table are the yearly output of the Commonwealth Edison Company of Chicago, and the yearly load factor of the Hydraulic Power Company of Niagara Falls, N.Y.

Data on Large American Generating Systems.

System.	Peak load in kw.	Date of peak load.	Yearly output in kw.-hr.	Yearly load factor, p.c.
Commonwealth Edison Co. ...	306,200	Dec. 15	1,114,130,000	43·6
Niagara Falls Power Co.	131,520	Jan. 5	906,513,620	78·7
Ontario Power Co.....	130,500	Sept. 23	781,664,400	68·4
N.Y. Edison & United Co. ...	229,787	Dec. 23	719,193,535	35·7
Hydraulic Power Co.....	87,457	Mar. 27	703,105,872	91·7
Pacific Gas & Electric Co.....	124,000	Oct. 29	658,298,000	60·6
Public Service Electric Co. ...	123,539	Dec. 23	430,818,532	39·8
Shawinigan Water & Power Co	85,000	July 7	430,000,000	58·0
Montana Power Co.	61,000	July 21	402,663,369	75·0
Mississippi River Power Co....	73,700	Nov. 16	356,578,000	55·6
Duquesne Light Co.	72,000	Dec. 21	315,210,796	50·0
Great Western Power Co.....	56,300	Dec. 9	315,000,000	64·0
Detroit Edison Co.....	83,300	Dec. 15	313,718,600	43·0
Puget Sound, Traction, Light & Power Co.	67,200	Dec. 17	299,622,508	50·9
Pacific Light & Power Corpn..	70,565	Sept. 17	292,545,094	47·37
Sthrn. California Edison Co....	53,835	Dec. 24	288,549,552	61·1
Utah Power & Light Co.	47,048	July 9	287,792,765	70·0
Pnsylvnia. Water & Power Co.	74,000	Dec. 17	277,200,000	42·5
Philadelphia Electric Co.	77,728	Dec. 1	250,697,952	36·8
Toronto Power Co.	72,000	Dec. 4	236,328,680	37·5
Tennessee Power Co.....	47,600	Dec. 11	228,504,650	54·8
Electric Co. of Missouri.....	52,528	Nov. 18	228,209,988	49·78
Boston Edison Co.....	65,342	Dec. 21	194,137,400	34·0
Union Elec. Light & Power Co	51,072	Dec. 7	189,677,593	42·4
Portland (Ore.) Railway, Light & Power Co.	44,315	Jan. 2	184,766,149	47·7
Washington Water Power Co..	29,641	Dec. 29	169,691,800	65·4
Worcester Edison Co.	44,124	Dec. 22	159,665,804	36·2
Brooklyn Edison Co.	49,300	Dec. 9	153,946,900	35·6
Georgia Railway & Power Co..	44,320	Oct. 28	145,684,800	37·5
Sierra & San Francisco Power Co.	40,080	Jan. 6	179,444,960	51·2
Great Northern Power Co. ...	30,400	Nov. 13	130,733,810	52·0
Rochester Rlwy. & Light Co...	28,500	Dec. 16	123,850,785	49·6
New England Power Co.	35,000	Dec. 15	120,000,000	39·0
Minneapolis General Elec. Co.	27,955	Dec. 7	110,346,460	45.06
*Alabama Power Co.	23,500	Dec. 22	55,837,740	27·1
Southern Power Co.				

* Many dates in operation April 14th. † No data received.

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INDUSTRIAL RESEARCH.

An important factor in ensuring commercial prosperity is industrial research, and the encouragement of such research is more effective than certain other methods that have been proposed for the protection of trade. There is no field of industrial research of greater promise than electrical engineering. The progress made in recent years in this branch of engineering is not the result of natural growth, but of forced growth. Curious as it may seem to many, the financial stability is greatest in those cases where the growth has been forced at the greatest rate. Forced growth is the wresting from Nature of her secrets, and the adaptation of such secrets to the use of man. Natural growth is the result of waiting for Nature to give up her secrets at her leisure, as the sea gives up its dead.

That the meaning of industrial research is imperfectly understood by those whose word carries weight in this country is shown by the fact that Parliament is prepared to grant money in thousands for the purpose of research to enable home firms to compete with German houses in the manufacture of coal-tar dye stuffs. Were the position less serious the proposition would be a comic one, and as such would be unworthy of notice in a technical journal. It is well that those in authority should know that the markets have been captured by the expenditure of millions, not of thousands. To recapture and to hold the markets when Germany is in a position to compete with us will necessitate an expenditure of tens of millions, and it is for those best qualified to form an opinion to decide whether there is any prospect of making the industry sufficiently strong to yield a reasonable return on the inevitable outlay. The reason why Parliament proposes to foster this particular industry is not clear to us, and is a question for Parliament to answer in good time.

Industrial research is called organised science by our

competitors. To us, organised science means the giving of a smattering of knowledge to many ill-fitted to derive any benefit whatsoever from such knowledge, or to be of benefit to anyone else. For our pains and industry we are rewarded by a Board of Education at a certain sum per student-hour. The result of this vicious system of training is that our young men and women are turned out badly equipped for taking their places in the world, either as leaders or as workers. We are anxious that our meaning should not be misunderstood. No country can substantiate the claim of having produced greater men than Britain has produced.

Without difficulty we could mention a score or more names associated with epoch-making discoveries on which rests the commercial greatness of our country; but we fear that many people fail to recognise that in the long run industrial strength depends on small things as well as on great. We do not doubt the ability of the inventor of the steam turbine to attend to the whole of the detail improvements of the turbine; but such attention would be waste of good material in so far as it could effectively be given by the rank and file, and, at the same time, leave the master mind free to make further fundamental discoveries.

Although no immediate return can be expected on the capital invested in a research laboratory, in the end industrial research, if wisely organised and efficiently conducted, does pay both the manufacturer and the community. It would be folly to expect any immediate return on capital so invested. Since every marked advance of science has produced marked effects on industry, it follows that one of the purposes of industrial research is to conduct investigations of a purely scientific nature, without regard to the probable commercial return. We call to mind several investigations of this kind made by our scientists which, for various reasons, were not pushed to a conclusion, and which, in the fulness of time, were turned to practical advantage by our competitors. The lay mind is incapable of realising the potentialities of an academic study of the laws governing the loss of heat in small wires, and of an investigation of the evaporation of tungsten. The direct result of this work, however, is the "half-watt" lamp. Other and equally important purposes of the research laboratory are the improvement of processes and the development of new or better materials. Frequently the goal, though perfectly definite, is only attained by persistent and resourceful effort. Drawn tungsten wire is a notable example.

In the present issue we publish an account of the research laboratory of the General Electric Company of America. The extent and variety of the equipment of this laboratory serves to give an idea of the field covered by the research necessary for the proper development of the business of a large manufacturing enterprise. In the future, greater battles will be fought in the workshops of the world than on the battlefields. Assuredly the writing is on the wall. Without delay, and without the [illegible] which characterises inefficiency, let us take stock of our resources; lest we bankrupt our successors by bequeathing to them a mortgaged heritage, be it organised research

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

La Elettrificazione delle Ferrovie. By ALDO RIGHI. (Bologna: Nicola Zanichelli.) Pp. 112. Lire 4.

A small popular treatise on the electrification of steam railways, and, as the author says in his preface, written so as to be easily understandable by even non-technical readers.

The early chapters deal with the advantages of electrification in replacing steam traction, and details are given of many electrified railways all over the world. A study is made as to what class of lines it is advisable to electrify, the first condition being a fairly dense traffic, then the characteristics of the line have to be considered, the frequency of the stops, the gradients and the weight of the trains. The author is of opinion that for new lines in mountainous countries, such as Italy and Switzerland, it would be more economical to have longer lines without tunnels, and heavier gradients, which are almost negligible when electrification is adopted.

The relative values of direct current, single-phase and three-phase are discussed, with the history of each system as applied to traction. The first he considers as only suitable for tramways and local railway lines with frequent light traffic and frequent stops, but he is of opinion that if the voltage can be raised to over 3,000 volts there may be a future for direct-current on main lines carrying heavy trains. As regards single-phase, the experience gained up to now is not sufficient to warrant its adoption on hilly lines, and the expense of upkeep and renewal of material will probably be heavy.

For Italy he strongly approves of the adoption by the railway authorities of three-phase for the main lines and branches, and of the transversal suspension of the overhead wires in place of catenary suspension.

At June 30, 1914, 2·11 per cent. of the State Railways were electrified, and 4,781,867 train-km. were run in the preceding 12 months, equivalent to 2·59 per cent. of the total train mileage. Italy, having to purchase all its coal abroad at 29s. 3d. per ton before the war, there is a big scope for electrification, more especially as she possesses numerous waterfalls.

In its small compass, the book contains a great deal of useful information clearly set out; it is well printed in large type on excellent paper, interspersed with several full-page illustrations of overhead construction and electric locomotives.

Advanced Theory of Electricity and Magnetism. By W. S. FRANKLIN and BARRY MACNUTT. (London: The Macmillan Co.) Pp. vii. + 300. 8s. 6d. net.

This book is written with the object of making the study of theoretical physics something besides a purely mathematical exercise, and the authors state in the preface that the "character of the treatment has been determined throughout by the desire to keep the student's mind jammed up tight against physical things!"

This prompts the authors to use only practical units (amperes, volts, coulombs, &c.) throughout the book; and it may be granted at once that our two systems of absolute units, together with the practical units, do not always tend to simplicity, and a great deal may be said in favour of the method employed in this work. Of course, the expressions for the capacity of a condenser, or for the force of attraction between two charged plates, for example, are made slightly more complicated than usual by the necessity of introducing a factor containing a constant B, which converts these practical units into absolute units. This in itself is a small matter, but it is a step from the educational point of view to find that the authors have been so afraid of wandering off into too much theory that they have given no hint to the student as to the reason for the introduction of this constant B, and have been satisfied with merely stating its numerical value, although it occurs dozens of times in a few pages and is evidently a most important quantity.

In a book of this description it is expected that a certain number of terms will be employed which seem strange to a scientist on this side of the water, *e.g.*, the dielectric constant,

which is already known by several names, is called the "inductivity," a term suggested first by Prof. S. P. Thompson in his well-known text-book. The product of the dielectric-constant and the intensity of the field is designated "the electric flux density." Forces are often measured in joules per centimetre, and so on. To most teachers it seems unnecessary to multiply these terms unduly, but there is, at all events, one advantage in the authors' nomenclature abohm, abvolt, abampere, abcoulomb, &c., for the absolute e.m. units suggested. The word "abohm" is much shorter than the expression "absolute electromagnetic C.G.S. unit of resistance."

The book fairly well covers the most important parts of the subject and comprises 10 chapters devoted to ferro- and electro-magnetism, magnetic properties of iron, compensation of ship's compass, inductance, the electric field and electric oscillations. The last chapter on electrons is much too brief, nothing of the recent work on the subject being mentioned at all.

The book is most clearly printed and is provided with some 238 special diagrams which greatly add to its value. Problems to the number of 138 are set to be worked out by the student, to most of which the answers are given. The work gives quite a fresh view of the subject to most English readers, and for this reason it may be found useful, especially to students of electrical engineering.

B. W. C.

THERMAL-INSULATION TESTS OF ELECTRIC OVENS.*

BY A. B. KENNELLY, F. D. EVERETT AND A. W. PRICE.

Summary.—The authors give the results of an experimental investigation of the resistance to heat offered by five different kinds of oven wall.

The object of the investigation was to find the effect of [illegible] materials inside the hollow walls of an electric oven on the thermal leakance of those walls at or near the steady thermal state.

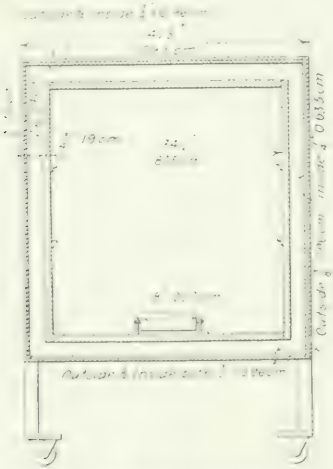


Fig. 1.—[illegible]

[illegible] on four legs, terminating in rollers, so as to stand well above the floor. The front view cross-section and longitudinal section of the [illegible] dimensions are given in Table I. At one end of the oven the walls [illegible] and these two windows are set one behind the other, so that illuminated objects inside the oven can be kept visible from the outside without opening the doors.

[illegible]

walls are (except the top) of two layers of the board—the inner $\frac{1}{4}$ in. (0·64 cm.) thick and the outer $\frac{3}{8}$ in. (0·95 cm.) thick. The top outside wall is of two layers each $\frac{3}{8}$ in. (0·95 cm.). The joints between slabs were caulked with 85 per cent. magnesia compound, and where a double layer of boards exists, as in all outside walls, the layers are staggered to avoid coincidence of joints. Doors and windows are flanged with metal to ensure good closure.

Heating System.—The heating of the oven is effected by means of six coils of bare "Ia-Ia" zero coefficient resistance wire, each wound specially on a horizontal porcelain cylinder. These heating cylinders are supported on the floor of the oven, as shown in Figs. 1 and 2. Each cylinder is 20·3 cm. (8 in.) long and 6 cm. ($2\frac{7}{16}$ in.) in diameter. The resistance of the wire on each cylinder is about 12 ohms, so that

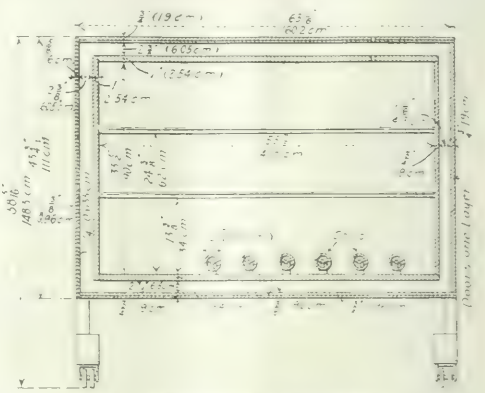


Fig. 2.—[illegible] of Electric Oven.

heat is developed in each at the rate of approximately 1 kw. when connected to direct-current 110-volt mains. By means of switches mounted on the outside of the oven the heater can be either disconnected or connected in various series-parallel groups, so as to regulate the heating up to a maximum of 6 kw. As a rule, all the heaters were connected in parallel, so as to obtain a floor distribution of generated heat as nearly uniform as possible, the voltage at heater mains being controlled externally.

In preliminary tests the distribution of final temperatures within the oven was found to be very uneven. As might easily be imagined, the air inside was much hotter at the top than at the bottom of the oven. In order to secure a more uniform thermal distribution, it

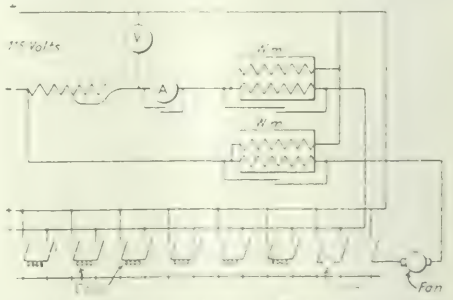


Fig. 3.—[illegible] of Electric Oven.

was necessary to employ a direct-current electric fan inside the oven operated from auxiliary mains. The fan and motor finally selected consumed about 50 watts and ran at 1,710 revs. per min., on 115 volts, at a room temperature of 21° C. The fan had a diameter of 30·5 cm. (12 in.), and had four blades. The oven temperature had to be limited to such as would not dangerously overheat the fan motor. The power absorbed by the motor was included in the heat input. The electric connections of the fan and the heating circuit are indicated in Fig. 3. The power absorbed by the fan motor was [illegible] on a separate wattmeter at 115 volts. At the working oven temperatures the power it absorbed diminished slightly. With the aid of this fan the temperature distribution within the oven could be kept nearly uniform, but without the fan it is doubtful if [illegible] could have been obtained for the

* [illegible]

Table I.—*Average Dimensions of Oven.*

	Length.		Breadth.		Height.	
	Cm.	Inch.	Cm.	Inch.	Cm.	Inch.
Oven external	160·2	63 1/16	105·5	41 1/2	111·0	43 3/4
Oven internal	141·8	55 13/16	87·5	34 1/2	90·1	35 1/2

	Outside slab.		Inner slab.	
	Cm.	Inch.	Cm.	Inch.
Side walls	1·60	5/8	1·9	3/4
Top and bottom walls	0·96	3/8	2·5	1·0
Distance between side walls	5·40	2 1/8	...	...
Distance between walls at top & bottom	6·05	2 3/8	...	...
Height of base from floor	37·30	14 3/4	...	...

mean internal temperature. The wattmeters used were calibrated against standards, and their readings were corrected accordingly.

Centigrade thermometers were used with scales readable to one-tenth of a degree. At first four thermometers were employed, one inserted through a sheet-iron tube, so as to have its bulb in the air at the top of the oven inclosure; one laid on the floor at the bottom; the third suspended inside near the top, and the fourth suspended inside half-way up. The internal thermometers were read by the light of a heating lamp within the oven, through the double-glass window. These thermometers were found to read too high, owing to direct radiation from the lamp. A paper cylindrical petticoat shield applied to the bulbs, so as to screen off the light without interfering with the circulation of air, overcame this difficulty. Then the thermometer inserted through the sheet-iron tube in the top was found to read too low, owing to conductive escape of heat along the tube. The tube was therefore removed and replaced by a pair of corks, one in the outer and the other in the inner wall. The thermometer then gave satisfactory indications. With the circulating fan working, all four thermometers were found to coincide in their readings within 0·25°C., so that only two thermometers were found to be necessary—the top one projecting through the corks and an extra one inside as a check. These were calibrated from standards in the physics department.

It is well known that if an electric oven starts cool, with all its parts inside and out at ordinary room temperature, the first effect of applying constant heating power within it will be to raise the internal temperature at a relatively rapid rate, this rate of rise gradually diminishing until, after an indefinitely great lapse of time, the internal temperature should cease to rise and the temperature elevation should reach a steady maximum value. The heat supplied to the oven is then entirely expended in leakage through the walls, and no longer raises the temperature. Consequently, in order to measure the leakage of heat with precision, it would be necessary to keep the power applied to the oven until the internal temperature was stationary. For an oven of the size here considered this would mean keeping on the heat for many hours together, a condition different from that ordinarily encountered in practice, besides entailing much difficulty and delay in arriving at results. It was, therefore, decided to make the measurements of thermal leakage after about eight hours of heat application. In the first half hour the internal temperature was brought up rapidly to the desired limit by applying a steady input considerably in excess of the final required amount. The input was then shut off to its estimated required steady value. The internal temperature would then drop slightly for an hour or so, after which it would slowly rise toward the limiting value. After seven or eight hours from the start the rate of rise was found to be sufficiently small to enable the heat input to be taken as heat leakage without serious error; but if the heat had been kept on for, say, 24 hours, the internal temperature would probably have been appreciably higher and the leakage per degree appreciably less. The comparative leakage of heat with different oven walls would not be likely to differ appreciably with 24 hours' run or with four hours' run, and it was the comparative rather than the absolute values that were sought for in these tests.

Five different kinds of wall were tried as follows:—

1. *Single Walls.*—In this test the outer shell of the double-walled oven was taken off, leaving the oven with the single inner wall of asbestos board. All joints in the single wall were carefully caulked to be as nearly air-tight as could be accomplished with magnesia plaster. The results with single walls were as shown in Table II. Each test lasted one day. By temperature rise in the table is meant the difference between the internal oven temperature and the outside room temperature at the end of the run.

The thermal resistance of the oven walls is the ratio of the difference in temperature between the air inside of the oven and the external air of the room to the steady heat escape in watts—was R=0·0254 thermal ohms.* The total wall area of the oven was approximately 69,000 sq. cm. (10,700 sq. in.), and the average wall thickness 1·27 cm. (½ in.), so that the thermal resistivity of the asbestos board forming the oven shell was 0·0254 × 69,000 ÷ 1·27 = 1,377 thermal ohm-cm. This is in accordance with the value of the thermal resistivity of asbestos board given by C. P. Randolph in the "General Electric Review" for February, 1903—viz., 1,140 to 1,397 thermal ohm-cm. (450 to 550 thermal ohm-inches).

Table II.—*Tests made with Single Walls.*

Test No.	Temperature rise, deg. C.	Length of run. Hours.	Min.	Steady input, Watts.	Watts per deg. C. rise.	Deg. C. rise per watt.
1	18·8	7	45	677	36·0	0·0278
2	25·6	6	55	1,015	39·7	0·0252
3	26·4	8	25	1,027	38·9	0·0257
4	35·4	7	30	1,540	43·5	0·0230
5	37·2	7	30	1,481	39·8	0·0251
Mean ...	...	...	...	...	...	0·0254

Table III.—*Tests made with Double Walls and Air Space Separation.*

Test No.	Temperature rise, deg. C.	Length of run. Hours.	Min.	Steady input, Watts.	Watts per deg. C. rise.	Deg. C. rise per watt.
1	15·5	7	15	373	24·1	0·0415
2	23·9	8	5	578	24·2	0·0413
3	31·4	7	37	770	24·5	0·0408
4	41·2	7	25	1,022	24·8	0·0403
Mean ...	...	...	...	...	...	0·0410

2. *Double Walls with Simple Air-space Separation.*—When the outside shell of asbestos board was replaced on the oven, corresponding to the condition indicated in Figs. 1 and 2, the series of observations given in Table III. were taken. The above results indicate

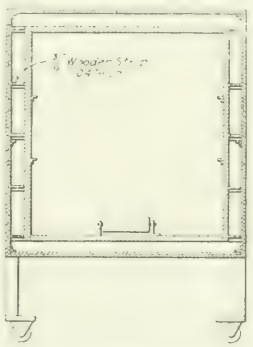


Fig. 4.—Cross-section of Electric Oven with Cellular Walls.

that, adding the outer shell to the oven, or changing from a single to a double wall of asbestos board, with a free air space between them, increased the wall thermal resistance from 0·0254 to 0·041 thermal ohm, or by about 60 per cent.

3. *Double Walls with Baffle Strips.*—In order to ascertain whether the thermal resistance of the double walls would be appreciably increased by breaking up the hollow space into cells, horizontal wooden strips were inserted at the sides and ends, between the outer and inner shells, as indicated in Figs. 4 and 5. These wooden strips were 5·3 cm. wide and 0·5 cm. (3/16 in.) thick. When inserted they changed the internal hollow wall space into [illegible] cells, 20 cm. high and [illegible] cm. deep. It was supposed that this breaking up of the walls into compartments might check the flow of internally contained air, and so tend to increase their thermal resistance. The results given in Table IV. were obtained. The

* The Heating of Copper Wires by Electric Currents, by A. E. Kennelly and E. E. Sheppard. Transactions A.I.E.E., June 25, 1907, p. 974. Simultaneous Electrothermal Calibration of Watt and Thermal Units, by Carl Hering. Transactions A.I.E.E., June 25, 1912, p. 1191.

Table IV.—*Tests made with Double Walls and Baffle Strips.*

Test No.	Temperature rise, deg. C.	Length of run. Hours.	Min.	Steady input, watts.	Watts per deg. C. rise.	Deg. C. rise per watt.
1	19·1	7	20	443	23·2	0·0432
2	27·3	7	25	663	24·3	0·0412
3	40·2	8	5	1,025	25·5	0·0392
4	42·8	8	40	1,056	24·7	0·0405
Mean ...	...	...	...	...	...	0·0410

Table V.—*Tests made with Double Walls packed with Cotton Waste.*

Test No.	Temperature rise, deg. C.	Length of run. Hours.	Min.	Steady input, watts.	Watts per deg. C. rise.	Deg. C. rise per watt.
1	15·0	7	5	243	16·2	0·0617
2	23·0	7	40	382	16·6	0·0602
3	40·7	7	10	684	16·8	0·0595
Mean ...	...	...	...	...	...	0·0605

average thermal resistance was, therefore, not appreciably increased by inserting the baffle strips in the walls.

4. *Double Walls Packed with Cotton Waste.*—The baffle strips used in the preceding series of tests were removed, and the hollow space between the two shells of the oven was filled with loosely packed dry cotton waste. The series of measurements shown in Table V. were then made. The effect of packing the double walls with cotton waste was to increase their resistance from 0·041 to 0·0605 thermal ohm, or by nearly 50 per cent.

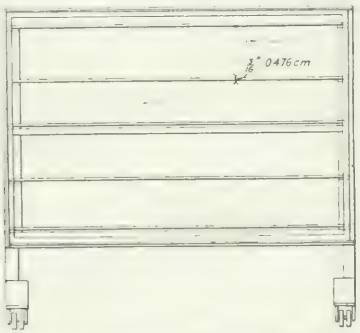


Fig. 5.—Longitudinal section of Electric Oven with Cellular Walls.

5. *Double Walls Packed with Metallic Wool.*—The cotton waste packing used in the preceding series was removed and replaced by so-called "metallic wool." This is the trade name of a substance resembling ordinary wool in appearance, but consisting of a mineral substance procured in Indiana. The material is fused and then blown out by compressed air. It is non-inflammable, and is, therefore, preferable to cotton wool as a packing for oven walls. The series of results given in Table VI. were then obtained.

Table VI.—*Tests made with Double Walls packed with Metallic Wool.*

Test No.	Temperature rise, deg. C.	Length of run. Hours.	Min.	Steady input, watts.	Watts per deg. C. rise.	Deg. C. rise per watt.
1	12·75	7	30	165·7	13·0	0·0769
2	12·6	8	0	163·9	13·0	0·0769
3	20·4	7	0	301·0	14·05	0·0712
4	25·0	7	10	298·8	11·95	0·0837
5	34·0	7	15	395·0	12·73	0·0786
6	45·1	7	30	564·0	12·50	0·0800
Mean .						0·0779

wool with other known heat insulators, such as flocculent magnesia, nor have we reason to suppose that the metallic wool is exceptionally advantageous in this respect.

Table VII.—*Summary of Results from the Various Tests.*

Series	Nature of wall.	Watts input per deg. C. rise, thermal mhos.	Deg. C. rise per watt input, thermal ohms.	Thermal resistance ratios.	
1	Single shell	39·4	0·0254	1·0	
2	Double shell and simple air space ...	24·4	0·0410	1·62	
3	Double shell and cellular air space	24·4	0·0410	1·62	1·0
4	Double shell packed with cotton waste .	16·5	0·0605	2·38	1·47
5	Double shell packed with metallic wool.	12·8	0·0779	3·07	1·9

Table VII. summarises the results in the various series. The ovens provided with double walls containing a simple air space between them showed about 60 per cent. more thermal resistance to the escape of heat than a single wall, after a steady input for from seven to eight hours. Inserting a few horizontal wooden strips into the walls to break up the air space into compartments had no appreciable effect. Packing the hollow walls with loose dry cotton waste increased the double-wall thermal resistance nearly 50 per cent., and packing with a loose flocculent mineral substance nearly 90 per cent.

CORRESPONDENCE.

"MAGNETIC STORM," JUNE 17, 1915.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The attached notes by my chief testing inspector may be of some use to you. If so, they are entirely at your service for any sort of use.—I am, &c.,

Derby, July 30. J. SAYERS.

Midland Railway,
Telegraph Superintendent's Office,
Derby, July 28, 1915.

J. Sayers, Esq.

"MAGNETIC STORM," JUNE 17, 1915.

SIR: On the 17th ultimo telegraph circuits were considerably affected by "earth currents." The Midland Railway system enabled us to make observations over an extent of country bounded by a line joining London, Lincoln, Hull, York, Edinburgh, Glasgow, Heysham, Liverpool, Bath and London. This report is based on replies to inquiries made to the chief telegraphists at Carlisle, Skipton, Leeds, Normanton, Manchester, Sheffield, Gloucester, Nottingham, Leicester, and London, and on facts collected by myself at Derby.

The disturbance was first noted in our offices about 7 a.m., and was more or less in evidence until about 8 p.m. From 7 a.m. to 9 a.m. the earth currents were strong; 9 a.m. to 12 noon, weak; 12 noon to 1 p.m., strong again; 1 p.m. to 3:40 p.m., quiescent; 3:40 p.m. to 6 p.m., very strong; 6 p.m. to 8 p.m., weak and dying away. (The terms "strong" and "weak" roughly imply that the needles were deflected to the stop pins and to a position short of the pins respectively, whilst "very strong" means that the dial could be revolved and still followed by the needle.)

By measuring the strength of the currents on the Derby–Bristol and the Derby Bradford about 8.30 a.m. I was able to calculate that the difference of potential between Derby and Bristol was 17, and between Derby and Bradford 12 volts, and it was noted that Bradford was positive relatively to Derby and Derby positive to Bristol, so that the potential at Bradford was at the time 29 volts above that of Bristol. This difference was still greater at one period of the afternoon. This feature of a graded fall (or rise) between distant points was noticed at Normanton where the potential proved to be intermediate between that of Manchester and that of Goole. There were, however, remarkable changes at times. For instance, about 5.33 p.m. Derby was noticed to be positive with respect to Bradford whilst remaining negative to stations in Leicestershire. At 5.35 p.m. the up and down block instruments at Blackwell (Lickey) indicated a fall from Bromsgrove through Blackwell to Barnt Green. This would suggest a continued fall in the direction of Birmingham, but observations on the Birmingham–Bromsgrove needle showed that the potential at Bromsgrove was *lower* than that of Birmingham. (No other instance of block circuits being affected has been reported.)

This storm fully confirmed the opinion that wires crossing the magnetic meridian at a considerable angle are more sensitive to these disturbances than other wires. Leicester reports that "circuits running in a south-westerly direction were mostly affected," and Nottingham says "the principal circuits affected were those running west to east (Nottingham to Lincoln ... whilst at your observers at Derby that currents per-

sisted on the Birmingham wires when all others were free. Negative evidence of the comparative immunity of wires parallel with the meridian is afforded by the report from St. Pancras, whose long circuits run in a north-westerly direction, which states that the disturbance was not noticed during the morning, and that during the period of greatest intensity (4.25 p.m. to 6 p.m.) there was no difficulty in regulating any circuit excepting the Derby quadruplex. If it should be questioned why the Derby–Bradford circuit, which also trends south-east to north-west, was affected more than the London circuits, it may be pointed out that it runs via Leeds, from which point it takes a south-westerly bearing.

A disturbance of this magnitude has not before occurred at midsummer within my recollection. The usual periods for the appearance of "earth currents" are the spring and the autumn seasons. I learn from the scientific weeklies that there was an exceptional display of aurora on the morning of the 17th, and a sun-spot on the 20th, which one observer reports as being larger than any seen by him for eight years.—Yours obediently,

G. EDMONDSON.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of July 16th, p. 559, you published a letter from Mr. Carl Hering referring to a Paper of mine which you were good enough to print, in abstract, in your columns (June 11th, p. 344).

Mr. Hering states that he has himself put forward some remarks on the same subject in 1908. I may be excused for not having known of this very interesting Paper, which, to my knowledge, was not reproduced in the French journals. It pleased me the more to notice that Mr. Hering's experiment, which retains all its initiatory value, differs notably from mine, and that my own communication is not, therefore, a useless repetition of his, although his conclusions are similar. I am, moreover, not quite in agreement with Mr. Hering in his use of the word "conductor" instead of "circuit," as I will explain later. My experiments had three objects in view, of which, I think, it will be useful to give a precise statement.

1. To show the falsity of the classical enunciation of the law of induction as applied to the variation of flux; this is the point that Mr. Hering has also investigated by a different method.

2. To show experimentally (what has never been done to my knowledge up to the present) that when a circuit is movable the E.M.F. induced has its seat in the part of the conductor that cuts the lines of force. This experimental demonstration adds something useful to the purely theoretical demonstrations, based on the consideration of energy, which are found to be at fault when it is a case of an open circuit. It contradicts the opinion often uttered by several physicists that it is not possible to localise the seat of the E.M.F. induced.*

3. To show that the formulæ given for the E.M.F. induced by variation of current and mutual induction

$$e = d(Mi)/dt = M\,di/dt + i\,.\,dM/dt$$
$$e = d(Li)/dt = L\,di/dt + i\,.\,dL/dt$$

can be at fault with the coils wound into position by the method I have indicated, and that in this case the method by which the potential energy is stored is different from the two mechanisms known at the present time.

Items (2) and (3) above have been dealt with in the second part of my communication. As for the general enunciation of the law of induction, I have just been referring to the "Transactions" of the American Institute of Electrical Engineers in order to obtain the enunciation given by Dr. Steinmetz.

This takes solely into consideration the cutting of the flux, and tends to reject Maxwell's statement based on the variation of the total flux in a circuit. I come to the opposite conclusion—that there is reason to retain, for practical use, the statement based on the variation of flux linking with a complete conductor, as I have indicated.

In reality, in the application carried out by electrical engineers, it is always looped circuits that are met with, and not merely bits of conductors; this is why I purposely employ the word "circuit" instead of the word "conductor."

Furthermore, it is easy to extend the case of unipolar induction to a continuous variation of the surface embraced by a circuit, considering the turning system as describing at each instant a small angle that increases the said surface.

The consideration of open circuits—that is to say, those not forming a loop—is only necessary in radio-telegraphy, and in this special branch it is best to return to the general equations of the electromagnetic field. This is not the question with which I wished to deal in my Paper.—I am, &c.,

Paris, July 31. A. BLONDEL.

* Some interest might also be attached to an experiment of replacing the radial conductor which connects the centre of rotation to the rim of the turning coil by a conductor of curved form. In this case E.M.F. is found to be induced as with the radial conductor, but it is now conceivable that the E.M.F. is in every case proportional to the flux cut, measured at each point of the conductor by the product of the magnetic induction, the velocity and the projection of the conductor element upon the plane formed by these two vectors. The experiment, in the form in which I made it, constitutes, therefore, a perfectly general method of experimentally demonstrating the law of induction in a conductor moving relatively to a magnetic field.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Concerning the correspondence of Mr. C. Hering and Mr. MacCallum published in your issues of July 16th and 30th:—

(*a*) In the position BB Fig. 1, one cannot say with Mr. Hering that the electric circuit is "*linked completely*" with the magnetic circuit, nor that in the position B′B′ it is "*unlinked completely*"; for in each position does the part of the electric circuit between the brushes consist of the whole of the brass block C, and not of either of the dotted straight lines drawn between B and B, or B′ and B′. Who could explain the meaning of those supposed paths BB and B′B′? Let us consider Fig. 2. When an *externally* produced P.D. is applied to the brushes BB the field of electric induction would shape itself in the form of the dotted lines shown in the drawing, these being the paths which the elementary electric currents would follow. Some of the currents would pass to the very end of the B′B′

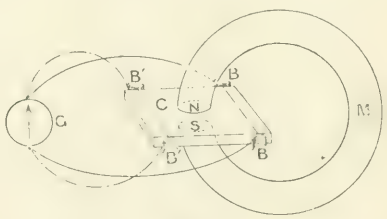


FIG. 1.

side of the block. Even in this case, could one think of a basis on which to combine these force lines in a way not to affect the results to be observed?

My first conclusion is that Mr. Hering does not clearly link and unlink an electric circuit, and that, in consequence, his deduction is not proved.

(*b*) The negative result of Mr. Hering's experiment was to be foreseen, and in the same way the experiments suggested by Mr. MacCallum are useless (as far as one might say that an experiment is useless). In my opinion no current will flow in the galvanometer circuit nor in any part of the brass block. For if there was a current we should witness the production of Joule effect and mechanical energy (if we care to utilise the electromagnetic force on the block). In fact, energy cannot be developed, as there is no corresponding power providing for it, and thus the electric currents cannot exist nor can there be any induced E.M.F.

(*c*) In Mr. MacCallum's experiment of the conducting bar moving through a bath of mercury, not only can one presume that there will be an E.M.F. induced, but one can affirm that it will be so. Let us add that the movement will not be effected without overpowering the antagonistic electromagnetic reaction.

(*d*) Let us consider another case, Fig. 3. N is a magnetic flux. Key B closed and key C open. We shut C and open B. The circuit *Gb* has become *Ge* without having been electrically

interrupted. The flux N, first unlinked, has become linked; notwithstanding, neither E.M.F. nor current has been set up.

This experiment might be supposed to show what Mr. Hering was aiming at, *i.e.*, "the electric circuit can be linked and unlinked with a magnetic circuit without producing the slightest induction of E.M.F., the electric circuit being closed all the time." But let us note that in these experiments there is always a special subtlety which prevents them from being neat and clear cases. In my experiment, for instance, what can one think of the physical discontinuities brought into the electric circuit by the manipulation of the keys?

(*c*) In conclusion, no experiment seems to show convincingly how it is possible to link or unlink a properly determined electric [illegible]

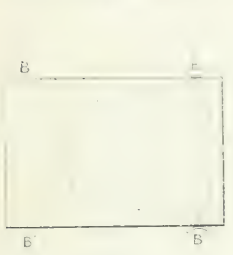


Fig. 2.

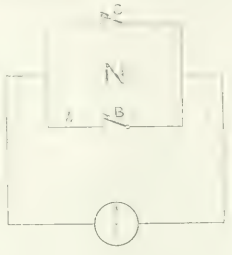


Fig. 3.

of the former to cut the induction lines of the latter. Whatever it be, a common and certain result of those experiments where no conductor cuts the magnetic field is that no E.M.F. will be induced.

Therefore, we can safely say with Mr. Hering, and many others: "To produce induction, the material of the conductor itself must cut the flux."—I am, &c.,

A. F. Gheysens, I.C.C., I.E. (Ghent University).

London, Aug. 2, 1915.

WIRELESS TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: If Dr. De Forest will read my original article in the "Year Book of Wireless Telegraphy" for 1915, from which The Electrician article is extracted, he will find the following statement:—

"Very little seems to have been done with the grid tube from [illegible] the introduction of the Audion tube as a definite magnifier for telephone signals revived the whole question. Dr. De Forest had in the meantime dropped his British patents, possibly on account of failure to recognise their importance."

If this statement is not true, perhaps Dr. De Forest will [illegible] If it is true, why does he expect to one of the foremost wireless companies using something quite open to them to use, even aside from any question of the original [illegible]

I am referring only to the British field, as I am not connected with the American Marconi Company.

The photograph of the "audion" which he states is in use by the American Marconi Company I know nothing about, but [illegible]

[illegible] Dr. De Forest calls the "ultra-audion" nothing was known to Mr. Franklin and myself of any developments in America until the beginning of 1915, and then [illegible] Mr. C. H. [illegible] the results obtained by Mr. Armstrong and [illegible] Dr. De Forest.

The [illegible] used by Mr. Armstrong were communicated to us at the [illegible] although at least [illegible] produced [illegible] Audion tube. Mr. Franklin [illegible] (practically with the [illegible] [illegible] [illegible]

North junction at 8:10 a.m. on Saturday morning, and was promised that I could start charging at 9:30 a.m. A number of hours I had to go into the station myself, behind switchboards, boosters, &c., tracing leads out, and ultimately got on charge at 12 noon.

For the purpose of assisting the Edison Company and the general development of electric [illegible] I took the [illegible] run to Sutton Coldfield and Birmingham [illegible] Birmingham Edison representative having arranged with the Sutton Coldfield supply department and the Birmingham supply department for charging. Sutton Coldfield is only 8 miles from Birmingham, but as a demonstration was required before the Council I considered it advisable to have a boost up. I left Loughborough at 6 a.m., arriving at Sutton Coldfield at 10 a.m., and hoped to be boosted up whilst having breakfast. I went round to the generating station, which is in the town, and was told that I should have to go to a sub-station a little way out. The sub-station proved to be 3 miles away from the main station and in the direction of Birmingham. When I got there I was invited to take the vehicle, weighing 4 tons, to the back of the sub-station, over some unmade ground, into which the wheels would no doubt have sunk up to the [illegible] and probably smashed them.

This I declined to do, and as the staff informed me that they had no suitable length of cable, I withdrew to the nearest garage on the main road and left the 'bus in their care, as there was not sufficient current left in the battery to take it back to Sutton Coldfield again and then on to Birmingham. I got a taxi right back to the Royal Hotel at Sutton Coldfield for breakfast, and whilst there the acting engineer for Sutton Coldfield found out where I had gone and telephoned up. Having arranged for the demonstration, he apparently got alarmed at the failure, and promised to do anything if only the 'bus would go back to the sub-station. I agreed, and got back there at 11:15; but it was not until 12:45 that we actually got some charging current through, and then there were no measuring instruments in circuit.

I got away from Sutton Coldfield at 1:30 p.m., and arrived at Dale End sub-station, Birmingham (adjoining the offices), where I had been informed all arrangements were complete. There certainly was a booster and a charging plug, though no one had any idea as to how it was connected. There was also a portable ammeter and voltmeter; the ammeter did not read the whole of the time there was a charging current on, but the voltmeter read "sometimes." The connecting up leads were 7/14 V.I.R. cable, which had to carry a current of 120 amperes or thereabouts, and they smoked delightfully. If this is the best the chairman of the Electric Vehicle Committee can do with all the resources at his disposal, I feel very pessimistic as to the prospect of the development of the vehicle in this country.

Last Saturday I went out, not as a central station engineer, but as an electric vehicle user who required charging facilities, and for which arrangements had previously been made. I venture to think that had I just been an ordinary driver, with no knowledge of central station work, I might have still been in Birmingham waiting for my vehicle to be charged. So far, beyond the work you personally have done, the Electric Vehicle Committee, as a committee, do not appear to have achieved very much. All their energy seems to have been devoted to standardising a plug.

I do seriously suggest that the whole equipment deserves to be dealt with, such as booster capacities and rates, switchgear (particularly including battery auto-switch), supporting bracket for cable, and also a good printed card to be supplied to every charging station to show at what rate and for what period various makes and sizes of batteries should be charged. It will no doubt be within your knowledge that the Edison Company [illegible] for lighting, but I decided to do away with this, and to take lighting from the main battery. Then the Edison Company offered 80-volt lamps across the main terminals of the battery; but I do not care to use such [illegible] if one lamp fails the whole of the lamps do not go out, and one section of the battery remains slightly undischarged until the lamp is replaced. The lamps used are 12 volt 10 c.p. lamps all round—

[illegible]

[illegible]

its spindle are raised vertically about ½ in., and operates in a reverse direction. The [illegible]

observation shows that a driver gets so much experience going ahead and coming back into the neutral position that he does not become familiar with the reverse, and when on reverse he goes into the first position to move a little way, and then by habit, thinking he is going to stop, pulls the handle further towards him, which puts him into the second speed instead of stopping. I do not think any better system will be found than the double drum tramcar type of controller, and I suggest that the Committee seriously consider this point.

No doubt you will think I am very full of complaints, but I do not feel that there is any need to apologise if, when one offers destructive criticism, one also makes suggestions which are the result of experience. I am, yours very truly,

Electricity Works, Loughborough, July 14, 1915. W. H. Allen.

LIGHTING OF RIFLE RANGES.

A discussion took place recently at the Illuminating Engineering Society upon the lighting of rifle ranges. In an introductory Paper on this subject Mr. A. P. Trotter called attention to some of the difficulties, most of which are largely physiological. There is a difference of opinion as to whether the firing line of a miniature range should be completely obscured, or whether it should be illuminated. If there is no illumination there is considerable difficulty in seeing the sights in normal [illegible]. Young men probably do not find much difficulty in this respect as they have good power of accommodation, but older men have not so much power in this way, consequently a difficulty may arise. It is quite clear that it is impossible to focus the target and the sights at the same time, the result being that the foresight may present a multiple appearance and the back sight may look muddy. By taking it very [illegible] there was less difficulty, but the foresight then appeared double, and the smallest motion of the head sideways caused complicated images to appear. If the firing line is illuminated there is not the same difficulty because the pupil is more closed. There is also the question whether the target should be against a black background. Experiments by Mr. H. Brazil have given good results when a series of white screens were placed between the firing line and the target, the latter being seen through apertures in the screens. The illumination of the screens should not be less than 5 candle feet. Against such a background the flat edge of the back sight can be seen and there is sufficient flux of light to cause the pupil of the eye to contract.

In the discussion that ensued various opinions were expressed. Mr. A. Blok has found comfort in having a brown card mount for the target, the light on the target being about double that of the surroundings. Thus with a brightness of 10 ft. candles on the target that of the brown paper should be about 5 ft. candles. On the other hand, he thought that the usual white target with a black bull's eye was best for beginners, though less contrast might be desirable later on. In his experience the most comfortable illumination was by 12 ft. candles on the target. With higher illumination a reddish coloured fringe began to assert itself along the backsight, and at 50 ft. candles shooting became difficult. Multiple images also appeared and when the illumination increased to values between 60 ft. and 100 ft. candles the bull became visible through the foresight. Mr. Blok gave a number of details of targets including particulars of adjustable illumination.

Mr. H. Brazil thought [illegible] Mr. Trotter [illegible] Mr. Trotter [illegible] difficulties and thought they might be largely overcome by practice.

Mr. S. G. Coram, an instructor in musketry, was strongly opposed to all the light being thrown on the targets because this was against ordinary methods. He found that men accustomed to miniature ranges where the firing line was kept dark had shown considerable [illegible] when [illegible] on an open range.

Mr. J. C. [illegible] some experiments [illegible] tions, the illumination varying from 4·5 ft. to 45 ft.-candles. The best results were obtained with 20 ft.-candles. In one case 16·5 ft.-candles [illegible] gave the greatest satisfaction.

Mr. W. [illegible] trouble [illegible] when [illegible] illumination at the latter point. Mr. J. S. Dow thought that the [illegible] Mr. Dow [illegible] the [illegible] 1 to 1.

THE ORGANISATION OF THE TELEGRAPH SERVICE.

It will be remembered that a Committee was appointed in 1914 "to consider the organisation of the telegraph service" with a view to its improvement and economical working. This committee was constituted as follows :—

Sir Archibald Williamson, Bart., M.P. (*Chairman*) ; Sir Henry Norman, M.P. ; Col. A. M. J. Ogilvie, C.B. ; Sir William Plender and Sir Charles Stewart-Wilson, K.C.I.E. Messrs. W. E. Weston and W. R. Birchall are the Joint Secretaries.

Several matters have been before the Committee since its appointment, and a report was issued on Wednesday (dated May 6, 1915) upon one specific question submitted for its consideration and report. This Specific Question was :—

"Is it desirable to provide a special class of operators for keyboard perforators or should they be worked as a part of the miscellaneous duties which ordinarily fall to telegraphists ?"

Following is the greater part of the text of the letter of the Postmaster-General to the Chairman of the Committee when submitting the question:—

A question which has been under consideration by the Committee on the Telegraph Service appointed immediately before the outbreak of war, there is a pressing question of considerable importance which might with great advantage be considered. For some years it has been the practice to use "keyboard perforators" similar in construction to ordinary typewriters for the preparation of the perforated slip used for the rapid transmission of telegrams over Wheatstone automatic circuits. So long as the use of these perforators was confined to this class of apparatus the total amount of work involved was too small to require the appointment of a special staff, and it has been the practice to train the ordinary telegraph staff in the use of these keyboard perforators as well as of other instruments.

Within the last two years a number of other forms of high-speed telegraph instruments have been so perfected as to make their use not only possible, but also very desirable, in dealing with telegraph traffic between busy centres. For these telegraphs the use of keyboard perforators of typewriter pattern is practically universal, and there can be no doubt that a comparatively large part of the work of transmitting telegrams will approximate to ordinary typewriting. The question, therefore, arises whether it is desirable to provide a special class of operators for these keyboard perforators, or whether they should continue to be worked as a part of the miscellaneous duties which ordinarily fall to telegraphists.

Owing to the withdrawal of a large number of telegraphists for naval and military duty, it has been necessary to obtain a good deal of temporary assistance from outside sources, and a number of typists have been engaged for working keyboard perforators. The experiment has been attended with considerable success, and it is found that good typists can without difficulty and without technical telegraphic knowledge readily learn to manipulate keyboard perforators. The experiment has, however, been viewed with some apprehension by the associations of the telegraph staff, as possibly affecting the future prospects and status of telegraphists, and in considering future arrangements this aspect of the question must be taken into account.

The Committee's report is as follows (in abstract) : —

To the Postmaster General.

In accordance with your request we have specially met to examine this question and in order to acquaint ourselves with the various considerations by which it is affected we have obtained evidence from a number of witnesses connected with the Telegraph Service, as well as from those concerned with the invention or manufacture of telegraphic keyboards. (These witnesses included, besides several prominent members of the Post Office Telegraph staff, Mr. F. G. Creed and Mr. Donald Murray, inventors and makers of telegraph instruments in which the use of typing keyboards is involved. The written views of Mr. J. Gell and of the Western Electric Co. were also obtained.)

Owing to the withdrawal of a considerable part of the staff of male telegraphists for naval and military purposes it has been necessary to engage a number of temporary assistants for telegraph work, and among these are included about 150 typists (all women), of whom 80 are employed in London. In some cases the typists have been taken direct from typewriting schools, but most of the temporary staff have previously had some experience of office work. The wages paid have ranged from 13s. to 25s. a week. The hours of duty are 48 a week, including intervals for meals. In all cases the typists have been given a preliminary training of two or three weeks so as to familiarise them with the prefixes, codes and service instructions used in the transmission of telegrams and also to afford them some practice in the use of telegraphic keyboards differing in some details from ordinary typewriters.

After this preliminary training the typists can, as a rule, deal with about 50 telegrams an hour and they become more expert after two or three months of practical work. In most cases from 65 to 75 telegrams can then be dealt with in an hour, and in some instances even a higher rate of working has been attained. At the same time few errors appear to be made by the typists.

Typewriting is now part of the curriculum in the Post Office Telegraph Schools and a considerable number of the ordinary telegraph staff have been trained in typewriting. A number of keyboard instruments are in use for the preparation of perforated slip in the Morse code, and, as telegraphists are trained to read perforated slip of this kind as a part of their ordinary training, they are at first better able than typists to check the correctness of the work by an occasional comparison of the messages with the perforated slip. Typists, however, soon acquire a knowledge of the Morse code, and many of those now employed have done so incidentally in the course of their work.

On the outbreak of war a considerable number of commercial typists were thrown out of employment and probably for this reason it has been possible to secure competent typists for telegraph work at lower wages than would have to be given in normal times. If, however, it were desirable to do so there would apparently be no difficulty in obtaining in the open market trained female typists who, in place of a knowledge of keyboard, would be expected to acquire a knowledge of the routine of telegraph business other than the manipulation of the Morse key and reading by sound. For such work, however, a scale of from 18s. to 30s. a week (with continuity of employment and the other advantages of Government service) would probably have to be paid judging by the ordinary business rates of payment for work demanding like skill, while it is possible that in time a higher rate of pay would have to be given. It is, therefore, probable that any ultimate savings in wages by the employment of a class of specialised typists would not be considerable.

Evidence has been given us that, as instruments of different kinds are employed in every large telegraph office and duties of considerable variety have to be performed by the telegraph staff, the elasticity of staff arrangements would be impaired by the employment of a specialised staff of operators. This would cause some inconvenience in the practical management of the telegraph service, and the opinion has been expressed on behalf of the telegraph staff that the conditions of their employment might be injuriously affected. At the present time the ordinary telegraph staff undergo a preliminary period of training occupying many months before they are capable of taking any share in practical work. They are taught the rules of the telegraph service, the routing or circulation of telegrams, the use of the Morse key, the reading by sound of messages sent in the Morse code, the preparation of perforated slip in Morse characters for transmission by Wheatstone automatic instruments and the transcription for delivery to the public of messages received in the printed Morse code. Telegraph learners in the large offices are now also being trained in typewriting. In each branch of work a certain proficiency is required before the operators leave the schools, and this proficiency is quickly and considerably increased by practical work in telegraph offices where telegraphists gradually pass from light to heavy duties. It has been stated both by supervising officers and by the representatives of the staff, that the change of duties rendered possible by this variety of training is advantageous to the service and to the staff. There is no doubt, also, that the telegraphists view with grave concern the possibility of the employment on telegraph work of operators with limited qualifications and with a lower rate of pay as likely to react unfavourably on the status of their class. Other difficult staff problems might also arise from the existence of different classes doing telegraph work side by side. For instance, it might seem anomalous that the busiest wires worked by machine telegraphs should be staffed by a class of operators receiving a lower scale of pay than the telegraphists working wires carrying a smaller volume of traffic.

We think, therefore, that the extension of the use of machine telegraphs would be facilitated if the working of the keyboards were treated as a normal part of the duties of female telegraphists. We regard proficiency both in speed and accuracy as most important, and high tests should be imposed before telegraphists are put on the establishment. Evidence has been given to the effect that the best results are frequently not obtained at present from the use of new and costly instruments.

After carefully considering the question specifically submitted to us, we are of opinion that, on the whole, while there would be no difficulty in arranging for a special class of typists to work keyboard telegraph instruments or in teaching them the necessary knowledge of telegraph rules, &c., the balance of advantage is against the creation of a special class of typist-telegraphists at the present time, although we recognise that the progress of invention may, in the future, alter the conditions which have led to our conclusions.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

25,951 Lautenbacher. Trolley wires for electric railways and the like. (2.12.12.)

26,631 H. Aron Elektricitatszahlerfabrik Ges. Electric clocks. (26/2/13.)

H. [illegible] & Chamberlain & [illegible] Electric time indicating instruments.

2[illegible] Siemens Bros. & Co. Ltd. [illegible] for telephone or other systems.

[illegible] 27.1.13.)

Comprises a taper plug carrying electrodes, a socket carrying an equal number of [illegible] partly overlapped by two on the socket, and vice versa. Means are also provided for [illegible]

2,290 Jakowlew. Electric massage apparatus.

[illegible] Electric [illegible] for [illegible] telephone [illegible]

Produced by means of glow discharges, the gas pressure within the generator being [illegible] descending current-tension characteristic can be employed.

(7.4.13.)

[illegible] (Addition to 22,013 10.)

[illegible] cuits. (Addition to 11,251 10 and 4,698 12.)

10,171 Scholz. Carbon electrodes for galvanic cells.

[illegible] core. (17/5.13. Addition to 3,912 14.)

[illegible] Ges. vorm. J. Berliner.) Electric signalling systems, particularly for use in mines.

15,939 Wilson & Harlow. Starting devices for electric motors.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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CHARGING FACILITIES FOR ELECTRIC VEHICLES.

Every new movement, no matter whether it be international, commercial, industrial or parochial, is characterised by an outburst of preliminary enthusiasm on the part of its sponsors, an outburst which may be compared to the feverish acceleration of the petrol engine of a motor car before the clutch is put in. To carry this analogy further, any carelessness or undue anxiety on the part of the driver in applying the clutch will bring the engine up with a jerk, and the vehicle remains aggravatingly at a standstill. Of course, there is nothing fundamentally wrong; the initial errors are corrected, the driver learns his business, and the vehicle purrs merrily along its way. These preliminary annoyances, however, stimulate and encourage the pioneers. Such disturbances must be expected in every movement, no matter what it may be. The petrol vehicle industry, like all other industries, has been built up on constructive criticism, the more ruthlessly applied as the number of car users has increased, and as there have grown up organisations dependent on transport by petrol-engine vehicles. Looking further at this particular industry, one of the most important results of criticism and annoyance is the availability of petrol on the road. Even in war time an abundant supply can be depended upon practically everywhere and at all times. The spirit merchants, under pressure from the organisation of motor vehicle users, have made good their arrangements.

The electric battery vehicle industry, in so far as it relates to the commercial and industrial world, is now experiencing a process of revival, a revival which has occasioned an encouraging measure of enthusiasm. The Electric Vehicle Committee, which has taken upon itself the task of organising this important section of electrical industry, has been in existence over 12 months, and has done much useful work. In one respect, however, the Committee lays itself open to serious criticism. Its quarterly publication contains a list of electricity undertakings which have agreed upon a maximum price for electrical energy for battery charging, and which have arranged to give facilities for charging whenever vehicles pull up at the works. In another column we publish a letter which was recently addressed by Mr. W. H. Allen, the borough electrical engineer of Loughborough, to Mr. Ayton, honorary secretary of the Electric Vehicle Committee, in which he points out the difficulties experienced in obtaining a charge upon the occasions on which he took the chassis of a battery-'bus from London to Loughborough and the complete 'bus from Loughborough to Birmingham. While the letter is couched in somewhat severe terms, doubtless as the after-effect of the annoyance occasioned, it does indicate the existence of a considerable measure of slackness in dealing with battery vehicles by the power stations and sub-stations of various electricity undertakings. Mr. Allen's criticisms are, of course, well meant, and will, no doubt, be taken in the spirit in which they are offered. We give them publicity because we feel that criticism of this character will be welcomed and will have a stimulating effect upon the organisation of battery-charging facilities throughout the country. At the present moment there are not many vehicles on the road, particularly in the provinces; but, if the movement is to develop, as few occasions for annoyance as possible must be given, particularly to non-electrical users of these cars.

Illuminating Woolworth Tower.—The tower of Woolworth Building, New York, the highest sky scraper in existence, is now seen in all its beauty and immensity by night as well as by day. An installation of electric projectors renders every architectural detail visible from the roof of the main building to the crow's nest, or lantern, which forms the sixtieth story. For this purpose, 600 lamps, each of 250 watts, similar to those used on motor cars, are used. They are of the new gas filled type, and while some throw their rays upwards from the gables of the roof on to the sides of the tower, others shine down from the tower top itself, these being hidden by an ingenious system of screens. The surmounting lantern contains 20 large lamps giving together 15,000 c.p., and by means of diffusing glass and an automatic dimmer, the intensity is constantly varied from a dazzling brilliance to a deep red glow.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the [illegible] 29, 1915, to July 31, 1915.

In view of the [illegible] is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at [illegible] Exports.

IMPORTS.

[illegible]

LONDON.—*U.S.A.:* Elec. machinery, £1,174; elec. lamps, £1,010; elec. carbon candles, £3,458; telephone materials, £73; lamp parts, £115; elec. wire and cable, £2,490; elec. bulbs, 278 pkgs.; unenumerated, £1,451—494 pkgs.; *Switzerland:* Unenumerated, £33. *Holland:* Elec. lamps, £1,052. *Sweden:* Elec. lamps, £55. *France:* Elec. carbon candles, £357; lamp parts, £60; unenumerated, £254—1 pkg. *Denmark:* Elec. mochinery, £123. *Italy:* Elec. wire, 50 pkgs.; elec. carbons, 6 pkgs.; elec. fan motors, 22 pkgs.; elec machines, 307 pkgs.; elec. machinery, £2,680; elec. carbon candles, £38; elec. wire and cable, £1,800; unenumerated, £200. *Norway:* Telephone materials, £102. *Belgium:* Telephone materials, £129.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Elec. wire and cable, £168; unenumerated, £243. *Melbourne:* Wire and cable, £9; unenumerated, £4,965. *Sydney:* Elec. machinery, £542; unenumerated, £1,832. *Wellington:* Elec. machinery, £534; telegraph wire, £1,544; unenumerated, £1,839. *Brisbane:* Unenumerated, £81. *Dunedin:* Elec. machinery, £56; unenumerated, £86. *Lyttelton:* Wire and cable, £110; unenumerated, £29. *Adelaide:* Unenumerated, £429. *Townsville:* Elec. machinery, £257. *Christchurch:* Unenumerated, £57. *Perth:* Unenumerated, £47. *Fremantle:* Unenumerated, £171. *Newcastle:* Elec. machinery, £250..

AFRICA.—*Durban:* Wire and cable, £653; elec. machinery, £1,844; unenumerated, £632. *Port Elizabeth:* Unenumerated, £209. *Cape Town:* Elec. machinery, £210; unenumerated, £518. *East London:* Elec. machinery, £24; unenumerated, £40. *Delagoa Bay:* Unenumerated, £22. *Sekondi:* Iron telegraph poles, 116 tons. *Napier:* Unenumerated, £693. *Fiji:* Unenumerated, £25. *Zanzibar:* Unenumerated, £22.

EGYPT.—*Alexandria:* Elec. lamps, £270; unenumerated, £69.

RUSSIA.—*Archangel:* Unenumerated, £1,257.

HOLLAND.—*Amsterdam:* Unenumerated, £127. *Rotterdam:* Wire and cable, £83.

PORTUGAL.—*Lisbon:* Wire and cable, £3,187; unenumerated, £286.

ITALY.—*Genoa:* Unenumerated, £3,030.

GREECE.—*Piræus:* Telegraph material, £8,163; unenumerated, £33.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Elec. wire and cable, £1,951; unenumerated, £486. *Batavia:* Unenumerated, £70. *Antofagasta:* Unenumerated, £285. *Valparaiso:* Unenumerated, £10. *Punta Arenas:* Unenumerated, £12.

JAPAN.—*Yokohama:* Unenumerated, £375. *Kobe:* Wire and cable, £350; unenumerated, £10.

CHINA.—*Shanghai:* Unenumerated, £172. *Honkong:* Elec. machinery, £56; wire and cable, £45; unenumerated, £163.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Elec. machinery, £100; unenumerated, £2,983. *Calcutta:* Wire and cable, £30; unenumerated, £1,620. *Colombo:* Unenumerated, £306. *Madras:* Elec. machinery, £155; unenumerated, £21. *Singapore:* Wire and cable, £430; unenumerated, £792. *Karachi:* Unenumerated, £107. *Saigon:* Unenumerated, £292. *Penang:* Unenumerated, £77. *Sourabaya:* Unenumerated, £12. *Padang:* Unenumerated, £603.

CANADA.—*Halifax:* Wire and cable, £17,343; unenumerated, £82.

FRANCE.—*Paris:* Wire and cable, £1,249; unenumerated, £421. *Boulogne:* Unenumerated, £92. *Dieppe:* Wire and cable, £18; uuenumerated, £193. *Marseilles:* Wire and cable, £66.

MALTA.—Unenumerated, £30.

GIBRALTAR.—Unenumerated, £14.

U.S.A.—*New York:* Elec. machinery, £68; unenumerated, £63.

FOREIGN GOODS (duty paid and free).

Sydney: Unenumerated, £103. *Bombay:* Unenumerated, £282. *Durban:* Unenumerated, £241. *Paris:* Unenumerated, £70. *Perth:* Unenumerated, £29. *Port Elizabeth:* Unenumerated, £190. *Shanghai:* Unenumerated, £56. *Petrograd:* Unenumerated, £51. *Singapore:* Unenumerated, £101. *Stockholm:* Unenumerated, £39.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

NEW BOOKS AND NEW EDITIONS.

[illegible] 7s. E[illegible]

TRICIAN Office on payment of the prices indicated in parentheses. Where an asterisk is added to the number 20 days will elapse before books are supplied. It is only necessary to specify the number when sending remittance.]

[illegible]

17s. 6d. net.

[illegible]

(4s. 10d.).

[illegible]

LEGAL INTELLIGENCE.

Hamilton v. Marconi's Wireless Telegraph Co. (Ltd.)

On Saturday last Mr. Vesey [illegible] reserved [illegible] agreement dated May, 1909, [illegible] he said that he had come to the conclusion that the [illegible] was given before the date of the agreement. The sale must be treated as having taken place at the date of the contract, and he found that the sales in question were those [illegible] and that by way, therefore, entitled to [illegible] to the amount of £103 15s. As to the sale of the lamp field sets to the Australian Government, the matter was more difficult, but had been termed the broken period prior to May, 1913, and for the defence it had been contended that the jury had dealt with that claim in the sum of £640. After careful consideration of the [illegible] the jury had not dealt with that matter, and that he would [illegible] of what was due to plaintiff in relation to it. As the sale of the field sets was effected between January and May, 1913, [illegible] on it. Defendants said as to the Australian battleships that that matter came within the agreement with the Admiralty and that no royalties were paid, but he came to the conclusion that the payments to defendants did not come within the agreement with the Admiralty of 1903, and he found that plaintiff was entitled to commission to the amount of £157. 10s. The claim in relation to the high-power stations was made under the agreement of July 19, 1912, which provided for commission on all sales effected, and plaintiff said that commission was due to him on a large sum which he said defendants would have received in respect of stations at Pretoria and Singapore had they been erected. As a matter of fact, no stations had been erected, but plaintiff contended that defendants wrongfully repudiated the agreement and so prevented the rest of the money upon which plaintiff would have been entitled to commission had not the agreement been repudiated. The contract of Jan. 16, 1913, required to be ratified by the House of Commons and until that was done plaintiff was not entitled to receive the money. There was never a contract which enabled defendants to receive the money, even if there had been no default on their part. He found that it had not been proved that if defendants had not repudiated the contract the ratification by the House of Commons would have been obtained. It had not been proved that the repudiation was the cause of the ratification not being obtained, and he found that plaintiff had failed to prove that he was entitled to commission as claimed. As to the claim for damages for breach of contract, he had to consider what were the chances of defendants obtaining the ratification and receiving any money and what commission plaintiff had lost. He found on consideration that plaintiff had not suffered any damage. As to the sale to the Australasian Wireless Australian Co., plaintiff's agreement provided that if defendants should create a company to take over the business plaintiff should be offered the post of managing director. The arrangement in his (the Referee's) opinion was that there should be an amalgamation of the Australian business so as to avoid competition. That there should be a taking over of the old business by a new company. The actual transfer was dated Nov. 12, 1913, and it was provided that the profits under the new arrangement should date from Oct., 1912. In his opinion when the consideration, which was to give his services, ceased, the agreement to pay the commission ceased. On the construction of the agreement he found plaintiff was not entitled to commission on sales effected after May 2, 1914, for which period the jury [illegible] whether the date of the transfer were taken at 1912 or 1913, that the transaction was not such a sale as was contemplated by the agreement and plaintiff was not entitled to any part of the commission which he claimed. On the question of the shipping contract, he decided that no commission was payable in respect of the Union Steamship Co. of New Zealand. As to the British India and the Shaw Saville Cos., the question was, did plaintiff secure the contract and after carefully studying the evidence he came to the conclusion that plaintiff had not proved that he secured those contracts and he was, therefore, not entitled to commission upon them. As to the New Zealand Government, it had not been proved that defendants received any money in respect of them, and plaintiff was, therefore, not entitled to commission. The same observations applied to the Malay States and the Australian Navies. The claim in relation to the British India Line and Messrs. [illegible] decided upon whether plaintiff was entitled to commission for life and he was not entitled for life he was not entitled to commission in that case. On the whole, he found that plaintiff was entitled to £482. 8s. 11d. and £411. 5s., which was more than covered by the amount paid into Court. The [illegible] of the King's Bench Division [illegible] should recover the costs of the action, and it was, therefore, not for him to deal with that question.

Postmaster-General v. Grand Canal Co.

In the Chancery Division of the High Court, Dublin, last week, Mr. Justice Barton delivered judgment in this case in which plaintiff asked for a declaration that he was entitled to erect telegraph lines on the [illegible] and to [illegible] by [illegible] and to [illegible] telegraphic

banks of the canal and local Highways Boards. The company objected to have to pay [illegible] the purposes, and that such purposes were not contemplated by the agreement.

Mr. Justice [illegible] question for decision was whether the words "telegraph" and "telegraphic" included telephone. It was admitted by the Postmaster-General that the popular meaning of "telegraph" did not include "telephone," and that it would not have that meaning in an ordinary agreement between ordinary business men. The word "telegraph" was a word which had a legal sense different from its popular sense. In the Telegraph Acts, 1863 and 1869, it was defined in very wide terms. The Telegraph Act of 1869 was the Act which gave to the Postmaster-General his State monopoly in telegraphs. It was referred to in the recitals contained in the agreement with the Canal Company and it created the authority from which the agreement flowed. After referring to the cases Edison *v.* Attorney-General and the Postmaster-General *v.* the Great Southern and Western Railway Co., he held that "telegraph" in the agreement included "telephone," and he gave judgment for the Postmaster-General. There was a good reason for giving no costs; there was a want of clarity in the agreement for which both parties were responsible.

Attwell v. West Ham Corporation.

At Bow County Court last week the hearing was concluded of this action by Arthur E. Attwell, an engineer's fitter, against West Ham Corporation for damages for injuries caused by electric shock. The evidence for [illegible] and evidence was called by the Corporation to show that the man's idea that he was incapable of working was unnecessary. It was suggested that if the man had received an electric shock from high-voltage current he would have been utterly incapable of standing up and walking as he did. It was contended that all that happened to him was that he had got his hand burned—perhaps badly—but that was only because he had failed to put on the gloves which were provided for every workman; they were found in his bag afterwards. If he had been badly "shocked" it could only have been caused by his meddling with things in the high-tension chamber which he had no right to touch. He had had specific instructions as to what parts he could handle and what not, and if he chose to go outside his duties it was at his own risk. The man held himself out as one who had electrical knowledge, and he could keep himself out of all trouble if he only chose to take ordinary precautions.

Ultimately the jury gave a verdict for plaintiff for £350, and judgment was entered accordingly, with costs.

Winding Up Petition.—A petition by A. E. & A. C. Wheeler (trading as the Acme Electrical Mfg. Co.) for the winding-up of the Adnil Electric Co. (Ltd.) will be heard in the Royal Courts of Justice, London, W.C., on Oct. 19.

PARLIAMENTARY INTELLIGENCE.

SOUTHAMPTON CORPORATION (EXTENSION) ORDER.

The Bill to confirm the Order recently [illegible] before a Select Committee of the House of Lords. It will be remembered that when the Bill was before a House of Commons Committee the local gas company made a determined but unsuccessful effort to get the Northumberland clause inserted (*see* THE ELECTRICIAN for July 9, p. 525). The gas company continued its opposition before the House of Lords Committee, and on this occasion it was successful, but the clause is only to apply to the area covered by the extension.

Royal Assent [illegible] following Acts and Provisions:—

Exeter Local Government Provisional Order, Huddersfield & District Tramways (Extension) Order Confirmation, Electric Lighting Orders Confirmation (Nos. 2, 3, 4 and 5), Stalybridge, Hyde, Mossley & Dukinfield Tramways [illegible] Co.'s Facilities, Plymouth Corporation, Rhondda Urban District Council, Tramways Extension and [illegible] Council (Money), Lincoln Corporation, Special Acts (Extension of Time).

BANKRUPTCIES, LIQUIDATIONS, &c.

The [illegible] of Wm. Wallis Hamilton, [illegible] Donald Smith & Co., electrical engineers, Imperial Buildings, 2 & 3, Red Lion Court, Leeds, has [illegible] a petition.

A [illegible] Aug. 17 at the Official Receiver's Office, Bankruptcy Buildings, Carey Street, London, W.C., for the Public Examination of [illegible] Electrical Engineer, of 7, Dorset Square, London, N.W.

A [illegible] to wind up the Electrical Supply Syndicate, Limited, and the Secondary Submarine Telegraph Co., Ltd., will be [illegible] Sept. 10 at 105, Cannon Street, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Chesterfield. On Wednesday the Council approved a proposal to extend the [illegible] undertaking at an estimated cost of £15,200.

The Electrical Energy Committee reported that they had approved the plans and estimates of the electrical engineer (Mr. R. L. Acland), and they recommended that tenders be obtained, subject to satisfactory financial arrangements being made, for the enlargement of engine-room, installation of a 2,000-kw. steam turbo-alternator, with pipework, condensing and air-filtering plant, switchboard and cables, a water-cooling tank and pipework, overhead travelling crane, two superheaters and two mechanical stokers for the existing water-tube boilers.

Islington (London). Additional mains are to be laid in order to meet the increased demand for energy by factories engaged upon war work, at an estimated cost of £9,076, and application will be made to the L.G. Board for sanction to borrow this sum.

Southampton. The L.G.B. is unable to sanction the proposed additional loan for the purchase of a 750-kw. rotary converter, in lieu of the 500-kw. converter, in respect of which a loan was sanctioned in June, 1914.

Stoke-on-Trent.—The Electric Supply Committee have decided to equip a sub-station at Messrs. Kerr, Stuart & Co.'s works, at an estimated cost of £1,085.

Watford.—The electrical engineer (Mr. A. W. Barham) has been directed to obtain prices for switchgear for the Library sub-station and to purchase three 100-kw. and three 50-kw. transformers, under the existing contract.

The L.G.B. have sanctioned the borrowing of £1,819 for the electricity undertaking.

GENERAL

Glasgow.—At the meeting of the Electricity Committee last week the accounts for the year ended May 31 were approved.

It was decided, in view of the serious increase in working costs, to add 15 per cent. to all accounts, but if in the course of the year the costs can be reduced consumers will get the benefit. It is estimated that the saving to the electricity and gas departments by the provision regarding contracts which has been inserted in the Price of Coal (Limitation) Act will amount to between £50,000 and £60,000.

Kingston-on-Thames.—Owing to the deficit on the past year's working of the electric supply undertaking, the charges for current have been again increased.

The borough electrical engineer (Mr. J. E. Edgcombe) reports that the deficit, after repayment of capital, amounts to £1,295, compared with £720 in 1913-14. The year's working was prejudicially affected by the war, principally by the compulsory shutting down of all outside lighting.

At the meeting of the Corporation last week, Ald. LYNES said the decrease in revenue had been almost entirely in shop lighting. One solution of the difficulties was that they should sell the concern. They could, undoubtedly, get offers in normal times, but under existing circumstances no company could be started to take it over. The additional increased charges were estimated to bring in another £2,088, leaving an estimated deficit on the current year of £200. If all their plant had been driven by oil they could have reduced the cost of fuel by £1,759, the cost [illegible] per unit and [illegible].

Linking-up Scheme.—Woolwich Borough Council has decided to apply for the Board of Trade approval to the proposed linking-up [illegible] with the South Metropolitan Electric Power [illegible].

Luton. The Electricity and Tramways Committee report that the demand for electric [illegible] increased by over 80 per cent. in 12 months.

Last month 1,119,901 units were generated for general supply and 25,035 units for traction, and an equivalent of 739·8 c.p. lamps, 8 motors of 11 h.p. and 3½ kw. in heating, connected, making a total of 1,815 consumers with 67,791 lamps, 1,097 motors of 212 h.p. and 1,176 kw. in heating. There are also applications for over 4,186 additional lamps, 728 h.p. in motors and 504 kw. in heating. This is the first time the [illegible] has exceeded 1,000,000 units in a month.

Maidenhead. The Electric Council have been asked to support the [illegible] application for the Electrical Distribution of Yorkshire (Ltd.) for a provisional electric lighting order for the district.

Councillor J. H. Helliwell said that the company was nothing more than [illegible] the Yorkshire Electric Power Co. and he [illegible] that [illegible] the company could [illegible] and [illegible] that Council would [illegible] as well. [illegible] to apply to [illegible] the Council would [illegible] policy."

The [illegible] was not [illegible].

Plymouth. [illegible] Mr. [illegible] Mr. [illegible] of the Next [illegible].

The Committee decided to [illegible].

Spark's good work and to give him a testimonial under the seal of the Council. The Committee appointed Mr. E. G. Okell, engineer of the Prince Rock Works, borough electrical engineer, at a salary of £600 a year, rising by two annual increments of £25 to £650. Mr. Okell was instructed to submit at the next meeting a report on the reorganisation of the staff at the respective works consequent on the resignation of Mr. Spark.

Risca. The Council have decided to apply for a provisional electric lighting order.

Salford. Application is to be made to the L.G. Board for sanction to borrow £867, [illegible] capital expenditure on the electricity undertaking, in respect of loans sanctioned prior to March 12 last, and for sanction to borrow £850, being the amount estimated to be expended in excess of amount previously sanctioned for the Robert Hall and Peru[illegible] stations.

The Electricity Committee recommends the Council to waive the condition as to completion of contract in connection with the acceptance of the offer of the British Westinghouse Co. for the supply of a 5,000-kw. turbo-alternator, in consideration of the company agreeing to the incorporation in the contract of clause 31 of the model general conditions of the Institution of Electrical Engineers, and on the further understanding that the contract has been placed by the War Office on the same footing as a war contract and that it will be so treated as such by the contractors.

Torquay. The L.G. Board have notified the Council that they [illegible] to sanction the raising of loans of £1,577 and £3,518 to cover liabilities actually incurred, but they propose to defer issuing a consent order until it has been settled what other sums can be included.

Woolwich. The Borough Council has appointed Mr. J. H. Paul, B.Sc., F.I.C., to make an investigation of a corrosion that is taking place in the new economiser installed at Globe-lane works, including three months' periodical inspection, until the matter is remedied, at an inclusive fee of £52. 10s.

The charge for steam generated from refuse for electricity purposes for the year ended March 31 last has been fixed at £540.

The Minister of Munitions is to be asked to declare the Council's generating stations munitions factories as it is considered that the depletion of skilled and unskilled labour at the works should be under control so that it could not be possible for any other employer to take a man away without the Council's consent.

LIGHTING, POWER & HEATING NOTES.

Electric Pumping at Sewage Works. Windsor Rural Council have decided to engage [illegible] electrical engineer in connection with the proposal to adopt electric pumping for the Sunninghill and Sunning-dale [illegible].

Electricity Undertakings. At the recent meeting of the Spen Valley [illegible] Mr. J. Arthur Bayes, M.P.) said that on the [illegible] the Board reported the borrowing sum of £185,999, an increase of about £117,000 over last year. As soon as the station had been completed the amount standing against that item would be included under the item capital expenditure on buildings, plant, &c.

Infirmary Lighting. Fulham-road Infirmary Committee of Westminster Guardians has directed the Clerk to inquire upon what terms the Chelsea Electricity Supply Co. will supply current to the Institution in order to ascertain whether this would not be cheaper than [illegible] electricity at the infirmary. In the meantime the Board has decided to be supplied with electric current from the Supply Co.

TRACTION NOTES.

Blackpool. The Council have acquired an electrically driven water sprinkler.

The vehicle which was supplied by the General Vehicle Supply Co., was publicly tested on the Promenade on the 29th ult. The sprinkler [illegible] capacity of carrying 750 gallons of water and of spraying [illegible] in 12 minutes.

Bristol. In the annual report of the city engineer (Mr. L. S. Moorhouse) it is stated that, owing to the scarcity of horses, two motor rotary-brush machines had been ordered for the highways department, and the question of the adoption of electric traction for the [illegible] was being considered.

Chester. The Council have decided to purchase three electric [illegible] each for the removal of refuse, the cost being [illegible] £860 each. It is estimated that the [illegible] will effect a saving of £124 a year.

Colwyn Bay. It is proposed to construct a new loop of the Llandudno and Colwyn Bay Electric Railway from Abon Lwyd to the Marine Hotel, Old Colwyn, but so far failure to obtain the consent of [illegible] on the proposed route has blocked the scheme.

Hull.—In a report by the special committee on the working and financial administration of trading departments it is recommended that all accounts should be kept as far as possible by the departments responsible for the transactions dealt with as many unnecessary and redundant books could be dispensed with.

The present system of dual control of the tramways department is stated not to be conducive to the best interests of the undertaking. They recommend that the Tramways Committee be requested to prepare and submit to the Council a scheme for the unification of control under a general manager, who shall be responsible for the whole undertaking, and shall have control over all men engaged in tramway work.

A lengthy debate arose on the committee's recommendations, and ultimately they were rejected by 32 votes to 11.

Leicester.—The Electricity & Tramways Committee estimate the current year's expenses at £30,000 in excess of last year's owing to increased generating expenses, war allowances, &c., and propose certain increases of fares on the tramways.

Leyton.—Having regard to the difficulty of obtaining supplies of tram-rails, fish-plates, steel tyres, axles, &c., and the rising prices thereof, the Tramways Manager has been authorised to purchase a sufficient quantity to bring the stock up to the estimated requirements for 12 months.

Southampton.—The Electricity Committee is to fit up the chassis of the fourth electric vehicle primarily for main-laying work, and the borough electrical engineer (Mr. H. F. Street) has been directed to obtain tenders for various types of batteries in connection therewith.

West Ham.—The Corporation has been recommended to agree to the transfer of the control of the maintenance of the tramway tracks from the Highways to the Tramways Committee.

The tramways manager (Mr. J. S. D. Moffet) reports that if the work is taken over the principal staff that will be required to ensure the duties being carried out in a proper manner would consist of the following members: A civil engineering assistant, a surveying assistant and draughtsman, a general foreman and a foreman platelayer, and the approximate wages would amount to about £700 per annum.

The Corporation is also recommended to alter the title "tramways manager" to that of "general manager," and to fix the next of the two increments to the manager's salary at the rate of £100 per annum instead of £50 as previously agreed.

Wirral.—Notice has been given of the intention of Messrs. Johnson & Phillips to apply for powers to construct electric tramways in this district.

Women Tramcar Conductors.—Women conductors are now employed on the Barrow and Huddersfield tramway systems, and Leicester and Southampton Tramway Committees are considering the question of the employment of women.

TELEGRAPH AND TELEPHONE NOTES.

Cheap Cablegrams. A system of cheap cable services between Europe and certain points on the Pacific Coast of North America is announced by the Commercial Cable Company. All particulars as to rates, &c., can be ascertained from the Commercial Cable Co.'s offices, 63-64, Gracechurch-street, London, E.C.

Radiotelegraph Notes.—It is announced that a Commission is to be appointed by the Commonwealth Government to inquire into certain matters in dispute between Mr. J. G. Balsillie and Father Shaw. The latter is the inventor of what is known as the Shaw Radio System. The point at issue appears to be the alleged similarity between Mr. Balsillie's and Father Shaw's systems of radio operation.

EMPIRE NOTES.

Australasia.—"Tenders," Melbourne and Sydney, says opportunity will be taken, when the Local Government and Greater Sydney Bill is introduced during the forthcoming session of the New South Wales Parliament, to include clauses dealing with the licensing of wiremen and the removal of some of the disabilities at present existing under the Electric Lighting Act. The Electrical Association of New South Wales has been consulted by the Minister of Public Works on the subject.

Kyneton (Victoria) Shire Council has instructed Mr. V. J. Crowley, consulting engineer, to report on a proposal for the electric lighting of Trentham.

Blue Mountain Shire Council has approved of the draft bill to be submitted to the N.S.W. Parliament, empowering the Council to borrow £20,000 for an electric lighting scheme. It is proposed to erect the generating station at Wentworth Falls. For street lighting purposes there will be 365 50-c.p. and 11 100-c.p. lamps.

Sons of Gwalia Gold Mining Co. (W. Australia) is considering the advisability of installing an electrically driven pump.

Walgate (N.S.W.) Council has decided to submit the question of establishing electricity supply works to a plebiscite of ratepayers.

The "Commonwealth Engineer" says East Fremantle (W. Australia) Council propose to borrow £1,428, to which Fremantle municipality will add £8,571, for additions to power house plant, boiler, tramway extensions, two cars, lighting extensions, mains, &c.

The question of constructing electric tramways recently came before Albany (W. Australia) Council, a letter having been received from Mr. H. Stirling, who, in consideration for a 40 years' concession, offered to lay tram lines from the deep water jetty to Middleton Beach. The Council will consider the question further.

A committee has been appointed to inquire as to the probable number of electric lighting consumers which could be secured at Clare (S. Australia). Messrs. Lincolne, Macdougall & Demaine are advising the committee.

Mr. J. Bonding recently wrote to Kingaroy (Queensland) Shire Council stating that he was applying for an order-in-council to supply electric light to the town. It was, however, decided to defer consideration of the matter.

Bridger (Ltd.) has floated a company to establish electricity works in Mount Gambier (S. Australia), and the municipal council has decided to apply for an order-in-council sanctioning the work. The necessary capital has been underwritten.

North Sydney Council have decided to accept the offer of the North Shore Gas Co. for street lighting for five years at £4 per lamp per annum. Sydney City Council offered to supply electric light at £3. 2s. 6d.

The Te Kuiti (N.Z.) electric supply plant (60 kw.) is to be duplicated at a cost of £4,000.

A bulletin by Mr. G. R. Knibbs, Commonwealth statistician, on the Australian railways and tramways at June 30, 1914, states that electric tramways in Australia showed 357¼ route-miles open for traffic, of which 145¾ miles were in New South Wales, and 62 miles in Victoria. The total capital cost was £10,544,235, excluding the North Melbourne tramway, and 34½ miles in Queensland. The mileage of tramways of every description open in the Commonwealth to passenger traffic was 545, of which 286 were owned by Governments, 110 miles by municipalities, and the remaining 149 by companies or individuals.

The electric tramways in the eastern and south-eastern suburbs of Melbourne were extended recently by the opening of the line from St. Kilda-road along Commercial and Malvern-roads due east to Burke-road (about 4 miles) double track. The Prahran-Malvern Tramway Trust has now under its control 53 miles of lines.

At the new State abattoirs, Homebush (N.S.W.), electric motors are used to raise the side and tilt the floor of a pen after a beast is slaughtered, to raise the carcase on to rails and subsequently to lift it into a hanging position ready for cutting into "sides," which are conveyed by electric lifts into the chilling rooms. Carcases of sheep and pigs are also taken by electric conveyors into the chilling chambers. Electric elevators convey part of the edible products to the cooking rooms and the offal converted into fertiliser, and the tallow and casings, which are also by-products, are raised by electric elevators to the railway platform. The machinery in the laundry, for washing overalls, towels, &c., is also driven electrically; the ammonia compressors are driven by four 250-H.P. Sandycroft motors, and electric fans are used in the refrigerating department.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Compañia Alemana Transatlantica de Electricidad recently applied to the Municipality of Buenos Ayres for permission to extend its services to suburban districts by overhead lines.

The Intendencia has issued a decree conceding the authority with a stipulation that when the consumption exceeds a specified quantity overhead service shall be replaced by underground cables.

"La Nacion" states that a contract is about to be signed between the municipal authorities of Lincoln (Buenos Ayres) and an important German firm in the Federal Capital whereby the latter take over the lease of the electric light and power services.

Budapest. The City Council, which owns Municipal Electricity Works, has decided to acquire the undertaking of the Budapester Allgemeine Elektrizitäts Gesellschaft.

Chicago River Disaster.—The steamer "Eastland" capsized and sank in the Chicago River on Saturday, when about to convey about 2,400 of the 7,000 Western Electric Co.'s employees to a picnic at Michigan City, Indiana.

Italy. In a report by Mr. H. G. Doring (of the British Embassy, Rome) on the finances of Italy in 1914 it is stated that owing to the increase in the number of electrical plants established, both for power and lighting, the excise tax on electricity reached more than the estimated amount. The estimate for gas and electricity, which are not recorded separately, was £646,000 and the return was £709,198 (increase £63,198).

Swiss Railway Developments.—The "Mechanical World" states that the Swiss Federal Railway authorities have decided on the construction of a large new hydro-electric station at Massaboden, near Brigue, to supply energy for the trains operating through the Simplon tunnel. The station will replace the temporary power station now established at the north end of the tunnel.

MISCELLANEOUS NOTES.

Competition with Germany and Austria-Hungary.—List No. 31 of articles, the sources of supply or markets of which have been interfered with by the war, has been published by the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. United Kingdom manufacturers and exporters of British goods can obtain copies from the Director.

Directories.—We are promised a new Directory giving a classified trade list of telephone subscribers, and the "Telegraph and Telephone Journal" (which we still receive "O.H.M.S." and "With the compliments of the Postmaster-General") sets out as boldly as it can the advertising merits of the new publication. We are informed that the one thing a business man requires is this particular classified list of trades of telephone subscribers. It is, of course, true that most business people are on the telephone. If, however, this should not be the case their inclusion in the new Directory, which has the Postmaster-General's benediction, will be impossible. The great mistake that is made in the lengthy notice in the "Telegraph and Telephone Journal" commending this new list, is that it exposes a singular want of knowledge of the United States in the way of directories. That great country is, singular to say, peculiarly deficient in industrial directories. There is, for instance, so far as we know, no real electrical trades directory, consequently a book giving a classified trades list of telephone subscribers is necessary in that country, whereas it is not necessary in the United Kingdom, owing to the fact that the famous Kelly and other trade directories are available, giving not only the firms who are on the telephone but all firms. It will be seen that the stern necessity for the new book, in addition to the many excellent directories which are available in the United Kingdom, is not quite so pressing as the "Telegraph and Telephone Journal" would lead its readers to suppose, and if it were possible for this classified list to be run as a private enterprise, it might fail of its purpose. The very excellent Telephone Directory already available is, we consider, indispensable; any aggravation of the telephone users' troubles is undesirable. We contend that the market is already well supplied with trade directories the outcome of pioneer private enterprise.

Distinguished Conduct Medal.—Information has been received in Rugby that one of the first volunteers to enlist from the B.T.-H. Co. has been decorated with a Distinguished Conduct Medal.

This medal was awarded to Private A. Hotz, of the 1st East Surrey Regiment, for conspicuous gallantry on "Hill 60," when he placed himself in front of a communication trench occupied by the enemy and, on the enemy advancing, attacked them with hand grenades and dispersed them. Before the war Mr. Hotz was employed in the construction department of the British Thomson-Houston Co., and the members of the B.T.-H. staff are very pleased that one of their number has won this reward for gallantry.

Fire.—On Sunday a fire broke out at the works of the Ebbw Vale Steel, Iron & Coal Co., near Newport, Mon.

It is stated that the electricity generating station was completely destroyed, and that the damage amounts to £10,000. The inconvenience caused by the stoppage of the electricity supply will be considerable, as the station supplied current for power purposes to the whole of the extensive steel works, to several other works and shops in the district, and for the lighting of 30 miles of roads, &c. The cause of the fire is not stated, but at the time of going to press supply had not been restored, and most of the works have been compelled to close down.

"Halifax, a Commercial and Industrial Centre."—Sells (Ltd.) Fleet-street, London, forward a copy of a book with the above title, issued under the auspices of the Halifax Chamber of Commerce, Halifax Chamber of Trade and Halifax Advertising Club.

The price is 2s. 6d. The aim is to show the vast range of work done in the Halifax district and to attract to the area those contemplating setting up new works. It contains many illustrations and descriptions of important business premises, public buildings, monuments, the municipal electricity supply, gas and other undertakings, particulars of sites vacant and available for new works, a map of the district, &c.

Presentation.—On the eve of departure for Australia Mr. W. A. Holmans, a member of the staff of the Edison & Swan United Electric Light Co., of Ponder's End, Middlesex, for over 16 years, was presented by the staff with a diamond ring, a cabin trunk and a pocket book. Mr. Holmans is to be stationed in the Ediswan showroom at Melbourne.

Visit to Works.—Mr. F. Carrodus, senior science master of King's College School, Wimbledon, with a party of science students visited the engineering and Royal Ediswan lamp manufacturing sections of the Ponder's End Works of the Edison & Swan United Electric Light Co. on Thursday, the 29th ult.

TENDERS INVITED.

Incandescent Electric Lamps.

The Commissioners of H.M. Works, &c., are prepared to receive tenders for the supply of Incandescent Electric Lamps for contract from Sept. 1 next. Forms of tender, conditions of contract and [illegible] can be obtained from the Controller of Supplies, H.M. Office of Works, 18, Queen Anne's Gate, Westminster, S.W. Tenders, addressed to the Secretary, Storey's Gate, London, S.W., by 11 a.m., Friday, Aug. 13. *See advertisement.*

Wiring and Fittings.

Blackpool Corporation require tenders by Aug. 13 for Wiring and Fitting at the Military Convalescent Camp, Squire's Gate, Bristol. Specification, &c., from the Borough Electrical Engineer.

Glasgow Corporation want tenders by Aug. 12 for an Electric Lighting Installation for Gavanhill and district public baths and washhouses. Specification, &c., from the Office of Public Works, 64, Cochrane-street, Glasgow.

Tenders are required by Aug. 12 for Wiring and Fitting the new police court, Pontardawe (Glam.). Drawings, &c., can be seen and specifications obtained at Pontardawe Police Court or at County Hall, Cardiff.

Tenders are required by 10 a.m. Aug. 17 for Wiring Two Villas at Hull City Asylum. Specifications, &c., from the City Architect, Guildhall, Hull.

Turbo-Alternator, Dynamo, Battery, Wiring, &c.

Bexley Corporation Electrical Committee invite tenders for a 6,000 kw. Three-phase Steam Turbo-alternator, with Condensing Plant. Specifications and forms of tender from the chief engineer and general manager, Mr. H. Faraday Proctor, to whom tenders by noon Monday, Aug. 23.

Earby Urban Council require tenders by noon Aug. 16 for supply of a Dynamo, Battery, Wiring, &c., at their sewage disposal works. Specifications, &c., from the Engineer, Council Offices, Earby.

Telephone and Telegraph Material, Wire, Instruments, &c.

The Deputy Postmaster-General, Perth (W. Australia), receiving tenders by Aug. 25 for supply of cab. Telephones to [illegible] 131 and 100 320; and by Sept. 29 for Telephone Switchboards and Parts (schedule 470). Specifications, from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are required by Aug. 25, for the supply of Salammoniac (Specification 305), and Steel Galvanised Wire (Specification 414), and by 2 p.m. Sept. 1 for Condensers, [illegible] Tenders for the Victorian Commonwealth Postmaster-General's Dept. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Adelaide (South Australia) [illegible] Aug. 18 for Battery Material; [illegible] Switchboard Mountings and Terminal Pillars (schedule 380); the Assistant Director of Posts and Telegraphs, General Dept., Melbourne, [illegible] Aug. 11 for Telephone Switchboards and Parts (schedule 1218), [illegible] Aug. 11 for Telephone Instruments (schedule 1219), [illegible] Aug. 11 for Miscellaneous Material (schedule 1239). Tenders for the Victorian Commonwealth Postmaster-General's Dept. Specifications, from the Deputy Postmaster-General.

The Deputy Postmaster-General, Melbourne, invite tenders [illegible] Aug. 17 for Telephone Instruments and Switchboards [illegible] and for Telephone Instruments (schedule 1222), [illegible] Aug. 17 for Telephone Instruments (schedule 1218), [illegible] Aug. 31 for Miscellaneous Material (schedule 1239). Tenders for the Victorian Commonwealth Postmaster-General's Dept. Specifications, from the Deputy Postmaster-General.

The Deputy Postmaster-General, Wellington (New Zealand) invites tenders [illegible] Aug. 12 for Telephone Switchboards and Parts (schedule 470), [illegible] Aug. 12 for Telephone Cable, [illegible] Aug. 12 for Telephone Instruments and [illegible] Aug. 12 for Telephone Switchboards and Parts (schedule 470). Specifications, from the Deputy Postmaster-General.

Tramway Materials.

[illegible] Aug. 12 for [illegible] Tramway Rails, [illegible] Aug. 12 for [illegible] Tramway Rails, [illegible] Aug. 12 for [illegible] Tramway Rails, [

departments of the municipal offices and the temporary offices recently erected.

WOLVERHAMPTON.—The Corporation have accepted the tender of Dick, Kerr & Co. for the supply of 12 motor equipments for the tramways department.

EDINBURGH.—The Corporation have accepted the tender of Harrison & Gubbins for wiring the Dundee, Grosvenor and Percy Houses at £48.

MERTHYR TYDVIL.—The Council have placed an order with W. Lucy & Co. for the supply of 90 electric lamp brackets at 17s. 6d. each.

ASHTON-UNDER-LYNE.—The tender of the Lancashire Electrical Engineering Co. has been accepted for supplying half watt lamps for the remaining are lamps in the market.

OSWALDTWISTLE.—The Council have placed a contract with W. Rothwell & Sons for repairs of the fire brigade's electric bells.

SYDNEY (N.S.W.)—The Electric Light Committee recommend the Council to accept the following tenders for the supply of switchgear for a.c. sub-stations:—

Standard Waygood Hercules (Ltd.), extensions to Westinghouse switchgear; Noyes Bros., extensions to Ferranti switchgear; Australian General Electric Co., extensions to B.T.H. switchgear; N. Guthridge, 18 5,000-volt feeder panels, £2,520, and 30 5,000-volt transformer panels, £3,438; British General Electric Co., 22 415-volt transformer panels, £46. 7s., 28 415-volt distributor panels, £45. 10s., and eight 415-volt summation panels, £71. 18s.; Australian General Electric Co., low-tension feeders panels, £248.

DIMBOOLA (VICTORIA).—The following tenders have been accepted in connection with the electric lighting scheme:—

R. Hornsby & Sons, 52-H.P. gas engine, suction gas plant, &c., £958. 1s.; Edison & Swan United Electric Light Co., generator, booster, spares, fuses, &c., £362. 7s. 4d., and switchboard, erection of power-house equipment, £247. 2s. 3d.; W. G. Watson & Co., aluminium cables, £271. 14s., and [illegible] W. Melhuish & Co., meters and [illegible], £67. 8s. 4d.; T. K. Steanes, D.P. battery, £716. 17s.; N. W. Clements, supply and erection of poles and outside equipment, £350. 10s.

WYNYARD (TASMANIA).—The following tenders have been accepted by Mr. V. J. Crowley in connection with the electric lighting scheme:

R. Hornsby & Sons, suction gas plant, £1,068. 15s.; Sutherland & Ashburn, power-house plant, £1,940. 3s. 9d., and line erection work, £355; British Insulated & Helsby Cables, h.d. copper cables, £463 5s.; W. T. Henley's Telegraph Works Co., insulated rubber cable, £33. 16s. 9d.; Grant & Vincent, meters, Australian insulators and fuses, £263. 6s.

COONAMBLE (N.S.W.)—The following tenders have been accepted in connection with the electric lighting scheme for Coonamble:—

Falkiner Electric Co., Dudbridge gas engine; Electric Construction Co., 50 kw. generator; Siemens Bros. Dynamo Works, booster; Tudor Accumulator Co., 435 ampere-hour storage battery; Amalgamated Gas Producers (Ltd.), Cambridge gas producer.

BUENOS AYRES.—The tender of the Gamewell Fire Alarm Telegraph Co. has been accepted for supply of 200 fire-alarm stations and central apparatus to the police department at $79,409 m./n. (about £6,900). The company will provide an expert to supervise the installation work at a monthly salary of $250 gold. Siemens, Schuckert (Ltd.) also tendered.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bedford.—The accounts of the electricity department for the year ended March 31 show total capital expenditure £155,049 (increase £11,376), of which £75,493 is outstanding.

Revenue was £28,076, and working and general expenses were £14,851, leaving gross profit £13,225. Interest required £2,800, and instalments of principal £6,814 and the amount transferred to reserve was £1,610 and to aid of rates £2,000. Units generated were 3,831,340 and sold 3,065,682. Total maximum supply demanded was 1,800 kw.

Bexhill. The electricity department's accounts for the year to March 31 show gross capital expenditure £80,962 (increase £3,371), of which £29,963 has been repaid.

Revenue was £13,017 (compared with £13,366 in previous year), working costs were £6,799 (£7,172), gross profit was £6,218 (£6,524). Interest and sinking fund required £5,223 (£4,975), and, after providing for depreciation and income tax, the net profit was £707 (£984). Average revenue per unit was 1·20d. (1·01d.), and per unit sold was 2·21d. (2·25d.). Working and interest and sinking fund were 1·70d. (1·55d.). Units generated were 885,104 (918,225) and sold 736,964 (769,571). Maximum demand was 376 kw. (400 kw.).

Mr. Chas. A. Frost (acting borough electrical engineer) says in his report the Crompton switchboard has been in every way a success. 111 additional consumers were connected, making a total of 1,174. Owing to the death of Isham Scrutton, director and chairman of the works, and also several members of the Local Bill and Rates Committee, it has been necessary to consider the application for a supply of electricity.

Bradford. The gross capital expenditure on the electricity undertaking to March 31 was £931,284 (increase £19,912), of which £405,570 (£405,570) has been repaid.

Income was £117,881 (£111,912), and working expenses £71,487 (£66,[illegible]), leaving gross profit £46,394 (£45,[illegible]). Interest and sinking fund required £[illegible] (£21,[illegible]), and [illegible] (£18,511), net profit £[illegible] (£14,900). Income per unit sold was 1·44d. (1·43d.), and expenditure [illegible] (1·[illegible]). Units generated were [illegible] (19,[illegible]), and sold 28,147,718 (27,[illegible]). Consumers connected at 31,610 (30,485). Maximum load was 9,850 kw. (9,181 kw.), and load factor [illegible] (3·81). Coal consumed, 22,261 tons. Price per unit [illegible] to 0·[illegible]. Total number of lamps [illegible] (11,088), and [illegible] (1,000). Total [illegible] and [illegible] (1,[illegible]).

Brighton.—The accounts of the electricity undertaking for the year ended March 31, which were received and adopted by the Council last week, show total capital expenditure £839,958 (increase £2,985), of which £380,460 has been repaid or provided for repayment.

Revenue was £88,345 (compared with £92,908 in previous year), and total costs were £45,379 (£45,889), leaving gross profit £42,966 (£47,219). Interest required £17,871 (£18,291) and sinking fund £26,149 (£26,586), and the net result was a deficit of £1,354 (compared with a profit of £2,342). Total costs were 1·06d. (1·01d.), or 2·10d. (2·02d.) including capital charges. Average price obtained was 3·38d. (3·33d.) per unit. Units generated were 12,342,172 (12,882,747) and sold 10,214,436 (10,713,110). Maximum load was 4,960 kw. (5,250 kw.) and load factor 23·5 (23·3) per cent.

The engineer and manager (Mr. John Christie) says in his report £1,979 was spent out of revenue on new meters. The curtailment of outdoor and shop lighting and other restrictions enforced by the military authorities have caused a loss of £3,708 in revenue. Units for private power, heating and cooking increased by 121,041. Consumers were 6,453 (increase 307) with the equivalent of 441,691 30-watt lamps (increase 18,700). 67 of the men have enlisted, and the allowances paid to their dependents amount to £2,000 per annum.

Bury St. Edmunds. The account of the electricity department for the year ended March 31 shows revenue £5,079, an increase of £729.

Working expenses were £4,138, interest required £1,039 and sinking fund £975. The total outgoings were, therefore, £6,152, thus showing a net deficit on the year, but the working expenses included £300 for repairs. Units sold were 963,886. Working expenses were 2·42d. per unit sold, but this figure is affected by the expenditure on new plant and by the fact the fuel consumption was increased by continuous running of the generating plant while the new steam turbine was being installed. There are 75 motors connected (increase 17) 420 H.P. A free wiring scheme was introduced in the autumn of 1914, current being supplied at 6d. per unit, and the expenses of this have been [illegible]. Two consumers are supplied on a two-part tariff, and over 40 applications have been received for similar installations.

Bootle. The electricity department's accounts for the year ended March 31 show total capital expenditure £182,774 (increase £8,071), of which £59,000 has been repaid.

Revenue was £29,191, and total costs were £16,000, leaving gross profit £13,188. Interest required £4,035, instalment of loan £2,044 and sinking fund £4,[illegible], leaving a balance of £[illegible] to be carried forward. Units generated were 1,232,288 and sold 1,[illegible]. Total maximum supply demanded was 2,480 kw.

Carlisle.—At March 31 the capital expended on the electricity department was £126,174 (increase £13,693), of which £82,746 is outstanding.

Revenue was £21,404 (against £21,229 in previous year), total working expenses were £13,063 (£14,068), and gross profit was £8,341 (£7,161). Interest required £2,963 (£2,626) and instalment of capital £5,301 (£4,744), leaving net profit £76 (compared with deficit £209). Units generated were 4,282,873 and sold 3,470,492 (3,140,457). Total maximum supply demanded was 2,018 kw. (1,944 kw.), and plant capacity was 2,670 kw. (as in previous year). Load factor was 19·6 (18·45) per cent. Works costs were 0·49d. (0·50d.) and total costs, including capital and special charges, 1·47d. (1·64d.)

Mr. F. W. Purse (city electrical engineer) says it is not proposed to make any increase in the present scale of charges in spite of the higher price of coal and other commodities.

Croydon. The accounts of the electricity department for the year ended March 31 show total capital expenditure £367,632 (increase £4,281), of which £268,248 is outstanding.

Revenue was £70,055, total expenditure was £43,201 (£45,935), and gross profit £26,854, sinking fund, interest and income tax (£1,684) absorbed £25,142, leaving net profit £2,595.

Mr. Alex. C. Cramb (borough electrical engineer) reports that the units generated were 9,553,001 (against 9,767,313 in 1913-14) and sold 7,777,812 (7,802,772). Efficiency of distribution was 84·38 (80·81); heating and cooking units were 338,515 (212,665) and power units 976,539 (858,624), and traction supply also increased slightly, but there were reductions in public and private lighting supplies. Average price of coal was 17s. 8d. (17s. 11d.) per ton. Average price obtained was 2·11d per unit (as in previous year). Load factor was 24·6 (20·3) per cent. In spite of the heavy increase in working expenses the only increase in charge for current has been the increase in the flat rate for lighting from 3½d. to 4d. The whole of the office staff eligible for the army joined last September, the vacancies being filled by women, and 31·25 per cent. of the employés have joined or been called up.

The reports and accounts were adopted at the Council meeting last week.

The gross capital expenditure on the tramways is £286,000, of which £106,000 has been redeemed. After providing for working expenses, interest, &c., the surplus was £7,605, out of which £7,414 was required for repayment of loan and sinking fund contribution, leaving a net profit of £190. This has been placed to reserve, which now stands at £41,643. Men of the tramway department who have been called up or enlisted are 133 (34·04 per cent.)

Glasgow. The accounts of the electric supply department for the year ended May 31 have been approved by the Electricity Committee.

The gross revenue was £405,372. 16s. 6d. (against £378,315), working expenditure £218,517. 18s. 10d. (£200,807), and the net revenue £186,854. 17s. 8d. (£177,417. 19s. 11d.). Interest on loans and contributions to sinking fund amounted to £134,568. 15s. 5d. (against £124,428), leaving £52,286. 2s. 3d. Depreciation at same rates per cent. as in 1913-14 required £52,745. 6s. 4d., making a deficit on the past year's operations of £459. 4s. 1d., against a surplus of £819. 0s. 9d. The reserve fund amounts to £48,854. 10s. 3d. There was an increase of income from all sources of £27,057. 15s. 7d., despite the abnormal conditions prevailing. On the other hand, working expenses increased by £17,620. 17s. 10d., due (apart from the larger output) to an advance in wages to workmen, a general overhaul of plant and mains, increased rates and taxes and to a sum of £3,144. 12s. 10d. for allowances granted to those on active service with his Majesty's Forces. The average price received from consumers was 1·074d. per unit, compared with 1·157d. in 1913-14. The capital expenditure during the year amounted to £173,150. 6s. 6d., and the total capital expenditure at May 31 (less depreciation) was £2,577,187. 9s. 4d. The total depreciation written off capital account is £653,203. 19s. 8d. The number of consumers is 32,030 (against 30,098); the quantity of electricity sold to private consumers during the past year was 85,718,795 units, against 73,988,649 units, increase of 15·85 per cent.

Gloucester. The accounts of the electricity and light railways department for the year ended March 31 were approved by the Council last week.

The revenue of the electricity department was £15,562 (against £15,125 in 1913-14), working expenses were £7,910 (£7,904), and gross profit £7,118 (£7,021). Capital charges required £7,118 (£7,201), leaving net profit £nil (£179). After crediting £2,653 to [illegible] house services, &c., and £2,465 to [illegible] the deficit was reduced to £1,000, although there were decreases in the demands for street lighting and tramways. The question of increasing the tariff for current has been deferred.

The gross capital expenditure on the light railways is £147,782. Revenue was £12,504, working expenses £8,401, leaving gross profit £4,103. Interest, sinking funds, rent for county lines, income tax, reserve, &c., required £7,612, towards which £3,510 was provided by City [illegible] £1,000 [illegible] and £102 [illegible] £621,402, and units sold to [illegible] and to [illegible] 140,384

Hastings.—The electric supply accounts for the year to March 31 show total capital expenditure £176,883 (increase £3,335), of which £94,232 has been repaid.

Revenue was £25,226 (compared with £25,338 in previous year) and total expenditure was £12,732 (£12,468), leaving gross profit £12,494 (£12,870). Interest, sinking fund, &c., required £11,648 (£11,573), and the net profit was £846 (£1,297). Fuel cost 6·79d. (0·85d.) per unit sold, and total costs, apart from capital charges, were 2·12d. (2·05d.). Units generated were 1,383,072 (1,388,186) and sold 1,277,072 (1,284,501). Plant capacity was 1,850 kw., maximum demand 640 kw. (700 kw.), and load factor 22·77 (20·95) per cent.

The restriction of window lighting and prohibition of outside lighting affected trade adversely, and the expenditure out of revenue included £113 war service allowances and £213 for meters.

Mexborough.—The past year's trading of the electricity department shows a net profit of £329 which has been placed to reserve. Last year the surplus was £1,043.

The Council are applying for permission to borrow £4,000 for electricity works extensions.

Newcastle-under-Lyme. The borough electrical engineer, Mr. A. J. C. De Renzi, says in his report, which accompanies the accounts of the electricity department for the year ended March 31, units sold show an increase of over 54,000 units, or 57 per cent.

Cost of fuel oil has been reduced by 27 per cent., the average price paid being approximately 70s. per ton, against 81s. per ton in 1913-14. Working costs have been reduced by approximately ¼d. per unit. These results are almost entirely attributable to the large increase in the power load secured last autumn. The plant can now be run at all times with a good load. The use of the new storage battery installed in October last has been very beneficial. Had the old battery been still in use it would have been necessary to run the plant all night except at week-ends. 50 per cent. of the staff have joined either the Army or Navy, and other members have offered their services but have been rejected. In the present year Mr. De Renzi thinks it probable that the undertaking will make both ends meet without resorting to any advance in price. For this result the Diesel engines are largely responsible. In December last the department accepted a 12 months' contract for fuel oil at a very reasonable price, and they were not affected in the same way as undertakings using coal.

The accounts show total capital expenditure £20,088 (increase £3,429), of which £14,146 is outstanding. Revenue was £3,303, working and general expenses were £1,671, leaving gross profit £1,632, and after meeting capital charges, &c., the net profit was £255. Maximum load was 182 kw. (161 kw.), units generated were 270,783 (188,501) and sold 200,064 (145,509).

Norwich. The electricity department's accounts for year ended March 31 show total capital expenditure £352,863 (increase £23,193).

Revenue was £57,261 and working and general expenses were £31,011, leaving gross profit £26,250. Interest required £11,259 and sinking fund £7,241, while £4,055 was spent on permanent works, leaving a balance of £3,957. Units generated were 8,969,315 and sold 7,718,540. Total maximum supply demanded was 4,202 kw.

In moving the adoption of the accounts at the Council meeting last week the chairman of the Electricity Committee (Mr. E. Wild) said the surplus (£8,000) was the highest they had had with the exception of the previous year. During the last three years £34,000 had been applied to capital purposes. The cheap supply of electricity had enabled the local factories to attract war work to the city. The Committee hoped so to manage that they would not have to raise their rates. There was a saving in working expenses of £222, but that has been more than absorbed by war allowances. The saving of £706 on coal was entirely due to higher efficiency of plant as the average price per ton was 17s. 4d. (against 16s. 11d.)

Portsmouth. The accounts of the electric supply department for the year ended March 31 were approved by the Council last week.

Ald. F. G. Foster said they had only a profit of £385 to hand over this year, entirely in consequence of the war, compared with £3,342 last year. Cost of coal, &c., had increased, and 40 of their staff had joined H.M. Forces, so that they had difficulty at times in keeping the works going. Revenue was less by £1,741. The smaller power lamps which had been tried for street lighting would not stand the vibration, and the old lamps were reverted to. He regretted, in view of the war, that they had undertaken to pay about £10,000 for a new engine out of revenue.

The capital expenditure on the undertaking is £365,886 (increase £10,176), of which £182,809 has been redeemed or is in loans fund. The year's revenue was £51,608 (against £53,349), working and general expenses were £28,642 (£29,146), and £605 has been granted to dependents of employés serving in H.M. Forces, the balance carried to net revenue account being £22,361 (£24,203). Instalments of loans and interest required £21,550 (£20,696) and income tax £425 (£164), leaving £386, which has been transferred to reserve. Last year £3,000 was devoted to relief of rates. Total maximum supply demanded was 2,550 kw. Units generated were 4,761,520 and sold 3,779,600.

Redditch. The accounts of the electric supply department for the year ended March 31 show total capital expenditure £18,296 (increase £122), of which £9,138 is outstanding.

Revenue was £9,588 (against £9,661 in previous year), and total costs

(including special expenditure on wiring sundries, meters, free wiring rents and insurances, £343) were £8,970, leaving £618 gross profit. Interest and tax required £1,170 and instalments of principal £1,956 Units generated were 1,537,683 (compared with 1,604,753) and sold 1,283,927 (1,433,666).

Mr. R. N. Mayne (engineer and manager) says in his report coal and destructor men's wages were equal to 0·68d. (0·71d.) per unit sold, and total working costs were 1·63d. (1·37d.). The results obtained during the year were far from satisfactory, owing to several causes, including a breakdown of the turbine for 14 days in August, and for 3½ months from Dec. 18 to the close of the year. During the time the turbine was out of commission it was necessary to run all the old plant, and a larger amount of fuel was consumed, while the output was diminished, consumers not being able to have the full current required.

Sheffield.—The accounts of the tramways department for the year ended March 25 show capital expenditure (less depreciation on old horse-traction system) £1,425,664 (increase £36,807), and the total sum provided out of revenue for loan redemption is £512,567.

Revenue was £396,229 (compared £392,397 in previous year) working expenses were £246,829 (£232,761). Income tax required £5,566 (£3,305) and interest and sinking fund £73,893 (£78,722), leaving net balance £69,939 (£77,607), of which £22,876 (£30,581) is being devoted to relief of rates. Average fare charged per mile was 0·371d. (0·379d.), revenue was 10·747d. (10·527d.) and working expenses, including power, were 6·568d. (6·288d.). Passengers carried were 107,023,195 (104,851,408). Car-miles run 8,810,252 (8,883,576) and units used 18,329,775 (18,809,360). There have been paid in war allowances to employés £5,706. The amount spent out of income in general repairs and maintenance during the year was £48,285.

Southampton.—On the tramway undertaking the gross capital expenditure at March 31 was £257,008 (increase £451), and the outstanding loans amount to £158,728.

Revenue was £71,038 (against £70,598 in previous year), and gross profit £20,732 (£24,077). Interest required £8,336 (£7,708), and redemption and sinking fund £12,396 (£16,369). £5,000 (£7,118) was set aside for depreciation, leaving £5,000 (£7,118) for relief of rates. Average receipts per car-mile were 10·01d. (10·97d.) and working expenses 7·09d. (7·23d.). Passengers carried were 13,265,715 (13,162,224), car-miles run 1,703,032 (1,543,941).

Tunbridge Wells.—The report of the borough electrical engineer (Mr. R. N. Torpy) for the year to March 31 states that the total capital expenditure on the electricity undertaking was £100,384, an increase of £4,798 during 1914-15.

Revenue was £8,613 (increase £1,942), and gross profit £9,629 (increase 9·8 per cent.). Interest and loan repayments required £6,472 and net profit was £3,157 (£2,165). Coal cost 0·74d. per unit sold, and total costs (other than capital charges) were 1·49d. (1·65d.). Units sold were 1,334,729 (1,126,622). Maximum load was 907 kw. (765 kw.), and load factor 16·8 (16·90) per cent. During the last six months of the year prices of materials increased by 10 to 15 per cent. and fuel by 4s. per ton, or 22 per cent. The popularity of the 1d. power and heating rate is very evident. Units for those purposes increased by 48 per cent., and new connections for power and heating amounted to 4,693, equivalent to 30 watt lamps. The changes which have taken place have generally improved the lighting of the district—16 50 c.p. lamps were raised to 100 c.p. each, and 12 arc lamps replaced by half-watt lamps.

A new 300 kw. high-speed turbine has been installed at the works, and the steam trials have been most satisfactory. During the day when this set runs steam consumption drops from 28 lb. to 21 lb. per unit. Under-feed mechanical stokers have been fitted to three Babcock boilers, and have proved economical and reliable. A new Hall slow-speed feed water pump and a feed water filter have been installed. The coal bunkers have been extended, and a new coal store and wharf have been obtained, in which about 700 tons of coal have been stored. Works costs per unit were reduced by over 10 per cent. The liability of the undertaking is now under £30,000, and last year's net profit was (£3,157) the highest ever obtained. Coal cost was again reduced by 0·04d. per unit, but wages increased slightly. Average price obtained decreased from 3·45d. to 3·25d. for private supply, and from 3·21d. to 3·05d. for the total supply, chiefly owing to the increase of power units. In 1914 168,228 units extra were sold at no extra cost, and this year 208,107 extra units were sold at an extra cost of £511, or a little over ½d. each. Statements have been made that the undertaking loses money on all 1d. units, but the increases in units sold in each year are more than 50 per cent. of 1d. units, and yet the net profit for each of the last two years has increased by about £1,000.

Wimbledon.—The accounts of the electricity department for the year ended March last were adopted by the Council last week.

Ald. Stuart, in submitting the accounts, said the undertaking had made a net profit during the year of £2,183 (against £3,471 last year). That was very satisfactory, considering what the department had had to go through in connection with coal matters, enhancement of wages, &c. The outstanding debt was £166,103, and the year's gross profit was £19,618. Last year the profit represented 11¾ per cent. on the capital cost, and that figure had been practically stationary for the last three years. £96,163 had been paid off since the undertaking was started 17 years ago. The maintenance of the station was second to none in the country for efficiency. The committee had to watch carefully the coal question, for the present average price per ton was 22s. 11¼d., against 16s. 7½d. last year.

Winchester.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £101,402 thereon £1,737 of which £735 has been repaid.

Revenue was £14,649 (compared with £13,157 in previous year), working expenses were £8,047 (£7,819), gross profit being £6,601 (£5,338. £5,015 (£4,694) was appropriated for loan redemption and interest, and £268 (£240) for other purposes, leaving net profit £1,317 (£404). Coal cost per unit sold 0·415d. (0·440d.), and total costs, exclusive of capital charges, were 1·523d. (1·977d.). Units generated were 1,221,470 (947,316) and sold 965,622 (739,529). There are 1,189 (1,166) consumers, and total connections are equal to 2,294 kw. (2,025 kw.). Motors connected are 137 (118). The maximum load on station was 639 kw. (547 kw.), and the plant capacity is 850 kw.

COMPANIES' MEETINGS AND REPORTS.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—At the meeting last week the chairman (Sir Chas. Ollivant, K.C.I.E.) said that they had not increased the rate of dividend (6 per cent.) but they had adopted the more prudent course of increasing the carry-forward from £4,349 to £8,326. The gross receipts were £302,569 (increase £26,100) and net receipts £157,582 (increase £12,010). Their traffics had been affected by the heavy falling off in the export and import trade of the Port of Bombay and to other causes. For the first seven months of 1914 they carried 24,192,216 passengers (against 23,092,082 in 1913), but for the second five months they only carried 16,257,418 passengers, compared with 17,599,940. The decrease in net earnings of £4,961 was mainly due to the fact that the traffic expenses for 1914 exceeded those of 1913 by £4,173. There had been a continuous recovery in their traffic receipts since the commencement of the current year. The progress of the electric supply branch had been very satisfactory, the net earnings showing the handsome advance of £17,700. They were fortunate in securing temporary supply for power purposes to two of the Bombay mills during the last six months of 1914. Those mills were under contract to purchase electric energy from the Tata Hydro-Electric Co. so soon as that company was able to give a supply. This occurred early in February, when the two customers passed to the Tata Company. The latter company was restricted to supplying factories and railways whose annual consumption was not less than 500,000 units. For the five months of the current year there had been a considerable increase in the number of units sold compared with last year, and all the extensions of mains laid last year were yielding good results. During the year the capital expended was £46,461, of which £36,195 was on the supply and £10,266 on the traction branch. They deemed it advisable to postpone for the present some extensions of the tramway lines which they had in contemplation owing to the very heavy rise in the cost of materials and the adverse influences checking the normal growth of traffic. On the other hand, they were steadily pursuing the policy of extending the supply mains into any districts of the city not yet served and where it was demonstrated, as the result of careful canvassing, that the returns in sight justified the expenditure. The progressive realisation by all classes of the Bombay public of the conveniences and economy of electric lighting and the hygienic benefits of electric fans had resulted in a growth in the demand for both, which rendered possible many extensions which could not have been justified a year or two ago.

COUNTY OF DORSET ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the directors' report for 1914 stated that the capital expended and invested in the associated companies to date was £39,041. 5s. 1d. The revenue receipts (exclusive of Lyme Regis dividend) were £1,062. 5s. 1d. against £46. 0s. 9d. last year, and the gross profit (including Lyme Regis Co.'s dividend) was £339. 10s. 11d. Interest on temporary loans required £499. 14s. 9d., and the deficit on the year's operations was £160. 3s. 10d., against a deficit of £653. 14s. 6d. in 1913. The subsidiary companies, viz., the Lyme Regis Electric Light & Power, the Blandford Forum & District Electric Supply and the Swanage Electricity Supply Companies, have each shown satisfactory progress. The Lyme Regis Co. showed a substantial profit on the year's working, and a dividend of 10 per cent. was declared. The Blandford Co. only commenced supply three weeks prior to Dec. 31, 1913, and the Swanage Co. has only been operating for about 11 months. The number of consumers in Dorchester on Dec. 31 last was 89, in Blandford 39, in Lyme Regis 126, and in Swanage 70. The company's progress from its inception to the present moment has been uniformly steady and satisfactory. The report and accounts were adopted.

ELECTRIC SUPPLY CORPN. (LTD.)—At the meeting last week the chairman (Mr. J. G. B. Stone) said there was a satisfactory growth in the number of lamps connected, from 210,266 to 214,715 32 watt lamps. The Hendon company had progressed most favourably, and they had received a handsome dividend on their shareholding. The Dumbarton tramway paid the same small dividend. As regards the sale of current, they had been adversely affected by the war, but they had had an increased demand for power supply, more particularly in Dumbarton, which is an active centre for shipbuilding and for the production of war munitions.

The actual cost had not been very materially affected. They would have higher prices for skilled and unskilled labour and for coal in future. In addition to bringing their reserve to £10,000, they now proposed to inau- [illegible] The board do not think it politic to pay more than 2½ per cent. dividend. The small additional payment under present conditions was encouraging, and marked the general improvement in face of the difficult conditions [illegible]

NORTH BERWICK & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.)—At the meeting last week Sir E. Schafer, who presided, said that for all practical purposes the report represented the result of the first year's working, and that was distinctly encouraging, since, in spite of the outbreak of war, there was only a comparatively small deficit on the year's working. The directors looked confidently to a large increase in business in the near future, for a considerable number of houses had already been connected during the present year, and new applications were continually being received.

YORKSHIRE ELECTRIC POWER CO.—The directors' report for the six months ended June 30 states that there has been an increase in the revenue from the sale of electrical energy, but owing to additional costs occasioned by the war, the net profit, after payment of mortgage and other interest, shows a small decrease on that for the corresponding half-year of 1914. Both wages and materials have become more costly during the war and the conditions of the coal market have been especially difficult. The net profit was £9,873. 8s. 9d., against £10,414. 5s. for the corresponding period in 1914 and £6,971. 18s. 9d. in 1913. The directors have declared a dividend for the half-year on the 6 per cent. cumulative preference shares which will absorb £5,051. 3s. 3d., but they are of the opinion that under the circumstances the consideration of a dividend on the ordinary shares should be deferred until the end of the year. The advantages which have repeatedly been claimed for a public supply of electricity have been emphasised by the present conditions. Old consumers have increased their demands and many important new consumers are being supplied. Power users whose premises are connected to the company's mains find that with a minimum of expenditure and without delay they [illegible] the ample extended requirements for war and other purposes. Owing to over one-fifth of the company's employees having enlisted and to the growth of the business more work has fallen upon a depleted staff. The directors have pleasure in drawing attention to the cheerful spirit with which these extra responsibilities have been undertaken.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

AMALGAMATED STORES (LTD.) (141,060.)—Reg. July 22, capital £1,000 in £1 shares. Mortgage and general trading business of general suppliers, distributors and sellers of all kinds of goods by retail, wholesale, auction or otherwise, to carry on business of installers of electric light and power, &c. Private company. First directors, T. G. O'Sullivan and others to be appointed by subscribers.

E. M. B. SYND. (LTD.) (140,933.)—Reg. July 10, capital £1,000 in £1 shares (900 preferred ordinary and 100 ordinary) to carry on the business of mechanical and electrical engineers, machinists, wire drawers, [illegible]

HOBSON MANUFACTURING CO. (LTD.) (141,144).—Reg. July 28, capital [illegible] (Ltd.) for acquisition of the goodwill of the branch of their business established for the manufacture and sale of patent sparking plugs known as new Hobson plugs, to carry on the business of manufacturers of and dealers in sparking or ignition plugs, component parts and accessories. [illegible] and P. R. Shackel. Reg. office: 29, Vauxhall Bridge-road, S.W.

INVICTA GLASS & NAUTICAL INSTRUMENT CO. (LTD.) (140,980)—Reg. July 15, capital £10,000 in £1 shares, to carry on the business of [illegible] insulator manufacturers, glass blowers, moulders, cutters, polishers and [illegible]

NEW ERA SIGNS (LTD.) (140,951) Reg. July 12, capital £5,000 in [illegible] [illegible], W.

PHŒNIX ARMOURING & CABLE CO. (LTD.) (141,042.)—Reg. July 20, capital £1,000 in £1 shares, to carry on the business of cable armourers, cable makers, mechanical and electrical engineers, &c., and to adopt agreement with F. Pugsley and I. S. Watts. First directors, F. H. Pugsley and I. S. Watts.

RAMSDEN GREEN (LTD.) (141,122).—Reg. July 27, capital £2,000 in £1 shares, to take over from F. J. Green the business of an electrical and mechanical engineer carried on by him as the Crathorne and Green Manufacturing Co. Private company. First directors are F. J. Green (permanent) and B. E. Green. Reg. Office: 10, Wagner-street, Old Kent-road, S.E.

SMETHWICK MACHINE SHOPS (LTD.) (141,067.)—Reg. July 22, capital £2,000 in £1 shares (500 preference), to carry on the business of ironfounders, mechanical and electrical engineers, machinery manufacturers, &c. Private company. First directors, C. G. Garrard (chairman) and S. Egerton.

STRATFORD ENGINEERING & GRINDING MILLS (LTD.) (141,124).—Reg. July 27, capital £10,000 in £1 shares, to carry on the business of mechanical, electrical and general engineers, machinery manufacturers, metal workers, &c. Private company.

TELEPAD (LTD.) (141,030.)—Reg. July 19, capital £4,000 in £1 shares, to take over the benefit of patent No. 8,973 (1913), to carry on business of manufacturers of and dealers in telephone attachments and fittings, &c., electrical and general engineers, &c. Private company.

WAVE TRANSMISSION (BRITISH EMPIRE) SYND. (LTD.) (141,159)—Reg. July 30, capital £1,000 in £1 shares, to acquire any patents, buildings, works or other real or personal property, and to carry on the business of engineers, manufacturers of engines and other machinery, tool makers, metal workers, &c. Private company. First directors are W. Haddon (chairman) and Gogu Constantinesco (both permanent). Reg. office: 3, St. Bride's House, Salisbury-square, E.C.

E. H. WHEELER & CO. (MANCHESTER) (LTD.) (140,979)—Reg. July 15, capital £5,000 in £1 shares, to carry on the business of manufacturers of indiarubber insulating materials, asbestos of all kinds, &c. Private company. E. H. Wheeler is first governing director. Reg. office: 8, South-parade, Deansgate, Manchester.

STATUTORY RETURNS.

ANCHOR CABLE CO. (LTD.)—Return dated May 20, 1915. Capital £250,000 in £10 shares. 6,500 shares taken up. £10 per share called up on 6,100. £61,000 paid. £4,000 considered as paid on 400 shares. Mortgages and charges: £50,000.

ANGLO-FOREIGN TRAMWAY SYND. (LTD.)—Capital in return to Aug. 19, 1914 (filed May 31, 1915) is £10,000 in 9,500 preference shares of £1 each and 5,000 A, 1,000 B and 1,000 ordinary shares of 1s. each. 4,200 preference, 370 A and 74 B shares taken up. £1 per share called up on the preference and £ per share on the A and B. £4,222. 4s. paid. Mortgages and charges nil.

BIRKDALE DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The capital return to May 17 is £50,000 in £5 shares. 9,200 shares taken up. £5 per share called up on 6,000 and £3 per share on 3,200 shares. £39,600 paid. Mortgages and charges at date of return: £3,000. Since issued (May 18, 1915): £3,000 debentures, ranking equally with 1st £3,000.

BROOK, HIRST & CO. (LTD.)—Capital in return to Jan. 14 is £20,000 in £1 shares. 12,500 shares taken up. £12,500 considered as paid. Mortgages and charges: £7,000.

ELECTRIC SUPPLY CO. OF WESTERN AUSTRALIA (LTD.)—Return to [illegible] capital at £100,000 in £1 shares. 7,697 shares taken up: £16,697 paid and £28,400 considered as paid. Mortgages and charges: Nil.

ELECTRO CHLORINATION SYND. (LTD.)—In return dated Dec. 31, 1914 (filed May 21, 1915) capital £50,000 in 18,000 preferred ordinary shares of £1 each and 40,000 deferred ordinary shares of 1s. each. Seven preferred ordinary shares taken up. Nothing paid up. Mortgages and charges, nil.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—Capital at April 14 was £50,000 in 25,000 preference shares of £1 each and 10,000 ordinary shares of £2 each. 18,850 preference and 3,050 ordinary shares taken up. £34,153 paid, including £1,203 [illegible]. Mortgages and charges: £25,000 1st and £15,000 2nd mortgage debentures.

HASTINGS & DISTRICT ELECTRIC TRAMWAYS CO. (LTD.)—Return to [illegible] capital at £1,250,000 in [illegible] shares of £1 each, and 485,885 ordinary shares of 10s. each. (Originally £500,000 in 50,000 preference and 50,000 ordinary shares of £5 each. Reduced 1911 [illegible] preference and £5 [illegible] ordinary.) £50,000 paid on preference and £134,117. 10s. considered as paid on the ordinary. Mortgages and charges: £50,000.

NEW SYSTEM PRIVATE TELEPHONE CO. (LTD.)—Capital at June 15 [illegible] £10,000 in £1 shares. All [illegible] and £8,000 paid. £2,000 considered as paid. Mortgages and charges nil.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—According to return to April 14 capital is £35,000 in 25,000 ordinary shares and £10,000 preference shares of £1 each. 5,000 preference and 18,525 ordinary shares taken up. £23,525 paid. Mortgages and charges: £10,810 4 per cent. debentures (part of £11,000 authorised).

POPE'S ELECTRIC LAMP CO. (LTD.)—In return dated Oct. 12, 1914 (filed May 15, 1915), capital £25,100, in £1 shares (25,000 preference and 100 ordinary). 22,579 preference and 100 ordinary shares taken up. £4,254 paid. £18,425 considered as paid. Mortgages and charges, £1 [illegible].

STANDARD ELECTRIC CO. (LTD.)—In return to May 26 capital is £10,000 in £1 shares (5,000 preference). 3,077 preference and 5,000 ordinary shares taken up. £1 per share called up on 4,177 ordinary and 10s. per share on 400 preference. £4,377 paid. £3,500 considered as paid, being £1 per share on 823 ordinary and 2,677 preference, and 10s. per share on 400 preference shares. Mortgages and charges, £3,500.

VACTITE WIRE CO. (LTD.)—In returns to Dec. 31, 1914, capital is £450 in £1 shares. All shares taken up. £2 paid. £448 considered as paid. Mortgages and charges, £1,700.

VERA CRUZ TELEPHONE CONSTRUCTION CO. (LTD.)—Return to Feb.1 gives capital as £10,000 in £1 shares. 9,655 shares taken up. £2,500 paid. £7,155 considered as paid. Mortgages and charges: [illegible].

WESTERN ELECTRIC DISTRIBUTING CORPN. (LTD.)—At Aug. 12 the capital was £31,000 in £1 shares (13,000 cumulative preference, 3,000 preferred ordinary and 15,000 ordinary). 9,715 cumulative preference, 2,600 preferred ordinary and 8,893 ordinary shares taken up, £18,415.10s. paid. Mortgages and charges nil.

WREXHAM MOTOR & ELECTRICAL ENGINEERING CO. (LTD.)—Return to May 25 gives capital as £5,000 in £1 shares. 928 shares taken up. £928 paid. Mortgages and charges, £600.

MORTGAGES AND CHARGES.

FRINTON-ON-SEA & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.) Particulars of £4,000 third debentures, created July 1, 1915, have been filed, the whole amount being now issued. Property charged, company's undertaking and property, present and future, including uncalled capital, subject to first and second mortgage debentures, and money secured thereby amounting to £6,000. No trustees.

CITY NOTES.

MEMORANDA (Aug. 4).—Bank rate 5 per cent. (since Aug. 8, 1914.) Consols 65. Consols Pay Day Sept. 1. Stocks and Shares Ticket Days Aug. 11 and 26. Pay Days Aug. 12 and 27. Price of silver, 22 7/16d.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—The directors have declared the usual dividend of 4 per cent. for the quarter ended June 30.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—Owing to the unfavourable rate of exchange with Brazil and the prolongation of the war, and notwithstanding that the earnings have continued to increase in a satisfactory way, the directors have decided to pay a dividend on the common stock for 1915 at rate of 4 per cent. per annum. Three per cent. has been paid during the first half of the year, and the directors have now declared a dividend of ½ per cent., making 3½ per cent. for the three-quarters of the year.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—An extraordinary meeting has been called to consider two agreements between the company and two of its subsidiary companies for the operation of branch lines. Owing to the large decrease in earnings since the turn of the year the Company is unable to recommend any further dividend on the preferred or deferred ordinary stocks for the year to June 30. The approximate net earnings for the six months to Dec. 31, 1914, were [illegible] against £61,252, compared with the corresponding period of 1913. For the six months to June 30 the [illegible] earnings show a decline of £152,379, or an approximate decrease in net earnings of £213,631. The approximate net [illegible] to the end of June 30 amount to £270,588.

BRITISH INSULATED & HELSBY CABLES (LTD.)—Warrants for the dividend on the 6 per cent. preference [illegible] per share [illegible].

CENSORED TELEGRAMS—It [illegible] the Submarine Cable Companies [illegible] June 15, 1915 [illegible].

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.)—[illegible] of the West End undertaking for the half-year ended June 30 at rate of 4 per cent. per annum. Warrants will be posted [illegible].

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—A dividend of 1s. 3d. per share [illegible] 1.5 per cent. per annum [illegible] for the quarter ended June 30.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following will be struck off the Register of Joint Stock Companies unless cause to the contrary is shown before Nov. 3 :—

Auto-Electric Vacuum Drying Synd., Boudjah Electric Lighting Co., Chapman Motor Starter Synd., East Kent Electric Supply Co., Filaments, Radiographic Processes, Small Power Dynamo & Motor Co., United Sherardizing.

J. F. & G. HARRIS (LTD.)—At the statutory meeting on Saturday the directors will report that the total number of shares allotted is 12,554 3 per cent. cumulative preference shares of £1 each, and 21,404 ordinary shares of 2s. 6d. each. Seven ordinary shares have been allotted for cash and 17s. 6d. has been received, while 12,554 preference shares and 21,397 ordinary shares have been allotted as fully-paid shares in accordance with the agreement of June 22, 1915, made between Messrs. J. F. & G. Harris and the company.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The directors have declared an interim dividend of 3 per cent. on the ordinary shares for the half-year ended June 30.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—An interim dividend for the half-year ended June 30 last at rate of 2 per cent. per annum has been declared, payable Aug. 13.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors have decided to postpone for the time being the interim dividend on the ordinary shares.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have ordered 2,178 £5 fully-paid ordinary and 2,014 £5 5 per cent. cumulative preference shares of the [illegible] Company, Limited, and a further issue of £400,000 4½ per cent. perpetual consolidated debenture stock of the *Winnipeg Electric Railway Co.* to be quoted in the Official List.

VICKERS (LTD.)—An interim dividend of 2½ per cent. (less tax) has been declared on the preferred stock and preference shares and 1s. per share (tax free) on the ordinary shares.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—Subject to final audit, an interim dividend is recommended at rate of 6 per cent. per annum (less tax), for half-year ended June 30, payable Sept. 1.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Aug. 4. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Wed. Aug. 4.	Ratio per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9⅝	7 2 3	Mar, Sept
10	4½	Do. 4½% Cum. Pref.	9⅞	4 11 3	Feb, Aug
1	5%	Do. 5% Deb. St.	102	5 18 0	Feb Aug
5	10	Brighton & Preston Ord.	3⅜	6 0 -	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 -	..
St.	4%	Charing Cross West End & City Debs...	90	4 1 10	Jan, July
5	2 3	D. 4% Pref.	4⅛	5 1 -	..
5	..	D. ..	4	6 0 0	Apl, Oct
10	9%	City of London Elec. Lt. Ord.	13½	6 14 6	Feb, Aug
St.	5%	Do. 6% Pref.	124	4 17 0	Mar, Jly
St.	5%	Do. 5% Deb. St.	110	4 10 11	Jan, Dec
10	..	County of London Ord.	1	.. ..	Mar. Sept
10	6%	Do. 6% Pref.	1	.. ..	Feb, Aug
St.	4½	Do. 4½% Deb.	97	4 12 -	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs...	91	4 18 5	July
5	3%	Kensington and Knightsbridge Ord. ..	7/8	6 4 -	Feb, Aug
St.	4%	Do. Deb. St.	90	4 13 0	Jan, Jly
5	3	London Elec. Supp. 6% Pref.	..	.. 1	..
St.	4	Do. 4% Mort. Debs.	89	4 9 11	Jan, Jly
..	3½%	Metropolitan E. Supp. Ord.	..	.. ..	Mar, Aug.
St.	4½	Do. 1st Mort. Deb.	..	4 11 -	Jan, Jly
..	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	..	.. ..	Jan, Jly
5	..	Newcastle & Dist. E.L. 6% 2nd Dbs ..	5	1 1	Mar, Sept
St.	..	Newcastle-on-Tyne E.S. 5% 2d Mt. Do. St.	102	.. ..	Mar, Sept
1	..	North Metropolitan E. P. Supp. 6% Pref	1⅜	5 11 -	Apl, Oct
St.	..	South London E.S. 1st Mort. Debs. ..	..	5 3 -	Jan, Jly.
St.	4½	Urban Elec. Supp 4½% Db. St.	..	.. ..	Apl, Oct
1	..	[illegible]	1	.. ..	Mar, Aug
1	..	Westminster E.S. Corp. Ord.	1	.. ..	Mar, Sept
5	4½	[illegible]	1	4 14 -	Jan, Jly.
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	79	.. ..	Apl, Oct
..	4%	[illegible]	..	8 16 6	Feb, Aug
St.	4%	Central London Cuar. Assented Ord. ..	..	.. ..	..
St.	..	Do. do. Assented Def. Ord. ..	..	5 4 3	..
..	..	Do. 4½% Pref.	..	4 10 0	Jan, Jly
..	..	..	..	4 5 9	Jan, Jly
St.	..	City & S. London Deb.	..	4 15 3	..
St.	..	..	80†	.. ..	Feb, Aug
10	..	..	..	.. ..	Feb, Aug
1	..	..	..	.. ..	Jan, July
St.	..	..	..	6 7 3	Mar. Sept.
St.	..	..	85	.. ..	Jan, Jly.
..	..	..	..	4 4 11	..
..	..	..	..	4 10 6	Feb Aug
..	..	..	..	4 14 3	..
..	..	..	..	.. ..	Jan, July
..	..	..	..	.. ..	..
..	..	..	..	.. ..	Feb, Aug
..	..	..	..	.. ..	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	NAME.	Price, Wed., Aug. 4.	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electric Railways and Tramways			
St.	4½%	Metropolitan Dist. Ry. 4½% First Pref	64½	6 9 4	Feb, Aug
St.	6%	Do. 6% Pref. Det	125⅜	4 12 8	Jan, July
St.	4%	Do. 4% Deben. Pref.	82½	4 10 8	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	87½	4 11 7	Jan, July
St.	4%	Do. 4% Guar. Stock	75½	5 6 0	Mar, Sept
10	..	Underground E. Ry. of London Shares	11	.. ..	..
1/0	..	Do. A Ord.		.. ..	..
St.	6%	Do. 6% Inc. Debs.	104½	5 14 5	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 15....	75	8 0 0	Mar, Sept
..	4½%	Do. 4½% Bds.	98	4 12 0	Jan, July
..	..	Yorkshire W. Riding Ord.	⅛	.. ..	March
5	6%	Do. Pref.	4	7 1 8	Jan, July
		Electric Manufacturing, &c.			
1	1/9	Babcock & Wilcox Ord.	2⅞	6 6 0	Apl, Oct
1	1/0	Brit. Aluminium Ord.	1	5 0 0	Mar
100	5%	Do. Prior Lien Debs.	93½	5 6 6	Jan, July.
1	6%	Do. 6% Pref.	⅝	6 12 0	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	11⅛	6 14 10	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	6⅝	4 15 5	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm. 6% Pref.	⅛	6 6 4	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	1⅜	9 4 7	April
100	6%	Do. 6% Prior Lien Debs.	100½	5 19 8	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	130	5 16 4	Jan, July
5	2/6	Do. 5% Pref.	5	5 0 0	Feb, Aug
1	15%	Castner Kellner	3⅝	4 16 2	Mar, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	7⅞	7 13 7	Sept
..	..	Ericsson & Swan U Exss Ltd. A. £3 pd.	⅛	.. ..	Feb, Aug
1	6%	Elec. Construction Ord.	⅜	9 5 11	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	64½	5 15 4	Jan, July
10	6%	General Electric 6% Pref.	⅜	6 5 0	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 8 2	Feb, Aug
1	2/6	Do. 4½% Cum. Pref.	4½	5 0 0	..
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	8⅛	5 17 8	Feb, Aug
5	5%	Do. Pref.	6⅛	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	98	4 1 8	Apl, Oct
12	20/0	Telegh. Con. & Main. Co.	31	7 14 10	May, Aug
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅜	4 10 4	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	80	5 0 0	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	100	4 10 0	Jan, Dec
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	9½	6 3 2	Fb,My,Aug.N
St.	11%	Do. Def. Ord.	21½	6 19 6	Fb,My,Aug.N
St.	4%	Commercial Cable 4% Debs.	72⅝	5 13 4	Ja.Ap,Jly.O
10	5%	Cuba Submarine Ord.	6⅛	5 13 6	May, Nov.
10	10%	Do. 10% Pref.	15⅛	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅜	6 13 4	..
10	4%	Direct United States	6⅝	5 16 10	Ja.Ap,Jly.O
St.	25/0	Eastern Tel. Co. Ord.	118½	5 18 2	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	69	5 1 5	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	81	4 18 1	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs...	73½	5 1 9	Feb, Aug
10	7%	Do. Ord.	11⅝	5 18 2	Ja, Ao, Jly.O
10	22%	Ct. Northern Tel. Co. with Coup. 8....	33	6 13 4	Ja, My, Jly
25	13%	Indo-European	54	6 0 4	May, Nov
1	16%	Marconi's Wireless Tel. Co.	1⅜	5 1 7	April
1	7%	Do. 7% Pref.	1	4 0 0	July
10	9d.	West Indian & Panama Ord.	1⅛	8 17 9	May Nov
10	6%	Do. 1st Pref.	9⅞	7 1 2	May, Nov
10	3/0	Western Telegh. Co.	11⅛	6 1 9	Mr, Jly.O.Dec
St.	4%	Do. 4% Debs. St.	83	4 16 5	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	95	4 14 9	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	125⅛	6 7 10	Ja,Ap,Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	77½	6 9 0	Jan, Jly
1	7½	Monte Video Telephn. Ord.	⅝	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	97⅛	4 12 7	May, Nov
1	10%	Oriental Telephone Ord.	⅛	5 10 4	Apl, Oct
St.	4%	Do. Db. St.	86½	4 12 8	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St.	88	5 2 3	Jan, July
5	8%	United River Plate Ord.	5⅛	6 19 2	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅞	5 3 3	Jan, July
St.	4½%	Do. Deb. St.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	9⅜	6 5 11	Sp.Dc.Mr,Jn
10	6%	Do. 6% Pf.	10⅜	5 18 6	Sp.Dc.Mr,Jn
100	5%	Mexican Continental Common	8⅜	6 5 0	Ja, Apl, Jly.O
..	4%	Do. 4% Pref.	67⅛	5 18 6	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	120½	4 15 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	73	6 13 4	Jun, Dec
St.	4½%	Do. 4½% Debs.	89	5 12 6	Jan, July
St.	4%	Do. 4% Debs.	70	5 14 3	Jan, July
5	2/9	Do. 5% 1st Pref.	4	6 17 6	Jan, July
5	2/9	Do. 5% 2nd Pref.	3⅜	7 19 6	Jan, July
100	3½	Brazillian Traction Ord.	43⅛	14 2 9	Fb,M,Aug,N
100	5½	Do. 6% Pref.	8	6 19 2	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	7	5 11 3	May
..	..	Do. 5% 1st Pref.	4⅛	5 2 7	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	94⅛	6 15 7	..
..	5%	Calcutta Ele. Supply Ord.	..	9 1 8	Mar, Sep
..	5%	Havana Elec. Pr. 5% Bds.	..	5 13 1	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	5	6 0 0	..
100	5%	Mexican Tramways 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Tramw Co. Com. St.	31	.. ..	Fb.M.Aug.N.
..	..	Do. 5% Pref.	81	8 15 5	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)..	97⅛	4 12 3	Feb, Aug
100	..	Nouvelle Compagnie Havraise Peninsulaire	..	7 2 5	Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds.	90	4 14 ..	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	5%	Anglo-Argentine Tramway Pref.	..	6 13 7	Mar, Sept
St.	5%	Do. 5% Debs.	..	5 2 2	Jun, Dec
1	..	Buenos Ayres Tramway Pref.	1⅜	5 14 3	..
..	..	Calcutta E. S. Corp. Ord.	1⅛	5 5 3	May, Nov
..	..	Canadian Gen. Elec. Common St.	..	7 4 4	Ja,Apl,Jly,O
St.	5%	Mexican Light & Power Co. Debs.	..	5 1 7	June, Dec
St.	..	Do. 5% Cons. Deb. St.	79⅛	6 6 6	Apl, Oct
..	..	Montreal Water & Power 5% Bds.	..	5 1 3	Jan, July
St.	4½	Do. 4½% Cons. Deb. St.	11⅛	4 10 10	Ja,Apl,Jly,O
St.	4½	Do. 4½% Gen. Mtge. St.	..	4 14 1	Jan, July
1	..	Do. 4½% 2nd Mtge. Pref.	..	6 15 4	May, Nov
1	..	Victoria Ry. & Transvaal Power Co., Ltd.	..	.. ..	Jan, July
..	5½%	Do. 5½% 2nd Mtge. Deb.	84	6 8 7	Jan, July

† Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date August 4, the following as the present basis prices of

New Metals.	per lb.		Old Metals.	per ton.		
Solid Drawn Brass Tubes	13½d.		English Lead	£24	15	0
Solid Drawn Copper Tubes	13½d.		Antimony	£120	0	0
Brazed Copper Tubes	13⅞d.					
Brazed Brass Tubes	15⅞d.					
Brass Wire	14d.		Clean Scrap Copper	£65	0	0
Copper Wire	14½d.		Brazlery Copper Scrap	£60	0	0
Rolled Brass	13⅞d.		Clean Scrap Brass	£54	0	0
Brass Sheets	14½d.		Old Lead	£20	0	0
			Old Zinc	£50	0	0
	per ton.		Hollow Pewter	£120	0	0
Copper Sheets	£102 0 0		Black Pewter	£85	0	0
Spelter	£98 0 0		Gun Metal	£62	0	0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date August 3, the following prices of Scrap Metals:—

	per ton.			per ton		
Aluminium Cuttings	£75	0 0	Gun Metal	£64	0	0
Clean Mixed Brass	£57	0 0	Old Lead	£21	10	0
Clean Copper	£68	0 0	Tea Lead	£19	0	0
Clean Copper Cuttings	£70	0 0	Hollow Pewter	£120	0	0
Brazlery Copper	£62	0 0	Shaped Black Pewter	£85	0	0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £75; Commercial Tinman's Solder, £95; Blowpipe Solder, £105.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount	Aggregate. Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	July 22	1,586	— 132	8	15,498	— 339
Anglo-Argentine	.. 24	47,136	— 3,899	30	1,531,614	— 137,239
Ashton-under-Lyne	.. 31	447	+ 51	18	8,753	+ 233
Ayr Corporation	.. 31	623	+ 16	11	5,397	— 305
Bath Electric Trams. Ltd	.. ..	..	..	..	..	..
Birkenhead Corporation	Aug. 1	1,459	+ 154	18	24,227	+ 1,262
† Birmingham Corporation	July 31	14,278	+ 1,992	18	232,182	+ 7,403
Blackburn Corporation	.. 28	1,561	+ 220	18	23,167	+ 526
Blackpool Corporation	.. 24	2,748	— 591	17	26,045	— 8,511
Blackpool and Fleetwood	.. 31	1,586	— 338	30	17,843	— 3,920
Bolton Corporation	.. ..	..	..	..	..	..
Bournemouth { Trams	.. ..	..	..	..	..	..
Bournemouth { Buses	.. ..	..	..	..	..	..
Bradford Corporation	.. ..	..	..	..	..	..
Brighton Corporation	Aug. 1	1,512	+ 24	18§	19,562	— 1,412
Bristol Trams { Trams	July 30	4,749	— 33	30	139,019	— 2,187
Bristol Trams { Buses, &c.	.. 30	5,430	+ 232	30	141,853	+ 23,341
Burmah E. Trams & Ltg	.. 31	R3,726	— R314	30	R193,816	— R47,240
Burnley Corporation	.. 31	1,663	— 67	18	43,251	— 67
Burton Corporation	.. ..	..	..	..	..	..
Bury Corporation	Aug. 1	1,430	+ 80	18§	24,646	— 527
Calcutta Tramways Co.	.. ..	..	..	..	..	..
Camborne-Redruth	July 24	135	— 3	29	3,934	— 146
Cardiff Corporation	.. 24	2,508	— 2	16	44,749	— 3,867
Cork Electric Trams Co.	.. 24	561	+ 35	30	14,829	— 303
Coventry Corporation	.. ..	..	..	..	..	..
Croydon Corporation	.. 23	1,866	+ 73	16	30,761	+ 509
* Derby Corporation	.. 31	1,097	+ 56	17§	18,527	— 177
Dover Corporation	.. 31	364	+ 46	17	5,491	+ 910
Dublin & Lucan Ry	.. 30	158	— 17	4	676	— 97
Dublin United	.. 31	6,073	— 118	30	182,060	+ 5,306
Dundee Corporation	.. 24	1,360	+ 168	11§	14,664	— 16
East Ham Council	.. 31	1,330	+ 237	17	23,323	+ 4,282
Exeter Corporation	.. 30	417	+ 19	17	6,710	+ 118
Glasgow Corporation	.. 31	19,661	+ 1,811	9§	188,446	+ 9,781
Glossop Trams	.. 31	141	+ 12	31	3,738	— 127
Gloucester Corpn.	.. 28	331	— 4	17	5,708	— 177
Halifax Corpn. { Trams	.. 27	2,315	+ 170	17	38,816	— 177
Halifax Corpn. { Buses	.. ..	38	+ 4	17	865	— 11
Hastings Elec. Trams Co.	.. 29	1,199	— 110	30	26,271	— 1,957
Huddersfield Corpn.	.. 31	2,893	+ 456	17	47,812	+ 4,946
Hull Corporation	.. 31	3,121	+ 3	17	53,547	— 3,469
Ilford District Council	.. 31	677	+ 112	17	11,651	+ 2,011
Ilkeston Corporation	.. 25	146	+ 11	17	2,228	+ 134
Ipswich Corporation	.. 31	555	+ 37	11	9,553	+ 798
Isle of Thanet Co.	.. 31	1,338	— 861	43§	15,215	— 8,746
Kilmarnock Corporation	.. ..	..	..	..	..	..
Lanarkshire Trams Co.	.. 29	1,973	+ 436	30	56,898	— 683
Lancashire United	.. 28	1,919	+ 241	30	50,977	+ 1,451
Leeds Corporation	.. 31	9,465	+ 743	18	158,397	+ 5,953
Leicester Corporation	.. 31	3,169	+ 233	31	90,745	+ 1,606
Leith Corporation	.. 31	855	+ 39	11	8,921	+ 98
Lincoln Corporation	.. 31	177	— 34	18	2,442	— 25
Liverpool Corporation	.. ..	..	..	..	..	..
Llandudno & Colwyn Bay R	.. 30	2,[illegible]	— 124	35	10,058	+ 348
London County Council	.. 31	46,[illegible]	+ 3,452	16	671,098	— 40,222
Lowestoft Corporation	.. 31	238	— 34	13§	7,411	— 1,403
Maidstone Corporation	.. 29	236	..	17	3,805	— 132
Manchester Corporation	.. 31	11,221	+ 1,[illegible]2	17	317,032	— 449
Nelson Corporation	.. ..	..	..	..	..	..
Newcastle-on-Tyne Corpn	.. ..	..	..	..	..	..
Newport (Mon.) Corpn.	.. 31	816	— 23	18	14,810	— 512
Northampton Corporation	.. ..	2[illegible]	+ 1[illegible]	17§	13,342	+ 2,700
Nottingham Corporation	.. ..	3,770	+ [illegible]	17	64,888	+ 2,206
Oldham Corporation	Aug. 1	2,427	+ 1[illegible]	17	43,420	— 632
Portsmouth Corporation	.. ..	..	..	..	..	..
Preston Corporation	.. ..	..	..	..	..	..
Rochdale	July 31	1,944	+ [illegible]	17§	30,868	+ 1,274
Rotherham Corporation	.. 28	1,187	+ [illegible]	17	19,185	+ 1,662
Salford Corporation	Aug. 2	5,587	+ 471	18§	94,201	+ 318
† Sheffield Corporation	.. 1	7,[illegible]	+ [illegible]	18§	160,458	+ 13,595
Southampton Corpn.	July 28	1,519	..	17	25,134	+ 958
Southend Corporation	.. 31	811	+ [illegible]	17	13,913	— 5,446
South Shields	.. ..	..	..	16	13,142	— 246
Stalybridge, Hyde, Ll. & D	.. ..	..	..	..	..	..
Sunderland Corporation	Aug. 1	1,[illegible]	— [illegible]	18	26,335	— 1,165
Swansea District	July 28	[illegible]	— [illegible]	30	21,633	— 1,329
Swindon Corporation	.. 31	1,[illegible]	+ [illegible]	17	3,405	+ 341
Tynemouth Corporation	.. 31	675	+ 79	8	1,971	+ 132
Wallasey Corporation	.. 31	1,[illegible]	+ [illegible]	17§	23,008	— 1,021
Walsall Corporation	.. 31	1,[illegible]	+ [illegible]	31	21,669	— 2,364
Wolverhampton Corpn.	.. 31	987	+ [illegible]	18	16,655	+ 1,623
Warrington Corporation	.. ..	..	..	..	..	..
West Ham Corporation	.. 29	3,108	+ [illegible]	17	53,921	+ 3,955
Wigan Corporation	.. 30	1,582	+ [illegible]	17	26,587	+ 314
Wolverhampton Corpn.	.. 28	1,120	+ [illegible]	17	18,830	— 223
Yorkshire W.R. Trams	Aug. 1	1,776	+ [illegible]	31	48,302	+ 2,963

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses &c. ‡ Minus 2 days. § Minus 3 days. ‖ Plus 3 days.
¶ Plus 2 days. ** Compared with one week more last year.

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NOTES.

A Unique Opportunity.

THE brief description, given on another page of this issue, of salted carbons is opportune. In these days we hear little of arc lamp development; but it is inconceivable that the many engineers and scientists who have made a study of the arc will allow their labours to be set at nought by the gas-filled incandescent lamp. Rather should we imagine that the half-watt lamp will act as an incentive to arc lamp manufacturers and to students of the arc generally to turn out something still better. Although the difficulty of ensuring a plentiful supply of carbon electrodes (to say nothing of the effect of restricted lighting) has, without doubt, had a disturbing effect on the industry, we are, nevertheless, of the opinion that the interruption or cessation of the supply of such electrodes is a blessing in disguise, in so far as it affords a unique opportunity for the arc lamp specialist to investigate the properties of salted metal electrodes and to arrange for their production on a commercial scale. In all probability such an opportunity will not occur again. Till such time as an unrestricted supply of electrodes can be obtained at reasonable cost, the arc lamp cannot possibly compete with the gas-filled lamp. In all likelihood the supply will be cut off for some considerable time, and unless the arc lamp manufacturer turns his attention to the development of metal electrodes it is possible that, to all intents and purposes, the industry will be dormant. The several chemical, thermal and electrical problems connected with the development of the salted metal electrode, though difficult, are not insurmountable, and we have reasons for supposing that the metal electrode will not be more costly than the encrusted carbon electrode.

Surface Leakage.

IN dielectrics the extent of the surface leakage is often more important than the insulation resistance, or volume resistance, of the material itself; and, indeed, the practical value of very high volume resistivity may be limited by the surface leakage. The importance of this fact is brought out by an interesting investigation, which we give elsewhere, by Mr. H. L. CURTIS, of the Bureau of Standards. It will be noticed that Mr. CURTIS treats the property of surface leakage as being a property of the material itself. Actually this is not the case, as such leakage is due to a film of moisture quite distinct from the material. On the other hand, the extent to which the film will condense upon the surface depends upon the nature of the surface itself; therefore, it is not unreasonable to treat such leakage as being a property of the dielectric. It need scarcely be said that the film itself is of minute thickness, and its importance will vary very considerably according to the amount of salts which may find their way into solution. The film being minute, the effect of such salts may be very marked, and, consequently, any tendency for a dielectric to change its surface chemically—for example, under the influence of sunlight or ultra-violet light—may have a very harmful effect. Generally speaking, however, it would seem that the value of a dielectric from the surface leakage point of view depends more upon the mechanical state of the surface than on anything else. It is for this reason that porcelain and glass are so valuable; they give a surface which does not tend to take up moisture, and they are also very permanent in character under ordinary conditions.

Irrigation.

IN this country irrigation is but little required, and therefore it does not often come up for consideration, except to the very limited extent of the occasional erection of a small windmill for pumping. In our Colonies, however, it is otherwise, and irrigation frequently plays a very important part; consequently, from the electrical point

of view, it is worth while to keep an eye upon this subject. This point is very well illustrated by an article on "Electric Pumping for Irrigation," which we give in another column, and which shows what is being done in this direction in the United States. It is recognised that a pumping load is generally desirable, as it usually provides a fairly long-hour load. Moreover, in the case of irrigation, it should be remembered that the load is one which runs through the summer months, when other loads have a way of falling off. In the article to which we have referred it is stated that in one district the diversity factor is 3·0 and the annual load factor is 19·4, pumping being almost continuous from May to September. The extent of the irrigation in certain districts is sufficiently indicated by stating that the Western States Gas & Electric Co. operates 225 miles of transmission line for serving irrigation plants, and there are approximately 740 customers, with a total connected load of 6,100 H.P. Again, the Southern California Edison Co. has now over 1,500 pumping plant consumers, with a connected load of approximately 45,000 H.P., irrigating about 130,000 acres. The subject is, therefore, one to which attention should certainly be paid by the electricity undertakings in our Colonies.

New Submarine Cable.—The Compagnie Française des Cables Télégraphiques has recently opened a submarine cable between San Domingo (Dominican Republic) and Mayaguez (Porto Rico) and a land line of 186 km. (115 miles) between Mayaguez and San Juan de Porto Rico.

Ancient Telephones and Cables.—The interesting collection of historic electrical apparatus now being made by the Institution of Electrical Engineers includes a gift from Queen Alexandra of the telephone fixed at Marlborough House from the school-room to her sitting-room in 1878. There are also pieces of several submarine cables, among them being that laid from Dover to Calais in 1850.

A New Safety Signalling Bell.—In a Paper read at the annual meeting of the North of England Institute of Mining and Electrical Engineers, Prof. Thornton described an electric signalling bell, in which sparking at the trembler contact was prevented so as to ensure safety from explosion. By means of a new device which could be fitted to any signalling bell the current giving rise to the spark was diverted through a by-pass, so that the high potential causing the spark was avoided. Dr. Wheeler, of the Home Office, has testified to the efficiency of the apparatus.

Forthcoming Books.—"The Electrician" Company will have ready in September Dr. W. H. Eccles' "Wireless Telegraphy and Telephony: A Handbook of Formulæ, Data and Information." The book will be indispensable to the worker in wireless, and will be the first book of its kind published in any language. It will comprehend all systems of wireless, and will, consequently, be a work of international importance. Other books in "The Electrician" Series, nearly ready, are: "Electric Switch and Controlling Gear," by Dr. C. C. Garrard; "Theory of the Submarine Telegraph Cable," by Dr. H. W. Malcolm; a new edition of "Primary Batteries: Their Construction and Use," by W. R. Cooper; a new edition of "The Localisation of Faults in Electric Light Mains," by F. C. Raphael.

Funeral of Mr. Hammond. At the funeral of the late Mr. Robert Hammond, last President of the Institution of Electrical Engineers, at Hoddesdon Green Cemetery on Monday, the 9th inst., amongst others the following members of the Institution were present:—

Mr. John Hopkinson, Past President, Mr. A. Siemens, Mr. W. M. Mordey (Past Presidents), Mr. F. Gill, Mr. A. M. J. Ogilvie, Dr. A. Russell (Members of Council), Mr. H. W. Cozens, Mr. G. W. Spencer Hawes, Mr. F. Ince, Mr. J. E. Kingsbury, Mr. E. A. Nash, Mr. A. H. Preece, Mr. J. Rider, Mr. H. M. Sayers, Mr. S. Sharp, Mr. A. M. Sillar, Mr. A. A. C. Swinton, Mr. H. W. Wilkinson, Mr. W. Wyld (Members).

The following Members of Council and Past Members of Council wrote expressing their sympathy, and regretting that they were unable to be present:—

Mr. W. A. Chamen, Mr. R. A. Chattock, Sir William Crookes, O.M., F.R.S., Col. R. E. Crompton, C.B., Mr. W. B. Esson, Mr. J. S. Highfield, Mr. H. Hirst, Prof. T. Mather, F.R.S., Mr. S. Morse, Mr. G. W. Partridge, Mr. W. H. Patchell, Mr. H. Faraday Proctor, Mr. R. T. Smith, Mr. C. H. Wordingham, and Mr. P. F. Rowell.

A 2,400-Volt Continuous Current Railway.—According to the "General Electric Review" (U.S.A.) the Bethlehem-Chile Iron Mines Company possesses an exceptionally rich deposit of iron ore at Tofo, Chile, which it is preparing to mine in large quantities by electric power for shipment to the United States. Electricity will also be used to transport the ore by rail to the coast by a line 15 miles long on a gradient of 1 in 33. As it is the loaded trains that will be descending, a great saving will be effected by the regenerative braking that it is proposed to use. The locomotives which are to be arranged for continuous-current working at 2,400 volts, will be equipped with four 300 H.P., 1,200-volt motors connected two in series. The generating station will have oil-fired boilers, the oil being brought in tank vessels and pumped into a storage tank above the station. An ingenious feature is the method of obtaining boiler "make-up" water from sea water, part of the exhaust steam being "by-passed" into an evaporating condenser for this purpose.

Railway Electrification in Canada.—According to "Electrical News" there are two high-voltage continuous-current electrification schemes in Canada nearing completion, and a third under construction. The first 1,500-volt line in Canada will be that of the London & Port Stanley Railway. After the most searching consideration it has been decided that construction and operating costs justify the use of this higher voltage in preference to the time honoured 600 or 650 volts, which at the present time is universal throughout the Dominion of Canada. A 2,400-volt line is nearing completion in Montreal and will probably be in operation within the next three months. The locomotives are practically ready for shipment on both these lines. The third electrification, which is temporarily held up, is a section of the Canadian Pacific Railway line over and through the Rocky Mountains where the heavy grades and a long tunnel will make this form of traction particularly attractive and economical.

Mobilising Science.—A scheme has been developed by the Chemical Society for organising the scientific ability of its own Fellows and those of other bodies, and is making great progress. Already 1,200 forms have been received, in which each Fellow states how much time or laboratory accommodation he can give for the service of the country, and in what class of work he believes he can be of use. These Fellows belong to the following societies:—

The Chemical Society.	Institute of Metals.
Royal Agricultural Society.	Institution of Mining and Metallurgy.
Biochemical Society.	Pharmaceutical Society.
Society of Chemical Industry.	Physical Society.
Society of Dyers and Colourists.	Society of Public Analysts.
Faraday Society.	
Institute of Chemistry.	

Each society has also nominated six experts, who will form a committee to consider and report on matters referred to it by the Council. There will also be a general committee to decide questions of policy with reference to all scientific questions of importance to the nation, whether concerned with the war or not. The President of the Chemical Society, Dr. Alexander Scott, has stated that the society will be glad to receive useful ideas from the general public. Suggestions should be addressed to the Council of the Chemical Society, Burlington House, London, W.

Problems and Experiences in 150,000-volt Transmission.—Mr. E. Woodbury, of the Pacific Light and Power Corporation, California, has recently reviewed the experiences of 18 months' operation of the Big Creek Development of the Pacific Light

and Power Corporation, and has compared these experiences with the forecasts and assumptions made at the time of preparing the designs. One of the most stiking features of the operation of this 150,000-volt system is that in normal operation 60,000 kw. generated in two plants under a total hydraulic head of 4,000 ft. and transmitted 240 miles at 150,000 volts, is distributed with a continuity and reliability of service and voltage regulation even better than when the source of supply was a large modern steam plant transmitting only 20 miles at 15,000 volts. Moreover, the operation of the system has shown that there is no necessity for the expense of maintaining a steam reserve of 100 per cent. of the transmitted power in readiness at all times to take the load.

Electric Trucks for Handling Cargoes on Panama Railroad. According to the "Canal Record" a number of electric trucks have been ordered by the Panama Railroad Co. for handling cargo at the piers at Cristobal. The tractor trucks are 6 ft. long and weigh approximately 2,500 lb. They are equipped with two sets of storage batteries, and have a speed of 1 to 7 miles per hour, three speeds forward and three reverse being provided. They are rated to haul three trailers carrying 20,000 lb. Experiments are also to be made with trucks equipped with small cranes in order further to eliminate labour.

L. & S.W. Railway Electrification.—In connection with the electrification of a section of the above railway it is announced that current is to be switched on to the "Kingston Roundabout" in about a week. As soon as the trains are running on this section the others will be completed in quick succession. These are: Barnes to Twickenham; Thames Valley line to Shepperton; Maldon and Hampton Court; and Hampton Court Junction to Claygate. Altogether 140 miles of track will be electrified. Each train will consist of a unit of three coaches which will be permanently coupled, and it is intended to work these trains either as three or six coach trains according to traffic requirements.

Inventions Branch of the Ministry of Munitions.—The Ministry of Munitions is now to have an Inventions Branch (similar to the Board appointed by the Admiralty) to consider inventions or suggestions relating to warfare on land. Mr. E. W. Moir, M.Inst.C.E., has been appointed Comptroller, and the staff will be assisted by a panel of honorary scientific and other experts. The following gentlemen have accepted Mr. Lloyd George's invitation to act on this panel:

Col. Gould Adams.	Michael Longridge.
Horace Darwin, F.R.S.	W. H. Maw, M.Inst.C.E.
Macdougal Duckham.	Sir Hiram Maxim.
W. Duddell, F.R.S.	Capt. Moore, R.N.
Sebastian Z. de Ferranti, D.Sc.	Sir Henry Norman, M.P.
Prof. Glazebrook, F.R.S.	F. G. Ogilvie, C.B.
Sir Robert Hadfield, F.R.S.	Major-Gen. C. K. Scott-Moncrieff.
Prof. J. S. Haldane, F.R.S.	Wilfrid Stokes.
Col. N. B. Heffernan.	James Swinburne, F.R.S.
Sir Alexander Kennedy, F.R.S.	Sir Joseph John Thomson, F.R.S.
F. W. Lanchester.	A. J. Walter, K.C.
Prof. A. P. Laurie, M.A., D.Sc.	C. J. Wilson.
Prof. Vivian Lewes, M.A.	

All communications should be addressed to the Comptroller at Armament-buildings, Whitehall-place, where the branch will for the present carry on its work. According to a statement made by Mr. Lloyd George in the House of Commons on July 28th, the War Office has handed over the whole question of Army inventions to the Ministry of Munitions.

Street Car Development in the U.S.A.—The low-floor car so much used on American tramways is now reaching a standardised form. In the latest type employed by the Pittsburgh Railways Co. the weights of the motors, wheels and other parts of the bogies have been so much reduced as to bring the total weight down to 35,600 lb. made up as follows:

Weight of car body, conduit, wiring and air-brake piping	18,000 lb.
Weight of air brakes	1,350 lb.
Weight of motors	7,000 lb.
Weight of other electrical equipment	1,250 lb.
Weight of trucks	8,000 lb.

There are four 35 H.P. General Electric motors, for which a special system of control is employed with three running notches, in which the motors are all in series, two in series, or all in parallel. A small resistance is in series with the four motors for the single starting notch, and this resistance is again brought into circuit in one of the transition stages when moving to the fastest running notch, but otherwise no resistances are employed. The car is 45 ft. long and 8 ft. broad, and seats 60 passengers. The wheels are only 24 in. in diameter, and this has called for very careful design of the motors. These have the same number of armature-turns as the older motors of the same speed and rating, but the small size has been rendered possible by the use of commutating poles and forced ventilation.

Electricity and Aviation.—Although electricity at the present time is regarded as an unsuitable agent for the propulsion of aircraft, it seems probable that it will be used for the operation of the auxiliary apparatus. Apart from the searchlights and wireless apparatus that may be required in military work, there are several possible improvements in the aeroplane, which if made would greatly facilitate its use for commercial purposes, and it is in these that electricity can help. Much trouble is at present experienced in starting the engine of an aeroplane. Starting is usually accomplished by a mechanic who turns the propeller while others hold back the machine. It is, therefore, interesting to note that Messrs. C. A. Vandervell, of Acton, have perfected an electric self-starter for aeroplanes. This self-starter weighs 84 lb. and is capable of turning a 90 H.P. Beardmore-Daimler aero-engine at 50 revs. per min. for two minutes starting from cold. The starter is then developing 1·4 H.P. with a gear ratio of 38 to 1 in relation to the crankshaft. Another piece of electrical apparatus for aviation that should have a great future before it is the Sperry gyroscopic stabiliser, invented in America, which seems to have solved the problem of the automatic stability of aeroplanes. A double generator is used, furnishing both three-phase alternating current and 20-volt direct current. The former drives four small gyroscopes, while the continuous current operates magnetic clutches and is used to charge a small "Exide" battery. The stabiliser can be fitted to any type of machine, as it automatically performs the movements the pilot would have to carry out by means of the control levers. A trial on a Curtiss flying boat (reported some time ago in "Flight") gave excellent results, the machine balancing itself even when a passenger walked out on the wing. Steering vertically and laterally is effected by a small lever controlling the adjustments, so that the work of piloting is easier than driving a motor car.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. W. E. Burnand contributes an article on "Some Points in Transformers" (p. 701).

The article by Mr. H. L. Smith on "The Electrical Design of Induction Motors" is concluded (p. 695).

We also conclude the abstract of Mr. A. Still's communication to the Institution of Electrical Engineers on "The Inherent Regulation of Synchronous Alternating Current Generators" (p. 691).

An abstract is given of a Paper on "Wireless Call Devices," by Mr. L. B. Turner (p. 697).

We give a review of the Hydro-Electric Developments on the Pacific Coast of America (p. 703). Our Leading Article deals with the same subject (p. 704).

An abstract of a Paper by Dr. L. Lichtenstein on the "Testing of Cables after Laying with High-Pressure Direct Current" appears on p. 708.

We conclude the abstract of Mr. H. L. Curtis's Paper on "The Insulating Properties of Solid Dielectrics" (p. 692).

An article on "Electric Pumping for Irrigation" will be found on p. 706.

We give the substance of an article by Dr. H. Beckmann in the Elektrotechnische Zeitschrift" on the "Importance of the Electric Cable as a Source of Revenue to the Central Station" (p. 710).

An illustrated article on "Synchronous Motor Generators versus Rotary Converters," by Mr. Hugo Ring, is published on p. 712.

Reports of the Deutsch-Atlantische, Deutsch-Niederländische & Deutsch-Südamerikanische Telegraphen-Gesellschaften, and of the Grootvlei Proprietary, Transvaal and Victoria Falls and Transvaal Power Companies are given on pp. 720 and 721.

OBITUARY.

MR. ERNEST DANVERS.—The death is announced of Mr. Ernest Danvers, M.I.E.E., consulting electrical engineer, of Buenos Ayres. Deceased, who was only 51 years of age, had been for upwards of 25 years electrical inspector of the fire insurance companies, and was also electrical editor of the "Review of the River Plate." He took a considerable part in the formation of the Institution of Engineers of the River Plate, and he was secretary of the British and American Benevolent Society.

PERSONAL.

SIR AMHERST SELBY-BIGGE has been gazetted special secretary to the Committe of the Privy Council for the organisation of scientific and industrial research. He has been the Permanent Secretary of the Board of Education since 1911.

Mr. J. Horace Bowden, engineer and manager of the Poplar (London) Borough Council electricity works, has been appointed assistant manager for the Eastern District under the Metropolitan Munitions Committee.

Mr. Henry Mattinson, chief civil engineer of Manchester Corporation tramways, has been granted a commission in the Royal Engineers, East Lancashire Territorials.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the positions of shift engineers required at the new temporary station, Nechells, Birmingham. Applicants must have had sound mechanical and electrical engineering training, and must have had previous experience of a similar kind in a large electric generating station from which a.h.t., three phase and l.t. d.c. supplies are given. Commencing salary £104, rising to £200 per annum. Applications to city electrical engineer and manager (Mr. R. A. Chattock), 14, Dale End, Birmingham, by Aug. 30. *See also an advertisement.*

A civil engineering assistant (salary £200 per annum), surveying assistant (£117-£120), a general permanent-way foreman (£3. 5s. per week) and foreman platelayer (£2. 5s.) are required by West Ham Tramways Dept. Applications (on official forms to be obtained from the General Manager) by noon Aug. 28.

The High Tension Co. require a man with experience of assembling sparking coils. *See advertisement.*

Crewe Co-operative Friendly Society advertise for a first-class engineer's mechanic. Applications to the committee by the 17th inst.

Sutton Coldfield Corporation require an electrical engineer and manager. Commencing salary will not exceed £250. Applications to the Town Clerk (Mr. R. A. Reay Nadin) by Sept. 1.

The University of London is about to appoint a principal officer at a salary of £2,000 a year. Names of those desirous that their names should be considered should reach the Secretary to the Senate, University of London, South Kensington, S.W., by Sept. 15.

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply department. Salary £650, rising to £700 per annum. Applications to the town clerk (Mr. Thos. H. Nesbitt), by Sept. 13.

Mr. C. R. Everson has been appointed manager of the Plymouth Corporation tramways for a period of three years at £450 per annum, with house.

INSTITUTIONS AND SOCIETIES.

The Institute of Metals.—The following is a list of the Papers that are expected to be submitted at the meeting of the Institute of Metals to be held in Chemical Society Burlington House, Piccadilly, W. on Friday, September 17, 1915 commencing at 8 p.m.: (1) "The Corrosion of Copper," by Dr. C. H. Desch; (2) "Metallic Crystal Twining by Direct Mechanical Strain," by Prof. C. A. Edwards, D.Sc.; (3) "Notes on the Copper Rich Nickel-Tin Alloys," by Prof. Bruton and Prof. S. L. Mey...; (4) "The Constitution of Leads containing Small Percentages of Tin"; Contribution to the Study of the Ternary System Copper-Zinc-Tin," by Dr. O. F. Hudson and Mr. B. M. Jones, M.Sc.; (5) (a) "Structural Changes in Industrial Brasses," (b) "Hardness of Copper-Zinc Alloys," by Dr. D. Meneghini; (6) "Specifications for Alloys for High-speed Superheat Steam Turbine Blading," by Mr. W. B. Parker; (7) "The Physical Properties of Metals as Functions of Each Other," by Mr. A. H. Stuart, B.Sc.; (8) "Detection of Internal Blow-holes in Metal Castings by Means of X-rays," by Mr. C. H. Tonamy; (9) "A Thermostat for Moderate and High Temperatures," by Messrs. J. L. Haughton, M.Sc., and D. Hanson, M.Sc. In order that as much time as possible shall be available for discussion the Papers will be taken as read, but copies will be available at the meeting for the use of members, or supplied a week beforehand to those wishing to take part in the discussion.

EDUCATIONAL NOTES.

University of Manchester.—In the Faculty of Science complete courses of study (extending over three years) are arranged for the University Degrees in civil, mechanical and electrical engineering. Good facilities are provided for laboratory and research work, and the electrical engineering laboratory is housed in a new building. Complete theoretical and practical training is given to students preparing for the higher positions in the electrical engineering profession. Particulars of the courses can be obtained from the Registrar. The new session commences on Oct. 7.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses, giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

City & Guilds Technical College, Finsbury.—The day courses at this college are adapted to the needs of various students, including pupils from secondary schools above the age of 15 who desire to receive a practical and scientific training, and young men who, having previously served a pupilage or apprenticeship, desire to go through a more systematic training. Programmes from the Registrar.

Northampton Polytechnic Institute.—The session 1915-16 will commence on October 4 next. In the engineering day college there are full-day courses in the theory and practice of civil, mechanical and electrical engineering.

The courses in civil and mechanical engineering include specialisation in automobile and aeronautical engineering, and those in electrical engineering include specialisation in radio-telegraphy. (These courses include periods spent in commercial workshops and extend over four years. They also prepare for the degree of B.Sc. in engineering at the University of London.) The entrance examination will take place on Sept. 28 and 29. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examination in Sept., 1915.

In technical optics there are full and part time courses in all branches, and instruction is given in specially equipped laboratories and lecture rooms. An Aitchison scholarship (value £30) will be offered in this department at the entrance examination. Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to the principal, Dr. R. Mullineux Walmsley, St. John-street, London, E.C.

Heriot Watt College, Edinburgh.—This college provides theoretical and practical training for mechanical, electrical and mining engineers, chemists, &c. There are complete courses of instruction, extending over four years, for those who are studying for the fellowship of the Institute of Chemistry. An entrance bursary of £25 per annum is offered for competition on Sept. 20. Particulars of courses, fees, &c., from the Clerk, (Mr. R. Macnaughton, S.S.C.), Heriot Trust Office, Edinburgh.

ARRANGEMENTS FOR THE WEEK.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week ending August 21, 1915:

Monday, Wednesday and Friday.—Drills 6.30 and 7.30 p.m.

THE INHERENT REGULATION OF SYNCHRONOUS ALTERNATING-CURRENT GENERATORS.*

BY ALFRED STILL.

(*Concluded from p.* 660.)

Summary.—This Paper is written from the designer's point of view, the type of machine considered being principally the synchronous poly-phase generator with salient poles. The same considerations will apply, with rare exceptions, to high-speed machines with distributed field windings, and also to single-phase generators.

Influence of Flux Distribution on Regulation.

So long as a sinusoidal air-gap flux distribution can be assumed both on open circuit and under load conditions, the previously described methods of predetermining regulation are satisfactory; but in the case of new or abnormal designs of machines correct results can only be obtained by taking into account the alteration in the amount of the useful flux due to cross magnetisation and the changes in the E.M.F. wave shapes due to flux distortion. An attempt will be made to outline a method of study which has been elaborated by the present author.

The method is based on the fact that for salient-pole machines approximately correct flux-distribution curves can be drawn when the width and shape of the pole-shoe have been decided upon, and for high-speed generators with air-gap of constant lengths when the disposition and windings of the slots in the rotor have been determined.† The actual plotting of these curves for different load conditions is somewhat tedious. The permeance between pole face

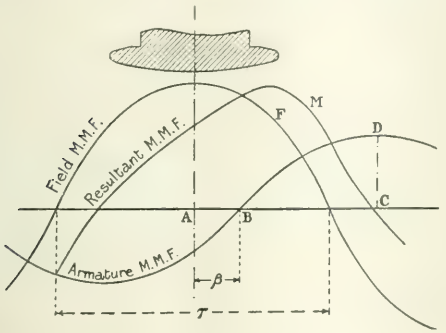


Fig. 5.

and armature for various points on the armature periphery, and the resultant magnetomotive force tending to set up a flux of induction at each point must both be known. These are obtained by drawing two curves showing the magnetomotive force distribution due to field ampere-turns only and due to armature currents only; the sum of corresponding ordinates of these two curves gives the required resultant magnetomotive force for any desired armature current and power factor.

It is then easy to derive the E.M.F. waves together with their R.M.S. values, and the problem of regulation may be summed up as follows: Given a definite field excitation, plot the open-circuit flux curve and obtain the R.M.S. value of the resulting E.M.F. Let this be E_0. Now draw the armature magnetomotive force curve for a given current and power factor; combine this with the field magnetomotive force curve used for obtaining E_0, and from the resulting magnetomotive force curve the E.M.F. developed under load conditions can be obtained by plotting the flux distribution curve. Let E_g' be the R.M.S. value of this voltage, the quantity previously referred to as the "apparent" developed E.M.F. Correcting for internal pressure losses, ohmic and reactive, a value is obtained for the terminal voltage E_t, and the corresponding regulation is:—$(E_0 - E_t) \div E_t$.

The actual working out of this problem is not quite so simple as this statement may suggest, the chief difficulty being that a knowledge of the external power-factor angle is insufficient to determine the exact position of the armature magnetomotive force curve relatively to the centre line of the pole. The position of this curve depends upon the internal power-factor angle, and also upon the phase displacement of the generated E.M.F. under load conditions, *i.e.*, on the degree of distortion of the resultant air-gap flux which, on open circuit, was distributed symmetrically about the centre line of the pole face.

Outline of Procedure in Calculating Regulation from Study of E.M.F. Waves.

In Fig. 5 let the curve F represent the distribution of magnetomotive force over the armature surface tending to send flux from pole to armature on open circuit. It should include the ampere-turns per pole required to overcome the reluctance of air-gap and teeth and those to send the total flux (including leakage) through the remaining portions of the magnetic circuit. Let BD be the magnetomotive force due to armature current only. If the load current be sinusoidal (an almost essential assumption, since its exact shape cannot be predetermined), BD will also be a sine curve, the maximum ordinate CD of which will be displaced beyond the centre line of the pole by an amount depending upon the power factor of the load and the distortion of the resulting air-gap flux-distribution. This maximum value will occur where the current in the conductors is zero, and the maximum armature current will be carried by the conductor displaced exactly 90 deg. (electrical space) from the point C. The point B is, therefore, the position on the armature surface, considered relatively to the poles, where the current is a maximum, the length AB or β, which depends largely on the power factor, being for the present assumed. Add the ordinates of curves F and D to get the curve M which gives the resultant magnetomotive force under the assumed conditions of load. Having calculated (by methods discussed elsewhere*) the permeance of the magnetic circuit for various points on the armature surface, the flux distribution curves A and B

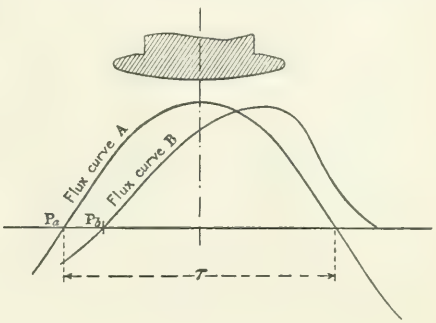


Fig. 6.

of Fig. 6 can be plotted. The first, which represents open-circuit conditions, is plotted from the magnetomotive force curve F, while curve B, showing the flux distribution under load, is derived from the magnetomotive force curve M. The respective areas of these curves (which can be ascertained with a planimeter) are a measure of the total air-gap flux under the two conditions, and since the average value of the "apparent" developed voltage will be proportional to these areas, the regulation can be obtained, as a first approximation, by assuming that the E.M.F. waves are sine curves.

The correct solution of the problem involves the actual wave-shapes of the developed E.M.F.'s. Whatever may be the number and spacing of the slots on the armature surface, the usual E.M.F. wave-shapes can always be plotted in the manner indicated in Fig. 7, where the full-line curve may be any one of the flux curves previously obtained, such as B of Fig. 6, the ordinates of which are a measure of the average flux density in the air space near the surface of the armature. Draw A and B properly spaced to represent the slots, *e.g.*, two in this illustration, of one phase of the armature winding. At the instant when the centre line C of this phase winding occupies the position shown in Fig. 7, the conductors in slot A are moving in a field of density AA′, while the conductors in slot B are moving in a field of density BB′. These conductors are all in series, and the instantaneous value of the voltage per phase winding will be

$$e = B_a \pi D l Z . 60 . 10^8$$

where B_a = average value of flux density, in gausses;
= (AA′ + BB′)/2 in this instance;
N = revs. per min.;
D = armature diameter in centimetres;
l = armature length (axial) in centimetres;
Z = total number of conductors in series per phase.

* Abstract of an original communication in the "Journal" of the Institution of Electrical Engineers.

† "Transactions" American Institute of Electrical Engineers, Vol. XXXI., p. 509, 1912. *Also* Purdue Engineering Review, May, 1914.

* A. Still, "Air-gap flux distribution in dynamo-electric generators." "Journal" of the Franklin Institute, Vol. CLXXIX., p. 21, 1915.

This value of x is plotted as CC' to a suitable scale, and the process is repeated for other positions of the armature slots, thus producing the dotted curve V, representing the E.M.F. that would be developed in the windings if all the flux in the air-gap were cut by the conductors in the slots. The E.M.F. actually developed will depend—as previously explained—on the amount and distribution of the slot flux; and the wave shape of the voltage actually developed can be predetermined if desired; but as the correction can be made with sufficient accuracy by means of a final vector construction, a knowledge of what has been called the "apparent" developed voltage is alone necessary.

Having obtained a curve giving the successive instantaneous values of the E.M.F. under load conditions, it is easy to derive its R.M.S. value. The most satisfactory way of obtaining this is to re-plot the curve on polar co-ordinate paper, and measure its area. The virtual value of the non-harmonic E.M.F. is then given by

$$E_g' = \sqrt{(\text{twice area of one lobe}/\pi)}.$$

The terminal voltage—which must be known before the regulation can be calculated—is most readily obtained by using vector diagrams; but this involves the substitution of "equivalent sine curves" for the irregular waves. The maximum value of a so-called equivalent sine wave is $\sqrt{2}$ times the R.M.S. value of the irregular wave; but its time-phase relatively to any defined instantaneous value of the irregular wave is not so easily determined. It can be obtained from the irregular curve when plotted to polar co-ordinates; but a preferable method for the purposes of explanation, although more tedious, consists in obtaining the average value of the true power and making the displacement between E.M.F. and current vectors equal to $\cos^{-1}$(true power/apparent power). The current wave (assumed to be a sine curve) from which the magnetomotive force curve BD of Fig. 5 is derived would have its maximum value at the point B, displaced β electrical degrees beyond the centre, A, of the pole. The actual full-load E.M.F. wave, such as V of Fig. 7, can also be drawn

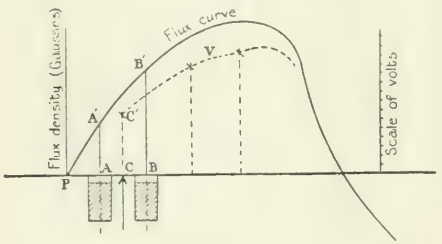


FIG. 7.

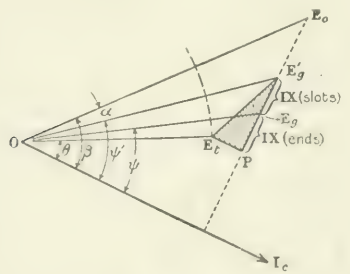


FIG. 8.

in the correct position relatively to the centre line of the pole; and, by multiplying the corresponding instantaneous values of E.M.F. and current, the power curve can be drawn and the average value of its ordinates calculated. The ratio of this quantity to the volt-amperes is equal to the cosine of the angle ψ' in Fig. 8. This vector diagram can be constructed as follows:—

Draw OE_o to represent the assumed open-circuit voltage corresponding to the field excitation used in deriving the magneto motive curve. Draw the angle EOI equal to β of Fig. 5. This is the estimated lag of current behind the open-circuit E.M.F. Draw OI equal to I_c in the calculated R.M.S. value of the "apparent" developed voltage under load conditions, and so that ψ [illegible] to be equal to one of the values obtained by multiplying the corresponding instantaneous values of E_g' and I_c. From E_g' drop a perpendicular on to OI_c, and set off $E_g'E_g$ and E_gP to represent the reactance drops in slots and end connections respectively, calculated as above. Draw PE_t parallel to OI_c to represent the resistance pressure-drop per phase, and join OE_g and OE_t. The regulation of the machine is then $(OE_o - OE_t)/OE_t$. This regulation may not correspond to the exact values of external power factor and terminal voltage assumed when estimating values for the open-circuit voltage E_o and the angle β; but, by using the vector construction on the assumption of sine waves throughout, a very close estimate of these quantities can be made. The important point in connection with this method of analysis is that the external power-factor angle θ and the terminal voltage E_t can be calculated for any value of the armature current I_c when the phase displacement of the latter relatively to the open-circuit voltage E_o is assumed.

The meaning of the other quantities in Fig. 8 may be summed up as follows:—

The angle E_oOE_g', or α, is the phase difference between equivalent sine waves representing open-circuit voltage and "apparent" developed voltage under load conditions. It is the result of flux distortion due to the armature cross-magnetising ampere-turns. The vector OE_g gives the R.M.S. value of the voltage per phase winding actually developed in the armature inductors by the cutting of the flux entering the armature core.

The angle E_gOI_c or ψ is the internal power-factor angle. The difference in length between OE_o and OE_g' is the voltage-drop due to armature demagnetisation and distortion. The point E_o is shown in Fig. 8 on PE_g' produced, but it does not necessarily fall on this straight line, and so forms one important difference between the construction of Fig. 8 and that of the vector method on any power factor, in which the assumptions made are not universally applicable.

In conclusion, it may be said that the use of vectors and vector constructions, such as were described in the earlier part of this Paper, will usually give sufficiently accurate results without the expenditure of time and labour involved in the plotting of flux curves and E.M.F. waves. It is in the case of abnormal designs, or when the conditions are unusual, that the problem of regulation may be studied most conveniently and correctly by a method such as that here described, which is subject to modification in matters of detail and may be elaborated if desired.

INSULATING PROPERTIES OF SOLID DIELECTRICS.*

BY HARVEY L. CURTIS.

(Concluded from p. 658.)

Summary.—Methods of measuring very high resistances are discussed, and diagrams given showing how they may be applied to the measurement of volume resistivity and surface resistivity. The effect of the humidity of the surrounding air, of the temperature of the specimen, and of the magnitude and length of application of the impressed voltage is discussed. The surface resistivity is shown to be due to a surface film, usually of water or oil, on the insulator. This is generally the important factor in determining the leakage between two conductors insulated by a solid dielectric. The surface resistivity of most materials changes through wide limits when the humidity of the surrounding air is varied. The effects of temperature and of exposure to light are also treated.

SURFACE LEAKAGE.

The current which flows between two conductors, maintained at different potentials and insulated from each other by a solid material, is made up of two parts—that which flows through the insulator proper, and that which flows through a film of moisture or other conducting material on the surface of the insulator. The relative importance of these will depend on the resistance of the two paths. Since water, even if very pure, conducts much better than the ordinary solid insulators, a very thin film of water may have much less resistance than the insulator. Before discussing these further, some definitions are desirable. The volume resistivity, ρ, of a material has already been defined as the resistance between two opposite faces of a centimetre cube. By analogy we shall define the surface resistivity as the resistance between two opposite edges of a surface film which is 1 cm. square. The surface resistivity depends upon the thickness of the film and is not a property of the material of the film, so that the term "resistivity," which is generally used to express the property of a material, cannot strictly be applied. However, since both the thickness and the volume resistivity of the surface film depend, under any given conditions, upon the material on which it is deposited, surface resistivity may be considered as a property of

* Abstract of a Paper from the "Bulletin" of the Bureau of Standards, Washington (U.S.A.).

the material on which the film is deposited. Thus we will speak of the surface resistivity of glass, hard rubber, &c., though these materials only serve for condensing the moisture and do not carry any of the current. It is quite impossible to devise a means for measuring the resistance of the surface film by itself, since some of the current will always flow through the insulator on which the film is deposited. However, by knowing the volume resistivity, a correction can be applied to the measured resistance to give the surface resistance. In only a few cases is this correction appreciable.

It is sometimes convenient to have a term to express the total resistance between two conductors insulated by a solid dielectric. We shall call this the leakage resistance. We shall define the leakage resistivity as the resistance between two conductors, each 1 cm. square, when they are placed 1 cm. apart on an insulator 1 cm. thick. While the leakage resistivity will in all cases be less than the surface resistivity, yet the difference between the two will usually be far less than the errors of measurement.

Effect of Humidity.—In order to determine the effect of humidity upon the surface resistance of a material a number of samples were placed in a case, and their resistance measured at different humidities. About 500 cc. of sulphuric acid solution of the proper density to give the desired humidity was placed in a crystallising dish in the bottom of the case, the temperature being maintained constant. Measurements of the insulation resistance were made after the samples had been kept in air at a given humidity for 18 or 20 hours. After computing and tabulating the results, a curve was plotted for each sample showing its change of surface resistivity with the humidity. Nearly 200 such curves have been plotted, of which Figs. 3–6 are examples. These and others given in the original paper cover practically all the materials investigated, and were chosen as being representative of these materials.

Before this, investigations were made on the length of time necessary for the surface resistance of a substance to become stationary after a change of humidity of the surrounding air. For instance, in the case of clean hard rubber when the humidity is increased from 50 per cent. to 93 per cent., it was seen that the resistance changed rapidly for the first two or three hours, when the change became slower and was approximately exponential. While the change was comparatively slow after two or three hours, yet a steady state had not been reached at the end of 19 hours. Investigations were made on samples which had been in air of 95 per cent. humidity when the humidity was lowered to 29 per cent. After remaining at this humidity for 48 hours the initial reading was taken. Hard rubber which had deteriorated on account of exposure to sunlight showed a very marked increase in the resistance, and the maximum had not been reached at the end of 19 days. Other materials showed that precise results are of little value in the practical use of insulators.

Except in a few cases where it was desired to show the effect of cleaning, the samples were cleaned in the same manner and to the same extent as would be done in practical work; *i.e.*, they were wiped with a cloth or dusted with a brush. All curves of surface resistivity given in Figs. 2, 3, 4 and 6, are plotted on the same scale, so that they can be readily compared. In order to make this possible, the logarithm of the surface resistivity is plotted as ordinate, so that the actual values of the surface resistivity progress by powers of 10. In this manner very large changes of resistance can be shown on one sheet. The abscissa is the per cent. of relative humidity. In order that the reader may judge for each sample concerning the lag of the surface resistivity after a change in the humidity of the surrounding air, those values which were taken with increasing humidity are indicated upon the curves by open circles, while those values which were taken with decreasing humidity are indicated by solid circles. To economise space and to facilitate comparison of one curve with another it has been necessary to place several curves on one sheet. Where uncertainty might exist as to the curve to which a given point belongs, a fine line is drawn to connect the point with the curve.

In Fig. 3 are given the results upon samples of mica. The clear mica was entirely colourless. The surface was cleaned with gasoline, but it was not subjected to any treatment which would remove the last traces of paraffin and grease. Another sample of India ruby mica was used, which gave a curve nearly coinciding with the brown African mica, clear. These results are mainly interesting on account of the variability which is found in this material. It is evident that it would require an extended investigation to determine the relative merits of the different varieties of mica. In Fig. 4 are given the results upon a number of materials which are manufactured under trade names. The Electrose samples were obtained from the Electrose Manufacturing Co., of Brooklyn. Two samples of two different kinds (black and yellow) were obtained several years ago. One sample of each kind was exposed to the light, while the other sample was kept in the dark. The results after exposing for three years are given in the curves. It will be noted that at low humidities the resistance of the sample of black Electrose is higher after exposure to the light than before. This is doubtless due to the formation of fine cracks on the surface, which increase the leakage path at low humidities, but which are bridged by small drops of water at the high humidities. In general the deterioration has been slight. Electrose No. 8 is a more recent product, being one of several very similar samples which were submitted. In Fig. 5 are the curves of some miscellaneous materials. Insulate No. 2 is representative of several samples, all having nearly the same surface resistivity, which were furnished by the General Insulate Co., New York. It is a moulding material, certain grades of which closely resemble hard rubber. Moulded mica and J-P Bakelite are also moulding materials, manufactured by the Johns-Pratt Co., Hartford, Conn. The moulded mica consists of ground mica and asbestos with shellac as a binder. It should be noted that, as in the case of the Murdock compounds (given in the Paper), this curve corresponds very closely with the curve for shellac, showing that so far as surface effects are concerned they are almost entirely dependent upon the shellac. The sample was also exposed to sunlight for a period of four months without appreciable deterioration. The J-P Bakelite is a bakelite compound. The samples of Galalith were obtained from the International Galalith Gesellschaft, having factories in England, France and Germany. The material is made from the casein of milk, and uncoloured is being used as a substitute for ivory. For insulating purposes it is somewhat better than ivory. In this case the introduction of colouring matter evidently improves the surface leakage.

Effect of Temperature.—The effect of change of temperature on the surface resistivity was investigated for a number of samples. Investigations were made at different humidities when the temperature

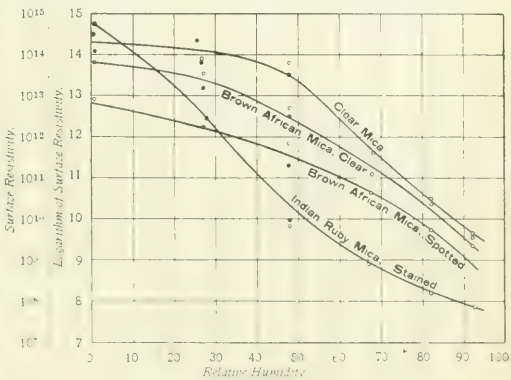


FIG. 3.—CHANGE OF SURFACE RESISTIVITY WITH HUMIDITY. MICA.

varied from 25°C. to 30°C. It was found that for practical work in the laboratory changes in surface leakage due to changes in temperature are of so little importance compared to the changes in resistance due to changes in relative humidity that they may be neglected. It is not to be supposed that this will hold for temperatures considerably removed from those used in this investigation.

EFFECT OF EXPOSURE TO LIGHT.

Exposure to light may produce either a temporary or permanent effect. The temporary effect causes a change in surface leakage only while the light is shining on the surface. This was observed by Goldmann and Kalandyk* in the case of sulphur and by Bates† in the case of sulphur and ebonite. These results could not be reproduced in this laboratory. Exposure to light may produce a chemical change at or near the surface which will be permanent. The work under this head may be divided into two parts; (*a*) the effect of exposure to sunlight, and (*b*) the effect of exposure to ultra-violet light. The chemical changes produced by sunlight are usually much slower than those produced by ultra-violet light.

Effect of Sunlight.—For some years a study has been made of the effect of sunlight upon hard rubber. A sample was prepared in January, 1907, and exposed to the diffuse light of the laboratory for nearly a year, when measurements were taken and marked deterioration noted. The sample was then exposed to sunlight, being placed vertically, just inside a south window. In July, 1908, the resistance

* Annal. Phys., (4), 36, p. 589, 1911.

† British Assoc. Adv. Sci., 1909, p. 405 and by Le Radium, 8, p. 342, 1911.

was very low, and it was decided to see if the sample could be restored to its original condition by cleaning. That this was accomplished is shown by the measurements of December, 1908, when the resistance was somewhat higher than it was when the sample was new. The sample was then placed in the sun, and subsequent measurements showed that it decreased in resistance, but at a somewhat slower rate than in the previous case. This is in agreement with the results of Rayner.* The cause of these changes is evidently in the chemical decomposition of the hard rubber by light. The author deals with these changes and discusses the renovation of the surface by cleaning. Two samples of Electrose which had been exposed to sunlight for more than two and a-half years were also experimented with. The changes which took place were not very marked and appeared to be more physical than chemical. Samples of moulded mica (this uses

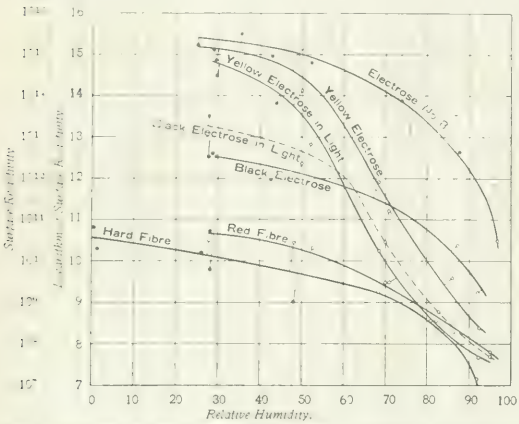


FIG. 4.—CHANGE OF SURFACE WITH HUMIDITY. ELECTROSE AND FIBRE.

shellac as a binder, and its surface properties are almost identical with shellac) and of moulding compositions furnished by the General Electric Co. (U.S.A.), were exposed to sunlight for four months in the winter of 1912 and 1913. The curves after exposure were identical with those before exposure.

Effect of Exposure to Ultra-Violet Light.—The effect of ultra-violet light in accelerating chemical action is well known. As the effect of light upon the surface resistivity is largely due to chemical action upon the surface layers, it seemed probable that those samples which

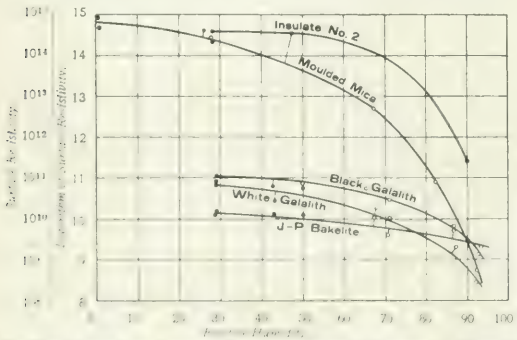


FIG. 5.—CHANGE OF SURFACE RESISTIVITY WITH HUMIDITY. MISCELLANEOUS MATERIALS.

deteriorate in sunlight would deteriorate much more rapidly in ultra-violet light. As this test could be applied in much less time than the test with sunlight, it seemed desirable to try it upon a number of samples. The source of ultra-violet light was a quartz mercury vapour lamp taking 4 amperes on 118 volts. The specimens were placed about 12 in. below this lamp and exposed to the radiation for over 20 hours. All the materials showed some change in appearance, except in the case of some samples of glass. The effect upon the surface resistivity was very different with different materials. In

* Report of the National Physical Laboratory," p. 40; 1910.

Fig. 4 are given curves for hard rubber and for a specimen of hard rubber coated with bakelite. In both cases there was an interval of but one day between finishing the first curve and beginning the second. In that interval they were exposed to ultra-violet light for about 20 hours. The hard rubber ha. deteriorated as much as after several months' exposure to strong sunlight. The curves for the sample of hard rubber covered with bakelite are very interesting. The hard rubber was cut from the same piece as the sample mentioned above. It was covered with a thin coating of bakelite by Dr. Baekeland. Bakelite lacquer was applied by spraying, then the sample air-dr ed, and finally baked for 12 hours at 120°C. The curves show that there was a decided improvement in the surface insulation* due to the thin coat of bakelite, especially at the higher humidities. However, when the sample had been exposed to ultra-violet light for 20 hours, the surface resistivity at the higher humidities was less than one-ten thousandth of the value before exposure. The relative decrease was somewhat larger than for the hard rubber. The exposed surface of the bakelite covered sample appeared but little different to the naked eye than the unexposed surface, but under a microscope the exposed surface appeared covered with innumerable very fine blisters. Whether a like effect would take place if the sample was exposed to sunlight can be ascertained only by experiment. Such experiments are now in progress. A number of other materials were also examined.

The author then goes on to discuss the nature of surface leaka e. It appears that when placed in an atmosp ere having high humidity the decrease in the surface resistance of insulators is due to the

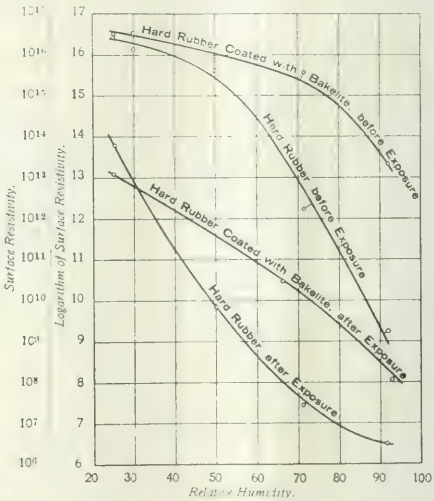


FIG. 6.—CHANGE OF SURFACE RESISTIVITY WITH HUMIDITY. HARD RUBBER AND HARD RUBBER COATED WITH BAKELITE BOTH BEFORE AND AFTER A 20-HOUR EXPOSURE TO ULTRA-VIOLET LIGHT.

condensation of moisture on the surface. Any condition which will affect either the amount of moisture on the surface or its conductivity will affect the surface leakage. Hygroscopic salts will increase the thickness of the water film, and any soluble salt will increase its conductivity. Hence the presence of inorganic salts on the surface of an insulator produces a decrease in the surface resistivity. Since the quantity of water in the surface film is very small the amount of salt required to produce very large changes in the surface resistivity is exceedingly minute. Besides water films, thin films of oil are often present on the surface of insulators. The volume resistivity of oil is much higher than of water. If we assume that the thickness of the oil film is 0·1 micron and that the resistivity of the oil is 10^{11} ohm-centimetres, the surface resistivity would be 10^{16} ohms. Since very few of the curves go above this value, it seems probable that the surface resistivity is generally limited by the resistance of a film of oil on the surface of the insulator. The only exceptions are the waxy materials.

Methods of Computing Surface Resistivity. The surface resistance must always be computed from measurements of the leakage resistance and volume resistivity. In the great majority of cases the

* This was observed by Wommelsdorf, who used this material in constructing a new type of electrostatic machine. *See* "Electrotech Zeitschrift," 35, p. 61; 1914.

current which flows through the solid is such a small part of the total that the surface resistance does not differ from the leakage resistance by as much as the error of measurement. However, at very low humidities this may not be the case. The resistance which the solid insulator offers to the flow of current can be computed for certain forms of electrodes, and in these cases the surface resistance can be obtained. The author goes on to show how σ, the surface resistivity, can be calculated. He also shows that it is at the low humidities where σ is large that the values are most inaccurate. Fortunately, it is in this region that precise values are of the least importance in practical work. In order to show the magnitude of the correction in the most unfavourable cases Table III. has been prepared. In this table are given the measured values of the volume resistivity and the leakage resistivity at low humidity. The surface resistivity at low humidity computed from these values is given in the third column.

Table III.—*Table giving Values of the Volume Resistivity, the Leakage Resistivity, and the Surface Resistivity at Low Humidities of 20 per cent. or less.*

Sample.	Volume resistivity.	Leakage resistivity.	Surface resistivity.
Bakelite 5,200 R. G. R.	4×10^{14}	10×10^{12}	60×10^{14}
Bakelite 5,199 R. G. R. B.	5×10^{15}	10×10^{12}	30×10^{12}
Bakelite No. 150	4×10^{15}	8×10^{12}	24×10^{12}
Bakelite No. L 558	2×10^{16}	3×10^{14}	9×10^{14}
Yellow stabalite	4×10^{15}	5×10^{12}	9×10^{14}
Vulcabeston	2×10^{10}	2×10^{10}	3×10^{10}
Dielectrite	5×10^{15}	6×10^{12}	10×10^{12}
Bakelite micarta	5×10^{16}	5×10^{16}	8×10^{16}
Moulded mica	10×10^{14}	7×10^{14}	9×10^{14}
G. E. No. 55A	10×10^{14}	5×10^{14}	6×10^{14}
Redmonite No. 157, L	2×10^{14}	1×10^{14}	1×10^{14}
Glyptol	10×10^{15}	2×10^{15}	2×10^{15}
Yellow electrose	5×10^{15}	1×10^{15}	1×10^{15}
Murdock No. 100	30×10^{14}	5×10^{14}	5×10^{14}
Insulate No. 2	80×10^{14}	4×10^{14}	4×10^{14}
Black electrose	100×10^{15}	5×10^{15}	5×10^{15}
Amberite	50×10^{15}	2×10^{15}	2×10^{15}
G. E. No. 55R	400×10^{14}	7×10^{14}	7×10^{14}

In the preceding discussion it has been assumed that the air which is above the solid dielectric is a perfect insulator. This is true except in so far as the air is ionised. Assuming the air to be ionised, the total current due to air conduction is only 10^{-17} ampere, which is quite negligible in comparison to the surface leakage of most materials.

THE ELECTRICAL DESIGN OF INDUCTION MOTORS.*

BY H. L. SMITH, A.M.INST.C.E.

(*Concluded from p.* 656.)

Summary.—In the present Paper the author briefly considers the designing required on induction motors from the time of receiving the customer's inquiry down to the sending of drawings to the shops.

Magnetic Leakage.—The subject of magnetic leakage may be approached from either of two standpoints. We may estimate the leakage inductance either separately for stator and rotor by considering the circular field produced by each coil (Fig. 15, in which case the

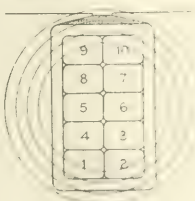


Fig. 15.

calculation takes the form of a more or less empirical expression consisting of the sum of two terms, one term representing the leakage inductance due to the embedded length of the winding and the other term that due to the free length. Or we may estimate the leakage jointly for both stator and rotor as it manifests itself in its three most important forms: Coil end dispersion, *slot dispersion*, peripheral dispersion (*mantel streuung*), zig-zag dispersion (*zic-zack streuung*).

If for machine A, say, we place the developed plan of the stator winding (Fig. 18) over the developed plan of the rotor winding and look down on both, the compensation of the cross-magnetising and de-magnetising components of the rotor current by the cross-compensating and re-magnetising components of the stator current appears to be perfect. But if we look at the *elevation* of the windings, Fig. 16, or the *end view*, Fig. 17, we see that the compensation is not perfect. The stator current flowing in one direction in conjunction with the rotor current flowing in the other, produces a number of uncompensated ampere-turns which send flux round the leakage paths.

In general it may be said that the ampere-turns producing the main flux are best seen in plan, those producing the embedded leakage in elevation, and those producing the end-winding leakage in end view. Fig. 19 gives all three views at once in isometric projection.

As regards magnetic leakage three grades of effectiveness may be distinguished :—

(1) The ideal transformer. (2) The ordinary transformer. (3) The induction motor.

In the first case, which is possible only with equal numbers of turns on primary and secondary, the primary and secondary are wound together on the core, and the transformer can be connected so as to act like a non-inductive resistance. In the second case, which is that ordinarily occurring, the numbers of turns on primary

Fig. 16

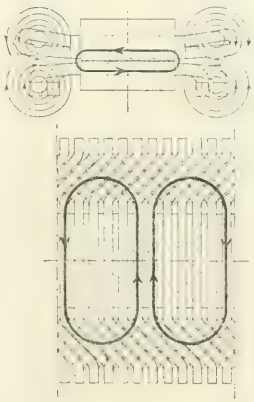


Fig. 17.

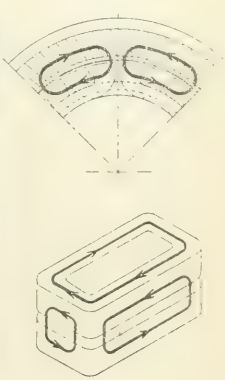


Fig. 18.

Fig. 19.

and secondary are not equal, so that half of the secondary is wound in a lump on each limb of the iron core, and then half of the primary in a lump on top of each half of the secondary. In the third case the primary and secondary are separated by an air-gap.

The Leakage Coefficient.—Another basic conception is that of each machine divided up into its component elements, each element comprising a pair of poles or 360 magnetic degrees. Thus, Figs. 16, 17, 18 represent in elevation, end view and plan an element of machine A, showing a wire lap winding on the stator, and a pressed cable chain winding on the rotor.

In studying the properties of induction motors, it is advantageous in many cases to study rather one of the elements of which a machine is composed than the whole machine itself, in particular, because it brings large machines and small machines down to a common basis for purposes of comparison.

Thus, the dispersion coefficient, which, being the ratio of the leakage reactance to the mutual reactance, is practically a criterion of the electrical, or rather the magnetic, excellence of a machine is dependent principally upon the four quantities : (1) The air gap. (2) The pole pitch. (3) The length of core. (4) The mean number of slots per pole on stator and rotor. All of which are properties of an element of the machine.

Whether a machine has 40 poles or four poles, provided these dimensions of the element are the same, makes no difference to the dispersion coefficient, nor, therefore, to the magnetic behaviour of the machine. The large machine consists simply of 10 of the smaller machines added together. The problem of settling the best proportions of these elemental dimensions in the case of the induction

* Paper read before the Rugby Engineering Society.

motor, as in that of so many other classes of machinery, is the problem of effecting a compromise between conflicting desiderata. It would seem at first sight that reducing the air-gap should reduce the dispersion coefficient almost proportionally, but, in fact, it does not, owing to the zig-zag leakage going up as the air-gap is reduced. Hence, when the zig-zag leakage is a large proportion of the whole, that is, when a small number of slots per pole is used, then a limit is soon reached, apart from mechanical considerations, beyond which it is not desirable to reduce the air-gap.

Any expression for the leakage reactance must appear as the sum of two terms, the first term representing the leakage inductance due to the embedded length of conductor, and the second term that due to the free length. If for the stator we call these two quantities l_1 and l_2, then we have

$$x_1 = 2\pi f (l_1 + l_2),$$

and similarly for the rotor.

The leakage inductance due to the embedded length, besides being proportional to the square of the effective conductors per slot, to the slots per phase and to the embedded length, is also directly proportional to the permeance of the magnetic path surrounding the slot, consisting partly of iron and partly of air. Hence, it is necessary to formulate a "permeance figure," which will appear as the sum of several terms, each term representing the permeance of a part of the air path, the reluctance of the iron path being taken account of by deducting a percentage from the whole.

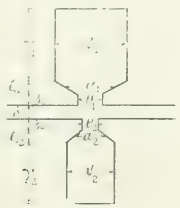


FIG. 20.

Using the notation of Fig. 20, a fair average permeance figure for partially closed slots may be written down for the stator as follows :—

$$\gamma_1 = \frac{\zeta_1}{3\omega_1} + \frac{\beta_1}{a_1} + \frac{\delta_1}{a_1} + \frac{\psi_1}{a_2}$$

and for the rotor as follows :

$$\gamma_2 = \frac{\zeta_2}{3\omega_2} + \frac{\beta_2}{a_2} + \frac{\delta_2}{a_2} + \frac{\psi_2}{a_1}$$

The embedded inductance can then be written down for the stator

$$l_1 = 12{\cdot}6\, W_1^2 \frac{Q_1}{Q_2} L K_1 \times \text{stator permeance figure},$$

and for the rotor

$$l_2 = 12{\cdot}6\, W_1^2 \frac{Q_1}{Q_2} L K_1 \times \text{rotor permeance figure},$$

where

$$W_1 = \frac{\text{wires per slot}}{\text{wires per slot} \times \text{poles in parallel} \times \text{slots in parallel}}$$

all poles and slots in parallel being considered as wires in parallel,

Q_1 = slots per phase on stator,

Q_2 = slots per phase of stator on rotor,

two-phase rotor windings being handled as if they were three-phase windings placed in the same number of slots,

L = embedded length in centimetres,

K_1 = factor depending on the slots per pole as shown in the curve, Fig. 21.

For the leakage reactance due to the free length, besides being proportional to the square of the effective conductors per slot, to the [illegible] to the number of poles, &c., depends also on the type of [illegible] and on the voltage.

For [illegible] and l_2 are of about the same length as for l_1 and l_2. The quantities involved being W_1, S_1, S_2, M_1, M_2, and P, [illegible] poles per phase on stator, S_1 = slots per pole [illegible] stator or rotor, M_1 = free length of turn on stator in [illegible] length of turn on rotor in centimetres, and P = number of poles.

[illegible] the leakage reactance in C.G.S. units, [illegible] necessary to multiply by [illegible] and l_2 due to different types of winding and [illegible] to take into account [illegible] by reducing go " and [illegible] voltage factor " respectively.

Seeing that any formula for the leakage reactance must of necessity be so largely empirical, it is desirable to check calculations by actual results as often as possible. Two of the first tests taken are a test running light and a test with locked short-circuited rotor; volts, amperes and watts being read in each case. The latter test has to be taken with a low voltage, so that the core loss is small, and there being no friction, the losses are practically all ohmic.

For instance, in the case of machine D as six poles, with locked squirrel-cage rotor, we can at once write down :—

Impedance = 1·95 ohms,

$\cos\varphi = 0{\cdot}455$ and $\sin\varphi = 0{\cdot}89$.

Therefore,

total resistance = 0·887 ohm and

total reactance = 1·73 ohms.

But stator resistance = 0·696 ohm, hot.

∴ rotor resistance = 0·199 ohm, hot.

The calculated reactances were : For the stator $x_1 = 1{\cdot}65$ ohms and for the rotor $x_2 = 0{\cdot}482$ ohm.

Dividing the actual total reactance between stator and rotor in the ratio of the calculated values, we obtain finally

x_1 (actual) = 1·34 ohms and x_2 (actual) = 0·382 ohm.

The Specific Electric Loading.—The currents in evidence on an induction motor are :—(1) The no-load sheet of stator current devoted to exciting. (2) The sheet of rotor current called into play by the load. (3) The countervailing sheet of stator current to prevent the no-load

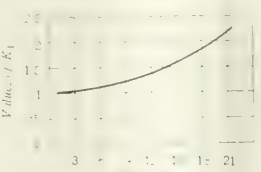


FIG. 21.

equilibrium from being deranged, this being an exact replica of the sheet of rotor current.

If we divide the sheet of current by the periphery in centimetres we get the specific electric loading. Thus, the specific electric loading of the stator as regards the sheet of compensating current only is equal to that of the rotor; but when the magnetising current is superposed upon this the specific electric loading of the stator becomes greater than that of the rotor.

The specific electric loading of the stator thus being greater than that of the rotor there must be more copper on the stator than on the rotor, and this difference is accentuated by the current density permissible on the revolving rotor being greater than that on the stationary stator. The copper on a wound rotor being some 30 or 40 per cent. greater than on a squirrel-cage rotor, it follows that in the latter case the disparity between the quantities of copper on stator and rotor becomes still more marked.

The question now arises of the division of these sheets of current into slots. The problem, as usual, resolves itself into a compromise between conflicting desiderata. Theoretically, so long as the sheets of current are there, it does not matter into how many slots they are divided. For high voltage machines it is desirable to have as few slots as possible, so as to waste as little space on insulation as possible in proportion to copper and iron. On the other hand, a small number of slots per pole increases the zig-zag dispersion. In the case of high-speed machines where the pole pitch is great, the slots on both stator and rotor can be made of large size without unduly reducing the number of slots per pole. This feature is particularly valuable when the voltage also is high. The number of slots on the rotor has to be different from that on the stator, these two numbers being chosen so as to have as small a G.C.F. (greatest common factor) as possible. Polar-wound rotors are at a disadvantage in this respect as compared with squirrel-cage, and hence, when short-circuited, the positions for maximum and minimum current are more marked in the former case than in the latter.

The Specific Magnetic Loading.—If we divide the total flux by the area at the air-gap in square centimetres, we obtain the specific magnetic loading of the machine. The core loss in the rotor, especially when squirrel-cage, is less than in the stator, both on load and at starting, in the one case because the frequency is small, and in the other because the mutual flux is small. Hence, the flux density in the rotor can be greater than in the stator.

The following table gives particulars as to the specific magnetic loading of machine A, and the ampere-turns required to produce it :—

Magnetic circuit.	Section, sq. in.	Lines per sq. cm.	Length, in.	Ampere-turns.
Stator core	112	11,400	12·9	61
Stator teeth	107	11,800	5·4	30
Rotor core	110	11,500	8·3	41
Rotor teeth	106	11,900	2·8	16
Air-gap	357	3,540	0·158	670
		Total ampere-turns		818

The Heating of Induction Motors. In order to summarise the above problem it should be noted that each considerable firm has a line of standard stator frames, which for the purposes of this Paper may be called frame A, frame B, frame C, and so on. Frame A will dissipate so many watts when the gap is of such a diameter, the end winding of such an overhang, the rotor has bigger ventilating ducts, and so on. Each frame again may be fitted with open type semi-enclosed or totally enclosed end-shields, or with pedestal bearings. The problem then resolves itself into one of organisation. An obvious plan would be to provide ourselves with a quantity of sheets of, say, quarto squared paper for the purpose of curve plotting, and to allocate so many of these sheets to each frame. In each case the allowable watts for the frame would be plotted along the axis of y, and the revs. per min. of the rotor along the axis of x. Thus, there would be one curve for frame F for a certain gap diameter when fitted with air guides, another without ; one curve with fans on the rotor, another without fans, and so on. If we were starting a line of machines from the very beginning, these curves would have to be estimated. But there is generally a continual stream of orders going through, so that these estimated curves can be gradually replaced by actual results. If there be not a likelihood of orders till the line of machines is designed, then a few experimental tests can be carried out scattered over the series and the curves continued by interpolation or extrapolation. This outfit of curves, being on loose sheets, can be amplified or contracted in any part as desired, or, as the test records come through, we can allocate the several losses to their respective causes, and plot fresh and more accurate curves until we have brought the outfit to any degree of elaboration that we desire.

Appendix.

The Unbalanced Magnetic Pull. The unbalanced magnetic pull is proportional, other things being the same, to the square of B_{mean} in the air-gap. On starting a squirrel-cage motor, about half the flux

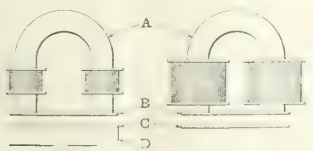


Fig. 22. Fig. 23

follows the stator leakage paths, and the remainder the rotor leakage paths, practically the whole of which follows the rotor leakage paths, the mutual flux being very small. With the same motor running light, nearly the whole of the flux crosses the air-gap, for B_{mean} in the air-gap at starting is only about half of B_{mean} at no-load. Hence, in a squirrel-cage motor without a compensator the unbalanced magnetic pull at starting is only about a quarter of that at no-load.

At the maximum torque point the air-gap flux is only about three-quarters of the whole stator flux, and the unbalanced magnetic pull is only a little less than half that at no-load.

If a motor with phase-wound rotor be required to start with a torque equal to the maximum, then the conditions at the maximum torque point are, as it were, shifted back to the starting point by the external resistance, and therefore the unbalanced pull at starting is only a little more than half that when running light.

If the motor be required to start with only full load torque, then it is the endeavour to pull load that is shifted back to the maximum point, and, therefore, the unbalanced pull at starting is practically equal to that at no-load. In any case, the unbalanced magnetic pull is a maximum when running light.

The magnetic actions when running light may be represented by Fig. 22, where A may be imagined to represent the stator, B and C are thin plates of good magnetic material separated by the leakage paths respectively, and D is the block of good magnetic material to represent the rotor mutual path. Plates C and D together represent the keeper or armature of the electromagnet. When running light practically the whole of the flux passes through D. The ampere-turns are small, but the flux crossing the air-gap is great. If the keeper were in actual contact with the electromagnet, then Maxwell's law of traction would apply—viz., $P = B^2S/8\pi$; but since there is an air-gap a modification of Maxwell's law has to be employed.* The pull is nevertheless proportional to the square of B_{mean} in the air-gap.

The flux at starting for a squirrel-cage motor is precluded by the adverse rotor M.M.F. from following the rotor mutual path, and, therefore, the latter might just as well be made of wood or cement or air. Hence, the magnetic actions at starting for a squirrel-cage motor may be represented by Fig. 23, in which the soft iron block D is removed. The ampere-turns are much greater, but the flux crossing the air-gap is only about half as great, and it is actual flux produced which counts, not the ampere-turns required to produce it.

WIRELESS CALL DEVICES.†

By J. E. Turner, M.A.

Summary. The author discusses the problem of producing a call device actuated by the small power in a receiving antenna, and describes various sensitive amplifying devices of possible use for this purpose. He describes two devices of his own design to meet the needs of the Post Office.

Introduction.

What distinguishes wireless telegraphy most from other kinds of power transmission or electrical communication is the small ratio of power received to power transmitted. The table shows in a rough illustrative fashion the orders of magnitude of the power transmitted and received in the several systems named.

	Watts transmitted.	Watts received.	Ratio.
Power line	Say 10^6	10^6	1
Submarine telegraph	1	10^{-4}	10^{-4}
Telephone	10^{-2}	10^{-6}	10^{-4}
Wireless telegraph.....	10^{-6}	10^{-6}	10^{-12}

This Paper deals with the problem of how the received signals can be made to actuate a call, by which is meant the ringing of a bell or making other commotion on a large scale in contradistinction to the feeble buzz in a telephone. Ten years ago when the coherer was used all such signals as were received at all actually did operate a bell or a Morse inker. But the coherer has given way to more modern detectors because it cannot possibly be made both sensitive and reliable. The primary difficulty in devising an effective call apparatus to-day is the extreme smallness of the power available ; for obviously if the device is to be of the fullest service the calling range must be as great as the signalling range. A secondary difficulty is the avoidance of false calls, that is, calls actuated by foreign wireless stations discharging their ordinary traffic, or by atmospherics.

The problem is, therefore, in the main to provide apparatus capable of responding noisily to such stimulus as may be got from an antenna fed with about one hundredth of a microwatt, but which will not respond to stray disturbances. I shall first discuss the main lines of approach to a possible solution, and then outline the special form in which the problem has presented itself to Post Office engineers, and describe the apparatus that has been devised to meet the want. Finally I shall describe another set of apparatus which, though not well adapted to immediate Post Office requirements, may at least be of some academic interest.

Instruments for Effecting a Call.

Excluding from consideration the coherer, no wireless call apparatus has yet so far as I am aware, been put into commercial operation. Much attention has been paid to the provision of a selective call device for shipwreck emergency purposes, but these need not be considered here, as they do not involve the question of selectivity.

In reviewing the various possible methods of making a call, it is convenient to notice three distinct stages in the process by which the final result may be obtained. Firstly, some apparatus of extreme sensitiveness controlled by the received energy is actuated by a minute power, conveniently expressed in microwatts. Secondly, this apparatus actuated other apparatus of medium sensibility, consuming power conveniently expressed in milliwatts. Thirdly, this [illegible] apparatus [illegible] such as a bell.

* Proceedings, Royal Soc., Vol. LXXVIII., p. 104.

† Abstract of Paper to be read before the Institution of Post Office Electrical Engineers.

utilising power conveniently measured in watts and capable of making clamorous appeal to the senses. We may for brevity refer to these three stages as the microwatt stage, the milliwatt stage, and the watt stage. The milliwatt stage is an elastic one, which may be absent altogether, or itself comprise several sub-stages; it may conveniently be taken to cover all connecting links between the microwatt stage and the watt stage.

If the apparatus responds quickly enough, it may be used to record Morse signals; the movement or other change from spacing to marking must then be effected in the microwatt stage with extremely small energy. If, on the other hand, the device is a slow responder, by suitable arrangements the microwatt apparatus can be made to accumulate energy over a considerable period of time; the change from spacing to marking is then more energetic, and instruments of a coarser nature can be used.

An obvious procedure is, of course, to take an ordinary wireless receiver with a crystal or other rectifying detector, and to replace the telephone by a relay whose local circuit includes a bell. If desired, a milliwatt relay of grosser construction may be inserted between the first relay and the bell. But the power received by the telephone, or the microwatt relay substituted for it, is so small that no relay as used in ordinary telegraphy could be operated. A Post Office "B" relay would require 5,000 times the power available.

There are, however, various relays capable of responding with extremely small power, which could be used. These are of two types: first, the critical or make-and-break type, in which, as in ordinary telegraph relays, the local circuit is either open or closed; second, the amplifying or microphonic type, in which the local circuit is not made and broken, but has its resistance varied between finite limits.

The available energy is so small, that no relay of the make-and-break type with solid metallic local-circuit contacts could, I imagine, be constructed to give reliable service; certainly I know of none. The ingenious jet relay of Dr. A. Orling, already employed in submarine cable telegraphy could, however, be used. In this instrument a moving coil in a powerful magnetic field has attached to it a horizontal radial arm of quartz fibre. A vertical fibre resting lightly against this has running down it a thin stream of acidulated water

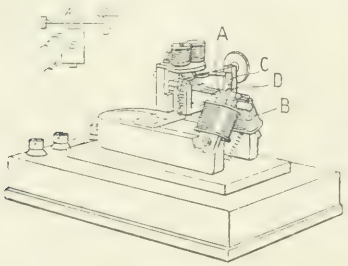


Fig. 1.

from a very small orifice; and this stream either hits or misses a platinum plate according to the amount by which it is deflected by the horizontal arm. I have seen such an instrument respond to a steady-current power of 7×10^{-11} watt. The relay as described above is of the critical or make-and-break type; by a slight modification of the form of the electrode on which the stream impinges, it can be converted to the amplifying type.

Of the amplifier type there is a diversity of patterns. Probably most familiar is Mr. S. G. Brown's telephone amplifier, capable, as the name implies, of responding to currents of telephonic frequency. In this instrument (Fig. 1) the steel armature A of a polarised electromagnet B carrying the current to be magnified controls the pressure, and thereby the resistance of the contact between an osmium-iridium point C and a plate D of the same metal or of carbon. With this amplifier in the microwatt stage, the milliwatt stage would contain one or more other Brown amplifiers fitted with microphonic granule, instead of single-point, local contact; for the single-point contact cannot be made to control sufficiently large power for operating directly a coarse relay suitable for actuating the apparatus in the watt stage.

Another highly sensitive amplifier, operating on quite a different principle, is that due to Mr. E. S. Heurtley, patent 17,555/1909. This device depends on the change of resistance produced in a hot thin platinum wire when it is slightly displaced across the edge of a blast of cold air. Such wires form two arms of a Wheatstone bridge, and are moved by a coil of fine gold-annealed across the front of the tube forming the jets. The balance of the bridge affects the amount of current from a local battery that passes through another stronger galvanometer.

Another instrument is the cathode ray amplifier of Von Lieben and Reiss, patent 1,482/11. In Fig. 2, A is a vacuous glass bulb containing a glowing filament B, a metal-grid C completely dividing the bulb into two portions and constituting the primary anode, and a third electrode D constituting the secondary anode. The filament B is a Wehnelt cathode, formed of a strip of platinum coated with a layer of barium and calcium oxides; for these substances emit at red heat a more copious stream of corpuscles than a platinum surface at even a much higher temperature. The temperature of the filament is regulated by the rheostat E, and the polarising voltage between the cathode which may be regarded as the negative end of the filament and the primary anode is regulated to any desired value below 30 volts, by the potentiometer F; the secondary circuit is polarised by a battery of small dry cells giving about 220 volts. The current to be amplified is led to the primary terminals P_1, P_2, and the amplified current is drawn from the secondary terminals S_1, S_2. The action may be very roughly described as follows. Corpuscles are discharged from the cathode with great velocity towards the grid C. These corpuscles, being negative charges, are repelled and therefore slowed up by any negative charge on the grid; the greater, therefore, the negative potential of the grid the less is the speed of the impinging corpuscles, and the fewer and feebler are

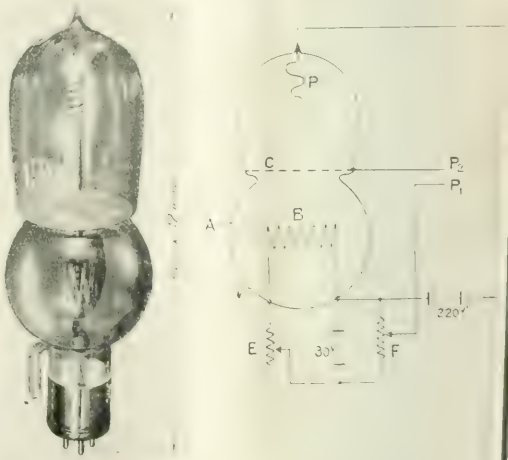


Fig. 2.

the corpuscles which penetrate the grid and ionise the gas above the grid. The resistance between S_1 and S_2 thus increases with the negative potential of the grid. By suitably adjusting the temperature of the filament and the potential of the grid, it can be arranged that a small change in the latter effects a great change in the resistance between S_1 and S_2; the instrument then constitutes a very sensitive amplifier.

The cathode ray amplifier is likely to play a very important rôle in the future. It can deal with the smallest powers, introduces no perceptible distortion, and is available for amplifying fluctuations of any rapidity up to the frequencies used in wireless telegraphy. The Marconi Company have developed a modified form (patent 28,413/13) of the Lieben-Reiss amplifier which plays an important part in their high-speed reception.

Any one of these extra sensitive relaying instruments might replace the telephone of an ordinary receiver, and so in conjunction with other instruments, convert signals which would have been a faint buzzing in the telephone into the ringing of a bell. But whereas the listening operator attends only to a message preceded by a certain sequence of dots and dashes, his call signal, the bell would not exercise this discrimination. It is necessary, therefore, to arrange that a signal of some special character shall be used for calling, and that the device shall respond only to signals of this character.

It is, of course, possible to attain some degree of selectivity by the ordinary tuning methods, and a special wave-length might be re-

served for calling as distinct from transmitting messages. But this would be not only inconvenient but inadequate, for the device would respond to some signals not in tune but very strong and also to atmospherics, for these make an impact on all tuned circuits of natural frequency.

A simple form of call signal is a long dash, and a receiver may be constructed so that it will respond only to a dash of not less than a certain minimum duration, which would, of course, be chosen longer than any dash likely to be made in transmitting messages. This principle has been utilised in the Post Office in one form of sounder silencer, and could be applied to any of the quick-acting relays which have been described.

With the musical note transmitter the spark frequency may be used for tuning by sound resonance or note syntony. The Telefunken amplifier consists of a bank of microphonic contact relays, each similar in arrangement to the Brown amplifier with granule contacts. The armatures, however, are comparatively loosely related to the energising circuits, and the natural frequency of each armature is mechanically adjusted to be equal to the spark frequency (500 periods per second).

But whether the transmitter is a musical one or not, it is possible to effect a syntony somewhat analogous to note syntony by transmitting dashes at small regular intervals. A scheme for a distress call device on this principle was suggested by Mr. W. S. Peake in a recent patent specification (No. 1,050/12). A magnet is switched in, in place of the ordinary telephone, and dashes and spaces sent at a definite frequency cause the armature to vibrate by the cumulative effect of the impulses. When a certain amplitude is reached contact is made, and a bell rings. This provides adequate selectiveness by the use of a practicable apparatus which could be added to an existing station, but the relay probably would not be nearly sensitive enough.

The Marconi Company's quite recently developed device for the remote control of fog-signalling apparatus constitutes, I think, the nearest approach that has been made to a practical call device which can be left to itself. The result has been achieved by reverting to the coherer, but in a specially reliable and consequently insensitive condition. The coherer controls a relay of conventional type, whose local circuit energises the magnets acting upon a pendulum of balance-wheel form. Dashes are sent at equal intervals (automatically) from the calling station, and at each dash the coherer operates, the relay tongue flicks over, and an impulse is given to the balance-wheel. The balance wheel has been mechanically tuned to the frequency of the transmitted dashes, which are of the order of two per second; its amplitude, therefore, grows under the repeated stimuli, until a fork carried by the wheel dips into mercury-cups and the fog-gun is thereby switched on or off.

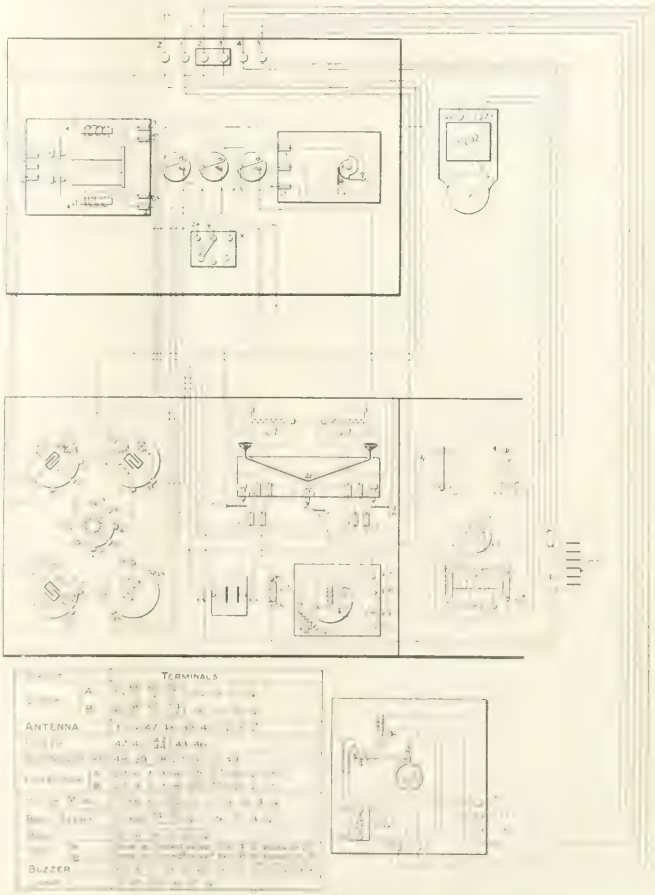


Fig. 3.

A Call Device for Post Office Work.

A constant watch is kept at the Post Office wireless stations for ship service, but call devices would be of service on small islands where there is no cable, or isolated parts of a coast. At the existing stations of this class the practice is for one of the pair to call the other once an hour, or at other defined interval, but when the operator has also many other duties it is obvious that precise punctuality cannot be expected and [illegible] results. Furthermore, in [illegible] it is desired, by the owning purposes, to have the [illegible] day and night.

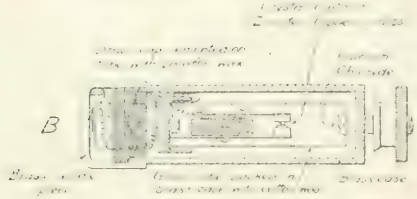
[illegible] likely to [illegible] with the call device, though it could not be [illegible] technical knowledge or mechanical ability on the part of the operator, who cannot be relied upon [illegible]

An apparatus of the type [illegible] meeting the [illegible]

The principle [illegible] pre-arranged times (four times an hour in this apparatus) a clock switches in a crystal receiver of ordinary [illegible] extremely sensitive D'Arsonval galvanometer [illegible] telephone. The receiver remains in circuit for a brief period (only about $\frac{1}{8}$ minute in this apparatus). If the key of the calling station is held depressed throughout this period, the needle of the galvanometer is deflected into position between the jaws of a hit-or-miss device (by Mr. R. W. Paul) actuated by a local circuit. When the needle is in its un-deflected position, the closing of the jaws is without effect, for the jaws are slightly staggered, like those of a bulldog; but if the needle is in place between them, it is gripped by the jaws, a local circuit is closed, a continuous-ringing bell relay actuated, and the bell rings. Any atmospherics or signals, whether of the appropriate wave-length or any other, and of whatever strength, are without effect unless they occur during the brief period of activity of the receiver. The probability of damage to crystals and of false calls is, therefore, reduced by the agency of the clock-switch in the ratio of 15 minutes to $\frac{1}{8}$ minute—*i.e.*, 120 times—whereas the delay of a telegram caused by this system of working cannot exceed a quarter of an hour.

For further safety two crystal detectors are [illegible] An [illegible] for [illegible] the mercury toppler, in addition to other duties, switches over after each period, so that the other crystal detector shall come into use at the next period. If, therefore, one of the detectors has been knocked off, and a call is [illegible] quarter of an hour later.

[illegible] diagram [illegible] the pendulum of the mercury toppler [illegible] carried by [illegible] about a horizontal axis below the centre of gravity of the whole. In the diagram the toppler is shown in the momentary unstable position through which



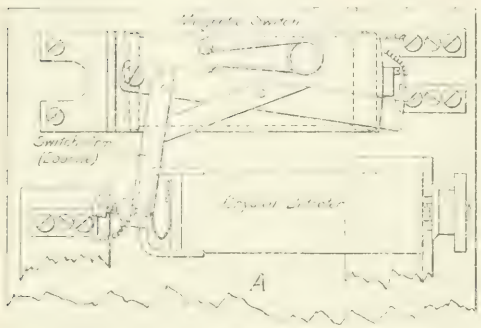


Fig. 4.

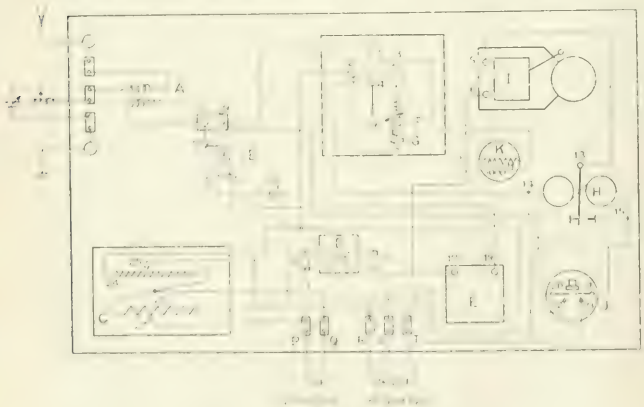


Fig. 5.

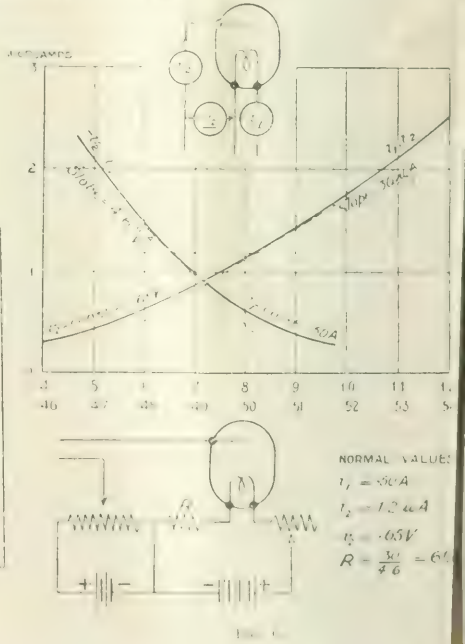


Fig. 6.

A Second Device.

In the absence of a suitable quick-acting relay of extreme sensitiveness, it is necessary to accumulate the energy of the received signal over some considerable time before a sufficiently energetic response can be produced. This is all we have dealt with in the last section, the accumulation takes place during the several seconds [illegible] gradually deflected. It is also possible to accumulate energy in an oscillating body, as in the Peake device described in sec. 2. But in a damped harmonic oscillation the power lost in damping is proportional to the square of the amplitude. Hence the accumulation of energy can be continued only until the amplitude reaches a certain value, at which the rate of loss just cancels the power supplied by the signal.

In the call device to which reference is now made, Peake's reed vibrating at (say) 25 periods per second is replaced by the coil of a galvanometer oscillating 25 times per second [illegible] 250 times slower. Consequently, if the decrements of the coil and reed were equal, signals would continue to add energy to the coil 250 times as long as to the reed. In this device, the galvanometer coil takes the place of the telephone in an ordinary receiver, and a swing is gradually built up from the sending station by keeping the key depressed during every alternate five seconds. Since the detector is always in circuit, a [illegible] crystal of a crystal, as the valve, though less efficient, is not liable to be knocked off by atmospherics. A diagram of connections is shown in Fig. 5.

The moving coil F is cast with wax into smooth cylindrical form, to reduce air friction. It has a resistance of nearly 6,000 ohms; [illegible] suspended by [illegible] and has a radial arm or tongue of fine [illegible] free to move between two fixed vertical platinum wires. The galvanometer constitutes a microwatt relay according to the classification at the beginning of sec. 2. The moment of inertia of the moving system (viz., 9·8 gm.-cm.^{2}) has been adjusted to give a period of [illegible] seconds.

NORMAL VALUES:
$i_1 = 50A$
$i_2 = 1.2\,uA$
$v_2 = .05V$
$R = \frac{.05}{.46} = 6$

The tongue is kept in mid-position between the side-electrodes by the [illegible] due to the polarising current of the valve. This polarising current, which may be [illegible] or 20 times the current [illegible] is affected by variations of the [illegible] current. [illegible] about half a [illegible] the current in the [illegible] the battery [illegible] This needs [illegible] but by use of the [illegible] shown in Fig. 5 [illegible] needs to compensate by [illegible] [illegible] to adjusting P.D. [illegible] that the [illegible] the [illegible] of the valve-circuit [illegible] shown in the [illegible] The arrangement has proved [illegible]

variation of ± 10 per cent. in $\frac{1}{4}$ produces [illegible] the pointer; whereas without the [illegible] 10 per cent. rings the bell and 10 per cent. [illegible]

This device possesses the merit of [illegible] and the makeshift set shown by the author [illegible] of 0·063 microampere [illegible] in about 1½ minutes. The sensitiveness [illegible] author, be considerably improved. [illegible] Post Office short range circuits [illegible] consumption of some 1 watt, which [illegible] supply the power.

The call devices of Figs. 3 and 5 [illegible] examples of the other instruments described were exhibited.

SOME POINTS IN TRANSFORMERS.

BY W. E. [illegible]

Summary.—The author [illegible] to penetration of the end turns on the high-tension [illegible] He then considers the destructive effects of the [illegible] and of the coils due to short-circuit. The [illegible] sections are dealt with, and a description [illegible] illustrating the conclusion. An arrangement [illegible] of conductors carrying heavy currents is also [illegible]

The rapid increase in the voltage [illegible] within recent years has brought [illegible] effects that previously could be safely ignored, among the chief being the increased liability to breakdown between end turns—*i.e.*, adjacent to the terminals on the transformer winding and mechanical destruction of the coils or frame work by short-circuits.

Since the primary cause of abnormal transient pressures is to a considerable extent the locally electro-statically stored energy it will be seen that it is important to keep this within the smallest practical limits, and thus a switch with small metal surfaces has an advantage over one with large surfaces; also cables arranged to have the smallest capacity by keeping them as far as possible from surroundings of different potential should be adopted.

It is often recommended as a safeguard to increase the insulation of the end turns of a transformer to double or treble the value of these in the body of the windings, but in my opinion this is far from sufficient for really high pressures (say, 50,000 volts and over), as the momentary voltage across the few end-turns may easily be 50 or more times the normal working pressure. Another point is that the extra insulation decreases the electrostatic capacity of the short length of wire near the terminals, which has the effect of causing the generation of a higher voltage, so that the protection afforded by this additional insulation is by no means proportional to its thickness. Where this method of protection is feasible, the use of flat strip rather than round wire [illegible] this has less inductance and more capacity, both tending to soften the shock of switching on.

These remarks apply to switching on the high-tension side. When the transformer is switched in on the low-tension side, the voltage in the high-tension windings is built up simultaneously throughout the winding, so that there is not so great a shock between adjacent turns. This voltage, built up from within, causes a rush of current towards the terminals, charging these and adjacent conductors up to the [illegible] potential, which rush cannot instantaneously stop on their attaining the potential, so that the potential [illegible] higher. This momentary higher potential, it can be readily shown, cannot reach [illegible] and is thus of little significance [illegible] unusually weak. [illegible] put some train of [illegible] and back again with [illegible] adjacent turns near the terminals.

It does not follow that the [illegible] end turns to [illegible] breakdown. What usually happens [illegible] such as might be [illegible] leaving the insulation sufficiently strong for normal P.D. This, of course, leaves a weak place which will give way under a smaller disturbance than the unpunctured insulation, but [illegible] it may be a long time before the weakness shows up. A rather curious point is that a single weak place does not safeguard the remainder of the winding a few turns away. I have seen coils with over 20 small punctures of this description, showing that the point of maximum P.D. varies from time to time. In this particular instance, however, circuit disturbances were frequent, due to [illegible] and it is probable that these disturbances, occurring at different places, caused a greater variation in the position of the crests and valleys in the high-frequency waves set up in the transformer windings than would be the case with ordinary switching.

Another effect that is liable to be brought forcibly into [illegible] voltages and sizes are increased, is the mechanical destruction of transformers in case of short-circuit, either internal or external to the transformer, but more particularly the latter, since an internal short puts the transformer out of service in any case. The effect on the core is simple since the core stampings are all magnetised in the same direction, and, as is well known, like poles repel, and it is the greatly augmented repulsion that does the damage. It might be thought that since in a transformer the ampere-turns on both primary and secondary are substantially equal and opposite, there would be little force exerted, but, as a matter of fact the difference in ampere turns between the two, which under normal conditions is slight (and only sufficient to force the requisite flux corresponding to the voltage, frequency and turns, through the core) increases roughly in proportion to the current taken from the secondary. Thus, under conditions of short-circuit, there is a very big difference, so that the mutual repulsion of the stampings becomes correspondingly great and [illegible] (allowing phase difference) in proportion to the square of the current.

In the coils of the transformer the conductors carrying current in the same direction tend to draw together. Thus, all the conductors of one coil tend to compress themselves together, whilst the primary and secondary coils, which are carrying current in opposite directions, repel one another. In case of a short-circuit on a winding, say, on the primary, the current in the short-circuited portion is reversed, and so tends to spread apart from the rest of the coil. This effect will often show if a fault originated inside the transformer or outside; but, of course, this is not always conclusive, as it is not impossible for an external fault to cause an internal fault of this character through the heavy forces exerted, breaking down the insulation.

The forces tending to compress the coils are not the forces that destroy the transformer, the most serious being the repulsive forces. Neglecting phase-differences, these forces are proportional to the ampere-turns in any coil multiplied by the ampere-turns in the opposing coil, and as the current in the secondary is proportional to that in the primary, the forces [illegible] reach many tons on a large system, especially with high voltage, allowing a greater proportionate increase of current under conditions of short-circuit than lower voltage systems.

It is often recommended as a safeguard against these forces to increase the reactance of the transformer windings by having the transformer windings in fewer and larger sections; this leading to greater magnetic leakage and diminishing the current the transformer will pass on short-circuit; but whilst it undoubtedly has this latter effect, I think the reduction in destructive forces is chiefly imaginary. Doubling the number of [illegible] transformer winding, obviously, with a given current passing, [illegible] given current. [illegible]

thus half the number of sections, each of four times the reactance, on a dead "short," neglecting resistance, the current would be half its former value. Thus, under these assumed conditions the sum of the forces would only be one half its former value, and apparently there is a great gain by this increased reactance. In practice, however, a dead "short",of substantially no resistance is not the "short" that occurs, so that the current is not reduced in proportion to the internal reactance, and very often the forces may be greater than with the lower reactance of the more sub-divided coil, this depending on the ratio of internal reactance to external reactance, resistance and voltage drop on the primary side of the transformer.

Another point is that with the subdivided windings, and considering a section of one winding sandwiched between two equal sections of the other winding, this first will be pushed equally in opposite directions, the resulting force being of little importance. Thus, the chief unbalanced forces are on the end sections only, which, I think, definitely brings the balance against internal reactance as a means of protection against damage by mechanical forces under conditions of abnormally heavy current.

For these reasons I think an external reactance is altogether to be preferred to internal reactance for pressures of, say, 60,000 or over as a means of protection, the mechanical forces in this external reactance being easily taken care of, the insulation easy, and enabling a better space factor to be obtained in the transformer windings with consequent better efficiency.

Iron in the external reactance would be a disadvantage, as it would have full effect on normal load, when it is usually a disadvantage, and of no increased effect beyond an air space under conditions of short-circuit, so that the inductance of a reactance with an iron core decreases with load, which is the opposite of what is wanted, assuming, of course, that the short-circuit current is sufficient to cause saturation of the iron.

As a check on this reasoning, the writer had made up a core of the shape and dimensions shown in Fig. 1, with, on the

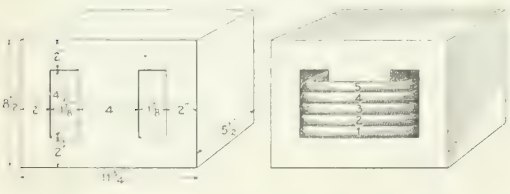


Fig. 1.—Experimental Transformer.

centre leg, five identical coils each of 40 turns of 0·092 in. diameter d.c.c. wire, the coils being a loose fit on the core, with a possible vertical movement of about $\frac{3}{8}$ in. The weight of each coil was 5 lb.

As we are concerned chiefly with the relative values of the forces with the different arrangements, the forces observed were those required just to float one or more of the coils, this [illegible] coils [illegible]. The core was, of course, [illegible] vertical.

Considering the coils as numbered 1, 2, 3, &c., from the bottom upwards, three groupings were tried, on a 50-period circuit, with the results below :—

1. Coils 2 and 4 reversed with respect to coils 1, 3, and 5, this corresponding to maximum sub-division and minimum [illegible]. With [illegible] 125 volts passed 27 amperes just floating No. 5 (top) coil.

2. Coils 1 and 5 reversed with respect to coils 2, 3, and 4, thus giving an intermediate value. With this arrangement [illegible] 125 volts passed 17 amperes, the just floating No. 5 coil.

3. Coils 1 and 2 reversed with respect to coils 3, 4 and 5, this corresponding to maximum inductance and minimum sub-division. 125 volts [illegible] 1 ampere, the just floating coils 1, 4 and 5.

It should be noted that the voltages shown are not directly significant as regards relative values of reactance, being chiefly the values necessary to produce approximate saturation in the core, so that the required current might pass through the coils. The greater part of this voltage is therefore due to the main flux through the core reacting on the odd coil of the three, in which the current flow was in the same direction, a smaller component being due to the leakage reactance of the coils, and a still smaller component due to the resistance of the windings. The leakage reactance being the only one affected by the different groupings, may be roughly estimated as follows : Assuming leakage reactance in phase with that due to the main flux, and allowing 100 volts for this latter, which would be about its value from the manner in which the current varied with voltage, and, say, 2 volts for resistance drop (this is only approximate as the resistance reactance is not in phase with the induced reactance), leaves for the leakage reactance the values 23, 18 and 28 respectively. For an equal current in each case, say, 20 amperes, this would give 17, 20·5 and 31. As, in experiment No. 3, the weight floated was three times that in the other two cases, it will enable a clearer comparison to be made by finding the current required to float the weight of one coil, and, as we know that the force varies as the square of the current, this is simply $18 \div 3 = 10{\cdot}4$. We then get the following relative values :—

1. Rough estimated leakage reactance	17	20·5	31
2. Amperes for a given specific force	27	17·5	10·4
3. Force exerted with 27 amperes	1	2·38	6·75
4. Ratio of 3 : 1	0·059	0·116	0·218

No. 3, of course, is considerably worse for the high reactance grouping than the relative values that may occur in service,

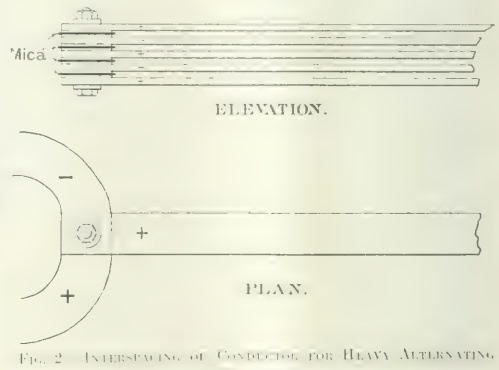


Fig. 2.—Interleaving of Conductor for Heavy Alternating Currents.

and No. 4 is equally, of course, more favourable to the high-reactance grouping. Therefore, since the same result applies between these two extremes, it appears that the destructive forces on transformer windings, are in all cases higher with high-leakage reactance than with low-leakage reactance. This shows that the usual assumptions are much too favourable to the high reactance transformer, the chief points being that the forces with the extra interleaved type (low reactance) largely counterbalance one another, and the non-uniform magnetic reluctance surrounding the coils is against the high-reactance arrangement.

At the other extreme—low pressures and heavy currents—these impulses and surges have little significance, but mechanical forces and inductance are liable to attain unexpected values. As an instance of the latter, in connection with an apparatus I had to design for a firm some time ago, it was desired to transmit some 500 k.v.a. at 10 volts terminal pressure a distance of a few feet, but making a preliminary experiment as I rather suspected this would not be feasible with the usual arrangements, it was very soon apparent that the 10 volts would not even pass the required current through the distance required, even with the ends of the leads short-circuited [illegible] more than 500 k.v.a. would be absorbed in

the reactance of the leads in this short distance—though the true resistance loss was not of serious consequence.

The method I devised to get over this may be of some interest, as heavy currents are becoming more frequent, especially in connection with electric furnaces, the low power-factor of which in some instances may be accountable to an unsuspected extent to the inductance of the low-pressure leads. The arrangement is shown in Fig. 2, from which it will be seen that the two leads are divided up into a number of sections relatively deep and narrow, a section of the going alternating with a section of the return lead. This gives an almost non-inductive arrangement, with good cooling surface and convenient terminal arrangement, where the two leads are required to go close to the same spot.

NEW SALTED ("CRUSTA") CARBONS FOR ARC LAMPS.*

These carbons are the result of experiments made by Messrs. F. Lewis and H. G. Hatfield, and are manufactured by the firm of C. Conradty, of Nürnberg. The positive carbons consist of a tube of homogeneous carbon, A, surrounded by a cored, B, formed of a mixture of salts containing flouride of calcium, tungstate of sodium and chromate of potassium. This jacket of salts around the carbon causes the rate at which the latter burns away to be extremely slow. The negative carbon is an ordinary homogeneous cored carbon, the composition of the core differing only slightly from the normal. The arc burns quietly when springing from any point on the positive carbon, even from points which are far removed from the illuminating salts. The enhanced lighting effect is produced mainly by the formation of a kind of coating on the ends of the carbons, which are readily moistened by the molten illuminating salts, so that the latter are fed thereto in ample quantity. There is no accumulation of residues from the salts during burning. The carbons, in order to obtain the above results, must be burnt in a vertical position.



A special lamp, the Celdis lamp, has been made by Messrs. Körting & Matthiessen, of Leutzsch-Leipzig, for use with these carbons. This lamp burns 40 to 50 hours with one pair of carbons at an efficiency of 0·14 watt per hefner-candle with continuous current, this including the losses in the resistance.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Jahrgang 35, pp. 1079, 1080.

HYDRO-ELECTRIC DEVELOPMENT ON THE PACIFIC COAST.*

At the recent meeting of the National Electric Light Association, of America, the sub-committee on water-power developments on the Pacific Coast presented an illustrated report containing a map and tabulated data relating to practically all hydro-electric plants in the western part of North America. Brief histories of many of the organisations were given, with a list of their officials. The map presented showed the routes followed by all hydro-electric transmission lines west of Denver. The order in which these plants were developed chronologically was given in one Table, with the location of the respective generating stations, their ratings, line voltage, length of the transmission system and its terminal, and the name of the present parent company. Other data were given to make evident the growth in number and total rating of hydro-electric plants in California. These showed that in 22 years 79 stations have been built, the average rating per station in that time having increased from 480 kw. to 55,000 kw. From information given in another Table it appears that the water power available from the Sacramento River has been less utilised than that from any of the other large rivers in the West, only 184,437 kw. having been developed out of a possible 3,435,000 kw. The San Joaquin and Kern Rivers rank next in the list of only partially utilised water powers. Power from the Klamath and Rogue Rivers has been more completely developed than that from any of the others named. The amount of power at present being developed in California is 436,045 kw. (about 6·4 per cent. of that possible), in Washington 300,000 kw., and in Oregon over 100,000 kw. Extracts from the data for each company are shown herewith.

The loads which exist on the Pacific coast have been acquired by educating the people to do things electrically. There are not so many manufacturing industries using electricity as in the East, so that the load is more diversified than where manufacturing is a more important factor. As with every other new industry, the growth of the electrical business in the district has been slow. At first flat rates were offered to both lamp and motor users. Now the companies are having great difficulty in charging for energy without securing the ill-will of the consumers. Considerable effort was also expended in developing the present irrigation load. In many cases electric-service companies replaced gasoline engine-driven pumps with electric motors at their own expense, with the understanding that if the consumers were not better satisfied with electrical operation the plant would be restored to its original condition with no expense to the consumer. Dredge operators have not hesitated to adopt the electric drive where energy is available, but it is only during recent years that oil-well operators have recognised the advantages of using electricity. In every case the use of electricity has been encouraged by liberal line extensions.

* From the "Electrical World."

[illegible] Companies' Revenue and Equipment.

Name of Company.	Number electric [illegible]	Gross electric [illegible]	kw.-hours generated		System load-factor (per cent.)	Miles of		Plants installed.				Gross revenue. All departments.
			Hydro.	Steam.		High-voltage transmission.	Overhead distribution.	Hydro.		Steam.		
								No.	Kw.	No.	Kw.	
Portland Railway, Light & Power Co.	37,938	£448,367	162,125,167	22,640,982	47·6	277	6,880	5	43,000	3	22,500	£1,254,634
Washington Water Power Co.	29,119	410,719	...	...	65·3	631	748	3	40,000	...	...	120,905
North Western Electric Co.	6,467	62,661		825,590	50·0	65	105	1	12,000	1	7,500	...
Oregon Power Co.	8,365	65,073		350,024	45·0	92	729	1	500	...	...	65,073
British Columbia Electric Co.				7,867,882	45·0	188	66	4	65,900	...	...	...
West Kootenay Light & Power Co.	722	82,777		...	79·0	200	60	3	23,000	...		...
Western Canada Power Co.	1,190			...	52·0	...	170	1	20,000	...		...
Puget Sound Traction Co.	26,046	366,083		4,200	50·0	370	425	3	...,000	2	20,500	1,383,382
Pacific Power & Light Co.	16,372		39,004,288	3,714,999	43·0	176	777	10	13,400	5	4,900	181,163
Pacific Gas & Electric Co.	148,957	1,751,890	374,957,993	101,639,560	60·6	1,534	3,685	10	90,340	4	81,700	3,444,101
Mount Whitney Power & Electric Co.	5,811	[illegible]		1,682,100	50·0	179	1,035	4	8,850	1	6,750	128,746
Great Western Power Co.	17,000	[illegible]		51,700,000	65·0	340	900	1	52,000	2	31,200	536,398
Western States Gas & Electric Co.	8,719	115,849		1,208,700		204	341	1	3,000	1	1,500	155,715
Pacific Light & Power Corporation		[illegible]	...	212,192,288	48·0	810	2,296	8	54,500	3		...
San Joaquin Light & Power Corporation	19,033	[illegible]	106,828,450	1,093,903	64·0	704	1,770	4	27,800			313,637
Nevada California Power Co.	2,429	191,327			64·0	359	145	3	18,750			193,658
Southern Sierras Power Co.	2,516	[illegible]		[illegible]	56·0	274	110	2	3,480	1	5,000	94,150
Southern California Edison Co.	108,120	892,361	202,819,110	81,412,505	64·1	423	1,803	5	51,000	3	57,500	971,028
Sierra & San Francisco Power Co.	3,717	[illegible]	[illegible]		31·2	480	240	3	43,375	1	18,000	227,858
Snow Mountain Water & Power Co.	...	25,593	...		48·0	106		1	6,000	...	...	...

[illegible] Revenue from [illegible] [illegible] Total [illegible] Sold to [illegible] companies.

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HYDRO-ELECTRIC DEVELOPMENT.

The subject of "Hydro-electric Development on the Pacific Coast" was discussed at the recent meeting of the National Electric Light Association of America, and [illegible] extracts from the data for each company are given on [illegible] page of this issue. Certain of the figures are of a striking character.

The Pacific Gas & Electric Co. operates hydro-electric plants of a total capacity of 120,000 H.P. and four steam-driven plants of a combined capacity of 110,000 H.P. There are 152,000 consumers, having a total connected load of 438,000 H.P. Of the connected load, some 50,000 H.P. is used for agricultural purposes. An area of 37,775 sq. miles is supplied by the company, and this area comprises 30 of the 58 counties in California, and includes 175 towns. Of the many plants owned by the company the newest and most interesting is the Lake Spaulding-Drum, which embraces a watershed of over 120 sq. miles in area, the maximum run-off of which is over 150,000 and the minimum about 200,000 acre-feet. A notable feature of this water-shed is the succession of drops available at high head. When the development is complete there will be no less than seven power houses at different levels, of capacities varying from 6,000 kw. to 50,000 kw., the aggregate capacity being 133,500 kw.

In the report presented by the above committee on water power developments on the Pacific coast, several cases are cited which serve to show that hydro-electric companies are hampered in much the same way as electric supply undertakings in this country are hampered in their proper development. It appears that much of the land on the coast has been made a forest reserve, and the companies have only been able to acquire title in fee to the property at any price. Furthermore easements and rights of way across such property are terminable at the pleasure of the Secretary of the Interior. As one would expect, these conditions, together with other Government requirements, have

greatly retarded the development of property which falls within the forest reserve. One company, having under construction a 50,000 kw. plant, found that its canal right of way would have to cross one corner of the forest reserve. Rather than sign the required Government permit, and thereby cloud the title to the property, the company constructed an inverted siphon around the reserve at a cost of about £14,000.

Notwithstanding these restrictions, rapid developments are being made, and a pleasing feature of many of the American power stations is the exceedingly high load factor at which they operate. This shows that industrial enterprises find it more economical to purchase power from the power companies than to generate their own. Slowly but surely this truth is being recognised at home.

Evidence of this development and of the importance of the industrial load in promoting the growth of a power company's business was given in the "Electrical World" by Mr. M. HEBGEN, the general manager of the Montana Power Company. The territory supplied by this company measures 250 miles in a north and south direction by 225 miles in an east and west direction, and in the near future the latter dimension is to be extended to 400 miles. The transmission lines of the company and of associated systems are 1,500 miles in length. They interconnect some 18 water-power and steam plants, distributing their output to 40 or more towns, besides supplying very large amounts of power for the important irrigation, mining and railway loads in the area covered by the high-tension distributing network. During 1914 about 3·5 per cent. of the energy delivered was used by the resident consumers, who number 20,653, while the remaining 96·5 per cent. of the energy was utilised by 996 industrial undertakings. With one exception, all the power stations of the company are on the Missouri or its tributaries, and, taken as a group, they afford interesting illustrations of the rapid growth and development of hydro-electric transmission. The first plant was put into service about 18 years ago at a pressure of 15,000 volts. Five years later an important addition to the generating system was put into commission at 50,000 volts, and the pressure was shortly afterwards increased to 70,000 volts. In 1910 the standard transmission pressure of 102,000 volts was adopted. At the present time the aggregate rating of the company's generating stations is 75,580 kw., and hydro-electric plant now nearing completion will increase the rating to 200,000 kw. The new plant will be used partly for helping to take the rapidly increasing load of the district and partly for the operation of some 450 miles of railway, the electrified main line of the Chicago, Milwaukee & St. Paul Railway Co. being within the district served by the power company.

By some it is thought that hydro-electric power is expensive on account of the heavy initial cost of the plant and works. As a matter of fact, hydro-electric plant costs one and a half to twice as much per kilowatt as steam plant of the same output, but the percentage fixed charges on the former are only about two-third of the corresponding charges on the latter. Moreover, the operating costs of hydro-electric stations are very much less than the corresponding costs for the steam station. The ratio of the operating costs is usually about 1 to 10. Another factor which must be kept in mind in comparing the cost of energy supplied by the steam stations in this country and the hydro-electric or steam stations in America is the difference in the value of money in the two countries. We have no wish to labour the point, but it is generally known that certain of the large hydro-electric power companies are prepared to, and do, sell energy at the low rate of [illegible] per unit [illegible] a profit.

REVIEWS.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, [illegible] free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Electrical Instruments in Theory and Practice. By W. H. F. Murdoch, B.Sc., and A. Ogilvie, B.A. Pp. [illegible]. 308. London: Whittaker & Co. Price 10s. 6d. net.

For many years there has been a real need for a good English work on electrical instruments, and it was, therefore, with a feeling of pleasurable anticipation that we opened the present book, which is certainly a considerable advance, from the theoretical standpoint, upon the existing almost purely descriptive ones. It would have been better, however, if the authors had entitled their work "The Theory of Electrical Instruments," as the practical details of construction and operation are almost entirely omitted. This does not greatly militate against the usefulness of the book, as the authors have helped to fill a most important gap in the subject on the theoretical side, but the title as it stands will probably mislead a great many as to the nature of its contents. For those, however, who have already a good general knowledge of the construction and fundamental principles of electrical instruments, the condensed theory and experimental verification of the errors of the various types will be of considerable service, and the authors give references to many of the more important Papers where a fuller treatment can be found.

It is difficult to appraise the general scheme and scope of the work, as the authors speak of a second volume, without indicating the nature of its contents. The present volume starts with a general historical summary, after which a chapter is devoted to a very thorough treatment of the theory of damping, with experimental verifications. Chapter III. deals with permanent magnet moving coil instruments and includes vibration galvanometers. We are glad to see that the authors realise that the theory of the latter instrument is the dynamic analogue to that of a circuit having resistance, inductance and capacity. Some useful tests made by the Washington Bureau of Standards on the errors of the various types of instruments are included in this and subsequent chapters. Chapter IV. is devoted to iron-cored instruments, and starts off rather [illegible] with a discussion of Dr. Sumpner's [illegible] alternating current potentiometer and quadrature transformer, leaving the ordinary moving-iron instruments till later. Some interesting tests on the effect of irregular wave-forms on the [illegible]

[illegible] Chapter [illegible] with the [illegible] The theory of the [illegible] [illegible] [illegible]

again as a surprise to find potentiometers, including the alternate-current potentiometer and the Brookes deflection potentiometer, dealt with under the second heading, while something seems to have happened to the symbols in the proof of the theory of the latter instrument.

One cannot help feeling that the authors might have chosen a much more felicitous classification of the instruments they have dealt with, but we are glad to see the information they have given us collected together, and we await their second volume with interest. C. V. DRYSDALE.

Single-Phase Electric Railways. By EDWIN AUSTIN. (London: Constable & Co., Ltd.) Pp. xiv.+303. 21s. net.

Many of the valuable and authoritative articles on single-phase railways, which have long been a prominent feature in that excellent periodical "The Engineer," are here collected and republished in book form. Edited in this manner, these articles will prove of great service to all interested in electric traction. To facilitate reference, in addition to the general index, there is also an index of railways wherein the subject matter is carefully classified.

Among the more important of the electrified lines described may be mentioned the London, Brighton & South Coast Railway in this country, the Midi Railway in France, the Dessau-Bitterfeld Railway in Germany, the Loetschberg Railway in Switzerland and the New York, New Haven & Hartford Railway in the United States of America. The descriptions are arranged in an orderly manner and are easy to follow. The illustrations are particularly lavish, though some of the photographs are not as well reproduced as one might wish.

The best description is probably that of the Brighton line, which has served as a model in many ways for foreign countries. In addition to a very lucid account of the overhead and motor equipment, the author also discusses questions of policy and the reasons that led to the adoption of the single-phase system, whilst attention is also drawn to the admirable financial results that have been achieved.

It would have greatly enhanced the value of the book if some of the other articles had also been revised and brought more up-to-date. Several of the original articles dealt with the period of projection and construction, but many alterations and improvements have since been introduced as the result of experience. If such information could be added, it would be of inestimable value to those interested in the electrification of railways. A further reason why revision is desirable when articles are re-published in this way is that the author is able to make valuable and relevant criticism on the various schemes that have been tried. As illustrative of these suggestions, we might refer to the description of the Loetschberg Railway, where both motor coaches and locomotives are described, but we think we are right in saying that only the latter have been adopted. We also find in this article the expression "some three years ago," which is quite misleading. Again, when discussing the Mittenwald Railway, we should have liked to have seen what justification there is for the opinion held by many engineers that this experiment has proved a failure. Another feature that would enhance the value of the book would be a greater profusion of maps, profiles, &c., and more political and geographical information.

In making these suggestions, it must not be thought that we underrate the value or importance of the information given. The articles are good and well written, and we have no desire to discover faults of omission, but if the subject matter could be brought up-to-date and criticised, we should have really a [illegible] on single phase railways. That Mr. Austin is quite competent to do this is proved by his present work, and we hope he will be able to continue his labours with equal

[illegible] book of this kind at the present time cannot fail to [illegible] what effect the war will have on single-phase railways. For our own part we think it is quite possible that questions both of an economic and a strategic nature may come into prominence. What a chance might be offered by petrol-driven stations to munitions, or by traction power stations to bomb-droppers!

STANLEY PARKER SMITH.

ELECTRIC PUMPING FOR IRRIGATION.

The "Electrical Review and Western Electrician" has recently given a review of the use of electricity for irrigation pumping in the United States. These developments have taken place chiefly in the West, especially in Idaho and California, the central stations of the Middle West and East having given little attention to the possibility of a pumping load, although the rainfall is often insufficient.

As the cost of power is the largest item of expense in pumping, care should be taken that the equipment is of the best class as regards material, design and workmanship.

When this is done electric motors working centrifugal pumps will be found to be the most economical and reliable form of power, though the lower cost of petrol as compared with electric energy for the same work has lead to a keen competition between engines using this fuel and electric motors. When, however, the total cost is considered the results favour electricity, as is strikingly shown in a recent Government report on a group of irrigating installations in Central California. The report shows the total cost per acre-foot of water pumped to average for 17 installations investigated, £1. 12s. for energy or a total cost of £4. 1s., including labour, energy, fixed charges, &c. The average price for energy in these 17 instances was 1¼d. per kilowatt-hour and the average head, including suction, friction and discharge, 115 ft. The same report shows that for 46 petrol-engine installations the average cost per acre-foot of water pumped for fuel was 10s., while the total cost was £5. 2s., a saving of £1. 1s. per acre-foot in favour of electricity. Fuel cost for the 46 plants is based on an average price of 2⅞d. per gallon for petrol.

In replacing a petrol engine with an electric installation, and in new installations great care should be exercised in the general arrangement of the machinery and attention should be paid to the size, type, design and efficiency of the different units. The number of units installed should be proportioned so that a delivery capacity of from 30 to 100 per cent. can be obtained without creating a demand for power much in excess of the ratio of the water delivered.

For low lifts the pump to be recommended to the customer is the horizontal direct-connected unit which completely eliminates belt friction on bearings from belt pull and the wear and tear from vibration. A type of pump is commonly installed in the West which has a non-overloading impeller, giving constant power characteristics under variable heads. This insures non-overloading of the motor which is an important factor in direct-connected pumps where the head varies, or where different heads are to be pumped against by the same unit, as there is no way of changing the speed of the motor for the different heads, unless a variable-speed motor is used.

The pump runners should be designed for the maximum average head, but the angle of the impellers should be such that with a 30 per cent. reduction of head, the pumps would show good operating characteristics. In the Southern California district served by the San Diego Consolidated Gas & Electric Co., pump and motor are installed in pits as near the water level as possible, or from 5 ft. to 6 ft. below it, therefore keeping the pumps always primed.

Where the water level is so low that the pit construction becomes too expensive then the direct-connected vertical pump is used, but this is not advised where the horizontal set can be used on account of the difficulty of replacing parts, &c.

MOTOR CHARACTERISTICS.

For driving centrifugal pumps, three types of motors can be used—namely, squirrel-cage induction motors, phase-wound induction motors and synchronous motors. The efficiencies of these machines are practically uniform for similar capacities. Because of serious voltage surges developed by throwing large squirrel-cage motors on a line this type is recommended only for units of less than 50 H.P. The current required for starting is from 2·5 to 4 times full-load current.

For installations of 50 H.P. or over the phase-wound motor is recommended, as the current required for starting is only about 2 to 2·5 times the full load current and excessive line disturbances are avoided.

There is very little difference between the cost of the squirrel-cage and phase-wound motor. The synchronous motor is often necessary on long transmission lines and where units are above 100 H.P. in capacity. This type of motor often improves line regulation and power-factor and increases the efficiency of the transmission line where other types of motors might greatly impair the service. However, the synchronous motor is somewhat more expensive to install and operate than induction motors and is, therefore only installed where conditions make it essential.

With small quantities of water at a high head, the centrifugal pump is very inefficient, and here much [illegible] of the [illegible] is

it is best to look for a more efficient plant. This is also true in deep-well pumping where the water is from 50 ft. to 200 ft. below the surface of the ground.

Wherever possible it is advisable for the consumer to have the consumer install a high efficiency plant from, say, 50 to 100 gallons' capacity per minute and pump into a reservoir. This reservoir or tank should be capable of holding a 12-hour supply.

The San Diego Consolidated Gas & Electric Co. has developed a large irrigation pumping load, and its practices may be considered typical for individual pumping plants. At present the company serves a territory of approximately 400 square miles. In this district there are 273 installations representing an aggregate connected load of 2,664 H.P. The average kilowatt hours per year per horse-power connected, for all plants, is 19·8.

The company builds line extensions wherever the installation will warrant, or when the revenue per year amounts to 40 per cent. of the cost of the line. The company stands as much of the cost of the line as the installation will warrant and requires the customer to deposit cash sufficient to cover the balance of the cost. As other Express companies and banks throughout the district act as agents for the company in collections.

A typical installation in the San Diego district is that of the Lakeside Farmers' Mutual Water Co. This operates the water plants and sells the water to each farmer in the company. There are two 25 H.P. squirrel-cage 440-volt induction motors, each direct-connected to a 7 in. single-stage centrifugal pump rated at 1,250 gallons per minute against a head of 38 ft. The third 25 H.P. motor is direct-connected to a 10 by 10 Gould triplex pump which delivers 450 gallons of water per minute against a total head of 144 ft., through a 10·25 in. pipe into a reservoir.

The low-lift plants pump into the water-distributing system from 14 ft. wells whose average depth is 70 ft. and average suction depth 24 ft.

The high-lift pumps operate about 14 hours per day seven months per year and six hours per day for five months of the year.

The alfalfa ground is irrigated eight times each year. This installation was originally driven by a 60 H.P. and a 35 H.P. oil engine burning stove distillate at a cost of 4 cents per gallon delivered on the

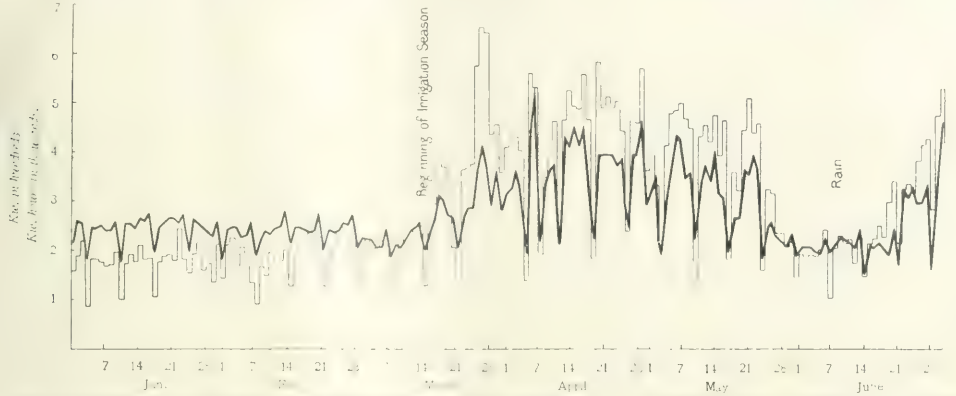


FIG. 1.—CURVES OF DAILY PEAK LOAD AND ENERGY CONSUMPTION FOR POWER STATION OF ROSWELL GAS AND ELECTRIC CO. (FOR FIRST SIX MONTHS OF 1914).

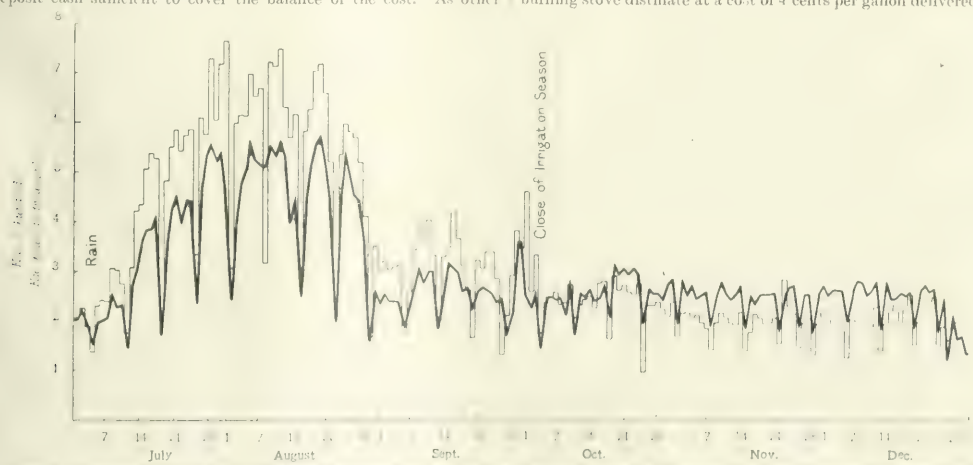


FIG. 2.—CURVES OF DAILY PEAK LOAD AND ENERGY CONSUMPTION FOR POWER STATION OF ROSWELL GAS AND ELECTRIC CO. (FOR LAST SIX MONTHS OF 1914).

customers are taken on each pays his proportion of the cost of the customer's cost.

The average cost per mile of line in California is $1,000 ($208). The San Diego Company uses No. 10, and 10 ft. poles. No. 4 bare copper wire for 11,000-volt lines and No. 6 on 2,300-volt lines. Poles are usually spaced 300 ft. apart on straight runs.

One man is employed who lives in the geographical centre of the district who sets and reads meters and takes care of all trouble.

The average size motor used by the private irrigating plant is 7·5 H.P. A typical plant of such size supplied by the San Diego Consolidated Gas & Electric Co. serves about 20 acres, 15 of which are devoted to alfalfa. The installation consists of a 7·5 H.P. 220 volt three-phase motor, running at 1,800 revs. per min., belted to a Byron Jackson 4 in. centrifugal pump, pumping water from one 10 in. well, 40 ft. deep. The total head, including friction is 35 ft. and the pump

ground. Electric service at a higher unit rate is, however, proving much more satisfactory and economical.

induction motors are used almost exclusively. The pumping load is almost continuous through the months of May to September, inclu-

3·0. The average energy consumption per 1,000 gallons pumped is

energy consumption of the Roswell Gas & Electric Co. (Figs. 1 and 2).

When the population was small, sufficient water was obtained from rain and melting snows in the mountains during the winter months to

The land without water rights was used in dry farming, principally

As the population increased and the demands for irrigated lands became greater, it was found that the supply of gravity water was insufficient to meet the situation, and many of those owning water-bearing land began drilling wells and developing an independent supply of their own. Others who owned gravity water stock found that, in dry seasons, the supply of water was not sufficient, and, as a means of insurance against drought, also found it necessary to sink wells. As land without water sold for $50 and up per acre, while land which developed water brought several hundred dollars more and, as water development by pumping plants offered more certain

under high cultivation that would otherwise have remained dry.

The Southern California Edison Co. has been one of the pioneers in promoting the use of electric energy for irrigation pumping. It now has over 1,500 pumping-plant consumers with a connected load of

The price of energy for operating pumping plants varies according

2 cents (1d.) per kilowatt-hour, with a monthly minimum of $2 (8s. 4d.) for each horse-power of connected load for not less than six

would be 2·5 to 3·5 cents (1½d. to 1¾d.) per kilowatt-hour. Con-

THE TESTING OF CABLES AFTER LAYING WITH HIGH PRESSURE DIRECT CURRENT.

higher pressures are really quite unnecessary. If these tests are to be carried out in situ, a large amount of heavy apparatus is needed. With regard to this the author has already published particulars. If the test is to be carried out with alternating current, the weight of the necessary apparatus is tremendous, and the expense of its transportation and use corresponds. Thus, if it were a question of testing a length of 15 km. of cable after laying, the cable being of the three-cored type for three-phase current, with a working pressure of 35,000 or 40,000 volts, the testing pressure to be 60,000 volts, the apparatus might weigh about 25 tons; if the pressures were still higher the weights would, of course, be greater. It is, therefore, not difficult to see that this plan has its practical limits.

It is, therefore, a question as to whether direct current at high pressure might not be used for this work of testing. The Delon method has already been mentioned on a previous occasion by the author, and it is now proposed to describe some actual tests in which it has been applied. The Siemens-Schuckert works has a transportable Delon apparatus, giving 10 k.v.a. on the alternate-current side. Rectifiers similar to that of Delon have been known for some time in a slightly different shape; but he has patented improvements, which are now the property in Germany of Siemens-Schuckert, for applying the rectifier to the testing of cables of high capacity. Delon's apparatus consists of a rotary insulated metallic conductor, which passes in front of insulated metallic electrodes. Fig. 1 shows at A the rotary arm; 1, 2, 3, 4 are the fixed electrodes; I, II., III., IV. are four successive positions of the arm. One pole, V, of a high-tension transformer, Tr, is connected to the metallically-connected electrodes 1 and 2; the other, N, is connected to one of the conductors, l_1, of a three-core cable. The electrodes 3 and 4 are connected to the conductors l_2 and l_3. It is essential that the arm A should rotate synchronously with the generator supplying alternate

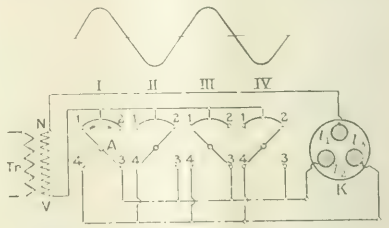


Fig. 1.—Diagrammatic Sketch of the Method of Working Delon's Apparatus.

current; it makes contact alternately between the contacts 1 and 3 and between 2 and 4. Thus, it puts the pole V of the transformer alternately in connection with l_2 and l_3. It ought, perhaps, to be stated that there is no actual connection between A and 1, 2, &c.; the connection is rather effected through a spark. For the sake of simplicity, let us suppose that the contacts 1, 2, 3, 4 are in a row, though in point of fact this is not the case. The position of I. 2, 3, 4 is so chosen that the rotating arm makes contact at the instant at which the curve of the transformer voltage reaches its maximum. In the position I., A is a connecting link between the transformer and one of the conductors of the cable. A spark passes at 1 and 3 which carries a certain electrical charge to the conductor l_2. Thus, when the arm has left the contacts 1 and 3, l_2 has a certain positive charge, equal in amount to the negative charge on l_1; l_3 is at the moment uncharged. In the position II. the contact arm has turned through a right angle. The conductor l_2, with its positive charge, is now disconnected from the transformer, and a connection is made with l_3. The voltage of the alternate current has now changed its sign, as compared with the position I.; the conductor l_3 gets a negative charge through the spark, which corresponds to an equal and opposite charge on l_1. This latter neutralises the charge received by l_1 in the position I. In the position III., where the voltage has again changed its sign, the process is as in I. If the absolute values of the charges are taken as q, we have now negative charges of the value of q on two of the conductors, and a positive charge of twice this amount on the other. IV. corresponds to II., and thus the charges on l_1 and l_3 are a positive charge of $2q$ and an equal negative charge on l_2. Thus, if the arm has been rotated the proper number of times, all the conductors l_1 and l_3 receive equal and opposite charges of the value of Q, while the conductor l_2 receives double charges of opposite signs. The result is that the charging currents at constant pressure, actually the currents of the charged conductors tend to reach the potential of the transformer pole V at the moment of contact.

Thus, after the earliest stage, the electrode E_1 gives up a slower rate. If the arc formed gives 50 000 cycles per second, the voltage between L_1 and L_2 would be about 140,000 and that between L_1 and L_3 would be about $50{,}000 \times 2\sqrt{2}$. The voltage between them, and the other connection will be about 70,000 volts. In practice these voltages are scarcely reached, owing to various causes. For one thing, it is scarcely possible to make the distance between the rotating arm and the contacts 1, 2, 3, 4 less than 0·5 mm. or 1 mm., and thus there must be a certain loss due to a spark of this length. The resistance is not likely to be absolutely perfect.

The Delon apparatus has also to limit the current which passes through the dielectric between the conductors. Thus, suppose we have to test a cable 50 km. long with a pressure of 150,000 volts between the conductors. Let us suppose the insulation resistance to be 500 megohms per kilometre. Then a little calculation will show that, during the spark discharges, about 5 kw., or rather more, will be required. The portable apparatus used by Siemens & Schuckert has a transformer giving 10 k.v.a. at 100,000 volts on the high-pressure side at a periodicity of 50. At 62,000 volts this gives a normal output of 6·2 k.v.a., which is found to be sufficient. The output of this transformer might appear small for testing a length of 50 km. of cable at 150,000 volts; but this is not so. The duration of the charging period is very short; thus the heating of the transformer scarcely comes into the question, and during the period of the spark contact it can furnish a much larger current without risk. Very considerable quantities of electric charge can thus be stored in the charged cable; in case of a fault, it might be supposed that the result would be very disastrous if the resistance of the fault were small. But this is hardly the case. In addition to the resistance of the fault, we ought to take into account the resistance of the cable itself, because the charge is not concentrated at the point where the fault occurs, but is distributed uniformly over the whole length of the cable. It may also be said that, besides the plan sketched out in Fig. 1, there are other ways in which the connections might be made; but it is not necessary for present purposes to go further into these possibilities.

As for the portable apparatus itself, various changes have been made from Delon's original suggestions. He proposed to drive the synchronous motor from the network; but, as low pressure is not always available, it might mean the use of a transformer with various means of adjustment. This seemed a complication. Therefore a petrol motor, giving 11·8 kw. at 1,500 revs. per min., is used, coupled to a small alternator giving 9 kw. at 500 volts. The motor has a flywheel and governor, and thus runs fairly steadily. If the load is suddenly thrown off the motor the speed rises for an instant by 12 per cent. A very carefully arranged adjustment allows the voltage to be varied between 50 and 500. The rectifier has four poles, corresponding to the alternator; the fixed electrodes are supported on arms of "repelit," which is much less sensitive to shocks than porcelain and much lighter. The contact arm can be adjusted in any position, and so placed that the contacts correspond to the maximum of the voltage wave. The whole is conveyed in a wagon; it is enclosed from the weather, but the sides can be lifted for inspection. The high-tension transformer is carried on a separate wagon. It gives 10 k.v.a. with 500 volts on the low-tension side, and 100,000 volts on the high-tension side. The weight of the two wagons with their apparatus is about 8 tons. Apparatus of this kind ought to be sufficient for all ordinary testing work in situ. If in future testing pressures should be higher, the transformer giving a higher pressure would be the only thing to be altered. The rectifier is so designed that all parts under pressure can be raised to a potential of 200,000 volts to earth. If the direct-current pressures were to be determined directly, very special instruments would be required; it is, therefore, generally sufficient to determine the pressure of the alternate current on the low-tension side.

It may now be as well to give some account of tests that have been carried out. The first were carried out in the workshop, using a synchronous motor and an extra contact rectifier. There were at first difficulties in measuring the voltage. Electrostatic voltmeters filled with oil were thought to be necessary. The arrangement shown in Fig. 2 was finally employed. C_1 and C_2 are fixed metallic cylinders. C is a movable metallic cylinder suspended on the arm of a balance. It presses is applied to C_1 and C_2, is connected into the latter, and the glass vessel is filled with [illegible]. A source of alternating the motor, paper plates [illegible]. In order to avoid point discharges the movable [illegible] provided with a metallic covering which [illegible] The instrument is calibrated [illegible] from the action of external fields. The [illegible] high, using thin sheets of [illegible] In the particular apparatus described the [illegible] about 90 000 volts alternating. The [illegible]

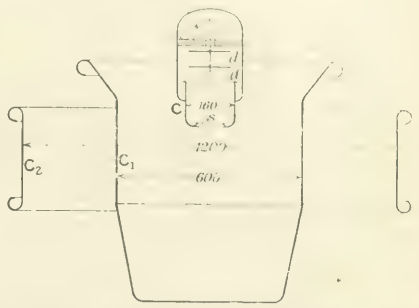


Fig. 2.—Diagram showing arrangement of the Electrostatic Voltmeter.

the ratio of the direct-current pressure to the alternate-current high-tension pressure, which latter is determined from the ratio of the windings of the transformer. If the capacity of the cable is sufficiently great, the ratio varies between 2·70 and 2·85. It may, therefore, be regarded as practically constant. For very high pressures the ratio is slightly less. A test was carried out on a length of 150 metres of lightly insulated rubber cable, and it was found that a direct-current pressure of 200,000 volts corresponded to an alternate-current pressure of 100,000 volts. For very short cables the above ratios will not be reached; it is an advantage in that case to put a considerable capacity in parallel with the cable. Thus, for this purpose, a length of 250 metres of a cable of average capacity might be used. The following table gives the ratio of the direct-current pressure to that of the alternate current if the connections are made on the before-mentioned plan.

A.C. voltage in kilovolts.	D.C. pressure in kilovolts.	Ratio.	A.C. voltage in kilovolts.	D.C. pressure in kilovolts.	Ratio.
10·0	16·0	1·6	40	98·5	2·46
12·5	28·0	2·24	50	120·5	2·43
15·0	35·5	2·36	60	143·0	2·38
20·0	48·8	2·44	70	158·0	2·26
30·0	73·7	2·46	80	175·0	2·18

These values were obtained on a length of 3 km. of three-phase cable for 10,000 volts, each of the cores having a cross-section of 35 mm. The total length of the connections was about 150 metres, which was intended as a precaution against any accident in the course of the tests. For low voltages the ratio of the direct-current pressure to that of the alternate current is rather low, a fact that is probably to be explained by losses at the spark contacts. The times taken to charge the length of 3 km. up to a direct-current pressure of 80,000 volts was about 40 seconds; for higher pressures and capacities it would, of course, take a longer time, but the period required is quite reasonable in every case.

As for the breakdown tests, the dielectric is subjected, with direct current, to a steady stress, quite unlike that due to alternating current. It is not necessary or possible to answer very exactly the question as to how the two tests compare. It was noted, at the moment of application of the direct current, to find out any weak spot in the cable that may have been overlooked, needless to say, in the preliminary testing of the cable. A piece of test cable with the Delon apparatus, these tests carried out were very helpful to find out what could be known. Breakdown tests were carried out on 60 test lengths of paper, each [illegible] plate electrodes, having surfaces of 20 sq. cm., immersed in oil; half were tested with direct and the other half with alternate current. The mean values of the breakdown voltage with alternate current [illegible] to be 16,500 volts per millimetre, corresponding to 150 volts. [illegible] the ratio 1·1 to 1. The [illegible] tests [illegible] per cent. [illegible] Other [illegible] All the [illegible] 20,000 volts per millimetre [illegible] With rubber [illegible] each 1·20 m. long. In [illegible]

separate sets. The first showed the ratio between the alternate-current breakdown pressure and that of the direct current was 1 to 2·8; the second set gave 1 to 2·45 and the third 1 to 2·5. These values are not very different from that obtained with paper cables. With the portable Delon apparatus tests were carried out on a number of samples of cable for 700 volts, each 2½ metres long; these gave a mean value of the ratio as that of 1 to 2·53.

These investigations are being continued. At present sufficient has been done to show that the breakdown effects with direct current are comparable with those due to alternating current. Taking 1 to 2·6 as the mean value of the above-mentioned ratio, we find that for a three-phase cable which has a working pressure of 20,000 volts the testing pressure with direct current is 45,000 volts between the lead covering and the conductor, and 78,000 volts between two conductors, always supposing that a testing pressure 50 per cent. above the working pressure is considered sufficient. In case higher pressures are required or desired, they can obviously be found from these figures by multiplying by the required ratio. These figures have, of course, only a provisional value; it may be quite likely that the work of testing the cable after laying can be satisfactorily carried out with lower pressures than we have been discussing.

The weight of the Siemens-Schuckert portable apparatus is about 8 tons, and, as has been before pointed out, the weight of a corresponding alternate-current equipment for testing a length of only 15 km., would be about 25 tons. The advantage gained in weight is, therefore, quite surprising, especially seeing that the Delon system is suitable for much greater lengths of cable than a mere length of 15 km. With alternate current, the testing at the spots where the network is divided up into sections—*i.e.*, the testing at the dividing points themselves—is impossible. Moreover, a test which formerly took in many cases several weeks, owing to difficulties of transport and the time occupied in re-laying the apparatus afresh, can now be carried out in a few days. It is possible, too, to complete the whole of the testing of the cable before the central station is ready to supply power, and this is often an advantage of great value. The apparatus, already described in the portable form, ought to be sufficient for all purposes, in so far as the future can be foreseen. It may be said that a smaller apparatus of similar type, giving 4 k.v.a. at about 80,000 volts, is being got ready. It is to be hoped that this method of direct-current testing will become more widely known, and so simplify the difficult and thankless work of testing a cable after it has been laid.

THE IMPORTANCE OF THE ELECTROMOBILE AS A SOURCE OF REVENUE TO THE CENTRAL STATION.

BY E. H. LECKMANN.

The limitations of distance and speed are at first sight serious objections to the electromobile; but there are many cases in which these objections are of no importance. As touring cars it is hardly likely they will ever have any great vogue; but there are many industrial purposes of a local character, such as the conveyance of goods, the watering of the streets and many other functions of municipal activity, that might be instanced as a likely field of operation. Thus, in many places they are used in the work of the fire brigade. There are 134 wagons of this kind in use in Germany, 50 of which are in Berlin and another 30 in Vienna. Sixty wagons are used in Berlin of the electric type for watering the streets. The German Post Office uses electrically-driven tricycles for the postmen who empty the letter boxes, and for other kinds of postal traffic. In Berlin the Post Office has 83 heavy wagons and 71 electric tricycles; in Leipsic there are 30 vehicles similarly employed, and 13 in Bavaria, while in Vienna there are 30 such vehicles used in postal work, and in Copenhagen 12. A table is given showing the number of electromobiles in the different countries of Europe, from which it appears that Germany has 1,001 cabs, Austria, France, England and Switzerland have each of them between 200 and 300, and the other countries of Europe, with the exception of Holland, which has 115, scarcely use them at all.

[illegible] quite certain that if it is to have a more extended field of operation [illegible]

[illegible] E., 1914.

industrial purposes, is cheaper in running expenses by something between 10 and 25 per cent. than the petrol van, the precise figure depending on local conditions; yet, notwithstanding this, the current consumed by such a wagon in the course of a steady year's work is quite considerable. Let us suppose that a trade wagon covers 15,000 km. in the year and a cab 40,000 km. The following figures will show the result of experience in Berlin. A so-called Bef wagon (*i.e.*, one made by the Berlin Electromobile Factory), taking a load of 8 cwt., requires from 0·18 to 0·2 kw.-hours per kilometre covered; its yearly consumption will, therefore, be about 3,000 kw.-hours. A cab, taking a load of the ordinary kind, requires 0·4 kw.-hour per kilometre, or a yearly consumption of 16,000 kw.-hours. A 1-ton wagon requires 0·35 kw.-hours per kilometre, and has a yearly consumption of 5,250 kw.-hours. And so on, till we find a 5-ton wagon, taking 1 kw.-hour per kilometre, consumes 15,000 kw.-hours annually. If these consumptions are translated into lamps, or rather into the yearly consumption of lamps, we see that a 5-ton wagon takes as much as 1,110 metal filaments of 25 c.p. This shows the load that would result in any place if it were possible by local suasion to induce the people who have cabs, omnibuses, trade carts, postal vans or any such things to adopt the system of electric traction.

A fair instance can be found in the central station at Neumarkt, in Saxony, which is quite a small place. Here for the last five years four electric omnibuses have been plying between the railway station and the town over a distance of 2½ miles. The current required amounts to 40,000 kw.-hours a year. Seeing that the whole output of the station is only 260,000 kw.-hours, it is evident how important this traffic in electric omnibuses is. The load, moreover, as is well known, is unusually acceptable, inasmuch as it can be dealt with at times of light load. And, if there were a number of these charging stations on the circuits of a central station, it is plain that the average load factor would be much improved. Take, again, the case of the charging stations in Berlin, which are used for this electromobile work, and which are probably the largest of their kind in the world. In one of these, the batteries belonging to 215 cabs and other vehicles are charged. Polyphase current at 6,000 volts is received from the Berlin network. This current is transformed to 120 volts, and then passed through rotary converters, three of which have a capacity of 120 kw. and another gives 440 kw. All these rotaries work on one set of bus bars, to which the batteries are connected in whatever state of charge they may happen to be. The charging proceeds at variable voltage till gas begins to be given off, the current being kept constant; the current taken depends on the times available for charging and on the state of the batteries. As soon as the batteries begin to give off gas the current is gradually diminished. The author gives some curves relating to the output of this station. The charging appears to be done between 7:30 a.m. and 3 p.m. and between 8 p.m. and 4 a.m.—at least, these are the hours in winter. There is also a diagram showing the switchboard connections at this station, with notes which enable one to understand the method of working. The load spreads itself very evenly over a number of hours in the day. Thus, at this station in Berlin, charging proceeds through 5,600 hours in the year. It would probably be difficult to find any other kind of demand for current that can spread over the times of light load so evenly and with such regularity from day to day. Neither is there any reason why this kind of work should not be capable of being undertaken by any central station, provided the district in which it is situated is not too hilly. The only necessary preliminary is to persuade users that this form of traction is economical, a fact which is quite capable of demonstration. In Greater Berlin there are altogether 12 public charging stations, and three charging stations used exclusively for postal vans. Of course, some of these stations are much smaller than others, and the one above mentioned is the largest of the lot. Nevertheless, the total amount of energy that is used in Berlin for charging electric vehicles is very considerable, and amounts, according to a reliable estimate, to about 10,000,000 kw.-hours annually. If the price is put down at about 1d. per unit, we see that an income of about £40,000 is derived from this source. This income is derived from the charging of 810 electromobiles that work in the city.

In the United States a great deal of progress has also been made. Here it is said that there are in all 50,000 electric wagons of different kinds, including cabs. Naturally this is regarded as a satisfactory start, and the hopes that are expressed in competent circles may be judged from the fact that Steinmetz is reported to have said that he hoped in 10 years there would be 10 million electric vehicles on the Continent of America. Thus a great future is thought to be in prospect for this class of work; but it must not be forgotten that everything depends on the co-operation of the electrical interests and on the price at which the charging can be done. Not only must the consumer be supplied at a reasonable rate, but the central station ought to be content with a reasonable profit. The extra

costs incurred by the central stations for this class of output mainly resolve themselves into the cost of coal, water and perhaps something for attendance. There is little in the way of indirect charges that ought to be reckoned in, and little is likely to be done in the way of expenditure for special plant. There is perhaps, also, the further argument in favour of the electromobile that it makes the consumer independent of petrol and its very fluctuating price. The money spent on petrol goes largely out of the country, though if this aspect of the question were to be followed up in our columns it might bring us within the sphere of contentious political problems. It is better, perhaps, to say nothing further about this argument, but to leave it to those to expound to whom it may seem to appeal with force. It is, however, a fact that petrol is a commodity the price of which has varied a good deal in the past, and there seems to be good reason to suppose that its price is likely to go up rather than to go down.

CORRESPONDENCE.

CHARGING FACILITIES FOR ELECTRIC VEHICLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with considerable sympathy the letter of Mr. W. H. Allen, of Loughborough, in your last week's issue, but I am afraid that his exasperation at the delay he experienced at Sutton Coldfield and Northampton has led him to do serious injustice to the provision that is made in Birmingham (by the Corporation electric supply department) for charging electric vehicles. I have for the last three weeks availed myself daily of the facilities given at Dale End sub-station, and in almost every case the vehicle has been on charge within five minutes of my arrival, and the charge has been carried out in every case precisely to instructions. In cases where a car has been returned by unskilled drivers, and no instructions as to charging have been given, the batteries have been properly charged up.

The arrangements at Dale End are only temporary, and I understand that permanent arrangements are to be at the rear of the sub-station, where there is a large yard which is very convenient for the purpose. This work is in progress, and when complete will furnish an ideal arrangement for the charging of electric vehicles.

To state, as Mr. Allen does in his letter, that "No one had any idea as to how it (the charging plug) was connected" is so entirely contrary to my experience that I am afraid Mr. Allen's irritation at the time had distorted his sense of observation.

Apart from Birmingham and Luton, I quite agree that the arrangements in many centres require to be better organised if the electric vehicle is to have a fair chance of development, and I hope that Mr. Allen's strictures will have that effect.—I am, &c.,

Birmingham, Aug. 10. J. P. KEMP.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my letter on the above subject in your issue of August 6th the following paragraph was omitted from section (*a*), immediately before the last paragraph: "In Mr. Hering's experiment the very existence of the E.M.F.s is questioned. If such E.M.F.s were induced they would be set up in the very mass of the block C or in unknown parts of the circuit. In my opinion, this increases the difficulties of the problem."—I am, &c.,

London, Aug. 10. A. F. GHEYSENS, I.C.C., I.E. (Ghent University).

[We regret the omission.—ED.]

BOOKS RECEIVED.

[Copies of the undermentioned works received from The Electrician Printing and Publishing Company, Limited, 1, Salisbury Court, London, E.C., may be obtained under the 5 per cent. co-operative system.]

"Collected Researches." By the National Physical Laboratory. London: Harrison & Sons. Vol. XII. Pp. [illegible]. 12s.

"Science Abstracts." Issued by the Physical Society of London. London: E. & F. N. Spon.) Vol. XVIII., Part 7, No. 211. Section A: Physics. Section B: Electrical Engineering. [illegible]

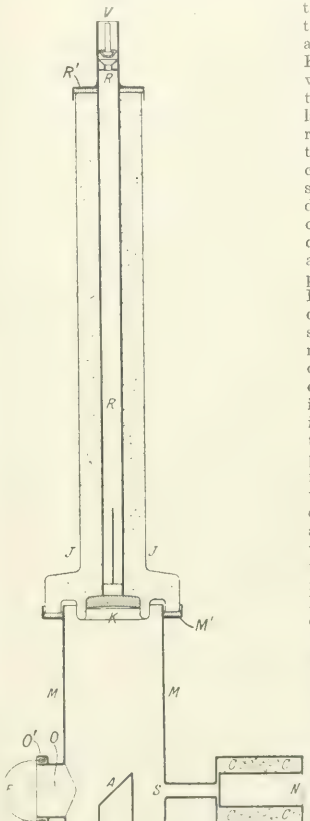
"Transactions of the Royal Canadian Institute." [illegible] Physics. No. 24. Vol. X. Part 2. 8s.

SAFETY METAL RÖNTGEN RAY TUBES.*

BY DR. L. ZEHNDER.

This tube is made almost entirely of metal, so that the Röntgen rays can only pass out through a small thin walled part forming a "window," thereby effectually protecting the operator from the action of the rays; moreover, it is almost unbreakable.

Its construction is as follows (*see* figure): M is a metal casing (*e.g.*, of thick brass tubing), on which is mounted a tubular porcelain insulator, J (which may be 1 metre long or even longer), the joint being made air-tight by means of cement, such as sealing wax, or an indiarubber ring arranged in an annular seat M′ formed around the top of the casing M. Through the insulator J extends a thick metal tube R (*e.g.*, of copper), also provided with an annular seat R′, in which the upper end of the insulator is cemented air-tight. The lower end of the metal tube R is split and receives the cathode K, which fills a space provided for its reception in the lower end of the insulator J, so that cathode rays can only issue from the concave surface of the cathode, all the other surfaces of the latter lying directly against the porcelain. The whole metal casing serves as the anode, and can be earthed for the protection of the operator. In the middle of the bottom of the casing M, which consists of concentrically-corrugated sheet metal B, is a copper anti-cathode, A, the operative surface of which is coated, either by soldering, electro-plating or by the Schoop metal spraying process, with a layer of a metal of high atomic weight. Opposite the anti-cathode, the casing M has an opening also provided with an annular seal, in which a window, F, of a material transparent to Röntgen rays, such as glass or aluminium, is cemented. It will be noticed that all joints are arranged *outside* thick metal tubing, so that the cement, indiarubber packing or other jointing material is protected from the action of cathode rays; this is essential. Opposite the window F, and separated from the main body of the casing M by a zigzag partition S, there is a branch chamber, N, containing pieces of carbon, C, which when heated supply air to the interior space of the tube, and when cooled absorb the same. This branch chamber is preferably electrically heated by a coil of wire doubled on itself or by a heater made by [illegible] not to produce a stray magnetic field. The anti-cathode A is of thick metal, and is artificially cooled; the thin corrugated bottom B permits of the inclined anti-cathode surface being adjusted in position, *e.g.*, by screws [illegible] to the cylinder M. The cathode K may be made of refractory insulating material, such as magnesia, and have its concave surface covered with a thin layer of a metal of high melting point, such as tungsten, produced by the Schoop spraying process.



* Abstract of an article in the "Elektrotechnische Zeitschrift," Vol. XXXVI., p. 19.

and by doubling the tube R, so as to provide the two leads, a heating current may be passed through this metal coating. By this means, in conjunction with a high vacuum, hard rays can be produced as in the Coolidge tube. Shutters, filters and obturating caps can be fitted to the window F as desired. After exhausting, during which the whole tube is warmed by a strong current and by a small gas blow-pipe flame (the joints being kept cool), the tube is closed by an iron valve, V, covered with indiarubber, and magnetically operated. The tubes can be made extremely powerful, so that exposures of 0·2 second only are sufficient. Dr. Zehnder has not patented his tube, and gives permission for it to be used by all.

SYNCHRONOUS MOTOR GENERATORS *VERSUS* ROTARY CONVERTERS.*

BY HUGO RING.

Two different methods were adopted in converting polyphase energy into that of direct current as soon as the problem became of real importance. Naturally, it was hoped to reduce the losses attending the conversion, to a minimum, and, therefore, the rotary converter seemed the most likely solution. But there were great difficulties as soon as sizes increased, and the experiences with the first models were not very satisfactory. This was more particularly the case where they had to run in parallel with shunt machines or with batteries. Thus, the motor-generator type had its advantages in spite of obvious defects in the system. But in the course of years the rotary converter has improved, especially since certain auxiliaries have been introduced. Thus the motor-generator set seems to be gradually being displaced by its rival. But the question ought to be answered as to whether the rotary should be preferred under all conditions, and this is by no means certain, as the following considerations tend to show.

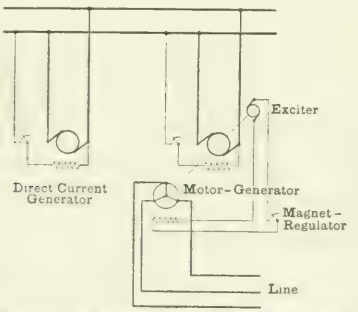


FIG. 1.—DIAGRAM OF SYNCHRONOUS MOTOR-GENERATOR SET IN PARALLEL WITH AN ORDINARY DYNAMO.

Fig. 1 shows a synchronous motor generator set in parallel with an ordinary direct-current machine. The synchronous motor-generator is directly connected to the high-tension cables, as is the usual case. The high-tension voltage has nothing to do with that on the direct-current side, and this is the main advantage of this method. Thus, it can run in parallel with another direct-current machine, or have its voltage varied in any way. Thus we have a second advantage, inasmuch as ordinary direct-current methods are available for distributing purposes. A third advantage is that the phase-displacement can be regulated without affecting the direct-current side, and this is done simply by altering the excitation of the synchronous motor. It is known that by a change in the excitation of the motor a wattless current can be produced, which causes a displacement between the current and the terminal voltage. And seeing that the motor is directly connected to the high-tension network this will effect a change in the displacement between the line-voltage and the current carried by the line.

Fig. 2 shows a rotary converter in parallel with an ordinary direct-current dynamo. Here the voltage of the high-tension side is in a given constant ratio to that on the direct-current side. This means that [illegible] bar-voltage to be slightly above that of the rotary. In order to prevent any rush of current, the bus-bar voltage must be lowered to that of the rotary, which can then be switched in. If the rotary is to take some of the load, this can be done by lowering the voltage of the other dynamo, until the rotary has taken the whole load. There are, of course, losses in the rotary, so that its voltage will fall slightly; but these losses are very small, as is also the fall in voltage. But still it must be noted that this fall in voltage is caused solely by its internal losses. Seeing that this voltage-fall is determined by the external characteristic of the rotary, we propose in the following remarks to call it the characteristic voltage-drop of the rotary, and it will be referred to later on. When the rotary has taken its load, the induction due to leakage in the transformer and the self-induction of the transmission line and of the rotary itself make it possible by changing the excitation of the rotary to react on the direct-current voltage, as will be seen. Then a further distribution of the load can be effected by changing the shunt excitation of the rotary, but this can only be done to a very insufficient extent. Thus, we see that on this plan it is not possible to use the ordinary methods of a direct-current station for purposes of regulation, and this is a decided disadvantage when we contrast it with the synchronous motor-generator set.

If an ordinary transformer is used an alteration in the excitation of the rotary reacts on the direct-current voltage to a very small extent. But in most practical cases, a change of 5 per cent. from the mean is wanted. This is produced by designing the transformer, so that it has a greater magnetic leakage, or by inserting either in the primary or secondary side something of the nature of a choking coil. If the phase-displaced currents react on the self-induction of the choking-coil or on the external self-induction (for this is the effect of magnetic leakage in the transformer), then there is a change in the polyphase voltage and therefore also in the direct-current voltage. The necessary self-induction in the transformer must be produced by its magnetic leakage, which normally is insufficient in amount, and

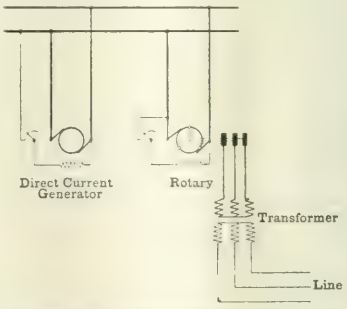


FIG. 2.—DIAGRAM OF ROTARY CONVERTER WITH A REDUCTION TRANSFORMER IN PARALLEL WITH AN ORDINARY DYNAMO.

which must, therefore, designedly be increased, or by the insertion of choking coils. The rotary on the polyphase side must be handled on the same principles as hold with the synchronous motor-generator. In both cases there are phase-displaced currents when the excitation is altered; these currents lag when it is under-excited, and lead when over-excited. But there are other points with regard to the rotary to be considered. We know that by a change in the excitation of the synchronous motor it is possible to produce a phase-displacement in the current in the line. But with the rotary any such reaction must take place through the intermediary of the transformer. The result is that the phase-displacement in the secondary of the transformer—*i.e.*, in the rotary—differs substantially from that in the primary circuit, which is the transmission line. With a normal excitation of the rotary—*i.e.*, with no phase-displacement between current and terminal voltage of the secondary—the phase-displacement on the primary side is not also zero, but a lag of the primary current exists to an extent that depends on the power-factor of the transformer when working on the secondary side on a non-inductive load. If there is no phase-displacement in the transmission line on the primary side, then an over-excitation of the rotary would produce a considerable lead in the current on the secondary side. But this does not matter much. On the other hand, there is the important consideration that a change in the excitation of the rotary reacts through the transformer on the phase-displacement in the line, if in consequence of a necessary lowering of the voltage on the direct-current side a lag of current in the secondary circuit is caused by under-excitation of the rotary. This method of regulation causes an

* Abstract of a paper read before the Zurich Electrotechnical Society.

ever-increasing wattless current in the line. The synchronous motor has the advantage that it is possible to react on the phase-displacement in the line without affecting the direct-current side. With the rotary there is a direct connection between the direct-current side and the phase-displacement in the line, in so far as changes of voltage on the direct-current side are effected by increased magnetic leakage. If the phase-displacement in the line is to be changed, then there must be a change in the excitation of the rotary. But this causes a corresponding change in the direct-current voltage, and this affects the distribution of the load if there are other machines in parallel, unless their excitations are also altered. Thus we see that there are fundamental differences between the two methods. With the rotary a change in the phase-displacement on the secondary side or in the line, independently of the direct-current voltage of the rotary, is not possible without increased magnetic leakage in the transformer or the use of choking coils; and a change in the direct-current voltage produced by these means is not possible without affecting the phase-displacement in the line.

The adjustment of the voltage on the direct-current side is now produced by a potential regulator, which produces no marked effect on the phase-displacement in the line, and which is inserted between the reduction transformer and the rotary, as shown in Fig. 3. By adjusting the potential regulator by means of a hand-wheel, the direct-current voltage can be regulated with a constant phase-displacement. By its use it is possible to regulate the phase-displacement in the line by altering the excitation of the rotary, and this scarcely affects the voltage on the direct-current side. Thus, increased magnetic leakage and choking coils are done away with.

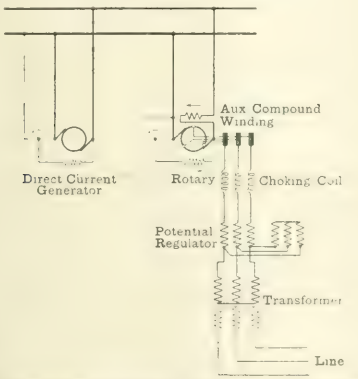


Fig. 3.—Diagram showing Rotary with Transformer, Potential Regulator, Choking Coil and Auxiliary Compound Winding in Parallel with an Ordinary Direct-current Dynamo.

Moreover, it is possible to run machines in parallel, as with synchronous motor-generators, in the usual direct-current fashion; and this is done, not by regulating the rotary, but by the potential regulator. With the magnetic leakage or choking coil method, the attendants require special experience. This raises again the question as to whether rotaries with potential regulators are as good as motor-generators.

We have already seen that the characteristic voltage-drop of the rotary is very small. When run in parallel with the ordinary dynamos of the old-fashioned kind, or with batteries, the rotaries will tend to take up all the shocks, owing to the fact that they have a smaller voltage drop than the machines with which they are in parallel. If these shocks occur seldom, it may be possible to deal with them by adjusting the other machines by hand. But if they are frequent and sudden, the rotary becomes from time to time suddenly overloaded. The solution would appear to be to increase the characteristic drop of the rotary. This could be done by [illegible] a compound winding on the [illegible] by building choking coils in the connection of the rotary to the transformer, as shown in Fig. 3. Thus the rotary is designed so that at half-load the power-factor is unity; at higher loads, there is a lag with a power-factor of about 0·95, and at lower loads there is a lead. Thus all the disadvantages of the rotary, as have been previously mentioned, reappear. Moreover, all these additional devices detract from the [illegible] which [illegible] to be a higher efficiency. Further, there is the [illegible] necessaries to be taken into account, the total cost of [illegible] higher than for the synchronous motor-generator. All this apparatus requires attention, cleaning, repair; and it is, therefore, by no means clear that the greater simplicity of the motor-generator system is not to be preferred. The rotary may be capable of taking a greater overload; it may also be possible to start it without synchronisation, and to run it at the start in a synchronous fashion. This latter method of starting requires not less care and experience than the synchronous method, and there are also cases where it is inadmissible. Thus it will be seen that the rotary labours under very special difficulties, not altogether counteracted by what appear at first sight to be its strong points.

We have hitherto supposed that there are no fluctuations in the line; but these things happen, and ought to be considered. If the rotary is working under certain conditions, what happens if the line voltage changes? For we know that the line voltage bears a direct ratio to that on the direct-current side. Thus a change in the voltage of the line alters the voltage on the direct-current side and thereby the distribution of the load between the different machines in parallel. Thus the rotary may be either overloaded or it may lose its load, and the running in parallel with other machines becomes very difficult. Any regulation by hand might be too late, especially if the variations were sudden and marked. Here we must have recourse to the quick-regulator, which alters automatically the excitation of the rotary. But for the synchronous motor-generator set, even with marked variations in the line, there is no need for any accessory. For under given conditions of load, a change in the line voltage causes a change in the relative displacement between the rotor and stator of the synchronous machine; this causes a change in the current taken by the motor. But the speed of the machine remains unchanged, and thus also the voltage on the direct-current side and the distribution of the load.

In conclusion, it may be said that the whole question demands a very careful consideration of all the conditions that are likely to arise. Before placing an order the purchaser ought to be clear in his mind as to whether a rotary is likely to be able to meet all the requirements of the case which he has in mind. In particular he ought to be on his guard against the idea that later on he may be able to add choking coils or auxiliary compound-windings without mentioning this notion to the makers. For, in such a case, he would be working with phase-displaced currents, which might mean a considerable overloading of the conductors of the rotary, and for which it was not designed.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1913 [illegible] Act.

27,260 K[illegible] Method [illegible] tension electricity. (25/11/12.)

27,457 L[illegible] & B[illegible], Ltd., and W[illegible]. Supply [illegible] filaments and the material for same.

27,426 Moore-Light Akt.-Ges. Electric vacuum light apparatus. (28/11/12. Addition to 1,218,13.)

27,473 Siemens & C[illegible] Arrangement [illegible] (10/2/13.)

27,515 Baron. (Aldendorff.) Control of electromechanical switches for telephone exchanges.

27,590 Romanes. Cramp belts adaptable to electrode contact cramps and holders and for other purposes.

28,291 Baron. (Aldendorff.) Electromechanical switching systems for interconnecting telephone lines.

28,362 Aldendorff. Switching systems and apparatus for interconnecting telephone lines.

28,502 Aldendorff. Switching apparatus for interconnecting telephone lines by electromechanically controlled switches.

28,833 Baron. (Aldendorff.) Method of interconnecting lines by electromechanically controlled switches.

29,946 Von Arco & Meissner. Transmitting arrangements for high-frequency wireless telegraphy and telephony.

A transmitting station for wireless telegraphy and telephony in which the high-[illegible] or system is employed for raising the frequency of an alternating current in which it is possible to attain by static transformers with auxiliary magnetisation any desired multiplication of the frequency; or by arrangement of several such transformers in series it is possible to multiply the frequency several times.

284 Marks. (Siemens & Halske Akt.-Ges.) Anode of hard lead for electrolytical [illegible]

[illegible] commutator motors. (4/1/13.)

450 Baron. (Heimann.) Semi-automatic or automatic graded service telephone systems. (Addition to 11,868/13.)

[illegible] vention date not granted.)

[illegible] semi-automatic telephone systems. (17/4/13.)

742 Fried. Krupp Akt.-Ges. Electrode furnaces which have an arrangement for automatically mixing up the charge. (17/1/13.)

900 Cacha. Self-locking electric lamp-holder.

railways and the like.
9,289 DIRKS. Controlling switches for electrically-actuated lifts. (14 4 13.)
13,933 WATERS & CALLENDER'S CABLE & CONSTRUCTION CO. Electric cables and cable systems and joints for use therein. (Cognate application, 14,946/14.)
14,294 WEST. Electric controllers.
16,093 SCOTT. Armature windings of electric motors or dynamos.
16,111 CONWAY. Gloves for preventing electric shocks.
16,149 SMITH & LOACH. Holders for electric incandescent lamps.
16,315 BURT. Electrical device for controlling race-starting barriers.
16,342 MARKS. (International Quadruplex Co.) Telegraphy.
quadruplex, and to land lines as well as lines with great capacity. Consists in methods of recording vibrations to denote that no message has arrived over a line, and in also recording straight lines to denote that messages have arrived.
16,411 RELAY AUTOMATIC TELEPHONE CO. (formerly known as Betulander Automatic Telephone Co.), BRYANT & WARD. Automatic telephone systems.
16,471 EASTERN TELEGRAPH CO. & DAVIES. Electric relays. (Cognate application, 17,452 14.)
16,583 OSTERREICHISCHE SIEMENS-SCHUCKERTWERKE & REGAL-PATENTE GES. Apparatus for electrically transmitting patterns and pictures in textile machines. (12.7 13.)
16,595 BANNEYER. Electric alarms.
16,712 HUGHES & COOPER. Telephone systems, more particularly for police and fire alarms.
16,737 WILSON. Igniting and lighting generators. (17/4/14.)
16,869 B.T.-H. CO. (G.E. Co., U.S.) Electric meters.
An induction motor meter in which the two cores of magnetic laminations carrying the potential and series windings are clamped between common frames of magnetic material.
16,979 SIEMENS BROS. DYNAMO WORKS (LTD.) & KIEFFER. Cooling arrangements for dynamo-electric machinery.
16,986 PARSONS. Cooling of dynamo-electric machinery.
17,037 ECKMANN. System for the operation of electric winding motors and the like.
17,089 SIEMENS & HALSKE AKT.-GES. Process and apparatus for the electrolysis of halogen alkalies. (26/7/13. Addition to 18,102/13.)
17,133 HARRIS. Electro-deposition of metal upon metal by means of high-current density, specially applicable for coating printing rollers, hydraulic rams, and other like purposes.
17,292 LANGNER. Engine-starting devices. (21/7/13.)
18,314 JOHN DAVIS & SON (DERBY) (LTD.) & MACDONALD. Signalling apparatus such as is employed in collieries and the like.
17,331 HEYLAND. Apparatus for generating high-frequency electric currents. (18/8/13.)
The active stator and rotor surfaces are differently subdivided in the direction of their movement and the iron surface of the armature forms segments which bridge the gaps between the pole tips successively under different phases.
17,446 CONNER & ROBINSON. Telephone systems.
17,611 BENDIXEN. Electric fire and temperature alarms.
18,281 JUHLIN. Ventilation of dynamo-electric machines.
18,607 ZIEBAU. Attachments for telephones and the like.
18,661 STERLING TELEPHONE & ELECTRIC CO., BELL & DUNGEY. Electric signalling systems, particularly for use in mines. (Patent of addition, 13,062/14.)
18,738 MELLERSH-JACKSON. (Commonwealth Electric Tool Co.) Electrically-actuated tools.
18,882 BRITISH THOMSON-HOUSTON CO. (General Electric Co.) System of electric distribution.
A system containing a vapour apparatus, such as a mercury vapour rectifier, the object being to decrease the liability of discharges of undesired polarity, particularly after an idle period when the tendency of an anode temporarily to become a cathode is increased by the condensation of mercury on or around the anode or anodes.
19,441 DOUGLAS & HODGSON. Electric staff exchangers. (28/10/13.)
19,587 BRITISH THOMSON-HOUSTON CO. (General Electric Co.) Electric circuit interrupting means.
An electric circuit interrupting device having a separate arc chute for each terminal in which the terminals are enclosed by laterally and transversely arranged refractory insulating walls, so that only a circuitous creepage path exists between the terminals.
20,286 BALL. Electric heating unit.
21,046 JOHN DAVIS & SON (DERBY) (LTD.) & DAVIS. Magnetic lock for miners' lamps.
21,727 PLANCQ. Electrolytic apparatus.
21,793 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Automatic selecting devices for telephone systems. (Addition to and divided application on 29,883 dated 16.7/14.)
22,047 REILLY. Electric advertising devices and signs.
22,914 LAMME. Operation of polyphase electric motors in connection with single-phase alternating currents. (26/12/13.)
Energy from a single-phase alternating-current transformer is converted into polyphase energy for the operation of induction motors by means of a phase converter, one phase winding of which is connected across one winding of the single-phase transformer, which latter also supplies correcting voltage components which are so superimposed on the voltages of the phase converter as to compensate for voltage drop caused by the load.

1915 SPECIFICATIONS.

131 LIVERSIDGE & PENNSYLVANIA APPLIANCE CO. Electric fusible cut-outs.
[illegible] GRINSTED. Circuit arrangements for telephone systems.
945 REASON. Electric switch and fuse service boxes.
1,007 GRINSTED. Means for obtaining periodically interrupted currents of electricity.
1,085 STR[illegible]THEPT & PITT & FRANKLIN. Controlling and indicating electric motors from a distance and the application thereof to weighing machines.
1,468 CONRAD. Starting means for vapour electric devices. (30/1/14. Addition to 37,12.)
2,767 [illegible]
(21,2/14. Addition to 605/09.)
5,184 [illegible]BERT BOSCH (FIRM OF). Electric light systems, more particularly adapted (6/3/14.)
5,676 Alternating-current voltmeters.
5,994 [illegible]n. Lanterns for electric lamps. (15/6/14).
6,618 [illegible]r dynamos. (Divided application on 16,093/14. July 6.)
6,619 [illegible]r electric motors or dynamos. (Divided application on
7,913 [illegible]r. Dynamo-electric machines, particularly applicable for [illegible]tor system. (14,7,13. Divided application on 13,022 14. May 27.)
Automatic switching apparatus for electrically illuminated designs and (30/4/14. Addition to 923 15.)

APPLICATIONS FOR PATENTS

[illegible] * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.

Electric apparatus for driving clocks and similar

June 15, 1915.
8,773 WIRTZ. Electro-deposition of metals.
8,[illegible] B.T.-H. Co. (G.E. Co., U.S.) Electrical incandescent lamps.
8,813 WAHL. Cell, battery, or refill for use in connection with portable electric lamps, and for other purposes. (Addition to 7,213/15.)
8,[illegible] BARDELONI. Telephonic transmission without return wire.*
8,[illegible] BERRY. Electric heating and resistance devices.

June 16, 1915.
8,850 XENAKY & GILMAN. Electric meter.*
8,860 RAILING, GARRARD & GREENHALGH. Electrical resistances.
8,881 KIRKBY. Micro-telephones for portable instruments.
8,891 RELAY AUTOMATIC TELEPHONE CO. & AITKEN. Automatic and semi-automati telephone systems.
8,[illegible] BEATTIE. Protecting telephone, telegraph and the like instruments against lightning or excessive electric potentials.
8,[illegible] TEDESCHI & ROSSI. Electrical relays.*
8,[illegible] ISHERWOOD. Anodes for the electrolysis of solutions of metallic salts.*

June 17, 1915.
8,923 BOURGEOIS. Production of an electric discharge of high frequency by means of sparks.*
8,926 & 8,927 MARCONI'S WIRELESS TELEGRAPH CO. & WRIGHT. Wireless telegraph [illegible]
[illegible] MARCONI'S WIRELESS TELEGRAPH CO. & WRIGHT. Wireless telegraphy.
[illegible] SCHIESSLER. Coupling-devices suitable for relay purposes. (Divided Application on 20,238,14. 16/4/14, Austria.)*
[illegible] DUKE. Metallic lead-in wires for electric lamps, scientific apparatus, and the like.
[illegible] SHARMAN. Apparatus for detecting the presence of electric conductors.

June 18, 1915.
[illegible] ELECTRIC & ORDNANCE ACCESSORIES CO. & ETCHELLS. Guards for fans.
[illegible] BRUNTON. Insulating covering for telegraph and like wires.
9,003 PATTERSON. Miners' electric safety-lamps.
9,012 ELECTRICAL POWER STORAGE CO. & SCHOFIELD. Secondary battery plates.
9,015 LANDIS & GYR AKT.-GES. Motor-actuated electric switches. (14/7/14. Germany.)*

June 19, 1915.
9,021 JONES. Electro-magnetic apparatus.
9,023 WALSALL ELECTRICAL CO. & DELEBECQUE. Ammeters and voltmeters.
9,052 RENWICK. Localising bodies by the aid of X-rays.

June 21, 1915.
9,054 PEDERSEN. Magnetos.
9,085 WELCH. Electric kettles, urns, and the like.
9,097 MARKS. (Sidney le Fèvre Varvel, Australia.) Electric hot-water storage installations.
9,101 B.T.-H. Co. (G.E. Co., U.S.) Regulating-mechanism for controlling the flow of fluids.
9,110 DUCKHAM. Oil-cooled electric transformers.
9,111 9,112 VARLEY. Systems for producing electrical discharges from a source of energy. (21/3/14, 7/1/14, U.S.)*
9,113 INTERNATIONAL ELECTRIC CO. & ROBERT GUSTAV LE N[illegible]S. Telephone transmitters.*

June 22, 1915.
9,120 MURDOCH. Electric meters.
9,135 CHERNE. Dental reflectors or lamps.
9,141 BILLING. Apparatus utilising electro-magnets or permanent magnets, for the protection of ships, harbours, and the like from torpedoes or mines.
9,148 MCCARTNEY. Mine signalling-apparatus.
9,157 LEWIS. Electrodes for arc lamps.
9,158 JACKSON ELECTRIC STOVE CO., GRIESBACH, HOLMES, SMITH & WILLIAMS. Electric cooking.*

June 23, 1915.
9,235 UNDERWOOD & UNDERWOOD. Portable telegraph and telephone apparatus applicable for signalling apparatus.
9,245 SYKES INTERLOCKING SIGNAL CO. & SYKES. Electric relay.*
9,250 CROWE. Telegraphy.

June 24, 1915.
9,272 HAY. Rotary duplex visual and audible signalling arrangement.
9,279 B.T.-H. Co. (G.E. Co., U.S.) Targets for X-ray tubes and the like.
9,282 LANGDON-DAVIES & SOAMES. Means for driving dynamo-electric machines.
9,283 RELAY AUTOMATIC TELEPHONE CO. (Gotthilf Ansgarius Betulander, Sweden.)* Automatic or semi-automatic telephone systems.*

June 25, 1915.
9,330 SCHUER. Lampshade and globe holders for gas and electric lighting.
9,336 WOOD. Devices for establishing electric connection between conductors.*
9,345 RELAY AUTOMATIC TELEPHONE CO. & BYGRAVE. Automatic and semi-automatic telephone systems.
9,34[illegible] B.T.-H. Co. (G.E. Co., U.S.) X-ray devices.

NEW BOOKS AND NEW EDITIONS.

[Copies of the new books mentioned below can be obtained *post free* from THE ELECTRICIAN Offices on payment of the prices indicated in parentheses. Where an asterisk is added to the number 20 days will elapse before books are supplied. It is only necessary to specify the number when sending remittance.]

555. "Alternating Current Work." An introductory book. By W. P. Maycock. 6s. net (6s. 3d.)

556. "Wireless Time Signals. Radiotelegraphic Time and Weather Signals transmitted from the Eiffel Tower, and their Reception." 3s. 6d. net (3s. 9d.)

557. "Text Book of Practical Mathematics for Advanced Technical Students." By H. L. Mann. [illegible] (7s. 6d.)

558. "Handbook for Wireless Telegraph Operators Licensed by H.M. Postmaster-General." Revised edition 3d. (4d.)

559. "Theory of Permutable Functions." By V. Volterra. 4s. 6d. net (4s. 9d.)

560. "The Motor Manual." [illegible] 1s. 6d. net 1s. 9d.)

561. "The Automatic Pocket Book." By E. C. Matthews. 3s. 6d. net (3s. 10d.)

562. "Simple Electrical Experiments." By C. R. Gibson. Commercial Dictionary. By G. R. Macdonald. 7s. 6d. net (7s. 9d.)

563. "Steel Cutting, Boring and Screw Plate Guide." By C. S. Baker. 12s. 6d. net.

564. "X Rays and Crystal Structure." By W. H. Bragg. 1s. 6d. net (1s. 9d.)

565. "Steam Tables." By H. F. Collenette. 3s. net (3s. 3d.)

566. "Revision Papers in Algebra." With and Without Answers. By W. G. Borchardt. 2s. (2s. 3d.) and 1s. 6d. (1s. 9d.).

567. "Experimental Electrical Measurements." A Laboratory Manual. By G. F. C. Searle. 4s. 6d. net (4s. 9d.).

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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THE ELECTRIC HOUSE IN BEING.

Slowly but surely electricity consumers in this country, in Canada, in the United States and in certain of our Colonies are being provided with a tariff for electricity supply which admits of the use of the service for practically all domestic purposes. The ultimate object of these facilities is the establishment, in every district in which electrical energy is available, of electric homes which will ameliorate the lot of those who inhabit them. The problem is not wholly one of cheap electrical energy, it is also concerned with the design, construction, reliability and availability of the apparatus for converting the cheap energy into light, heat and power. On the score of design and construction a great deal of good work has been done, and is being done. From the point of view of reliability it can also be fairly said that excellent progress has been made. As to availability, this matter has already compromised two important sections of the industry, the station engineers and the contractors, and there is still much stony ground to be covered. The difficulties in this respect are being partly removed by manufacturers, who are producing in quantities on standard lines and at prices which enable a certain section of the public to buy outright. So far as actual practical results are concerned, the record, although it includes many failures and disappointments, is, on the average, one which should encourage those engaged in the industry to persevere.

The enthusiasts in domestic electrical development have always contended that electricity engineers and electrical contractors should live in model electric homes. These would be in the nature of permanent and practical exhibits of the uses of electrical energy under every-day conditions. It is a regrettable fact that only a very small percentage of station engineers and contractors show any enthusiasm in this regard, and they are, therefore, unable to point the way in their particular districts, and thereby to give real encouragement to their consumers. On another page we cite the experience of a Glasgow builder who has been sufficiently enterprising, not to say Utopian, to erect a number of electric houses in the suburbs of Glasgow. Mr. G. Hamilton, the builder in question, records a considerable amount of opposition from local electrical contractors to his all-electric homes, an opposition which must have been extremely discouraging, seeing the source from which it came. He has, however, satisfactorily overborne his would-be detractors, and after a period of over 12 months in one of his electric houses he has nothing but praise for the reliability and convenience of the service, and pleasure at the small cost which it has entailed. Mr. Hamilton speaks highly of the encouragement which Mr. W. W. Lackie, the city electrical engineer at Glasgow, gave him at the outset, and he attributes much of his successs to the amount of zeal and practical assistance ungrudgingly given him by Mr. Lackie. While we can understand that such an experiment of electric homes on a wholesale scale might give rise to local misgiving, at the same time some kind of start has to be made, and every credit must be given to those who have the courage to take the initial steps and incur the risks which pioneers invariably experience.

There is now far less reason for electrical engineers and contractors to refrain from making their homes as electrical as possible than there was a few years ago, when apparatus was unreliable, expensive to instal, and also costly to operate and maintain. Example is far and away better than precept in such matters, and with Glasgow leading the way the rest of the country should also follow.

Electric Lighting for Railway Construction Work.—Electric light played an important part in the construction of the Pinelada-Lobito Railway, South Africa. The work of 112 miles was carried out in record time, the average daily output being equal to 2·25 miles per day. According to the *Engineer* the maximum mileage completed in any one day was 3·25 miles. When once the work was properly set going it was carried on day and night, an up-to-date electric light generating plant enabling operations to be continued after dark. The plant, which was hauled by two powerful motor lorries, travelled along the line at the rate of one mile per hour, and carried everything necessary for the generating of electricity. It is said that the speedy construction of the line was considered necessary in order to facilitate the movement of troops towards the German south-west border.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week ending July 31, 1915, to Aug. 7, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]

LIVERPOOL.—*Spain:* Elec. carbons, 97 pkgs. *U.S.A.:* Insulating tape, 28 pkgs.; unenumerated, 107 pkgs. *Canada:* Insulating tape, 28 pkgs.

LONDON.—*U.S.A.:* Elec. machinery, £2,794; elec. carbon candles, £270; telephone materials, £601; lamp parts, £109; elec. wire and cable, £37; unenumerated, £722. *Switzerland:* Unenumerated, £142. *Holland:* Elec. lamps, £777—360 pkgs.; elec. machinery, £313. *France:* Elec. carbon candles, £257; lamp parts, £10; elec. lamps, £415; wire and cable, £50: unenumeraed, £196. *Canada:* Uneunmerated, £84. *Denmark:* Elec. machinery, £128; unenumerated, £467. *Norway:* Telegraph poles, 2,065. *Sydney:* Telegraph materials, 1,315 pkgs. *Italy:* Elec. machinery, £227; unenumerated, £26.

SOUTHAMPTON.—*France:* Unenumerated, 25 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £202. *Melbourne:* Elec. machinery, £433; wire and cable, £143; unenumerated, £265. *Sydney:* Elec. machinery, £244; unenumerated, £2,581. *Wellington:* Elec. machinery, £100; telegraph material, £825; unenumerated, £153. *Brisbane:* Unenumerated, £29. *Adelaide:* Wire and cable, £52; unenumerated, £152. *Christchurch:* Unenumerated, £232. *Perth:* Unenumerated, £279. *Fremantle:* Wire and cable, £417. *Hobart:* Unenumerated, £98. *Launceston:* Unenumerated, £17. *New Plymouth:* Unenumerated, £63.

AFRICA.—*Durban:* Wire and cable, £410; elec. machinery, £524; unenumerated, £1,424. *Port Elizabeth:* Unenumerumerated, £116. *Cape Town:* Wire and cable, £12; unenumerated, £295. *East London:* Unenumerated, £11. *Mauritius:* Unenumerated, £22. *Beira:* Unenumerated, £153. *Madagascar:* Unenumerated, £32.

EGYPT.—*Alexandria:* Wire and cable, £544.

SPAIN.—*Huelva:* Unenumerated, £142

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Unenumerated, £953. *Antigua:* Unenumerated, £60. *Guayaquil:* Unenumerated, £106.

JAPAN.—*Kobe:* Unenumerated, £22. *Nagasaki:* Elec. machinery, £27.

CHINA.—*Shanghai:* Unenumerated, £148. *Honkong:* Unenumerated, £222. *Hankow:* Unenumerated, £43.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £277; unenumerated, £494. *Calcutta:* Wire and cable, £14; unenumerated, £497. *Madras:* Unenumerated, £59. *Singapore:* Unenumerated, £299. *Bankok:* Unenumerated, £232 *Fort Swetenham:* Unenumerated, £240. *Penang:* Unenumerated, £26.

CANADA.—*Montreal:* Elec. machinery, £142; unenumerated, £111.

FRANCE.—*Paris:* Unenumerated, £25. *Marseilles:* Unenumerated, £217. *Gravelines:* Unenumerated, £320.

U.S.A.—*New York:* Unenumerated, £399.

HOLLAND.—*Amsterdam:* Wire and cable, £75; unenumerated, £64.

MALTA.—Wire and cable, £58; unenumerated, £32.

FOREIGN GOODS (duty paid and free).

Melbourne: Unenumerated, £16. *New York:* Unenumerated, £95. *Auckland:* Unenumerated, £18. *Bombay:* Unenumerated, £650. *Buenos Ayres:* Unenumerated, £57. *Singapore:* Unenumerated, £116.

IN TRANSIT.

Bombay: Elec. lamps, &c., £2,532. *Napier:* Elec. lamps, £110.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LIQUIDATIONS, &c.

A meeting of the creditors of the Baldur Engineering & Supply Co. (Ltd.), in voluntary liquidation, was held yesterday (Thursday) at Messrs. Strong & Bolden's, 70, Gracechurch street, London, E.C. The Company is being wound up voluntarily, with Mr. Hugh Charles Cayley, 39, Victoria street, Westminster, S.W., as liquidator.

The South American Cable Co., Ltd., is being wound up voluntarily. Messrs. F. Chapsal, G. Patel, U. Pierrard and L. Pasquet have been appointed liquidators. A meeting of creditors will be held at 12 noon to-day (August 13th) at the offices of the company, 22, Royal Exchange, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barking. [illegible] the Council last week to obtain [illegible] amount [illegible] for extension of generating plant and mains were [illegible]

The chairman of the Electricity and Tramways Committee (Councillor [illegible] the Council how it could [illegible] they [illegible] the power at the [illegible] promptly in order [illegible] demand for electricity. [illegible] recently with the view of [illegible] and the necessity of a continuance of the [illegible] the applications for additional [illegible] within the last few years, they would have [illegible] thereby [illegible] He had no doubt that [illegible] but the matter might be to some extent saved if they did their utmost to secure the sanction of the L.G. Board to an amended loan based on the tenders. With that object in view, he hoped they might be unanimous in their purpose to install the new plant. The question of extensions was originally considered as far back as 1910, and if they were necessary then, when their maximum demand with a plant capacity of 1,010 kw. was only 645 kw., how much more necessary were they now, with the capacity of the station reduced to 630 kw. and a maximum demand last winter of over 700 kw., which, with the increased applications for power received, would be increased to over 1,000 kw. during the coming winter. The number of units for power sold in 1910 was 399,913, but last year it was just short of a million. They were under a very grave obligation to their consumers, particularly large power consumers, and they should take steps to guarantee that the supply of power to their works should be reliable. The capital expended on the works, which was originally over £60,000, had been reduced by the repayment of loans to £30,954. A number of their largest consumers were engaged on Government work. Their present plant was out of date. The only thing they could do was to reduce the cost of generating electricity, and he was sure that by the proposed plant they would be able to reduce it by quite 40 to 50 per cent. If they could only reduce it 40 per cent. he could not see why the undertaking should be a further burden on the rates. He also explained that they had been unable to get additional power from neighbouring authorities.

The tenders were then considered, and several were conditionally accepted, amounting in all to £13,536. It was decided to submit a revised estimate to the L.G. Board, and to ask for sanction to borrow £15,500.

Barnsley.—At a meeting of the Corporation on Tuesday it was reported that the L.G. Board had sanctioned a loan of £15,220 for extensions of the electric generating plant and supply mains.

Darlington.—The L.G. Board have sanctioned a loan of £26,100 for extensions of generating plant, &c.

The Council applied for a loan of £34,050, but the board have struck out an item of £5,000 for extensions of mains. The Electricity Committee report that they are satisfied with the sanction granted, but it is possible that during the next two or three years something will have to be spent out of revenue on extensions of mains, &c.

Ilford.—The Urban Council have been authorised by the Board of Trade to put down electric generating plant at their refuse destructor works.

Leyton.—An unopposed inquiry was recently held into the application of the Urban Council for sanction to borrow £18,158 for the electricity undertaking, £17,158 being for generating plant and £1,000 for service.

Of the last-mentioned sum, the electrical engineer (Mr. F. HARMAN LEWIS) said £500 had been spent, and the £1,000 was required for the supply of small works in the district engaged on Army contracts. If new properties were not wired by their builders at the outset the chances that electricity would subsequently replace gas were rendered somewhat remote, and it was patent that every item of increased business for the electricity undertaking tended to cheapen the cost of the current.

The inspector (Mr. A. W. BRIGHTMORE, D.Sc.) expressed the opinion that the L.G. Board might grant the £500 expended, although he doubted the grant of the other £500 expenditure in prospect.

Mr. LEWIS said, while such a sum would not be a serious item for the country, it would, if it were not granted, prove a serious matter for the undertaking. With regard to the main application, the Council did not press for an early sanction; but, while being in a position to carry on during the war, they wished to forestall the trouble that might arise with the cessation of the war, for while at the moment they had a certain margin due to the decrease of lighting, with the termination of the war and the sudden removal of the embargo on lighting, they would have a very considerable burden thrown upon them.

Sheffield.—Electric supply mains are to be extended at an estimated cost of £570.

Wednesbury.—On Monday the Light and Water Committee reported that the accounts of the electricity undertaking for the year ended March 31 show a loss of £116.

The Committee recommended the purchase of additional plant for the King's Hill sub-station at a cost of £1,580, and also £420 be spent in laying cables. To meet the outlay, the L.G. Board will be asked to sanction a loan of £2,000. The Committee also recommended the expenditure of a further £815 on cables extension at King's Hill.

GENERAL

Belfast.—The troublesome and much-debated question of the reorganisation of the electricity undertaking has been once more before the Corporation.

Last week the Tramways and Electricity Committee reported at length on the proceedings of the Joint Sub-committee appointed to consider the question of the electricity department and its reorganisation. The sub-committee stated that "[illegible] opinion that the reorganisation of the electricity department can only be effected by the chief engineer of the undertaking, and as the present holder of that office, on the committee's instructions, submitted a scheme, which was not adopted by them, the sub-committee have reluctantly come to the conclusion that he should be given an opportunity of testing it, and that the Council should proceed to select a successor."

The minutes of the Joint Sub-committee were rejected by the Tramways and Electricity Committee, and the matter caused considerable discussion at the meeting of the Corporation last week. Ultimately the following resolution by Ald. D. King Kerr was passed by 25 votes to 19: "That all minutes relating to the reorganisation of the electricity undertaking be deleted, and that it be a direction to the committee that the Chief Electrical Engineer is, subject to the supervision of the committee, to have full control in the reorganisation and administration of the electricity department until the Council decide otherwise."

This seems a common-sense decision. The City Electrical Engineer is the proper person to draw up a scheme for the reorganisation of the department under his charge; he must know more about it than the members of the committee controlling the undertaking, and it is to be hoped that the last has been heard of the long drawn-out contest between two factions of a presumably business committee.

Blackburn. The Board of Trade have consented to the use of land at Whitebirk for electricity supply works.

Castlewellan.—An inquiry by the L.G. Board was recently held into the application of the Rural Council for the power of an urban sanitary authority to enable them to carry out an electric lighting scheme for the town.

The proposed contractors for the erection of the electric generating plant are the Irish Towns Light & Power Co., and it is proposed to erect forty 25 c.p. lamps in the streets for the public lighting.

Dartford. The charges for electric current are to be increased, as from Sept. 30, as follows:—

Ordinary lighting consumers, an increase of 1d. per unit; long-hour consumers, ½d. per unit; and power, ½d. per unit. The rates for bulk supply to the West Kent Electric Light Co. cannot be raised without the company's consent, and negotiations are proceeding on the matter.

Ilkley.—The formal inauguration of the electricity supply undertaking of the Urban Council took place on Monday last, when the chairman of the Council (Dr. Bates) set the machinery in motion and switched on electric current to the public lamps.

The generating station is at Little-lane, and the plant comprises a 200 H.P. Diesel engine and two 100 kw. dynamos, with a storage battery. The generating plant is to be duplicated immediately, and orders have already been placed. Four miles of feeder cables and about 15 miles of distributing cables have been already laid, and there are over 50 consumers. The total cost is estimated at £21,000.

Dr. BATES said some thought the scheme should have been held up owing to the war, but, unfortunately for the Council, the undertaking was commenced, and the money spent before the war broke out. He thought the Council had acted wisely in completing the scheme as far as possible, and in a very short time they might reasonably hope to see some return.

The CHAIRMAN of the Electricity Committee (Mr. J. W. Dixon) said he hoped that the time was not far distant when electricity would be extensively used for cooking and other purposes in the district, as well as lighting and power, so that the sheep on the moor, which were at present blackened by smoke, would be known as the "white sheep of Ilkley."

Interest on Local Loans.—The Treasury have directed that on loans granted out of the Local Loans Fund there shall be chargeable, in lieu of the rates fixed in September last, the following rates of interest: Loans secured on local rates, not exceeding 30 years at 4½ and not exceeding 50 years at 4¾ per cent.

Kilburton (Yorks).—The Electrical Distribution of Yorkshire propose to apply for a provisional order to supply electricity in Kirkburton, Lepton, Whitley Ypper, Flockton, Emley, Skelmanthorpe, Clayton West, Denby and Cumberworth. Meetings of the local authorities interested are to be held in order to consider the question.

Londonderry.—A special meeting of the Corporation was recently held to consider tenders for the supply of coal to the electricity department.

Only one tender was received, and that quoted 28s. per ton compared with last year's price of 17s. 6d. per ton, an increase of 70 per cent.

The electrical engineer (Mr. R. N. Macrory) said there were only three weeks' supply, and he did not know whether he could purchase in the open market at less than 28s. per ton. The contractor was required to leave 1,000 tons in stock, but they had only 190 tons now.

A committee was appointed to deal with the matter, and the contractor was called upon to fulfil the terms of his contract.

Lytham. At last week's Council meeting it was stated that the award of the arbitrator appointed to settle differences between Lytham and St. Anne's Councils respecting the supply of electrical energy by St. Anne's to Lytham had been received, and it was resolved to affix the seal of the Council to the agreement.

Marsden.—It was notified to the Urban Council last week that Huddersfield Corporation proposed to apply for a provisional order to enable them to supply electricity to Marsden.

The chairman (Mr. C. Ewen) said the Council were not likely to give away any authority they had in that matter, and if the Corporation sent they would be for all time unable to supply their own district with electric light.

Mr. A. ROBINSON said the suggestion of the Corporation was far worse than the offer made by the Yorkshire Electric Power Co., which was thrown out by the Parliamentary Committee. It was most unfair that they should bind their successors to buy electricity from Huddersfield.

Thereupon the Council decided to refuse consent to the order.

Penistone. The Rural Council have consented to the proposed application of the Electrical Distribution of Yorkshire for a provisional order to supply electricity in the district.

Queensbury. The Rural Council will hold a meeting in September in order to hear the views of Mr. W. B. Woodhouse, of the Yorkshire Electric Power Co., on a proposal to obtain a provisional order for Shelf, Queensbury and Clayton.

Rotherham.—The Electric Light Committee proposes to make special terms and arrangements with large consumers of energy for heating purposes.

The Tramways Committee, having considered tenders for the supply of stores, recommend the Council to enter into no contracts this year for the supply of heavy metal goods, but that the tramway manager purchase them, as well as cable and electricity meters, as required.

Wallsend.—The Council have made an arrangement with Messrs. Stuart & Moore for the installation of a system of street fire alarms.

Waterford.—The L.G. Board have notified the Corporation that their application for sanction to a loan of £30,000 for an electricity supply scheme must, having regard to the present restrictions on borrowing by local authorities, be postponed.

POWER & HEATING NOTES.

Electricity in Docks.—In the sixth annual report of the Port of London Authority it is stated that £111,844 was spent on new works during the past year, including £51,699 on plant and machinery and £3,812 on electrical installations.

Nelson.—The Sewage Commissioners have been authorised to install electric motors for pumping at the sewage works.

Coun. Townsley, chaiman of the Gas Committee, wanted the matter referred back because the Gas Committee had laid a ½ mile of mains to the works and if there were an installation of electricity those mains would have to be scrapped.

Coun. Wainwright, chairman of the Sewage Committee, said after extensive inquiries the Committee had come to the conclusion that it would make for efficiency if electric power were used.

West Bromwich.—The Electricity Committee have agreed to supply electrical energy for power and lighting to Messrs. J. B. & S. Lees by means of overhead cables, provided the firm enter into a five years' agreement.

TRACTION NOTES.

Aberdeen.—On the recommendation of the Tramways Committee the Corporation have decided that one-third of the surplus revenue of the tramways undertaking for the past year (£3,666. 13s. 7d.) shall be applied in giving £2,000 to the common good of the city, and £1,666. 13s. 7d. in defraying cost of recent street improvements.

Dublin.—The directors of the Dublin & Blessington Steam Tramway Co. propose to adopt petrol-electric cars.

The first delivery of cars has been by Messrs. Hurst, Nelson & Co., of Motherwell. The type of car has been designed by Mr. J. P. Tierney, C.E., and is stated to be the first petrol-electric car to be tried in Ireland. The car is lighted electrically both inside and outside, and has seating accommodation for 75 passengers. It can, if required, run over the Dublin United Tramways system, and when on that system will be propelled by two electric motors, taking current from the trolley wire in the usual way.

Euston-Watford Electric Railway.—The L. & N.W. Railway Co. is making an issue of £1,500,000 4½ per cent. preference stock for the completion of the Euston and Watford electric railway, and also for sundry works in connection with Holyhead. The price of issue is 96 per cent., and the stock will be redeemable in 1925.

L.C.C. Tramways.—The recent ballot of the men on the concessions offered to them under the award of the Tramway Conciliation Board has resulted in a majority of 980 in favour of accepting the award, and against leaving Board of Trade arbitrations.

The figures were: For Conciliation Board Award, 2,606; against, 1,626. The award offered a war bonus of 3s. a week to men earning 40s. a week or under. The men claimed a permanent increase of wages of 1s. a day, overtime at rate of time-and-a-half, an extra allowance of 2s. 6d. a day to motormen on trailer cars, and a reduction in the number of hours of labour to eight daily, but these were refused by the Conciliation Board.

TELEGRAPH AND TELEPHONE NOTES.

Radio-Telegraph Notes. The *Electrical World* announces that the radio station at Arlington, Va., is now working, with the new high power station at Darien, Canal Zone, Panama, and that all

U.S.A. Government messages between the capital and the Canal Zone will in future be transmitted between those stations.

The Darien staion has three masts 900 ft. apart, each mast 600 ft. high. The Arlington station has two masts 450 ft. high each and one 600 ft. high. The Darien equipment is of the 100 kw. continuous-oscillation type of apparatus. The station is situated at the edge of Gatun Lake, and the foundations and lower part of the works were constructed before the water was let into the lakes, a good electrical "ground" being thus obtained. Staff quarters for 20 men have been erected near the station, with Lieut. R. S. Crenshaw (under whose supervision the station was built) in charge. The Darien office is working also with the two small stations on the Isthmus, one at Colon and one at Balboa, and when the high-power station now being built at Hawaii is completed Darien will work with that office, Hawaii in turn communicating with the Phillipines.

It is announced, by the way, that Governor-General Goethals, the great engineer who has supervised the construction of the Canal, has resigned.

It is announced that on July 7 wireless telegraph communication was inaugurated between the new station at Funabashi, near Yokohama, and the Hawaiian Islands, a distance of 4,000 miles. Messages by wireless telegraphy between Japan and the United States will be regularly accepted in the near future.

The Federal Government of Brazil have the intention of establishing, under national control, a great network of radiotelegraph stations throughout Brazil. A scheme of the kind was actually approved in February last for establishing 71 wireless stations, including high-power stations at Pará and at Cape St. Martha. At present a financial vote has only been made for some of these stations, but it is announced that an agreement has been arrived at with the Amazon Wireless Telegraph & Telephone Co. for the transfer to the Government of the Company's undertaking in return for £140,000 as compensation. It is further stated that the Marconi parent company are endeavouring to obtain sanction for the establishment of two high-power stations to connect with Europe and North America, one of 300 kw. capacity at Belem do Pará, establishing communication with New York and Buenos Ayres, and with Panama, Madeira, St. Vincent, Dakar and Capetown, via Rio de Janeiro and St. Helena, the station at Rio to be of 150 kw. capacity and to be able to communicate direct with Belem do Pará and Buenos Ayres. According to information obtainable, there were 17 stations in operation in Brazil in 1913, including Telefunken stations at Bahia, Rio de Janeiro (Babylima), Rio Grande do Sul, Santos and Cabo São Thome, and four stations in the Acré territory, while Marconi stations established at Porto Velho and Manaos, belonging to and operated by the Madieré Mamoré Railway Co., are stated to have been working commercially since 1910. At Florianopolis the Poulsen system has been used, and at Olinda, Noroñha, the Rochfort system. The Schumacher stations at Pará, Santarem and Manaos are now under Brazilian Government supervision. It is further stated that a wireless service is being conducted between the Falkland Islands and Rio Grande do Sul, but whether communication can be maintained all the year round is waiting to be proved.

EMPIRE NOTES.

Australasia.—The "Australian Mining Standard" says Castlemaine (Victoria) Council has accepted provisionally the tender of Mr. G. W. [illegible] to supply electric energy for 10 years.

The South Australian Railways Commissioner recently applied to the Wallaroo and Moonta Mining and Smelting Co. to supply electric current [illegible] The company agreed to [illegible] per unit.

Acting on the advice of Mr. V. J. Crowley, the Shire Council of Korumburra [illegible] £1,200 for extension of and additions to the municipal electric lighting plant.

Footscray (V.) City Council has authorised its Electric Light Committee [illegible] Council [illegible] Werribee [illegible] Queenscliffe estates.

[illegible]

The Commonwealth Government propose putting in a complete power station plant and equipment at the naval dockyard, Cockatoo Island, Sydney. About 180 machine tools of various types are also to be installed.

The Works Committee of Sydney (N.S.W.) Council propose to invite tenders for electric motor lorries for the city surveyor's department.

Canada.—It is reported that the Ontario hydro-electric system has made considerable progress during the present year.

The Provisional Commission within the past two months has made contracts with 17 additional municipalities, while at the present time votes on hydro-electric by-laws are pending in 14 others. The Commission is now operating 2,200 miles of transmission lines outside of the municipalities and their local distributing systems, and 200 miles are under construction. Electric current is supplied to the towns and municipalities for tramways and for street lighting. It is supplied to manufacturers for power and to householders for ordinary household purposes. Farmers are using electric power in an increasing manner for farm and household purposes; thrashing machines are now driven by electric motors and barns and stables are lit electrically.

Japanese Trade with Australia.—In a recent report by H.M. Trade Commissioner for Australia (Mr. G. T. Milne) refers to the activity of Japanese traders in the Commonwealth, and states that efforts are being made to capture the trade in electrical fittings and appliances (glassware, insulators, &c.), formerly to a large extent controlled by Germany. The Yokohama Specie Bank is about to open a branch at Sydney, and Mr. Milne expresses a fear that, owing to the pre-occupation of many United Kingdom firms with contracts arising out of the war, much of the trade formerly done with enemy countries will be diverted to the United States, Japan, Sweden and other countries not directly involved in the struggle.

MISCELLANEOUS NOTES.

Empire Business Fair.—It is proposed to organise a business exhibition for the spring of 1917, which will comprise every British industry.

It is stated that a site of nearly 50 acres has been chosen at Willesden Green and a special station is to be built on the Metropolitan Railway, to which trains will run from Baker-street in seven minutes. There will be sections for machinery, power, heating and lighting; china, pottery and glass; chemist and druggist, surgical and photography; hardware, &c. The exhibition building is to be called the Palace of Industry, and the plans provide for a winter garden of 1 acre. The chief organiser (Mr. Wm. Glass) states that it is to be a British Empire equivalent of the famous Leipzig Fair, and it will not be open to the public, admission being confined to traders by invitation. The management (through an advisory council) will be in the hands of the trade associations and societies of the country. Fixed charges will be made for space, and any surplus over expenses will be returned to the exhibitors.

Holiday Resorts.—The Great Central Railway Company have just issued their new A.B.C. Guide to Health and Holiday Resorts.

Within an attractive cover is included a description of the various resorts, and interesting information is given regarding climatic advantages, bathing facilities, sports and entertainments, also a list of hotels, boarding houses and country lodgings, schools, &c. The book has been entirely re-written, is well illustrated, and anyone contemplating a short or long holiday, either at the seaside or in the country, cannot do better than obtain a copy, which will be sent free on application to the Great Central Publicity Department, 216, Marylebone-road, London, N.W.

Inquest. An inquest was held last week on Andrew T. Crook, a colliery chargeman at Redheugh Colliery, Gateshead.

Evidence was given that at about 12.30 a.m. Crook went to stop the electric pump, and subsequently he was found lying on his side near the pump and apparently dead. The current was switched off, and after artificial respiration had been tried deceased was taken home.

EDWARD WATSON, electrician at the Redheugh Colliery, said deceased was lying on the ground alongside the switch to the main cable. The starting switch was 6 ft. away in a direct line, and the current was at 300 volts. 6 in. of the main cable had the insulating covering torn off. The cable was rubber covered with tape wound round diagonally and cotton braiding. He found a piece of the cable tape lying between the switches, and on a further examination he discovered that three of the cables were tied together by a piece of rope. He had examined the switches and the cables on July 26, and found everything all right. The tape was quite unnecessary, and he could not explain how it came to be beside the cable.

The jury returned a verdict that "deceased had been found electrocuted, but there was no evidence to show how he had come into contact with the current."

London Electricians' Wages. Sir D. Harrel recently sat as arbitrator on the appeal from Leicester in advance of rates of 11d. per hour made by the Electrical Trades Union on behalf of their London members. The proceedings were private, but it is expected that the award will be issued shortly.

Municipal Employees and Military Service.—At the meeting of Halifax Corporation last week the Finance Committee recommended

that, in view of the large number of employees of the Corporation who had joined His Majesty's forces, no officer or servant of the Corporation who joined such force after that date should, notwithstanding the resolution passed by the Council in Oct., 1914, have the benefits referred to in such resolution, unless such officer or servant should have first obtained the consent to join of the chairman and the chief official of the Corporation in the department in which he is engaged.

Several members of the Council said the resolution would discourage recruiting, and they opposed it.

Ald. SPENCER, chairman of the Tramways Committee, said men would be released for military service wherever possible, but in some departments of the Corporation it was necessary that work should be fully maintained. A number of firms in the town employed on munition work were dependent upon the Corporation electricity works, and it was necessary that those works should be kept fully employed. A larger percentage of men from the tramways department had joined the forces than from any other department of the Corporation. Halifax, with its gradients, was a difficult town to work with tramways, and it was necessary that the drivers of the cars should be thoroughly skilled and experienced men. The places of those men could not be filled at a moment's notice, and difficulty would be experienced if vacancies occurred. There was a shortage of conductors, and women conductors might yet have to be resorted to, though the necessity for appointing them had not arisen.

After considerable discussion, the resolution was deleted from the minutes.

Patent Development.—The proprietors of patent No. 20,357 of 1912, for "Improvements in or relating to electrical connections," and the proprietors of patent No. 24,343 of 1912 for "Improvements in or relating to brushes or collectors for electrical machines," desire to make arrangements for exploiting the patents in this country. Communications to Messrs. Haseltine, Lake & Co., patent agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

Smoke Nuisance.—Last week the Burnley Paper Works Co. were summoned for having failed to comply with an order to abate a smoke nuisance.

It was explained that part of the company's plant was driven electrically, that the company was paying £300 a year for electricity, and but for the war it would have had a complete electrical installation, which would have resulted in spending £700 a year on current; but it would have obviated the nuisance.

The CHAIRMAN of the Bench said they knew the difficulties, and they hoped the company would install new machinery as soon as they could. They were merely ordered to pay costs.

TENDERS INVITED.

Enamelled Electric Conduit and Fittings.

The COMMISSIONERS of H.M. WORKS, &c., are prepared to receive tenders for the supply of Enamelled Electric Conduit and Fittings. Forms of tender, &c., from the Controller of Supplies, 18, Queen Anne's-gate, S.W., and tenders (by 11 a.m. Aug. 20) to the Secretary, H.M. Office of Works, &c., Storey's-gate, London, S.W. *See also an advertisement.*

Telegraph Material.

The Postmaster-General's department of the Commonwealth of Australia invites tenders (until Sept. 23) for the supply of Condensers, Galvanometers, Relays and Sundries, and for Incandescent Electric Lamps, and (until Oct. 6) for the supply of Poles (iron or steel) and Fittings. Tender forms, &c., from the Commonwealth offices, 72, Victoria-street, S.W. *See also an advertisement.*

Turbo-Alternators, Dynamo, Battery, Wiring, &c.

BRISTOL Corporation Electrical Committee invite tenders for a 6,000 kw. Three-phase Steam Turbo-alternator, with Condensing Plant. Specifications and forms of tender from the chief engineer and general manager, Mr. H. Faraday Proctor, to whom tenders by noon Monday, Aug. 23.

JOHANNESBURG Municipal Council invite tenders by Sept. 25 for supply and erection of two 3,000-kw. Turbo-alternators, Condensing Plant, Switchgear, &c. Specifications from the Controller of Stores, and tenders to the Town Clerk, Municipal Offices, Johannesburg. Copies of specifications may be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

EARBY Urban Council require tenders by noon Aug. 16 for supply of a Dynamo, Battery, Wiring, &c., at their sewage disposal works. Specifications, &c., from the Engineer, Council Offices, Earby.

Wiring and Fittings.

Tenders are required by 10 a.m. Aug. 17 for Wiring Two Villas at HULL City Asylum. Specifications from City Architect.

BRISTOL Docks Committee invite tenders for the Electric Lighting of the Base Supply Sheds, Avonmouth. Tenders to [illegible] inst.) for Wiring Pentonville-road Elementary School (74 [illegible]

Storage Battery Repairs.

[illegible] lators at DEVONSHIRE County Asylum. Particulars from E. H. [illegible]

Motors, Pump and Motor.

SYDNEY (N.S.W.) Council require tenders by Sept. 13 for [illegible] Specification from the City Electrical Engineer.

The Metropolitan Board of Water Supply and Sewerage, Sydney, N.S.W., want tenders by 2 p.m. Sept. 6 for Centrifugal Pump and Electric Motor for Richmond pumping station. Specification, &c., from 341, Pitt-street, Sydney.

Telephone and Telegraph Material, Wire, Instruments, &c.

The Deputy Postmaster-General, Perth (W. Australia), requires tenders by Aug. 25 for supply of c.b. Telephones—to specifications 431 and 409 (320); and by Sept. 29 for Telephone Switchboards and Parts (schedule 479). Specifications, from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are required by Aug. 25, for the supply of Sal-ammoniac (Specification 305), and Steel Galvanised Wire (Specification 414), and by 2 p.m. Sept. 1 for Condensers, Resistance Testing Sets, Relays, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Melbourne, invite tenders until 3 p.m. Aug. 24 for Telephone Instruments (schedule 1218), and until 3 p.m. Aug. 31 for Switchboard parts (schedule 1239) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specifications, from the Deputy Postmaster-General.

The Deputy Postmaster-General, Perth (W. Australia), invite tenders until 3 p.m. Aug. 25 for 320 c.b. Telephones for the Australian Commonwealth Postmaster-General's Dept. Specifications, &c., from the Deputy Postmaster-General.

Traction Lamps, &c.

JOHANNESBURG Council require tenders by noon Aug. 25 for 8,600 Drawn-wire Spiral Filament Traction Lamps; and spare parts for tramcars. Specifications, &c., from the Municipal Offices, Johannesburg.

Electric Lighting Plant.

Tenders will be received by the Municipal Authorities of CULLERA (Spain) until Aug. 23 for the installation of Electric Lighting Plant. The "Gaceta" de Madrid, of July 24, giving particulars, may be seen at 73, Basinghall-street, E.C.

Electric Cranes, &c.

Tenders are invited (until noon Sept. 6) by the Dirección General de Obras Publicas, Ministerio de Fomento, Madrid, for various work at the Port of MELILLA (Spain), including supply of Electric Cranes, Rails, &c. The "Gaceta," of July 25, containing particulars, may be seen at 73, Basinghall-street, E.C.

TENDERS RECEIVED AND ACCEPTED.

[illegible] Council passed an order with [illegible]

[illegible] Electrical Engineer, has accepted the tender of [illegible] for the supply of [illegible] under formation.

[illegible] Council has accepted the tender of H. F. [illegible] for the supply of [illegible] for electric lighting plant at Park Pavement Asylum.

WOLVERHAMPTON.—The Chloride Electrical Storage Co.'s tender [illegible] of electric [illegible]

ERITH.—The Council have placed an order with Babcock & Wilcox for a water-tube boiler, &c., at £5,054, subject to the consent of the L.G. Board to a loan.

ROTHERHAM.—The Electric Light and Tramways Committee has accepted the tender of Chadwick & Co. (at £1,854) for extensions of the boiler house, and that of the Anglo-American Oil Co. for the supply of petrol at 1s. 0½d. per net gallon.

REDDITCH.—The Council received the following tenders for the supply of a high-tension three-phase switchboard :—

Bertram Thomas	£1,875	Ferguson, Pailin & Co.	£2,240
Electric Construction Co.	1,893	Johnson & Phillips	2,274
British Westinghouse Co.	1,999	Edison & Swan United Electric Light Co.	2,298
General Electric Co.	2,090	Park Royal Engineering Works	2,400
Switchgear & Cowans	2,194		
British Thomson-Houston Co.	2,224		

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bootle.—The total revenue of the electricity department for the year ended March 31 was £29,494, including £10,128 from private lighting, £11,185 for power, £6,564 from tramways and £1,573 from public lighting.

Total expenditure was £16,006 and gross profit £13,489. After providing for interest, sinking fund, &c., and transferring £1,500 to district rate fund, £1,513. 19s. 4d. was carried to reserve. The gross capital expenditure was £182,883, of which £59,907 has been repaid.

In the report of the engineer and manager (Mr. T. D. Clothier) it is stated that the generating cost at Marsh-lane station was 0·44d. per unit, the total inclusive cost was 1·23d. per unit, and average price received 1·37d. per unit were lowest on record. A sub-station and converting machinery have been provided at Pacific-road, and the converting machinery at Messrs. Harland & Wolff's has been increased. At Marsh-lane station extensions will soon be required to meet the rapidly-increasing demand and to replace the Pine-grove works.

Heston and Isleworth.—For the year ended March 31 the total income of the electricity undertaking was £10,494, increase of £238 over 1913-14.

The working expenses were £5,453 (increase £484), leaving a gross profit of £5,041. After paying interest and loan charges (£4,651), the net surplus was £390. By debiting revenue account with balance of £1,549, cost of consumers' "free wiring," this surplus is converted into a deficit of £1,190. Early in the year it was decided to place all "free wired" consumers on the same terms as ordinary consumers, and to discontinue carrying out repairs to all "free wired" installations. The expenditure on these installations was provided by the Council several years ago, and has appeared under "Contribution from district fund account," so that the introduction of the item in the expenditure account for the current year is practically only a question of book-keeping adjustment, rendered necessary by the abolition of an "asset" against which it could formerly be placed. 1,509,227 units were generated during the year, against 1,407,351 in previous year, an increase of over 100,000 units.

Kingston-on-Thames.—At March 31 the outstanding capital expended on the electricity supply undertaking was £75,351, against £77,846 in 1914.

The total income of the past year was £15,273 (against £15,416), and total expenditure (including special war charges) £8,588 (1·773d. per unit sold), against £8,785 (1·697d. per unit); and after paying interest and providing for repayment of principal and contributions to sinking fund (£7,980, against £7,353 in 1914) there was a net deficit of £1,296 on the year's working. There are 1,789 ordinary and 191 prepayment consumers, the number of new consumers being 135, and the total connections (lamps, motors, heating and cooking apparatus) equivalent to 79,477 32-watt lamps. The units sold were 1,162,001 (against 1,242,042).

The report of the borough electrical engineer (Mr. J. E. Edgcome) states that the result of the working of the undertaking has been prejudicially affected by the war, as instead of the natural annual increase in revenue which occurs in normal times, the compulsory shutting down of all outside shop lighting and of the bulk of the shop window lighting, has resulted in the sale of current being less than for the previous year. There was a decrease in revenue from sale of current of £169, against an increase of £630. 11s. 7d. in 1913-14.) There were also increases of expenditure amounting to £1,072, including £132. 19s. 9d. special expenditure due to the war, £312 6s. 10d. for income tax, £162 for interest on loans, and £465 for repayment of principal. The two horizontal Diesel oil engines installed have been running throughout the year and have given every satisfaction. The steam plant generated 306,200 units, at a cost of £2,299. 18s. 8d. (1·802d. per unit), and the oil plant 855,801 units, at £1,512. 10s. 9d. (0·424d. per unit). The steam plant runs under unfavourable conditions, as it is required for the peak load, but the oil plant [illegible] load during the day and during the night. It is [illegible] that a very considerable saving [illegible] and that the steam plant were entirely [illegible] installed, provision being made for installing yet a third set when the load [illegible]

Wimbledon.—At March 31 the total debt of the electric supply department (after deducting sinking funds) was £166,103. 6s. 8d.

Last year's revenue was £38,668 (including £33,004 from private supply and £5,214 for public lighting), and total expenditure £19,060 (1·282d. per unit, against 1·250d.), leaving gross profit £19,608. After meeting interest and sinking fund, &c. (£17,424), the net profit was £2,184. The total revenue from the Maldens and Coombe supply was £1,862, and the capital expended is £13,044. Units generated were 4,666,801 (against 4,440,400); sold for public lighting 465,310 (537,396), for private lighting 1,734,525 (1,692,432), and for power and heat 1,369,382 (1,137,689); average price obtained 2·557d. (2·641d.), total cost 2·454d. (2·419d.). The total lamps, motors, radiators, &c., connected are equal to 9,850 kw. (8,681), and the total consumers are 7,041 (4,396 in Wimbledon, 1,125 in Merton and 365 in Malden and Coombe, and 1,155 consumers supplied on the fixed price light system). The maximum supply demanded was 2,120 kw. (2,197 kw.).

Wolverhampton.—The accounts of the electric supply department for the year ended March 31 have been issued.

The total receipts were £57,975 (against £56,113 in 1913-14) and expenditure was £30,658 (£29,833), leaving £27,067 (£26,030). After paying interest (£7,926), contributions to redemption and sinking funds (£11,967), income tax, &c., the net profit was £7,444 (£8,677).

The report of the Electricity Committee states that, considering the conditions of war which existed during more than half of the year, there is reason to consider the accounts most satisfactory. Of the expenditure items interest on capital and contributions to redemption and sinking fund increased owing to extensions at the works. The number of units sold were 13,126,271 (13,013,914), an increase of 112,357. The total costs were 0·551d. per unit (0·547d.) and average price 2·28d. per unit sold (2.69d.) During the year the equivalent of 50,171 32-watt lamps were connected to the mains, including 981 H.P. additional motors, the total horse-power of motors now connected being 9,745. In connection with heating and cooking apparatus absorbing over 980 H.P. was connected. The units generated at the destructor works amounted to 1,287,690, representing a revenue to the team department of £1,073, compared with 1,472,530 units and £1,227. 2s. 1d. in 1913-14. Of the net profit £2,215 has been transferred to relief of rates and £5,229 has been transferred to reserve. The balance in the reserve fund has been decreased to £17,806, due mainly to expenditure of a capital nature met out of that fund during the year. The Committee place on record their high appreciation of the manner in which the electrical engineer (Mr. S. T. Allen) and his staff have carried out their duties, and they congratulate the engineer on the materially increased output during the past year.

COMPANIES' MEETINGS AND REPORTS.

DEUTSCH-ATLANTISCHE TELEGRAPHEN-GESELLSCHAFT (A.G.)—At the recent meeting a dividend of 6½ per cent was declared for the year, against 7½ per cent. in 1913. The receipts were 3,847,966 M. (£192,398), against 5,376,350 M. (£268,817), and the net profit 1,400,251 M. (£70,012), against 2,931,473 M. (£146,573). On Aug. 5, 1914, both the Emden-Fayal (Azores) and Emden-Vigo were cut by the English naval forces.

DEUTSCH-NIEDERLANDISCHE TELEGRAPHEN GESELLSCHAFT.—The report for 1914 states that a dividend of 6½ per cent. has been declared, as in 1913. On Aug. 3, 1914, the administration of the Menado station was undertaken by the Netherland India Government, and on Oct. 7, 1914, when the Japanese naval forces took possession of Yap, the German staff of the station were transferred to Nagasaki, but they were subsequently released and allowed to go to Shanghai. A German superintendent, together with a Dutch telegraphist, remain at Yap. The cable is reported to be in good condition. The receipts were 2,164,150 M. (£108,207), against 2,173,153 M. (£108,657), and the net profit 614,744 M. (£30,737), against 56,1825 M. (£28,0941).

DEUTSCH-SUDAMERIKANISCHE TELEGRAPHEN-GESELLSCHAFT (A.G.)—A dividend of 6 per cent. has been declared for 1914, against 6½ per cent. in 1913. The report states that on Aug. 5, 1914, the English Navy cut the Borkum–Teneriffe cable, and the Lome station was seized two days later. On Aug. 21 the cable between Teneriffe and Monrovia was also cut, and the wireless station at the latter place was closed on Oct. 1 by the Liberian Government. The staff at Duala station were brought to

England, but the superintendent in Lome died in a French prison at Dahomey. There was a small loss on the year's working of the Cia Telegrafico-Telefonico del Plata, which was acquired by the company. The total receipts of the Deutsch-Südamerikanische Co. were 4,257,556 M. (£212,877) against 4,257,217 M. (£212,860), and the net profit was 3,142,217 M. (£157,210), against 3,134,088 M. (£157,704).

TYNESIDE TRAMWAYS & TRAMROADS CO.—At the meeting on Tuesday the directors reported that for the past half-year the divisable balance was £5,131, and a dividend of 3 per cent. was recommended on the ordinary shares, carrying forward £991.

The chairman (Dr. J. T. Merz) said the revenue had been £400 less than the corresponding half-year, and the profit had been almost exactly the same as last half-year. They had been obliged to run fewer cars owing to the reduced staff. The receipts per car-mile had gone up from 10·48d. to 11·06d., and the expenses had gone up from 6·58d. to 7·15d. Their men had been very loyal and worked a considerable amount of overtime. Their reserve fund was £20,666. The traffic receipts were still going up. The report and accounts were then adopted.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The report for 1914 states that the profit was £555,694, which, with £105,199 brought forward, makes £660,893. After providing for interest on debentures (£234,842) and for depreciation, income-tax, &c. (£159,603), the balance is £266,447. The directors declared a dividend in December last at rate of 6 per cent. per annum for the six months ended June 30, 1913, on the preference shares, and a further dividend on the preference shares at rate of 6 per cent. per annum for the 10 months ended April 30, 1914, was declared on June 10, 1915. These dividends absorbed £160,000, leaving £106,447 to be carried forward. Since the last report three 10,000 H.P. compressors have been brought into commission, together with the necessary boiler plant, &c., and considerable extensions to the air pipe system of the Rand Mines Power Supply Co. have been made and put to work. At the Brakpan power station 33,500 H.P. of electrical plant has been added and half of this is now in commission. The combined companies have now an ample reserve of air and electrical plant installed at their several stations.

WESTERN UNION TELEGRAPH CO.—The report for the half-year to June 30 states that the income was $24,019,260; expenses (including maintenance and reserves) were $19,359,745, interest on bonds $668,600; net income $3,990,915, increase of $1,891,080 over the corresponding period of last year.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ACCUMULATORS (LTD.) (141,197)—Reg. Aug. 6, capital £100 in £1 shares, to carry on any business bearing on the application or employment of electricity, electrical batteries and accumulators and the business of engineers, machinists, &c. Private company. Reg. office: Maybury Hill, Woking.

BERGIUS LAUNCH & ENGINE CO. (LTD.) (9,447)—Reg. in Edinburgh on July 31, capital £75,000 in £1 shares, to carry on the business of manufacturers of and dealers in motor launches and other sea, land and air craft, mechanical engineers, electric light, heat and power suppliers, &c. Private company. First directors are W. M. Bergius, D. W. Willocks and W. Gillies. Reg. office: 254, Dobbies Loan, Glasgow.

IRISH HYDRO-ELECTRIC SYND. (LTD.) (141,203)—Reg. Aug. 6 capital £10,500 in 10,000 ordinary shares of £1 each and 10,000 shares of 1s. each, to acquire water and other power and rights and concessions in respect of the use of waterfalls, rivers and waterways for generating electrical energy, to carry on the business of suppliers of power by water and electricity, &c. Private company.

MEDCALFE & CO. (LTD.) (141,192)—Reg. Aug. 5, capital £1,000 in £1 shares, to take over the business of mechanical and electrical engineers, chemical manufacturers, &c., carried on as Medcalfe & Co. Private company. First directors are J. E. Medcalfe and S. J. Medcalfe. Reg. office: 26-8, Audrey House, Ely-place, E.C.

SNYDER ELECTRIC FURNACE CO. (LTD.) (141,210)—Reg. Aug. 6, capital £1,000 in £1 shares, to acquire and turn to account any inventions relating to the manufacture of iron, steel, metals and chemicals of all kinds, to carry on the business of electrical, mechanical and general engineers, &c. Private company. First directors are G. J. Stock, C. J. H. Stock, G. H. Watson and F. T. Snyder.

MORTGAGES AND CHARGES.

COLLEY'S PATENTS (LTD.)—Particulars of £6,000 debentures, created by resolutions of Jan. 2, 1906, March 14, 1907 and July 8, 1915, have been filed, amount of present issue being £3,000. Property charged: Company's undertaking and property, present and future. No trustees.

SIMMONDS BROS. (LTD.)—Charge (supplemental to various agreements) on moneys payable under Army contract dated July 22, 1915, to secure all moneys due or to become due from company to Parr's Bank.

RECEIVERSHIPS.

SPAGNOLETTI (LTD.)—A. G. Morrish, 34 and 36, Gresham-street, E.C., ceased to act as receiver on June 29, 1915.

W. PARSONS & CO. (LTD.)—Notice of appointment of A. J. Mason, of Wolverhampton-street, Dudley, as receiver and manager by order of Court dated July 31, 1915, has been filed.

CITY NOTES.

MEMORANDA (Aug. 11).—Bank rate 5 per cent. (since Aug. 8, 1914.) Consols 65. Consols Pay Day Sept. 1. Stocks and Shares Ticket Day Aug. 26. Pay Day Aug. 27. Price of silver, 22 7/8d.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CORPN. (LTD.)—The directors announce interim dividends for the half-year ended June 30 as follows: On ordinary shares at rate of 9 per cent. and on preference shares at rate of 7 per cent. per annum (less tax).

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold to consumers during the four weeks ended June 25 amounted to 1,873,676, compared with 1,437,436 units in the corresponding four weeks of 1914.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The directors announce an interim dividend at rate of 4 per cent. per annum (less tax) on the ordinary shares for the past half-year, payable 15th prox.

LAND UND SEEKABELWERKE (A.G.)—For 1914 a dividend of 10 per cent. has been declared, against 11 per cent. in the previous year.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—The directors have declared an interim dividend at rate of 5 per cent. per annum (6d. per share) on the ordinary shares for the past half-year.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—The directors have declared an interim dividend of 5 per cent. per annum on the ordinary shares for the past half-year.

PUEBLA TRAMWAY, LIGHT & POWER CO.—At a recent meeting of the holders of the first mortgage 30-year 5 per cent. gold bonds a resolution was passed sanctioning the modification of the rights of the bondholders. The interest on the bonds during five years from Jan. 1, 1915, will only be payable if there are any earnings available, and the sinking fund has also been suspended.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—Major-Gen. Sir Percy Girouard has been re-elected a director, and Col. A. G. Haddock and Lord Sydenham have been elected directors, of this company.

TELEPHONE DEVELOPMENT CO. (LTD.)—The accounts for year ended June 30 show a credit balance of £10,458, which it is proposed to carry forward.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Aug. 11. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Wed. Aug. 11.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9 3/8	7 2 8	Mar, Sept
10	4 1/2%	Do. 4½% Cum. Pref.	9 1/2	4 15 3	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	10 1/8	5 19 3	Feb Aug
5	10%	Brompton & Kensington Ord.	8 3/4	6 0 2	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	90 1/4	4 8 5	..
St.	4%	Charing Cross West End & City Debs...	83 1/2	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	4 1/8	5 10 10	..
5	5%	Do. Ord.	4	6 5 0	Aug, Feb
10	9%	City of London Elec. Lt. Ord.	12 3/8	7 0 0	Feb, Aug
10	6/0	Do. 6% Pref.	12 1/2	4 17 0	Mar, Jly
St.	6%	Do. 5% Deb. St.	110	4 10 11	Jun, Dec
10	7%	County of London Ord.	10 1/4	6 10 2	Mar. Sept
10	6%	Do. 6% Pref.	10 3/4	5 13 3	Feb, Aug
St.	4 1/2%	Do. 2nd Deb.	97	4 12 9	My. Nov
St.	4 1/2%	Edmundson's Elec. Supp. 4½% Debs...	77	5 16 8	July
5	9%	Kensington and Knightsbridge Ord. ..	7 1/2	6 4 2	Feb, Aug
St.	4%	Do. Deb. St.	86 1/2	4 13 0	Jan, Jly
St.	3/0	London Elec. Supply 6% Pref.	5 1/2	5 13 1	..
St.	4%	Do. 4% Mort. Debs.	86 1/2	4 11 11	Jan, Jly
5	3 1/2%	Metropolitan E. Supp. Ord.	2 1/2	6 7 6	Mar, Aug
St.	4 1/2%	Do. 1st Mort. Deb.	95 1/2	4 14 0	Jan, Jly
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, Jly
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs ..	98 1/2	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S.5%2dMt.Db.St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/8	5 11 7	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs. ..	95	5 5 3	Jan, Jly.
St.	4 1/2%	Urban Elec. Supp 4½% Db. St.	85 1/2	5 5 7	Apl, Oct
1	5%	Waste Heat & Gas Elec. Gen. Stations.	1 1/4	7 2 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	7 3/4 †	6 7 5	Mar, Sept
5	4 1/2%	Do. 4½% Cum. Pref.	5	5 12 6	Jan, Jly
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	7 3/4	6 6 5	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	8 1/4	8 16 6	Feb, Aug
St.	4%	Central London Guar. Assented Ord. ..	7 3/4	5 8 11	..
St.	4%	Do. do. Assented Def. Ord. ..	7 1/4	5 4 3	..
St.	4%	Do. 4% Pref.	10	4 19 0	Jan, Jly
St.	4%	Do. 4% Deb. St.	93	4 9 9	Jan, Jly
St.	4%	City & S. London Deb.	91	4 15 3	May. Nov
St.	4%	Do. Pref. Ord.	80†	6 5 0	Feb, Aug
St.	5%	Lancashire Tramways	7 1/2	9 17 6	Feb, Aug
10	1%	London Electric Ry. Ord.	1 3/4	6 13 4	Jan, July
St.	4%	Do. 4% Pref.	62 3/4	6 7 3	Mar. Sept.
St.	4%	Do. 4% Deb.	85	4 14 1	Jan, Jly.
St.	1%	Metropolitan Ry. Con. Ord.	23 3/4	4 3 11	Feb, Aug
St.	3 1/2%	Do. 3½% Pref.	7 1/4	4 19 6	Feb, Aug
St.	3%	Do. 3% Consolidated Pref.	74 1/2	4 14 3	Feb, Aug
St.	3%	Do. 3% A Pref.	82 1/2†	4 4 6	Jan, July
St.	3 1/2%	Do. 3½% Deb.	93 1/2	4 4 1	Jan, July
St.	..	Metropolitan District Ry. Ord.	13	..	Feb, Aug
St.	4%	Do. 4% Perp. Deb.	92	4 7 0	May. Nov

†Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name.	Price, Wed., Aug. 11.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*	£ s. d.		
St.	4½%	Metropolitan Elec. Tr. 4½% First Pref.	69½	6 9 4	Feb, Aug
··	6%	Do. 6% Perm. Deb.	124½	4 12 8	Jan, July
··	4%	Do. 4% Deb.	88½	4 10 6	Jan, July
··	4%	Do. 4% Debs. (1903-5)	87½	4 11 7	Jan, July
St.	4%	Do. 4% Guar. Stock	90½	5 6 0	Mar, Sept
10	..	Underground E. R. of London Shares	11½	.. ..	..
1/0	..	Do. A Ord.	..	.. ..	..
St.	6%	Do. 6% Deb.	135	5 14 3	Mar, Sept
··	6%	Do. 6% Inc. Bon. with coup.	111	8 2 0	Mar, Sept
··	4½%	Do. 4½ Bds.	98	4 12 0	Jan, July
··	..	Yorkshire W. Riding Ord.	..	.. ..	March
1	6%	Do. Pref.	4½	7 1 8	Jan, Jly
		Electric Manufacturing, &c.			
1	1 9	Batterse & Wilson Ord.	2½	6 6 0	Apl, Oct
1	1 0	Brit. Aluminium Ord.	1½	5 5 3	Mar
100	1 0	Do. Prior Lien Debs.	93	5 5 0	Jan, July.
1	1 0	Do. 6% Pref.	17⅞	6 12 5	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	11½	6 14 10	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	6	4 15 5	Jan, July
1	0 0	British L.M. Ericsson Mfg. Cm. 6% Pref.	4	6 0 4	Mar, Sep
2	7½	Brit. Westinghouse Pref.	18	9 4 7	April
100	6 0	Do. 6% Prior Lien Debs.	100½	5 19 6	Apl, Oct
St.	4 0	Do. 4% Mort. Deb. St.	79	5 0 4	Jan, July
1	15 0	Callender's Cable, &c., Co. Ord.	15½	6 16 4	Jan, July
5	2 0	Do. 5% Pref.	5	5 0 0	Feb, Aug
1	15%	Clutton Keiller	3½	4 16 2	May, Nov
1	6%	Do. Kerr & Co. 6% Pref.	7	7 13 7	Sept
5	..	Edison & Swan U.E.C. Lt. A. £3 pd.	..	.. ..	Feb, Aug
1	6%	Elec. Construction Ord.	9	5 6 11	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs.	69½	5 15 4	Jan, July
10	6%	General Electric 6% Pref.	12½	6 5 6	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	11	7 3 0	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4½	5 0 3	..
St.	4½%	Do. 4½% Db.	98	4 11 10	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	8½	5 17 8	Feb, Aug
10	5%	Do. Pref.	8⅝	5 16 6	Apl, Oct
100	4%	Do. Debs.	98	4 1 8	Apl, Oct
12	20/0	Liverpool Con. & Main. Co.	31	7 14 10	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1½	4 10 4	May, Aug
1	6%	Do. 5% Pref.	⅞	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	89½	5 0 0	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	100	4 10 0	Jun, Dec
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	9½	6 3 2	Feb, My, Aug, N
St.	1½%	Do. Def. Ord.	2½	7 0 0	Feb, My, Aug, N
St.	4%	Commercial Cable 4% Debs.	72½	5 10 4	Ja, Ap, Jly, O
10	5%	Cuba Submarine Ord.	8½	5 13 6	May, Nov.
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5 0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	9½	5 16 10	Ja, Ap, Jly, O
St.	25/0	Eastern Tel. Co. Ord.	11½	6 0 0	Ja, My, Jly, O
St.	17/6	Do. 3½% Pref.	70½	5 1 0	Ja, My, Jly, O
St.	4%	Commercial Cable 4% Debs.	81	4 18 1	May, Nov
St.	4%	Eastern Extension Tel. Co. 4% Debs.	75½	5 1 9	Feb, Aug
10	7%	Do. Ord.	11½	5 15 2	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. with Coup. 8	33	6 13 4	Ja, My, Jly
25	13%	Indo-European	5½	6 0 4	May, Nov
1	1	Marconi's Wireless Tel. Co.	2	5 0 0	April
··	..	Do. 7% Pref.	1½	3 17 0	July
10	2½	West India & Panama Ord.	1½	8 17 9	May, Nov
10	6%	Do. 1st Pref.	8½	7 1 2	May, Nov
St.	3/0	Western Telegh. Co.	11½	6 1 9	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	83	4 16 5	Jun, Dec
··	4½%	Western Union 50 yr. Bds.	96	4 14 9	May, Nov.
		Telephones.			
··	£2	American Telephn. & Telgh. $100 Cap.	125½	6 7 10	Ja, Ap, Jn, O
··	5%	Canada Telephn. Co. 5% Bds.	77½	6 9 0	Jan, Jly
1	7½	Mexico Telephone Co.	1½	6 12 5	Jan, Jly
··	4½%	Mexico Telephone 4½% Bds.	97½	4 12 3	May, Nov
1	10%	Oriental Telephone Ord.	1½	7 1 6	Apl, Oct
St.	4%	Do. Deb. St.	86½	4 12 6	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St.	80	5 12 3	Jan, July
5	8%	United River Plate Ord.	5½	7 5 4	Apl, Oct
5	..	Do. 5% Cum. Pref.	4½	5 11 3	Jan, July
St.	..	Do. Deb. St.	97	5 9 0	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust.	12½	6 0 11	Sp, Dc, Mr, Jn
10	..	Do. 5% Bds.	10	5 0 0	Sp, Dc, Mr, Jn
1	..	Mexican Telegraph Concessions	1½	6 18 9	Ja, Apl, Jly, O
··	..	Do. 5% Bds.	3½	5 11 6	Ja, Ap, Jly, O
100	..	Submarine Cable Trust Certs.	125½	4 15 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	6%	Anglo Argentine Trams. 5% Debs.	10½	5 0 9	Jan, Dec
St.	4½%	Do. 4½% Deb.	89½	5 12 6	Jan, July
St.	4%	Do. 4% Deb.	83½	5 3 4	Jan, July
··	..	Do. Income Bds.	4	6 17 6	Jan, July
··	..	Do. Pref.	4½	6 13 4	Jan, July
1	1½	Brazilian Traction Ord.	49½	3 14 3	Feb, M, Aug, N
1	..	Do. Pref.	74½	5 7 6	Ja, Apl, Jly, O
5	8%	Buenos Ayres Tramways	5½	7 5 4	..
··	..	Do. 5% Cum. Pref.	4½	5 11 3	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	89½	5 0 9	Feb, Aug
··	..	Calcutta Tramways	1½	6 13 4	May, Nov
··	..	Do. Pref.	1½	6 13 4	..
1	..	Madras Elec. Trams 6% Cum. Pref.	1½	6 13 4	Jan, July
··	..	Mexican Tramways	10½	6 11 11	Feb, M, Aug, N
··	..	Do. Pref.	10½	6 11 11	Jan, July
St.	4%	Montreal Street Ry. 4% Debs. (1922)	77½	5 3 1	Ja, Ap, Jly, O
1	..	Do. Pref.	7½	6 13 4	..
1	..	Toronto Railway Co. 4% Bds.	77½	5 3 1	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	5½	5 11 3	May, Nov
··	..	Do. Deb.	10½	5 14 3	Jan, July
··	..	Do. Deb.	10½	5 14 3	Ja, Apl, Jly, O
··	..	Do. Deb.	9½	5 5 3	June, Dec
··	..	Do. Deb.	9½	5 5 3	Apl, Oct
··	..	Do. Deb.	9½	5 5 3	Ja, Apl, Jly, O
··	..	Do. Deb.	9½	5 5 3	..
··	..	Do. Deb.	9½	5 5 3	May, Nov
··	..	Do. Deb.	9½	5 5 3	Jan, July

† Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date August 11, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	13½d.	English Lead	£23 0 0
Solid Drawn Copper Tubes	13½d.	Antimony	Nominal.
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	15½d.	**Old Metals.**	per ton.
Brass Wire	14d.	Clean Scrap Copper	£64 0 0
Copper Wire	14½d.	Brazlery Copper Scrap	£59 0 0
Rolled Brass	13½d.	Clean Scrap Brass	£48 0 0
Brass Sheets	14½d.	Old Lead	£17 0 0
		Old Zinc	£30 0 0
	per ton.	Hollow Pewter	£120 0 0
Copper Sheets	£102 0 0	Black Pewter	£85 0 0
Spelter	£72 0 0	Gun Metal	£60 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date August 10, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£75 0 0	Gun Metal	£60 0 0
Clean Mixed Brass	£62 0 0	Old Lead	£19 0 0
Clean Copper	£65 0 0	Tea Lead	£17 0 0
Clean Copper Cuttings	£67 0 0	Hollow Pewter	£110 0 0
Brazlery Copper	£58 0 0	Shaped Black Pewter	£80 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £70; Commercial Tinman's Solder, £92; Blowpipe Solder £102.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or dec. (a)	No. of weeks.	Aggregate. Amount.	Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 8	1,441	— 12	9	17,539	— 351
Anglo-Argentine	..	57,413	— 2,964	31	1,583,027	— 140,203
Ashton-under-Lyne	..	1,301	+ 64	19	9,284	+ 247
Ayr Corporation	..	1,477	+ 85	12	6,004	— 219
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	..	1,488	+ 155	19	25,715	+ 1,417
†Birmingham Corporation	..	..	..	..	..	..
Blackburn Corporation	..	1,920	+ 604	19	25,747	— 381
Blackpool Corporation	..	5,075	— 113	18	31,120	— 8,699
Blackpool and Fleetwood	..	2,264	— 236	31	20,107	— 4,156
Bolton Corporation	..	2,771	+ 29	19	50,551	— 3,356
Bournemouth { Trams	..	2,874	+ 481	18	38,445	— 1,692
Bournemouth { Buses	..	53	— 37	18	490	— 176
Bradford Corporation	July 31	7,748	+ 1 034	17	117,326	+ 2,133
Brighton Corporation	Aug. 8	1,776	— 421	19½	21,338	— 1,333
Bristol Trams { Trams	..	6,908	+ 795	31	145,926	— 1,393
Bristol Trams { Buses, &c.	..	7,022	+ 1,047	31	148,905	+ 24,358
Burmah E. Trams & Ltg.	..	R3,765	— R834	31	R107,581	— R46,074
Burnley Corporation	..	1,645	+ 73	19	44,896	— 5
Burton Corporation	..	366	— 17	19	5,487	— 369
Bury Corporation	..	1,431	+ 60	19½	26,077	— 468
Calcutta Tramways Co.	..	R67,338	— R1,979	..	..	..
Camborne-Redruth	Aug. 7	147	+ 11	31	4,221	— 126
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	..	550	— 40	31	15,702	— 343
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	July 30	1,709	+ 208	17	32,670	+ 717
*Derby Corporation	Aug. 7	1,794	— 124	18½	19,821	— 52
Dover Corporation	..	..	..	..	..	..
Dublin United Tramway	..	219	— 10	5	896	— 126
Dublin United	..	7,291	— 433	31	189,351	+ 5,789
Dundee Corporation	..	1,378	+ 114	12½	16,043	+ 100
East Ham Council	..	1,478	+ 218	18½	24,801	+ 4,300
Exeter Corporation	..	462	— 13	15	7,172	+ 135
Glasgow Corporation	..	21,000	+ 1,488	13½	209,446	+ 10,850
Glossop Trams	..	141	+ 15	32	3,879	— 112
Gloucester Corpn.	..	431	+ 44	18	6,140	— 221
Halifax Corpn. { Trams	..	2,332	+ 146	18	41,398	— 28
Halifax Corpn. { Buses	..	53	+ 4	18	922	— 7
Hastings Elec. Trams Co.	..	1,794	— 12	31	28,065	— 1,269
Huddersfield Corpn.	..	2,993	+ 677	18	50,803	+ 5,703
Hull Corporation	..	3,376	+ 144	18	56,923	— 3,355
Ilford District Council	..	837	+ 160	18	12,488	+ 2,170
Ilkeston Corporation	..	171	+ 16	18	2,405	— 68
Ipswich Corporation	..	..	..	..	..	..
Isle of Thanet Co.	..	..	..	..	..	..
Kilmarnock Corporation	..	138	— 17	12	2,164	— 51
Lanarkshire Trams Co.	..	2,071	— 327	31	58,969	— 326
Lancashire United	..	2,313	+ 454	31	53,303	+ 1,135
Leeds Corporation	..	10,922	+ 2,257	19	169,320	+ 2,743
Leicester Corporation	..	..	..	..	..	..
Leith Corporation	..	..	..	..	..	..
Lincoln Corporation	..	..	..	..	..	..
Liverpool Corporation	..	14,000	— 303	31¶	414,841	— 1,000
Llandudno & Colwyn Bay R	..	..	..	..	..	..
London County Council	July 28	46,089	— 3,364	17	717,187	— 36,369
Lowestoft Corporation	Aug. 7	335	— 31	14½	7,716	— 1,068
Maidstone Corporation	..	93	— 3	1	4,114	— 12
Manchester Corporation	..	18,324	— 1,008	18	335,356	— 371
Nelson Corporation	..	..	..	..	..	..
Newcastle-on-Tyne Corpn	..	2,161	— 1,163	18	116,443	+ 16,578
Newport (Mon.) Corpn.	..	..	..	..	..	..
Northampton Corporation	..	962	+ 248	18	14,304	+ 2,208
Nottingham Corporation	..	5,517	+ 517	18	69,307	+ 1,704
Oldham Corporation	..	2,381	+ 319	18	42,811	— 314
Portsmouth Corporation	..	..	..	..	..	..
Preston Corporation	..	..	..	..	..	..
Reading	..	1,727	+ 203	18	32,595	+ 1,177
Rotherham Corporation	..	1,425	— 211	18	20,610	+ 1,176
Salford Corporation	..	5,380	+ 305	18	99,281	+ 168
Sheffield Corporation	..	9,691	— 1,041	18	170,149	+ 1,167
Southampton Corpn.	..	1,814	— 221	18	26,948	— 28
Southend Corporation	..	1,796	— 141	18	15,709	— 1,296
Southport Corporation	..	877	— 77	18	14,019	— 212
St'lyb'dge, Hyde, &c., Jt. B.	..	..	..	..	..	..
Sunderland Corporation	Aug. 8	1,444	— 71	19	23,849	— 1,320
Sunderland District	..	1,313	— 83	19	23,846	— 1,291
Swindon Corporation	..	..	..	..	..	..
Tynemouth Corporation	July 28	687	+ 37	17	2,630	+ 270
Wallasey Corporation	Aug. 7	1,685	+ 170	18	24,893	— 1,107
Walsall Corporation	..	1,026	— 74	18	22,695	— 1,046
Warrington Corporation	..	1,246	— 117	18	17,901	+ 1,865
Warrington Corporation	..	..	..	1	8,277	— 12
West Ham Corporation	..	3,595	— 1,000	18	..	— 4,411
Wigan Corporation	..	1,192	— 84	18	27,776	— 113
Wolverhampton Corpn.	..	1,451	— 114	18	20,281	— 1,141
Yorkshire W.R. Trams	..	2,388	— 174	18	..	— 3,691

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Including omnibuses &c. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 3 days.
¶ Plus 2 days. ** Compared with one week more last year.

THE ELECTRICIAN:

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NOTES.

Electric Iron-Ore Smelting.

THE progress made in the electric smelting of iron ore in Scandinavia is shown by the fact that the number of furnaces installed for this purpose was increased from nine in 1912 to more than double the number by the end of the following year, when no less than 20 furnaces were in full operation. In recent years the electric production of Swedish iron has assumed remarkable proportions. From 122 tons in 1908 this production rose to 870 tons in 1910 and 17,570 tons in 1912. The three great factors in this rapid extension are the availability of an abundant and inexpensive power supply, the price of charcoal, and the economy of this reducing agent brought about by the use of electricity. Details of the development in Sweden up to the present time were given recently by Mr. J. A. LEFFLER, and in this issue, through the courtesy of "Engineering," we give a description of several large electric furnaces installed at Domnarfvet, Hagfors and Söderfors. It is highly interesting to trace the development from the 500 kw. experimental furnace installed at Domnarfvet, in 1909, through the larger but still experimental 1,900 kw. furnace at Trollhättan and the 2,200 kw. Hagfors furnaces, and from the 3,000 kw. furnace at Domnarfvet to the 5,000 kw. furnace now being constructed at the Söderfors Works. For the three furnaces at Hagfors [illegible] and wages per ton were, for the year 1913, 3·85s. The corresponding figures for [illegible] 1912 at [illegible] furnace, were 7·25s. for Bessemer pig-iron and 7s. for Martin pig-iron. At Domnarfvet, with the furnace running under a load of a little more than 3,000 k.v.a., the average production of pig-iron was found to be 250 tons per week, with a consumption of charcoal of 77 cubic ft. and a consumption of electrodes of 15½ lb. per ton of iron. The plant at Trollhättan in 1913 produced 7,200 tons of pig-iron with an average load of 1,808 kw. The charcoal used per ton of pig-iron amounted to 84 cubic ft., and the electrode consumption was 9·1 lb. per ton of iron. We look forward to the early publication of the results of the smelting operations at these progressive Swedish works.

Slot Insulation.

IN an interesting article which we reproduce on another page Mr. H. M. HOBART deals with some of the problems connected with the design of extra-high-tension slot insulation. About 11 years ago there was a well-sustained discussion on the mysterious breakdown of the insulation of a number of high-voltage machines of reputable make. The materials used were found to be the best of their respective kinds, and on the face of it an ample factor of safety had been allowed. Moreover, the workmanship was above suspicion. If we remember rightly, the cause of the breakdown was chemical action, brought about by an invisible discharge across the thin films of air between the insulated conductors and the sides of the micanite tubes. Many of our readers will remember the experiment conducted by Mr. J. S. HIGHFIELD confirming this view. It was described in THE ELECTRICIAN, Vol. LIV., p. 573. In his article Mr. HOBART makes it perfectly clear why such discharges take place in certain cases. To minimise the risk of breakdown of the insulation on the conductors within the slots it is imperative to drive the air completely from the windings and to fill up the spaces with a solid insulating material. This does not eliminate the discharge across the air-film between the micanite tube and the slot. Mr. F. W. PEEK, jun., in his recently published treatise on "Dielectric Phenomena in High-Voltage Engineering," shows that altitude has an important effect on the problem. He gives as an example the insulation of an 8,000 volt armature. By assuming a thin air-film, 0·5 mm. across, it is found that the air is stressed to 26,700 volts per centimetre, and no discharge occurs. At an altitude of 5,000 ft. the disruptive strength of air is 25,500 volts per centimetre, and the air around the coils near the terminals, having a gradient of 26,700 volts per centimetre, would glow. In the latter case

the insulation would, in course of time, be destroyed by mechanical bombardment, local heating and chemical action.

THE conditions governing the production of chemical action in high-voltage windings have been dealt with in elaborate detail by Messrs. A. P. M. FLEMING and R. JOHNSON in a Paper on "Chemical Action in the Windings of High-Voltage Machines," read some years ago before the Institution of Electrical Engineers. It is well recognised that electrostatic discharge across the air-film between the slot lining and the walls of the slot may be prevented by coating the outside surface of each of the slot linings with slitted metal-foil grounded to the laminations. FLEMING and JOHNSON recommend the use of a similar shield underneath the insulation immediately around the coil and connected to one of its intermediate turns. In this manner the entire difference of potential is thrown on the dielectric between the two metal shields. Attention is, very properly, directed to the relatively short life of insulation, and Mr. HOBART suggests that it is more economical to work electric generators hard during a short life than to spare them and drag out their life over a long term of years. In the present state of the art it is, beyond question, sound policy to assume a short life both for prime movers and electric generators. Experience shows that a life of from 8 to 10 years may be assumed, which means a profitable life of about 30,000 hours, if the machines are run for eight hours per day. Although a life of 10 years is recommended, it must not be forgotten that improved insulating materials will greatly increase the life. The ideal insulation is one that is at least as strong and durable as any other part of the machine. Electrical engineers are men of high ideals, and as the electrical art advances we have every hope that materials will be available of a reliable and uniform quality. This hope is encouraged by the rapid progress made during the last few years in the manufacture of dielectrics.

Industrial Control for Hoisting Equipment.

WE give elsewhere the text of two Papers on the control of direct-current hoists read by Mr. W. T. SNYDER and Messrs. G. E. STOLTZ and W. O. LUM, before the American Institute of Electrical Engineers. Mr. SNYDER takes as examples three different kinds of hoist, namely, a blast furnace skip-hoist, a high-speed coal-hoist and a slow-speed ash-hoist. In the case of the control of a blast furnace skip-hoist, reliability and continuity of operation are imperative; in the high-speed coal-hoist, since continuity of operation is not absolutely essential, an ordinary delay is not a very serious matter, and such questions as simplicity, initial cost and maintenance, can be given more consideration; in the case of the ash-hoist, where all the operations are carried out by unskilled labour, the most important requirements are that the controller perform its functions positively, smoothly and automatically. Messrs. STOLTZ and LUM confine their discussion to a typical example of a skip-hoist. After outlining the conditions and dividing the load on the hoist into friction, inertia of the moving parts, and useful work in hoisting the net load, the authors determine the proper cycle of operations, and then give details of the control. As a rule blast furnace skip-hoists are of the balanced type. Their travel is about 150 ft., and the slope angle is usually 30 deg. to the vertical. The usual bucket speed is 350 ft. per minute. The buckets weigh 3 tons and have a capacity varying from $1\frac{1}{4}$ tons of coke to a maximum of 5 to 7 tons of ore. The motors are compound-wound, having from 10 to 20 per cent. series field and horse-power capacities varying from 100 to 300.

The Northumberland Clause.

IN our issue of July 9 we commented upon the attempt made by the Southampton Gas Co. to induce a Select Committee of the House of Commons to insert the Northumberland clause in the Provisional Electric Lighting (Extension) Order of the Southampton Corporation. Though the Gas Company was unsuccessful on that occasion it continued its opposition before a Select Committee of the House of Lords, when it scored a partial success, inasmuch as the Committee decided to insert the clause. However, the clause is not to apply to the whole of the borough, but only to the extended area of supply, *i.e.*, the Parish of Bitterne. It ought not to be difficult for the electric supply department to get sufficient customers in the new area within a couple of years to put the business of supply to Bitterne on a sound financial basis. It is to the interest of the Corporation to do so, but even if it were not it seems to us to be almost impossible to apply the clause to a small section of a big electric supply undertaking, or for the Gas Company to see that it is strictly enforced. It is by no means an easy matter to divide up the costs for different localities with anything like accuracy.

As we have stated many times, we are opposed to the principle of the Northumberland clause on other and higher grounds. We are of opinion that when once the Board of Trade have decided that it is in the public interest to grant a provisional electric lighting order to a local authority, and that this authority should be entrusted with the task of undertaking an important public service, such as that of electricity supply, no unfair check or hindrance should be placed upon it in its endeavours to perform its public obligations. If the electrical department of the Board of Trade, who know much more about the subject than any Committee of either House of Parliament, think it advisable to grant a provisional order to a local authority, then the latter should be allowed full latitude to develop its electric supply undertaking upon modern commercial lines and for the public advantage. In its essence the Northumberland clause is a shackle placed upon electricity supply at the instance of its gas rivals, and is, therefore, intended as a check upon competition and upon progress. The clause was invented in the days when there was a great outcry against municipal trading, but we think the time has now come when the situation should be reviewed. The ostensible object of the clause is to make local authorities run their electric supply departments on commercial lines, but in our opinion it must have the opposite effect, for it is difficult to see how increasing the price of electrical energy for lighting and

power can at any time, but especially in the early years of an undertaking, have anything but a deleterious effect. In these days of garden suburbs and of rural factories there is a considerable demand for lighting and power on the outskirts of industrial towns, but it takes a considerable time to develop building estates, and their owners will not readily enter into contracts to take electric current from electric supply undertakers who are burdened with the Northumberland clause. Again, all modern factories use the electric drive, and in the course of a few years all works will be equipped electrically. Power agreements sometimes cover long periods—five or even 10 or 12 years—but the unfortunate undertaker, who is tied down by the clause in question cannot hope to get customers of this sort for his undertaking.

Royal Engineers (T.F.)—The following promotions have been made :—

London Electrical Engineers—Lance.-Corp. Kenneth L. Wood and Sapper Garth B. Adeney to be Second-Lieutenants.

Long Distance Radio-Telegraphy.—At an extraordinary general meeting of Marconi's Wireless Telegraph Co., held last Wednesday, Mr. Marconi announced that direct communication had been established between the United States and Japan by means of the Company's stations in America and the Pacific. A regular commercial service is soon to be opened for the receipt of public messages and will be available from England via the Company's stations in the United States.

Further Electrification of the Chicago, Milwaukee and St. Paul Railway.—In addition to the main line between Three Forks and Deer Lodge now in hand, of which the locomotives are described in this issue, the C.M. & St. P. Company has converted to electric traction a short terminal line about four miles long in the city of Great Falls. The trains are hauled by a 50-ton electric locomotive which collects its power by a pantagraph from overhead construction of the catenary type. Energy is transmitted at 6,600 volts, three-phase, 60 cycles, supplied by a hydro-electric plant six miles distant. The equipment is arranged for freight trains of 580 tons to be operated at 9½ miles per hour, with a maximum gradient of 1 in 154.

Portable Wireless Sets of the U.S. Army.—Two types of field radiotelegraph sets have been developed for use by the Signal Corps of the United States Army. One of these employs a 1 kw. high-frequency alternator, and the other a 2 kw. machine. This can be thrown into gear with the petrol engine of the car on which the set is carried. A ¾-ton chassis of the commercial type is employed, and on the top are mounted a set of mast-hoisting shears, which are folded down during transportation. These enable the crew to put up the 80 ft. mast in five minutes. A signal lamp is also mounted above the car. This set can send messages 100 miles under ordinary conditions, or 150 if circumstances are favourable.

An Appeal to Professional Men for Munitions Work.—The following announcement was made by the Board of Trade on Tuesday :—

Professional men who have practical experience in any branch or grade of the engineering trades, and are anxious at the present time to place their services at the disposal of the Government, are invited to consider the possibility of undertaking manual work in connection with the production of munitions of war. The great need of the moment is for skilled mechanics (turners, fitters, millwrights, &c.).

Men whose training has included engineering workshop experience can now do valuable service by offering to do manual work at the usual rates of payment for such work. They will not displace any skilled workman who is already employed, or capable of being employed, upon the production of munitions. They will simply increase the army of those who by work at home help the armies abroad.

Professional men who wish to offer their services to this end should send full particulars of their qualifications to the "Engineers' War Service Register," Queen Anne's chambers, Westminster, S.W.

Engineering Institutions Volunteer Training Corps.—We are informed that good work is being done by the various sections of this Corps, under the staff of the London Electrical Engineers (T.F.), both in drill and the special technical work, for which it has been organised. Arrangements for the use of a miniature rifle-range, with rifles and instructor, are being completed, so that members will be able to take rifle practice at any hour of the day. Recruits will be welcome from among all those who are willing to fit themselves by training for military engineering work; it is not necessary that they should be members of one of the Engineering Institutions. Applications from men with an engineering bent, even if in other occupations, will be entertained. Applications should be addressed to Lt.-Col. C. B. Clay, Marconi House, Strand.

A New Electric Dredge.—In the latest electric dredge built by the Narbon Engineering Co. for the Northern Dredge & Dock Co., of the U.S.A., a somewhat new departure is made by the employment of self-starting synchronous motors. That driving the main pump is of 500 H.P. running at 720 revs. per min. and taking three-phase current at 2,300 volts and 50 cycles. Gearing is fitted to drive the pump at two speeds, namely, 300 and 200 revs. per min. The cutter machinery and the winding gear are worked by motors of the slip-ring type of 50 H.P. and 30 H.P. respectively, both connected like the pump motor direct to the main supply. For priming the main pump a water jet exhauster is used, and the auxiliary pump for this is driven by a small motor working on a stepped down voltage. There is also a motor-generator for the ordinary lighting, for a searchlight and electric horn. The dredge can excavate a maximum of 7,000 yds. in 24 hours, and is employed on Lake Nakomis, Minneapolis.

Stassano Arc-Furnace.—A technical description was given recently by Mr. W. M. McKnight, before the National Electric Light Association, of America, of the first Stassano electric furnace installation in the United States. A 1-ton furnace of this type has been operated 24 hours per day continuously since 1903, except for three two-day intervals during each month, necessary for re-lining. The furnace produces steel castings which are homogeneous and of good grain. The distinguishing feature of the Stassano furnace is that fusion is obtained by radiant heat from a three-phase electric arc at a distance of 2 in. to 3 in. above the metal and approximately 24 in. from the roof of the furnace. The operation goes on in a closed chamber with a neutral atmosphere for the chemical reactions which take place in the process of refining. The current consumption of the furnace varies from 800 amperes to 2,000 amperes per terminal on a three-phase 150-volt circuit, which is supplied through transformers from a 10,000-volt transmission line. The average demand is about 225 kw.

Electrical Rain-Making.—According to the "Pall Mall Gazette," the artificial production of rain is about to be put to the test of practice in Australia. The New South Wales Government will provide the cost of experiments on a large scale, to be carried out by Mr. J. G. Balsillie, who has for four years been conducting researches into these possibilities. A captive balloon at a height of 6,000 ft. or 7,000 ft. will be used to discharge electricity in two forms to the atmosphere. This, it is hoped, will cause sufficient ionisation to provide nuclei upon which the moisture of the clouds may condense. Any means of increasing the rainfall of Australia would be an immense benefit to the country, and Mr. Balsillie believes that a number of these stations set up in the path of the prevailing winds would draw all the moisture from the clouds carried by them, and would also cause the cessation of natural thunderstorms.

Locomotives of the Pennsylvania Railroad.—In "The Times" Engineering Supplement some details are given of the excellent results obtained by the Pennsylvania Railroad with the 33 electric locomotives placed in service in 1910 for hauling passenger trains between New York city and a point in New Jersey, reached through the tunnels under the Hudson river. In the first four years of service these engines ran 3,791,746 miles, with only 15 failures. These only caused a loss of 271 minutes, although the train movements during this period amounted to 163,558. The locomotives are of the

divided type, each half carrying one motor, and running on four coupled driving wheels and a four-wheeled bogie at the outer end. Continuous current at 650 volts is taken from a third rail, and the motors are of the commutating pole series type. They are field controlled, four running notches being provided. The complete weight of a locomotive is 156½ tons, and the tractive power as rated 66,000 lb., though 79,200 lb. has been developed. The engines were designed for starting a 550-ton train on a gradient of 1 in 52, but actually trains of 850 tons are often started under these conditions, and 1,000-ton trains are now and then handled. Inspection and small repairs are carried out every day, and a thorough overhaul after every 3,000 miles run; but some of the locomotives have run for about 100,000 miles before tyre turning or general repairs have been necessary.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Dr. R. S. Willows contributes an article on "The Theory of Oscillation Valves and Gas Relays" (p. 742).

We continue Dr. C. C. Garrard's article on "Apparatus for Protecting Electrical Machinery against Abnormal Electrical Conditions" (p. 736).

A description is given of the latest electric iron-ore smelting furnaces built in Sweden (p. 729).

We publish two Papers on the control of direct-current hoists recently presented to the American Institute of Electrical Engineers, one by Mr. W. T. Snyder (p. 732) and the other by Messrs. G. E. Stoltz and W. O. Lum (p. 738).

A description by Mr. A. H. Armstrong of the 3,000-volt Continuous-current Locomotives to be used on the Chicago, Milwaukee and St. Paul Railway is given on page 743.

These are also discussed in our Leading Article on "High Voltage Continuous-current Traction" (p. 740).

We publish an article on "Some Aspects of Insulation Design," by Mr. H. M. Hobart (p. 727).

A testing transformer for a pressure of 500,000 volts, built by the Oerlikon Company, is described on page 745.

The special report of the Board of Trade on the Keighley Provisional Electric Lighting Order is given on p. 751.

OBITUARY.

KILLED IN ACTION. We regret to record the death of Mr. W. A. B. Kirwan Ward, who recently died of wounds received in action. Mr. Ward commenced his business career in London as an apprentice in the National Telephone Co. in August, 1907, and on the completion of his apprenticeship in 1910 he took up outside construction work, but he resigned in 1912 and joined the Constantinople Telephone Co., where he remained until October, 1913. He joined the Relay Automatic Telephone Co. (then known as the Betulander Automatic Telephone Co.) in November, 1913, and he was for some time employed in London and in France in connection with the installation erected in the Bois de Boulogne. On the outbreak of war he was called up to serve with his Company, in which he held the rank of 2nd lieutenant. About six weeks ago he was ordered to proceed to Alexandria, with a view to joining the Mediterranean Force in the Dardanelles.

PERSONAL.

We [illegible] that the death of Mr. Robert Hammond will not [illegible] the business of the late Mr. Robert Hammond & Son, and that it is the intention of the firm to carry on the practice under the old name and in the same premises as hitherto. Pending the return to civil life of the present partner, Capt. R. W. Hammond, [illegible] Messrs. Preece, Cardew, Snell & Rider have kindly undertaken to execute, on behalf of the firm, all work now in hand and any future work which may be entrusted to the firm. Such [illegible] and [illegible] will be in a position to deal effectively and promptly with any matters which may arise in connection with existing work.

Mr. J. F. Shipley has now taken up the position of engineer to Messrs. Graham, Rowe & Co., of Liverpool.

Mr. A. M. Gray, assistant professor of electrical engineering at McGill University, has been appointed head of the electrical engineering department of Cornell University.

Mr. A. E. Wilson, deputy city electrical engineer, of Bristol, having been selected by the War Office for the appointment of electrical engineer to the chief engineer, Southern Command, he has resigned his present appointment, and he will take up his new duties at Salisbury on the 23rd inst.

APPOINTMENTS VACANT.

Applications are invited for the positions of shift engineers required at the new temporary station, Nechells, Birmingham. Applicants must have had sound mechanical and electrical engineering training, and must have had previous experience of a similar kind in a large electric generating station from which e.h.t., three phase and l.t. d.c. supplies are given. Commencing salary £104, rising to £200 per annum. Applications to city electrical engineer and manager (Mr. R. A. Chattock), 14, Dale End, Birmingham, by Aug. 30. *See also an advertisement.*

The High Tension Co. require a man with experience of assembling sparking coils. *See advertisement.*

Armature and stator winders are required for railway work in London district. *See advertisement.*

A civil engineering assistant (salary £200 per annum), surveying assistant (£117-£120), a general permanent-way foreman (£3. 5s. per week) and foreman platelayer (£2. 5s.) are required by West Ham Tramways Dept. Applications (on official forms to be obtained from the General Manager) by noon Aug. 28.

An assistant signal engineer is required for the New Zealand Government railways. Salary £425, rising to £475 per annum. Applications to the High Commissioner for New Zealand, 13, Victoria-street, London, S.W., by Aug. 31.

An engineer is urgently required for Beds. Reformatory, Carlton, Sharnbrook, to turn out war munitions with boys.

Sutton Coldfield Corporation require an electrical engineer and manager. Commencing salary will not exceed £250. Applications to the Town Clerk (Mr. R. A. Reay Nadin) by Sept. 1.

The University of London is about to appoint a principal officer at a salary of £2,000 a year. Names of those desirous that their names should be considered should reach the Secretary to the Senate, University of London, South Kensington, S.W., by Sept. 15.

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply department. Salary £650, rising to £700 per annum. Applications to the town clerk (Mr. Thos. H. Nesbitt), by Sept. 13.

INSTITUTIONS AND SOCIETIES.

Institute of Radio Engineers (New York).—On Thursday and Friday afternoons, September 16th and 17th next, joint meetings of the Institute of Radio Engineers and the American Institute of Electrical Engineers will be held at the Panama-Pacific Exposition, San Francisco. Prof. Harris J. Ryan will give the results of investigations on the "Sustained Radio Frequency High-Voltage Discharge," by Mr. Roland G. Marx and himself, taking up the flame and brush types of discharge obtained from conductors when a powerful arc generator is used to apply voltages up to 50,000 at frequencies as high as 200,000 cycles per second. On Friday Mr. Robert H. Marriott will read a Paper on "Radio Development in the United States," giving especial attention to Pacific Coast conditions.

ARRANGEMENTS FOR THE WEEK.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. E. Clay, V.D.

The following orders have been issued for the week ending August 28, 1915:—

Monday, Wednesday and Friday.—Drills 6.30 and 7.30 p.m.

SOME ASPECTS OF SLOT INSULATION DESIGN.*

BY H. M. HOBART.

Summary.—The voltage gradient through the slot insulation is considered at some length and the importance of using as insulation a material capable of withstanding high temperatures without deterioration is emphasised. The useful life of insulation is considered and the suggestion is made that the life be taken at 30,000 hours.

The thickness of the insulation employed in the slots of low-pressure armatures is usually determined largely from considerations of mechanical strength. Were it practicable to ensure continuity and unimpaired mechanical strength at all parts, thinner insulations than those customarily employed would usually afford ample factors of safety so far as regards immunity from disruption by the electrical pressure.

But for armatures wound for high pressures, say, for example, 12,000 volts, the insulation thickness is proportioned chiefly with reference to the strength which the material possesses for withstanding electrical pressures. This may be termed the disruptive strength of the material. Quantitative investigations of the properties of insulating materials are still disappointingly meagre. It may, however, be stated that the disruptive strength of the insulating materials usually employed for slot insulations does not increase in proportion to the thickness employed. As a rough guide for practical purposes, we may take it that the disruptive strength increases as the two-thirds power of the thickness. If for a certain insulating material, furnished in the form of sheets, the disruptive strength for a thickness of 1 mm. is stated to be 30,000 volts when tested for 60 seconds, we are to understand that a thickness of 1 mm. will, on the average, withstand a crest pressure of 30,000 volts for 60 seconds without puncturing. Applying the rough "two-thirds power" rule, a 0·5 mm. thick sample of the same material will have a disruptive strength of $0{\cdot}50^{\frac{2}{3}} \times 30{,}000 = 0{\cdot}63 \times 30{,}000 = 18{,}900$ crest volts, while a 2 mm. thick sample will have a disruptive strength of $2^{\frac{2}{3}} \times 30{,}000 = 1{\cdot}59 \times 30{,}000 = 47{,}500$ crest volts.

The three results are brought together in the following table:—

Thickness of sample.	"Disruptive strength" in (crest) volts.	"Disruptive strength" per millimetre in (crest) volts.
0·50 mm.	18,900	37,800
1·00 mm.	30,000	30,000
2·00 mm.	47,500	23,800

It is desirable again to emphasise that different materials exhibit different rates of variation with the thickness as does also a given material under varied conditions. It is rare, however, that it is practicable to obtain materials or conditions ensuring a disruptive strength directly proportional to the thickness, and for the purposes of this article the "two-thirds power" rule is assumed as being convenient and also sufficiently representative.

In actual practice, slot insulations for 1,200-volt armatures are generally about 2 mm. thick, while for 12,000-volt armatures a thickness of about 5 mm. is usually employed. Such insulations have in practice been shown to be adequate to withstand, not only the conditions of usual service but also, when new, the test required by paragraph 254 of the A.I.E.E. rules. This paragraph reads as follows:—

> 254. The standard test for all classes of apparatus, except as otherwise specified, shall be twice the normal voltage of the circuit to which the apparatus is connected, plus 1,000 volts.
>
> The essential conditions of the test are prescribed in paragraphs 248 to 252 inclusive, which read as follows:—
>
> 248. Condition of Machinery to be Tested. Commercial tests shall, in general, be made with the completely assembled machinery and not with individual parts. The machinery shall be in good condition, and high-voltage tests, unless otherwise specified, shall be applied before the machine is put into commercial service and shall not be applied when the insulation resistance is low owing to dirt or moisture. High-voltage tests shall be made at the temperature attained under normal operation. High-voltage tests to determine whether specified requirements are fulfilled are admissible on new machines only. Unless otherwise stated, high-voltage tests of a machine shall be understood as being made at the factory.
>
> 249. Points of Application of Voltage. The test voltage shall be successively applied between each electric circuit and all other electric circuits and metal parts connected.
>
> 250. Interconnected Polyphase Windings. [illegible] All windings of a machine except that under test shall be connected to ground.

* From the "General Electric Review" (U.S.A.).

251. Frequency, Wave Form and Test Voltage. The frequency of the testing circuit shall not be less than the rated frequency of the apparatus tested. A sine-wave form is recommended. The test shall be made with alternating voltage having a crest value equal to $\sqrt{2}$ times the specified test voltage. In direct-current machines, and in the general commercial application of alternating-current machines, the testing frequency of 60 cycles per second is recommended.

252. Duration of Application of Test Voltage. The testing voltage for all classes of apparatus shall be applied continuously for a period of 60 seconds.

A 1,200-volt armature will, in accordance with the quoted rule, be tested with $(2 \times 1{,}200) + 1{,}000 = 3{,}400$ virtual volts (corresponding to 4,800 crest volts). A 12,000-volt armature will be tested with $(2 \times 12{,}000) + 1{,}000 = 25{,}000$ virtual volts (corresponding to 35,400 crest volts). Since the thicknesses in these two cases are 2 mm. and 5 mm. respectively, the "disruptive strengths" per millimetre of thickness must be at least $4{,}800/2 = 2{,}400$ crest volts and $35{,}400/5 = 7{,}100$ crest volts.

The materials must in the two cases be such as shall, under the test conditions, correspond to the following values for samples of 1 mm. thickness:—

Working pressure of armature.	Thickness of insulation in mm.	"Disruptive strength" of a sample of 1 mm. thickness.
1,200	2	$4{,}800/2^{\frac{2}{3}} = 3{,}000$ volts.
12,000	5	$35{,}400/5^{\frac{2}{3}} = 12{,}000$ volts.

Evidently we are imposing a much more severe stress on the insulation when we test a 12,000-volt armature with only $25{,}000/12{,}000 = 2{\cdot}08$ times the working pressure than when we test a 1,200-volt armature with $3{,}400/1{,}200 = 2{\cdot}84$ times the working pressure.

But even the higher value, namely, 12,000 crest volts for a 1 mm. sample, appears at first sight to be exceedingly low when we mention

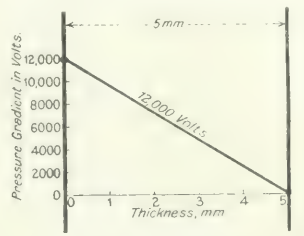


FIG. 1.—HOMOGENEOUS INSULATION STRESSED WITH 12,000 VOLTS.

that a 1 mm. thickness of natural mica, if free from impurities, has a disruptive strength of from 80,000 to 90,000 crest volts, while 1 mm. thick samples of many varieties of impregnated fabrics and papers and of re-constructed mica test above 20,000 crest volts.

But 1 mm. thickness of natural mica can only be obtained in flat plates, and such plates are rarely free from foreign substances. The purity corresponding to the above-quoted values of the disruptive strength is only obtainable in selected and relatively small pieces. When mica is split up and re-constructed into a sufficiently flexible and reliable form, the product is by no means exclusively pure mica, but has quite a considerable percentage of binding material usually consisting of thin paper and cementing varnish. Such a product when in the form of a flat sample, or circular tube, of 1 mm. thickness should still have a disruptive strength of nearly 30,000 crest volts. But when applied in ribbons or sheets so wrapped on as to form a continuous and uniform insulating covering around the slot portion of the coil, a 1 mm. thickness would hardly have a disruptive strength much in excess of 15,000 crest volts. A 5 mm. thickness would not have five times as great a disruptive strength but would only withstand some $5^{\frac{2}{3}} = 2{\cdot}9$ times as great a pressure as that withstood by a 1 mm. thick sample, or $(2{\cdot}9 \times 15{,}000) = 43{,}000$ crest volts, corresponding to a pressure of $43{,}000 \div 2 = 30{,}000$ R.M.S. volts. This leaves a margin of only 5,000 R.M.S. volts above the 25,000 R.M.S. volt test required by the A.I.E.E. rules for a 12,000-volt armature.

It must be remembered that the manufacturer requires his own factor of safety above the A.I.E.E. test, since he cannot afford to [illegible] on the ragged edge of breaking down [illegible] and it is now clear that the margin, [illegible] being precious, [illegible] of 12,000 volt armatures, so [illegible] to require good skill and care in design and construction.

The limits of this article will not permit of allusion to, or much less a comprehensive discussion of, the many points requiring attention

in the design of the slot insulation of high-pressure armatures. It has been considered desirable to draw attention to the order of magnitude of the quantities involved. Let us, however, give further consideration to the influence of the specific inductive capacity of the materials entering into the composition of the slot insulation.

Fig. 1 is a diagrammatic representation of a 5 mm. thick homogeneous insulation stressed by 12,000 R.M.S. volts. Each millimetre of thickness experiences a stress of 12,000/5=2,400 R.M.S. volts. In Fig. 2, the 5 mm. thickness of homogeneous insulation has been replaced with two 2·5 mm. layers, the left-hand layer being of a material with a specific inductive capacity of 6 and the right-hand layer of a material with a specific inductive capacity of 3. The total stress of 12,000 R.M.S. volts will be shared between the two layers in direct proportion to their thicknesses and in inverse proportion to their specific inductive capacities. Letting X represent

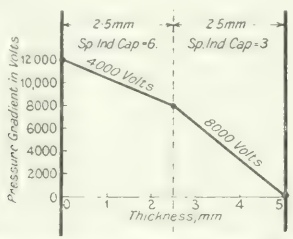


Fig. 2.—Insulation of Two Layers of Equal Thickness and Different Specific Inductive Capacity.

the pressure across the left-hand layer and 12,000−X that across the right-hand layer, we have X : 12,000−X=2·5/6 : 2·5/3. Therefore X=4,000 and 12,000−X=8,000. Consequently, as shown in Fig. 2, while the left-hand layer is subjected to a stress of only 4,000/2·5 =1,600 R.M.S. volts per millimetre, the right-hand layer is stressed to the extent of 8,000/2·5=3,200 R.M.S. volts per millimetre. Both of these values are quite moderate. But let us now consider the conditions represented diagrammatically in Fig. 3. The two layers each have the same specific inductive capacities as in Fig. 2, but while the thickness of the left-hand layer has been increased from 2·5 mm. to 4 mm., that of the right-hand layer has been decreased from 2·5 mm. to 1 mm. We now have X : 12,000−X=4/6:1/3, X=8,000, 12,000−X=4,000.

The left-hand layer is now subjected to 8,000/4=2,000 R.M.S. volts per millimetre and the right-hand layer to 4,000/1=4,000 R.M.S. volts per millimetre. While these values are still moderate,

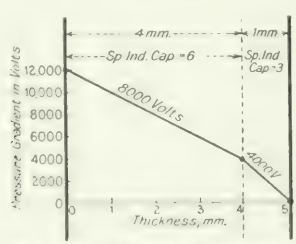


Fig. 3.—Insulation of Two Layers of Different Thickness and Different Specific Inductive Capacity.

that across the right-hand layer is considerably above the 12,000/5 =2,400 R.M.S. volts per millimetre, which is the average for the total thickness.

In Fig. 4 the thickness of the right-hand layer is still further reduced and is now only 0·1 mm., the specific inductive capacities being as before 6 for the left-hand and 3 for the right-hand layer. We now have X : 12,000−X=4·9/6 : 0·1/3, X=11,500 R.M.S. volts, 12,000−X=500 R.M.S. volts.

For the left-hand layer the stress is 11,500/4·9=2,350 R.M.S. volts per millimetre and for the right-hand layer it is 500/0·1=5,000 R.M.S. volts per millimetre.

Now retaining the two thicknesses of 4·9 for the left-hand and 0·1 for the right-hand layers and the specific inductive capacity of 6 for the left-hand layer, let us consider the case where the specific inductive capacity of the 0·1 mm. thick right-hand layer is reduced from the value of three corresponding to Fig. 4 to the value of only one, corresponding to air. Indeed, we may consider that the right-hand layer is made up of a film of air adjacent to the laminated side of the slot of an armature. We now have X : 12,000−X=4·9/6 : 0·1/1 X=10,700 R.M.S. volts, and 12,000−X=1,300 R.M.S. volts. The air film is stressed to the extent of 1,300/0·1=13,000 R.M.S. volts per millimetre.

It will be noted that in this last case we have a stress of 1,300 R.M.S. volts exerted on a layer of air of only 0·1 mm. thickness. The disruptive strength of 0·1 mm. of air is only some 700 R.M.S. volts. While the precise value depends upon several factors, we are evidently in the neighbourhood of values which may occasion discharges across the film of air between the side of the slot and the outer side of the insulation. This will take place more readily at corners, such as at the edges of ventilating ducts.

Instead of employing for the left-hand layer a material with a specific inductive capacity of 6, let us, in the last case, substitute a material with a specific inductive capacity of 2. This gives us X : 12,000−X=4·9/2 : 0·1/1; X=11,500 R.M.S. volts, and 12,000−X=500 R.M.S. volts.

This value of only 500 R.M.S. volts (less than half of that obtained in the preceding case) will not suffice to break down a layer of air of 0·1 mm. thickness. Consequently, from the standpoint of minimising the slow eating out of the insulation by static corrosion, the material employed for slot insulation should have a very low specific inductive capacity.

But the ideal way of eliminating the difficulty is to fill up all spaces solidly, utterly displacing the slightest traces of air. Since this is exceedingly difficult of complete achievement, it is well worth while providing the further safeguard of also employing for the slot insulation (so far as is consistent with obtaining the other essential

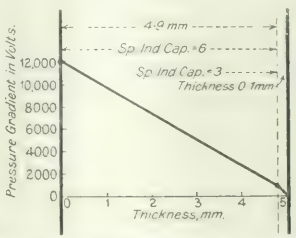


Fig. 4.—Insulation of Two Layers of Greatly Different Thickness, the Specific Inductive Capacity of the Thick Layer being Six, and that of the Thin Layer being Three.

qualities) material of very low specific inductive capacity. Unobservable discharges across the thin air films between the insulation and the sides of the slot may, under certain conditions, produce ozone and nitric acid and thus still further impair the insulation by setting up corrosive chemical reactions.

Heat-resisting Qualities.

It is, however, not possible to select whatever material best suits us in the matter of disruptive strength and specific inductive capacity. On the contrary, we must consider several other features, notable among which is the capacity for withstanding high temperatures. Nowadays the leading manufacturers are entirely willing to be conservative in the matter of temperatures for those classes of machinery which can be designed for low-temperature operation. But machines of certain types and ratings can only be so constructed that their operation will be attended by very high temperatures in certain parts. There is no known way which would at present meet with approval in avoiding these high temperatures, in extra high-speed turbine generators of very large capacity, or in totally-enclosed motors. It has become a matter of great importance to develop insulating materials which, while satisfactory in all other respects, will also withstand temperatures of the order of 125°C.

Although ordinarily the room temperature is some 25°C., there are summer days when it will rise (in an engine room) to 40 C. A thermometer rise of 50 C. brings us to an ultimate temperature of 90 C., as observed by thermometers at points on the surface. The nature of the construction, which must for mechanical reasons be employed in such machines, renders it inevitable in high-voltage alternators that there will often be local internal temperatures some 30°C. to 40 C. greater than the maximum surface readings. This leads to a temperature of 40 + 50 + 35 = 125 C. Usually the hot spots will be at the inside surface of the slot insulation where it lies against the copper coil. If the copper is, as is usually the case, the hottest part, then the temperature difference between the outside surface of the insulation and its inside surface will be greater the thicker the

insulation and the less perfectly air has been eliminated from all parts of the insulation.

Consequently, if only we can make a good insulation from the standpoint of withstanding the electrical stresses, an insulation which is relatively thin and dense, we not only have the great advantages of the saving in valuable space in the slot, which can be devoted to copper, but we also will have provided a much better path for conducting away the heat, than we should have with a thick insulation, especially if it be not dense but more or less permeated with air layers and particles. Suppose, for instance, that by means of immense pressure we could compress the usual 5 mm. insulation so as to reduce its thickness to 2·5 mm. We should thereby expel all air particles. We should have doubled the heat conductivity by virtue of halving the thickness, and also we probably should have again doubled it owing to the elimination of all air layers. The resistance to the escape of heat would, in this hypothetical case, have been reduced in the ratio of 4 to 1; and, for the same temperature rise of the copper, we could (assuming negligible heating of the copper by losses in the surrounding iron) allow the winding to absorb an internal I^2R loss four times as great. Thus we see that the same consideration, namely, the obtaining of complete impregnation, which eliminates gradual deterioration of the insulation by static corrosion, also leads to the best results from the standpoint of the transfer of heat.

Life of Insulation.

There is still a serious insufficiency of reliable data as regards the life of various sorts of insulations. When slot insulations have become exceedingly dried and brittle as the result of long use, then, for instance, in the case of railway motors, mechanical vibration plays a part in the further detericration of the insulation. This is also the case, to a certain extent, in stationary motors and in gene-

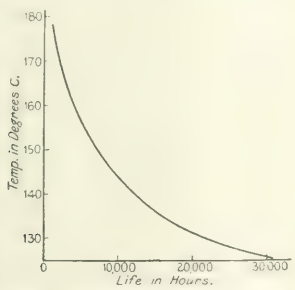


Fig. 5.—A Typical Life-Temperature Curve for a Particular Insulation.

rators. It is here desired to draw attention particularly to the case of such materials as are required for the slot insulation of large extra-high-speed turbo-generators.

It would appear to be in the interests of economy that such machines should be worked hard during a short life than to spare them and drag out their life over a long term of years. By adopting the policy of getting all we can out of them in a short space of time, we decrease the total interest and insurance charges on the investment and also the wages per unit of output. Ten years would appear to be an appropriate life to assign to such machines. By the end of 10 years the progress of the art is such that we are certain to be able to procure a more economical machine than was available at the beginning of that term of years. In the average lighting and power plant the load factor on the station is of such a value that, taking spare sets into account, we cannot economically keep any one machine in service for more than, say, one-third of the time. Consequently, instead of being in service for 87,500 hours at the end of the 10 years, such a generator will only be in service for some 87,500/3 = 29,200 hours or, say, 30,000 hours.

As good an indication as possible should be available of the temperature at which an insulation can be used, as one that should remain thoroughly sound and reliable for at least 30,000 hours. It would be, of course, impracticable to await the completion of 30,000-hour tests, but it should be practicable to make some "equivalent" test consisting of a higher temperature applied for a shorter time. Knowing, for instance, from an actual test that a certain insulation remains thoroughly sound at the end of a run of 1,000 hours at, say, 150°C., there should be a means by use of the latter data based in such investigations, of deducing data which would enable us to know the life of that same insulation when run at 140°C. and again at 125°C. Curves of the type shown in Fig. 5 should be obtained for many insulations under all sorts of conditions.

ELECTRIC IRON-ORE SMELTING IN SWEDEN.*

It may now be taken for an established fact that electrical iron-ore smelting has passed through its preliminary more or less experimental stages, and attained in Sweden to a sound and remunerative industrial basis, with a wide scope for adoption and extension. The experimental electric iron-ore smelting furnace at Trollhättan was built and carried on at the instance, and at the expense, of the Jernkontoret, in Stockholm. It was rather a novel venture on the part of this excellent institution; but the results have already shown how correct was the view which the Jernkontoret from the beginning took of this new process.

The following details of the further development up to the present date of iron-ore smelting by electric energy in Sweden were given by one of the Jernkontoret's mining engineers, Mr. J. A. Leffler, at a meeting held there on May 28, 1915.

It is highly interesting to trace the development of electric iron-ore smelting from the small experimental furnace at Domnarfvet (1909), through the larger, but still experimental, furnace at Trollhättan, to the furnace now in course of construction at the Söderfors Works. The first-mentioned utilised about 500 kw.; the Trollhättan furnace ran with a load of about 1,900 kw.; the Hagfors furnaces, with a load of about 2,200 kw., and the large furnace (electro-metal type) at Domnarfvet, with about 3,000 kw. The one now being built at Söderfors, however, will, in the first instance, be constructed for the absorption of 4,500 kw., and afterwards, some necessary alterations as regards the electrodes having been effected, probably of 6,000 kw., for which amount of energy the shaft has been dimensioned.

The arrangement of the smelting-chamber in the latest type of furnace presents several new features. At the bottom and up part of the sides there is now a layer of closely-packed crushed coke or electrode fragments; between the arch and the neck there has been placed a water-cooled ring, which serves as the terminus of the arch, and on the top of the arch, as a protection against pressure from within, there is now used a covering of steel plate, which, again, is connected with the plating of the bosh and smelting-chamber.

It is reported that at the Hagfors Works, in the construction of a new arch at furnace No. 2, and in the repair of the upper portion of the walls of the smelting-chamber, bricks, &c., costing £78 were used. The relaying of a 12 in. thick arch at Trollhättan took 130 hours from the current being switched off until it was switched on again; 10 bricklayers and six labourers were employed for the work, bricks and other material cost £55, and the labour amounted to £29. The last relaying at Trollhättan took 684 hours (from October 31st to November 29, 1914); there were used bricks, electrode waste, tar, &c., costing £278, labour amounted to £213, the repair altogether consequently costing £491.

Another great forward stride is in connection with the circulation of the gas by means of Jaeger fans. By using these or similar fans the circulating amount of gas per unit of time can be kept constant, which is a decided advantage for the working and its economy. The gas is drawn from the top of the furnace, cooled, washed, and then a portion of it is forced into the smelting-chamber to effect the reduction of the ore. The average production of pig-iron when the furnace was running with a load of rather more than 3,000 k.v.a., was normally 250 tons per week with a consumption of charcoal of 77 cubic ft. and a consumption of electrodes of 15½ lb. per ton of iron.

The newest electric iron-ore smelting furnaces are all surrounded with houses of reinforced concrete or iron, which also marks a distinct progress in construction; from electrical considerations it may be advisable, as has been done at Söderfors, to use reinforced concrete round the lower portions of the furnace. It is, however, a question whether the induction currents which arise in the reinforcement of the concrete may not cause the iron to rust, and thus weaken the structure.

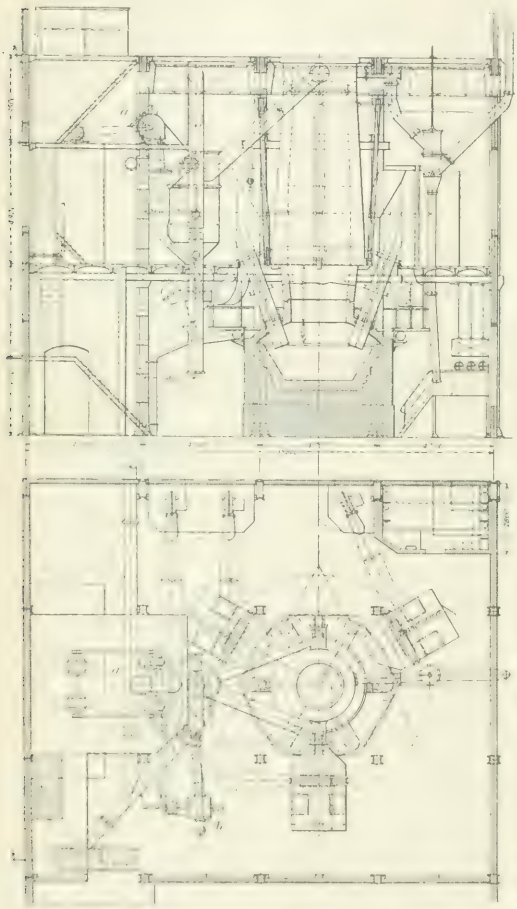
As to the manner of suspending the shaft, different methods are being adopted. At Domnarfvet and Söderfors the same system is being followed as at Trollhättan—that is, the house itself is being used as supporting foundation. At Hagfors, on the other hand, the shaft rests upon a separate and independent iron construction. Both systems no doubt have their advantages and their drawbacks. Should preference be given to the one of them, it would probably be to that used at Hagfors, inasmuch as it makes the furnace and the house round it free and independent of one another.

We will now proceed to give some details concerning the furnace (Elektrometall type) at Domnarfvet, those at Hagfors and the large new furnace at Söderfors.

Figs. 1 and 2 show how the fine ore is conveyed. The charcoal and iron ore are hoisted up by means of a traverse. The

* From "Engineering," slightly abbreviated.

ore is crushed in a Gates crusher to pieces of 60 mm. (2·4 in.) size; the crusher is worked by a 60 H.P. electric motor. The three transformers (Fig. 2) are each of 1,500 k.v.a. capacity, and have been supplied by the New United Electric Co., of Ludvika. They are placed immediately against the furnace and are cooled with air. The electric energy is received as three-phase current of 6,800 volts and 60 periods, and runs up to a maximum of 226 amperes. By hand regulation it is transformed down to 60 to 120 volts. From each transformer proceed eight copper bars, four for each electrode, measuring 125 mm. by 15 mm. (5 in. by 0·6 in.). From each bar, again, proceed eight 22 mm. copper cables (259 wires, 0·75 mm. diameter), and there are thus 32 cables for each electrode. The cables are wedged firmly into their terminals. The six carbon electrodes are round, of 600 mm. (24 in.) diameter. Each phase can be uncoupled independently of the other two.



Figs. 1 and 2.—Arrangement of Furnace at Domnarfvet.

[illegible] gas-cleaning plant are installed two Enloping fans (one in reserve) and one Jaeger machine No. 8, respectively *a* and *b* in [illegible] Figs. 1 and 2. The Enloping fans are worked by belting, each from its 35 H.P. electric motor, with three-phase current [illegible] 1,200 to 1,500 revolutions; by means of [illegible] high number of revolutions can be varied from 900 to [illegible] With [illegible] the gas is pressed at 15 lb. per [illegible] square inch. From the Enloping fans the [illegible] pass to the Jaeger [illegible] gas pipe 300 metres [illegible] 1,000 ft.) in diameter, to the [illegible] boxes, &c. The [illegible] is [illegible] by means of an electric motor, like those just referred to. In both gas-pipes from the gas outlets water [illegible] is supplied by means of [illegible] water pipes, four for each pipe with 5 mm. holes.

The electric iron-ore smelting plant at Hagfors comprises at present three furnaces, a fourth furnace being in course of construction, and the common furnace-house will be made so as to be able to accommodate a fifth furnace. Fig. 3 is a vertical section through furnace No. 1. This furnace was started on March 15, 1912, furnace No. 2 in the beginning of August the same year, and furnace No. 3 in the spring of 1913.

The requisite charcoal for the use of the furnaces is stored in three charcoal-houses, into which it is discharged direct from the railway waggons. The height of the fall in the charcoal-houses is 5·3 to 6 metres, and their capacity to level of rails 48,000 cubic metres; by further filling up, with horses, an additional 20,000 cubic metres can be stored, or about 1½ times the present annual requirements for three furnaces—namely, 20,000 tons of 80 cubic ft. The charcoal is conveyed to the top of the furnace by means of a rope railway. The working of the charcoal baskets is almost entirely automatic. The capacity of the rope railway is calculated at 4,200 cubic feet per 24 hours.

The ore arrives in railway waggons, which are discharged direct into a coarse crusher. Roasting of the ore does not take place. The coarse crushing of the ore is done by a Blake crusher, with 490 mm.

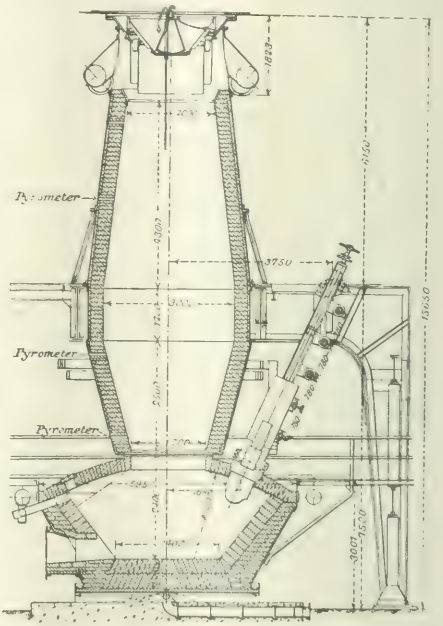


Fig. 3.—Arrangement of Furnace No. 1 at Hagfors.

by 620 mm. (19 in. by 24 in.) mouth; the finer crushing is done by two crushers, one making 250, the other 215, strokes per minute. The crushing plant is worked by an 80 H.P. electric motor, and the capacity is 30 tons per hour when all the crushers are going.

For the working at Hagfors electric power is derived from the power mains of the Uddeholm Company (power stations at Forshult 15 km., and Malta 5 km., distant, further power stations being in course of construction at Knon and Nain). The energy is three-phase alternate current of 25 periods and 12,000 volts. All the motors are for 190 volts.

For each furnace there are installed three water-cooled oil-insulated transformers of 1,000 k.w.a., one for each phase (two round electrodes of 600 mm. diamter per phase). From each transformer proceed eight copper bars (four for each electrode), 200 mm. by 10 mm., which, without any cable connection, are attached to the electrode contacts. The low voltage, 50 to 100 volts in eight steps, is regulated by hand by means of special regulators.

Water of 10 metres (33 ft.) natural head is supplied from a 200 mm. (8 in.) main pipe for the three furnaces at present in operation. When all five furnaces are complete, a pipe of 300 mm. will replace the present one. The branch lines to the furnaces are 125 mm. in diameter.

The furnaces Nos. 1 to 3 have the shafts suspended on an iron

frame with four legs and of 7·5 metres (25 ft.) height; the furnaces Nos. 4 and 5 will be suspended in a similar manner, but the iron structure will have three legs. The bottom base for the latter two furnaces will consist of a moderately reinforced concrete block, the upper surface of which lies 1 metre beneath the level of the ground.

Furnace No. 1 has a bowl-shaped smelting chamber; the others are cylindrical. The furnaces are encased in plates over all; the smelting chambers are built of basic Ifö bricks; in the bosh Stabbarn bricks are used, and in the shaft Höganäs bricks. The top is not bricked in. All the furnaces have Tholander charging-measures. The measures are lifted by means of an electric winch, of a lifting speed of 0·15 metre per second. The motor is an encased 4 H.P. motor. Each furnace has two gas outlets of 500 mm. (20 in.) diameter and a 300 mm. gas-torch. The gaspipes are swept by means of water, supplied by a high-pressure "Gamma" pump of 500 litres per minute capacity, with 50 metres pressure-height; the pump is direct-coupled with a 9 H.P. motor, and makes 1,400 revs. per min.

From all the furnaces a connecting 700 mm. (28 in.) gaspipe goes to the Martin works; each furnace can be shut off from this pipe. For the gas circulation there are installed two fans, with water injectors (one in reserve); these fans each make 1,000 to 2,000 revolutions, using 10 H.P. to 20 H.P., and, with 2,000 revolutions, give 3,000 cubic metres of gas per hour against a counter pressure of 350 mm. of water.

The slag is tapped into funnel-shaped cast-iron moulds in blocks of 1,300 kg., and is then, by a traverse, lifted into railway wagons and tilted into the lake. The pig-iron is tapped into ingot moulds and raised by means of a traverse.

The houses surrounding the furnaces Nos. 1 to 3 are of brick, whilst the house round the furnaces Nos. 4 and 5 will be an iron construction, with 10-in. brick filling, 5 in. on the top. The roof supports are of iron, and the roof of corrugated iron. The cost of construction of furnaces Nos. 1 to 3 at Hagfors is given in the tabular statement annexed.

For three furnaces 48 men are required, and wages per ton were, for the year 1913, 3·85s. The corresponding figures for the year 1912 at Blästerhyttan blast furnace were 7·25s. for Bessemer pig-iron, and 7s. for Martin pig-iron.

At present there is an electric ore-smelting furnace (Elektrometall-type) in course of construction at Söderfors, of which installation sections are given in Figs. 4 and 5. The charcoal is conveyed to the furnace-top by means of a rope railway (speed, 0·65 metre per second), which was previously in use at the Blästerhyttan blast-furnace. The ore will be conveyed in the same manner as at Hagfors.

The electric energy will be supplied by the power-station at Elfkarle, three-phase alternate current, 50 periods, voltage 20,000 volts at the power-station, which at Söderfors has gone down to 18,000 volts. In three water-cooled oil-insulated transformers, each of 2,300 k.v.a., the voltage is reduced to 50 to 100 in eight steps. Each transformer has 12 bars (300 mm. by 12·5 mm.) of copper, which, through re-coupling, may be converted into eight, four for each electrode, and which are direct attached to the copper contacts of the electrodes. The six charcoal electrodes have a diameter of 700 mm.

Cost of Construction of Hagfors Furnaces Nos. 1 to 3.

Building	£11,800
Furnaces	12,300
Electrical transformers with requisites, lighting	14,200
Charcoal and ore transport arrangements, cranes and traverses	5,600
Crushing plant	1,900
Water pipes and pumps	950
Putting ground in order, railway lines	1,930
Loose fittings, &c.	102
Instruments, not electric	170
Drawings, engineers' fees, &c.	1,840
Total	£50,342

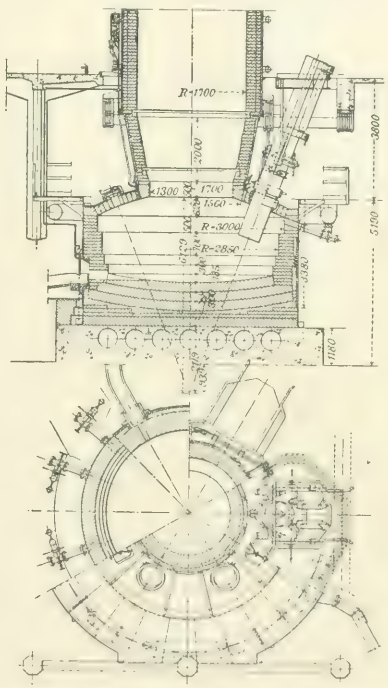
The smelting chamber stands on a concrete base, perforated by seven circular air-passages. The shaft is suspended from a girder construction. Both the smelting-chamber and the shaft are plate-mantled. The arch of the smelting chamber is attached near the neck with a water-cooled ring.

For the gas circulation, two ventilators are being installed (one in reserve), of the Zschocke system, and a Jaeger fan. The ventilators each have a capacity of 80 cubic metres per minute, against a pressure of 100 mm. of water. The motor is direct-connected to a three-phase commutator motor of 20 H.P., and the speed, capable of being regulated between 700 and 1,400 revolutions, is chosen by means of a reserve ventilator to an output of 20 H.P. and 1,420 revolutions, the number of revolutions by means of a commutator regulation, being capable of being regulated down to 700. The Jaeger fan is worked by toothed gearing from a [illegible]

like the one just referred to, and has a capacity of about 80 cubic metres of gas per minute. It is constructed for a maximum counter-pressure of 750 mm. (30 in.) of water, and can be adjusted for respectively 60, 120, 180 or 240 revolutions.

The gas leaves the furnace through an outlet of 800 mm. diameter. The slightly-sloping gaspipe from the outlet is swept by a water-spray. The continuation of the gaspipe is 1,000 mm. (40 in.) interior diameter; it first proceeds straight downwards, and afterwards ascends, ending in the water receptacle and water trap. In the descending and ascending branches are placed 20 centrifugal water-spreaders, which produce umbrella-shaped water-sprays across the pipe section. From the ascending branch the gas is drawn by one ventilator, where it is further cleansed with water and is then driven into the water-separator (or remover). On the pipe between the water-scrubber and the Jaeger fan is an outlet for the gas to the Martin works. The circulating gas is driven by the Jaeger fan to a ring-drum (500 mm. in diameter), and further into the smelting-chamber.

The pig-iron is run into ingot moulds, being raised by means of an electric travelling-crane of 5 tons capacity and with 10 metres span. The crane has three motors, and is fitted with lifting-hook and electro-



FIGS. 4 AND 5.—ARRANGEMENT OF FURNACE AT SÖDERFORS.

magnetic appliances. The lifting speed is 6 metres, the longitudinal speed is 75 metres, and the cross speed 20 metres per minute.

The house is being built of reinforced concrete to the level of the electrode floor, and above that as an iron construction, with 150 mm. brick fill. The roof is of corrugated galvanised iron.

The charcoal-house at Söderfors is of some interest. The length is 100 metres; breadth, 32 metres; its capacity is about 8,700 tons. The house frame is built of wood; roof and walls of corrugated plates. Two railway lines run through the house on supports of reinforced concrete, and 7 metres above the level of the ground. The charcoal is fed [illegible] emptied on to a transport band; this is 400 mm. broad, and moves with a speed of 0·35 metre per second, transporting 8 cubic metres per hour. The band delivers the charcoal to a shaking-sieve, which [illegible] a pocket, from where it is emptied into the baskets. The dust from the [illegible] by means of a band elevator to another transport band 250 mm. broad, and running at a speed of 0·25 metre per second, which discharges it in dust-pockets. The house is of an unusually strong construction.

DIRECT-CURRENT CONTROL FOR HOISTING EQUIPMENT IN INDUSTRIAL PLANTS.*

BY W. T. SNYDER.

Summary. In selecting a controller for application to various types of mill-machinery all the conditions must be considered, such as the class of operator, conditions of location, operation and maintenance, relative importance of reliability, simplicity, cost and repairs, and initial cost. These points are illustrated by three different types of control as applied to a blast-furnace skip hoist, to a high-speed coal hoist, and to a slow-speed ash hoist.

It is the purpose of this Paper to describe briefly the controllers on a few different types of hoisting equipment, and point out some of their advantages and disadvantages, also to point out what are good points to be desired, as well as the undesirable features to be avoided in selecting a controller for the different classes of service.

Blast-Furnace Skip Hoist.

A description of a particular skip hoist and controller is given below. Fig. 1 showing a general arrangement of the skip, cars and hoist. The hoist is driven by a 175 H.P., 300 revs. per min., 230-volt, compound-wound continuous-current motor, geared to two drums, each mounted on a common shaft. One of these drums winds up the hoisting cable while the other is unwinding, one car being at the top of the incline while the other is at the bottom.

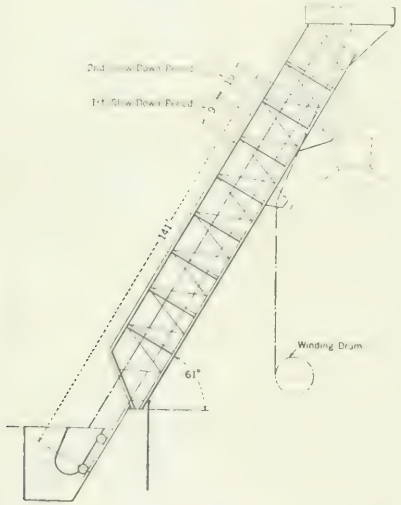


Fig. 1.—Skip Hoist for 500 ton Blast Furnace.

When the power is shut off the hoist, a solenoid-operated band brake is automatically applied. The solenoid is shunt-wound and is energised by the closing of the reverse switches, and released upon their opening. The amount of power and time required through an operating cycle is shown in Fig. 2.

As shown on the curve, which was taken under normal operation, the time required to hoist the car to the top of the furnace and dump it is 40 seconds. If for any reason faster charging is desired, this time can be reduced to 33 seconds per trip by adjusting the accelerating relay to shorten the time for acceleration, and also, by making a slight adjustment, to have it automatically inserted in the shunt field circuit immediately following the last point of acceleration, and to cut out again just before reaching the normal slow-down point. When coke is being hoisted it is necessary to make the necessary adjustments to allow the hoist to operate at normal speed. Should the brake ever become hot for any reason, such as a descending car stopping on account of derailment, broken axle, &c., before it reaches the bottom, or in case of the duplex cable should break, the magnetic brake will open an electrical contact which will immediately cut off the power and the motor cannot be started.

To the lower drum shaft is geared a contact arm which travels over a series of fixed contacts that control some of the operations of the main controller after the operator, who is located 40 ft. away, throws on the master controller to start. To the motor shaft is connected a small generator, the voltage of which varies with the speed of the hoist up to 70 volts maximum. Across the terminals of this generator is connected a relay which varies the resistance that is connected in multiple with the armature of the hoist motor at the slow-down point. This is accomplished by adjusting the relay so that it will operate, when a load of coke or an empty car is being hoisted, and cut out at this point a section of the resistance that is connected in multiple with the hoist armature. When a heavier load is being hoisted, the speed of the hoist is reduced, in consequence

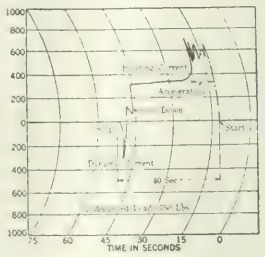


Fig. 2.—Skip Hoist—One 175 H.P. Compound-wound Motor, 230 volts, 300 revs. per min., 654 amperes.

of which the voltage from the small generator is not high enough to operate the relay, and all the resistance is permitted to be in circuit across the terminals of the hoist armature, thereby producing less retarding effect at this point. While the permissible overtravel is 28 in., the actual variation in the stopping point, with this simple slow-down arrangement, does not exceed 5 in., and is due to the slip of the brakes on the various weights of load.

A simplified wiring diagram of the connections of the motor and controller, and a chart showing the sequence of operation of controller switches is shown in Fig. 3. This controller is located in the same building as the hoisting machinery. It is inspected and given any necessary attention the same as all other electrical apparatus.

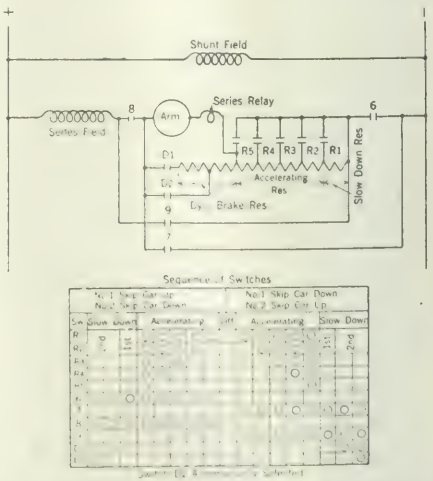


Fig. 3.—Scheme of Main Connections for Skip Hoist.

During the past four years, the entire electrical equipment in connection with this skip hoist, including motor, controller and wiring, has caused a stop of 35 minutes on the furnace, and was due to paralin running out of a relay coil and getting on a secondary contact, thereby insulating the contact and causing the controller to fail to start. Most of the time was spent in hunting the trouble. With proper arrangement of terminals this fault could have been found by test in a very short time.

When it is considered that the skip averages 16 trips per hour seven days each week, and that the controller goes through the

* Paper read before the American Institute of Electrical Engineers.

different operations of the cycle each time entirely automatically; accelerates, slows down and stops, with no further attention after it is started by the operator closing the master switch, the degree of reliability that can be obtained with a modern controller is evident.

The master switch being located remote from the main controller and hoist apparatus makes it inconvenient to manœuvre the hoisting machine when changing or adjusting cables. This objection was overcome by providing simple hand control in the hoist house, consisting of several small knife switches connected to the main controller. A single-pole, double-throw knife switch operates the reverse contactors: another single-pole, single-throw knife switch operates the accelerating switches, and another switch of the same type operates the slow-down contactors. This arrangement, in addition to convenience in manœuvring the hoist, permits the electric repairmen to try out the main controller after any adjustments or repairs without being required to signal some person to operate the master switch. The scheme has the advantage over a duplicate master switch in that any operation of the main controller can be performed out of its regular order.

To prevent the car from approaching the stopping point at a dangerous speed, a relay is provided in circuit with the hoist armature and retarding resistance, that will operate to cut off power and apply the band brake should the circuit through the motor retarding resistance not be made at the proper time.

A blast furnace can produce continuously a certain amount of iron which has a certain value dependent upon market conditions. The maximum possible output under best possible conditions would, while these conditions remain unchanged, result in 100 per cent. output. Certain conditions arise, however, which require that the rates of melting be reduced and which results in loss of production commonly and erroneously termed delay.

A decrease in the rate of the melting process results not in delay of production but in curtailment of production, and should be referred to as a loss in tons of iron or in units of monetary value, and not as a delay in units of time. The same reasoning does not necessarily apply in departments using the product from a blast furnace.

In the case of an open hearth department depending entirely upon iron from the local blast furnaces, a shut-down is not necessarily a curtailment of production. As long as there is storage for the blast furnace production during a shut-down of the open hearth department and there is sufficient open hearth capacity to absorb the stored iron along with the normal output from the blast furnace, the stop could be properly termed a delay in production which would be regained later and would not necessarily represent a monetary loss in so far as production is concerned.

On the other hand, if there is always an abundant supply of iron and a demand for the open hearth product, a halt in operation in the open hearth department would be a curtailment of production and a monetary loss.

Therefore a failure of auxiliary equipment in any department beyond the blast furnace may result in a delay of production or a curtailment of production, dependent upon conditions. But a failure of auxiliary equipment of a blast furnace that causes a reduction of the melting rate is almost invariably a curtailment of production and a monetary loss that cannot be recovered.

Thus it follows that in selecting auxiliary equipment for a blast furnace the feature most desired is reliability. In selecting a skip hoist controller the requirements are in the following order:

1, Reliability; 2, maintenance; 3, depreciation; and 4, initial cost.

Reliability.—The detail parts of the controller should be as few as practicable in order to have a minimum number of possible sources of trouble. There should be enough switches to limit the accelerating current to a value that will not be harmful to the motor or other parts of the equipment. Four accelerating switches, thus giving five steps of acceleration, are ample.

Main contacts should be self-cleaning to prevent excessive arcing and burning. Arcing [illegible] accumulation of insulating particles that may come from the atmosphere, or elsewhere.

Usually there is heavy electrically-driven machinery operating near blast furnaces that causes line voltage to fluctuate widely, and shunt-wound switches, designed for 230 volts, particularly for skip hoist controllers, should be designed to operate successfully on any voltage between 175 and 270. The complete controller and its wiring should be so designed that a deposit of conducting dust, that is common in the atmosphere about cables, [illegible] cause grounds, short circuits, or sneak circuits.

Skip hoist controllers have in many cases been unnecessarily burdened with elaborate and complicated schemes for obtaining smooth, uniform acceleration, and cut-off point confined within very narrow limits. This is sometimes a very desirable accomplishment for a skip hoist controller to have, but the apparatus necessary for the accomplishment introduces complications and chances for trouble that very materially lessen the reliability of the controller, and the necessity for this close regulation should, whenever practicable, be avoided. A skip hoist controller with which the writer is familiar was originally designed with retarding resistance graduated in about 50 steps, which, by means of regulating apparatus, could be varied to keep the motor speed practically constant from no-load to full load (that is, empty car to load of ore or limestone), through the slow-down period which gave a minimum variation in the stopping point. It was found that a perfectly satisfactory slow-down effect could be obtained with the use of but two steps of retarding resistance. While regulation is not as close as with the original scheme, it answers all requirements and is very much more simple and reliable.

Since operating a skip hoist is only one of numerous duties devolving upon one man, it is essential that the controller, after being started, performs all of its functions accurately, accelerating, retarding, and stopping automatically. All reasonable protection should be provided, including overload, no-voltage, open shunt field, slack cable cut-out, overspeed, overtravel, and provision to cut off power and apply the mechanical brake in case of failure to complete the circuit through the armature and slow-down resistance.

Resisters.—The resister to be used with a skip hoist controller is seldom given sufficient consideration, and for this reason it is very often a greater source of trouble than the controller, and invariably gives more trouble than it should. As the resister has equal responsibility with the controller proper, and one is useless without the other, they should be given equal consideration. It is important that the resister has sufficient carrying capacity to limit the temperature rise to 50° C. High temperatures will in time deteriorate any insulation now known to the art, and the result will be an ultimate breakdown.

Alternate heating and cooling of the resister result in loose connections, fatigued material, oxidation, broken grids, open circuits, short circuits, grounds, &c. The more frequent the alternations and the wider the temperature range the sooner will come one or the other of the above-mentioned failures. Cast iron is not a desirable material for resisters because of its fragility. Mica is not a desirable insulation for resisters because of its mechanical weakness and rapid deterioration under certain conditions, such as heat, moisture, &c.

Another weakness in banks of cast grid resistors and one that gives more trouble than any other is the multitudinous number of joints, each grid being afflicted with from two or four joints, one on either side of the lugs.

Wiring.—Too much emphasis cannot be placed on the importance of using the best materials and first-class workmanship in installing the secondary wiring of the controller itself, and from the controller to the master switch, &c., particularly in connection with a skip hoist controller. For 250-volt work, wire made for 1,500-volt working pressure should be used. Secondary wiring should be extra flexible, and no wire smaller than No. 12 should be used. Care should be taken not to run wires connected to high resistance relay coils in the same conduit with wires subjected to high induced voltages, which may cause improper action of the relays.

Maintenance and Depreciation.—All parts that are subject to renewal should be easily accessible for inspection, repairs and renewals. Spare parts should be as few as possible. This can be done by making all magnetic switches, all secondary contacts, &c., duplicate of each other. The terminals of all main and secondary wiring should be plainly marked and be so arranged to simplify tracing or testing in case of trouble.

A controller that is reliable and easily repaired and maintained will not be subject to depreciation; its life will be determined by obsolescence brought about by changed conditions. Unless there is a change in the design of the blast furnace or skip or some condition arises that renders the controller useless, it will give the same satisfactory service indefinitely.

Cost.—In selecting a controller for a blast furnace skip hoist, the purchase price should be the last consideration. A controller that would not be dependable seven days in every week should not be accepted at any price, one more dependable could be obtained.

High-Speed Coal Hoist.

An outline diagram of a high-speed hoist, the control equipment of which will be considered, is shown in Fig. 4. This is a double hoist, each being capable of hoisting 100 tons of coal per hour, with a grab-bucket of 70 cubic feet capacity, weighing 6,200 lb. empty. The average weight of coal per lift is 1¼ tons, making a total average load of about 9,000 lb. Each hoist is driven by a 300 H.P., continuous rating, compound-wound, 500 revs. per min., 230-volt, continuous-current motor, which is geared to a drum on which is the

closing cable. To this drum through a solenoid-operated friction clutch is connected the shell cable drum.

The solenoid which operates the friction clutch is controlled by a push-button switch in the handle of the operator's master-controller. After the bucket is closed and the stress on cables is equalised, the friction clutch operates, connecting shell and closing cable drums together. While the bucket is being hoisted, the sheave carriage is moved by an auxiliary drive up an incline, the path of the bucket describing a parabolic curve, the total vertical lift being 128 feet.

When the bucket reaches the dumping point the friction clutch is released, a band-brake, operated by foot lever, is applied to the shell drum, power is applied to the motor and closing cable drum in the reverse direction, and the coal is dumped into a chute, and the bucket continues lowering and moving down the incline at the same time. The hoist motor is retarded by dynamic braking, with the shell and closing cable drums locked together and the bucket in the open position.

The actual time required to complete a round trip is 37 seconds. The permissible time per trip based on 100 tons of coal hoisted per hour and 1¼ tons per lift is 45 seconds. The power and time required for the complete cycle of operation is shown in Fig. 5.

A simplified wiring diagram of the hoist motor and controller is shown in Fig. 6. The magnetic switches on this controller have a continuous rating of 1,000 amperes, and have given very satisfactory service for five years. The master controller, mains controller and motors are located as shown in Fig. 4. The resister is located in an enclosure separate from the controller house.

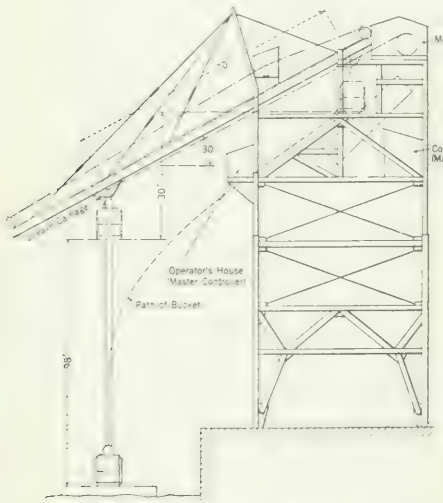


Fig. 4.—Coal Hoist.

On this kind of service it is important to keep all electrical equipment, particularly a magnetic controller, in an enclosure where it can be kept clean. Coal dust being a non-conductor will only be troublesome due to lodging on secondary contacts and insulating them, and by getting into moving parts of magnetic control apparatus; aside from this, it will do no particular damage except that precaution should be taken to prevent coal dust from accumulating in enclosures in which there is electrical apparatus, particularly in controller rooms, for the reason that arcing is liable to cause a conflagration of the dust.

Experiments that have been made by the U.S. Bureau of Mines [illegible] explosion with disastrous results. This feature should be kept in mind when installing electrical equipment of any kind about a coal-hoisting or crushing plant.

[illegible]

needed. To devise a controller for an equipment of this kind that would be proof against a careless or incompetent operator would be impracticable if not impossible. The only protection necessary, as has been proved by five years' operation, is current-limit acceleration and overload protection.

As stated, there are two duplicate equipments on a common structure operating as one unit, hoisting coal from the same boat. To provide against heavy current surges on the transmission line and power plant, the hoist controllers were interlocked electrically to prevent both hoisting at the same time, but allowing one to hoist while the other is lowering. In addition to the benefits that were expected, this arrangement has resulted in lower maintenance cost

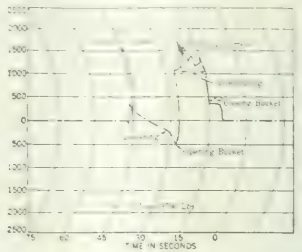


Fig. 5.—Coal Hoist—One 300 H.P. Compound-Wound Motor, 220 volts, 300 revs. per min., 1,050 amperes.

on the hoisting plant, brought about by more even stresses on the structure, and a more even pace on the part of the operators, there being less tendency to reckless operation, since one operator cannot hurry unless the other operator does likewise, and one cannot slow down without affecting the other. The result is that capacity is maintained while stresses on the hoisting equipment and structure, transmission lines and power plant, are much less severe. This arrangement also permits of a more efficient use of the transmission copper.

Since an equipment of this kind must necessarily have some reserve capacity, there is usually sufficient time during the working turn to do all ordinary repair and maintenance work. We therefore

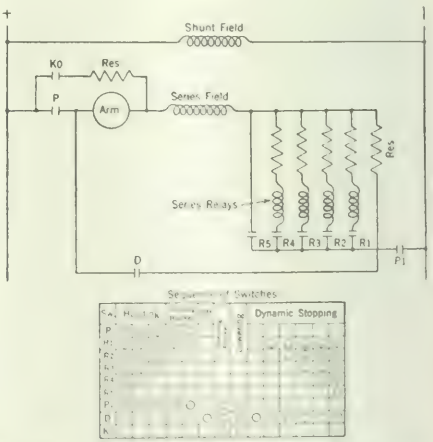


Fig. 6. Scheme of Main Connections for Coal Hoist.

attach less importance to continuity of operation for service of this kind, and give the matter of repair and maintenance cost, together with the initial cost, more consideration than if we were selecting a skip hoist controller.

The controller and its wiring, for service such as just described, should be easily accessible, simple in adjustment, and free from delicate refinements, so that the operator can make the necessary adjustments and locate and correct all ordinary defects and failures in order that delay and expense of having to send for other more skilled help be kept to a minimum.

The so-called series-switch would not be suitable for this class of service for the reason that selective speed points are desirable both in hoisting and lowering.

Referring to Fig. 5, it will be noted that to accelerate about 1,400 amperes are required for a period of about 7·5 seconds, and only about 1,100 amperes for three seconds are required after the accelerating resistance is all cut out until power is cut off. The accelerating resistance therefore is in circuit about 75 per cent. of the total time that the motor is hoisting, and it is in circuit about 20 per cent. of the total time required for a complete operating cycle.

The accelerating resistance for this work should therefore have a capacity of 1,000 amperes continuously with a temperature rise of 50°C. if it is to give satisfactory service. A resistor so designed would prevent excessive heating in normal operation and prevent burn-out in case of accelerating switches failing to close and leaving part of the resistance in circuit. With this rating, the saving in repairs and maintenance over a period of years would pay a handsome return on the additional investment necessary over what would be required for a resistor that would ordinarily be supplied for starting a 300 H.P. motor at full-load on a 35-second operating cycle.

It would be conservative to say that no steel plant is free from trouble and expense incident to accelerating resistance of insufficient current-carrying capacity, and that in a great many cases the repair and maintenance cost of the resistor alone, neglecting the expense and interruption to plant operation incident to resistor burn-outs, would justify the expense of replacing the troublesome resistor.

Slow-speed Automatic Ash Hoist.

The equipment to be considered here is used for hoisting ashes from a gas-producer pit and dumping into a car on an elevated track, the general arrangement of the hoist being shown in Fig. 7. The controller was designed to be operated by men who wheel ashes from the gas-producer, it being only necessary for them to push a button and the bucket of ashes is hoisted and dumped, and the bucket returned to the loading position without further attention. A simplified wiring diagram and sequence of switches are given in Fig. 8.

Without the automatic controller the man who would operate the hoist would have to be more skilled and be paid a higher wage rate than would a man who was only required to wheel ashes. This

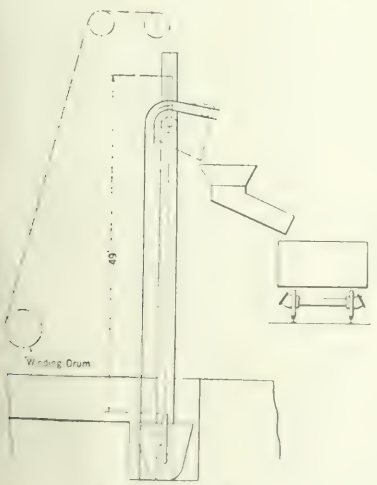


Fig. 7. Ash Hoist

feature alone would justify the installation of the automatic controller. Thus the possibility of an incapable operator damaging the hoisting apparatus is eliminated. The possibility of a properly designed automatic controller failing is very remote, as is evidenced by the record of failures referred to in our description of a blast furnace skip hoist automatic controller.

It will be noted in Fig. 9 that nearly double the time is required to lower than is required to hoist the bucket. The reason for this is that the operator elapse from the time that the full bucket is hoisted up until the man returns with a barrow of ashes for the next empty bucket. Advantage is taken of this time, and the bucket is allowed to return all the way down on very low speed in order to reduce wear and tear on the apparatus and simplify the control.

The requirements of a controller for this service would be about similar to that of a blast furnace skip-hoist controller, in that it should have every protection to avoid damage to the hoisting equipment and that it should function positively and accurately. These features, together with maintenance and initial cost, should be given most consideration. Continuity of operation although desirable is not absolutely essential, as is the case with a blast furnace skip hoist controller.

A controller for this service should be enclosed to prevent its being tampered with. All repairs and adjustments should be made by a competent electrical repair man. The accelerating resistance should carry full load current continuously with normal temperature rise to

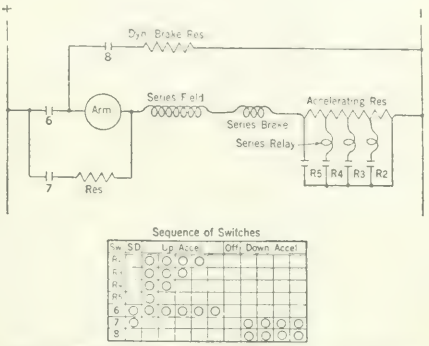


Fig. 8.—Scheme of Main Connections for Ash Hoist.

avoid excessive heating in case the accelerating switches fail to close and allow part of the resistance to remain in circuit.

Conclusion.

For applications similar to a blast furnace skip hoist where failure of auxiliary equipment is liable to cause a dead loss in production, the matter of reliability and continuity of operation is a necessity, in relation to which all other requirements are of secondary importance. The initial cost of a controller for this service should be a last consideration.

Where conditions are similar to those of the high-speed coal hoist that we have considered, where an ordinary delay does not affect plant operation, and where the operator, since he must be skilled to a certain degree to operate the equipment, could also take care of all ordinary repairs and maintenance of the electrical equipment, the questions of simplicity, repairs and maintenance, and initial cost should be given most consideration, the matter of continuity of operation, while desirable, is not a first consideration.

Applications similar to the slow-speed ash-hoist which has been considered and which is to be operated by unskilled labour, require that the controller perform its functions positively and accurately, and have all protective features necessary to avoid damage in all cases to the apparatus which it controls.

Where the controller is designed for automatic acceleration, to provide against accelerating switches failing to close and leaving part of the resistance in circuit and on manually-operated controllers where the accelerating period represents 10 per cent. or more of the

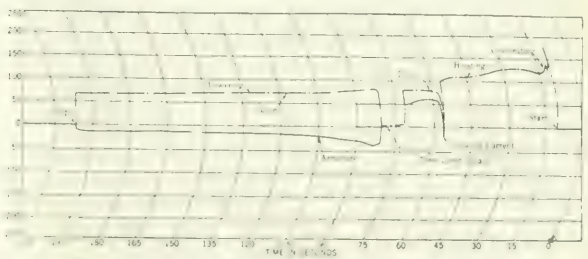


Fig. 9.—Ash Hoist—One 25 H.P. Compound-wound Motor, 550 revs. full mins., 250 volts, 101 amperes.

complete operating cycle, the resistor should have carrying capacity equal to that of its motor with a maximum temperature rise of 50°C.

Protective resistance in series with magnet switches is a possible source of trouble which should, when practicable, be avoided. Failure to short-circuit the resistance prevents the switch from sealing, thereby damaging the switch contacts. Defective resistance if not replaced immediately will result in the burning-out of the switch-coil.

The absence of any attempt at standardising high-resistance units requires very careful attention to ensure always having on hand spare units of the proper capacity and resistance value.

A simplified wiring diagram should be furnished with each controller. On the same sheet should be given all data necessary for obtaining spare parts; either catalogue reference or other means of identification.

Finally, in selecting a controller for a particular application all conditions must be considered, such as class of operator, conditions under which it will be located, operated and maintained, the relative importance of the different factors, such as reliability, simplicity, cost of repairs and maintenance and initial cost, the order of importance of which will be different for different applications.

A careful analysis of all of these factors will help to determine the best controller for the particular application, and whether it should be non-automatic, semi-automatic, full automatic, or manually operated. Generally speaking manually-operated controllers for service above 25 H.P. capacity should not be used on hoisting equipments.

APPARATUS FOR PROTECTING ELECTRICAL MACHINERY AGAINST ABNORMAL ELECTRICAL CONDITIONS.*

BY C. C. GARRARD.

(Continued from p. 544.)

Summary.—The author deals first with the conditions which give rise to abnormal electrical conditions of a transient type, such as those due to switching, arcs and sparks. Methods of suppressing arcs to earth are described. The author then passes on to pressure rises between the turns of electrical windings, and those due to causes exterior to the system, such as lightning. Various protective devices are described, such as water jet earthing resistances, the Moscicki and other condensers, Giles' valve and the more ordinary lightning arresters. In conclusion the question of earth plates is considered.

THE GILES VALVE.

It was shown on p. 996, Vol. LXXII., in connection with horn arresters, that in order to afford adequate protection against surges in the line the series resistance should be low in value, of the order of 50 ohms. Now, with a pair of horns discharging a high voltage current through such a resistance, the danger is present that the current will be suddenly ruptured when it is at, or near, its maximum value instead of at, or near, its minimum value, as in an oil switch. This is one of the most disagreeable features of the horn discharger, as the sudden interruption of such a current may itself set up dangerous pressure rises. For this reason the horn arrester, while affording a certain measure of protection, is by no means a perfect instrument for the purpose in view, and is, in fact, only installed when the question of cost is paramount. An ingenious form of spark-gap arrester, in which this disadvantage has been obviated is that invented by Georges Giles (*see* British patent No. 4,997 of 1909), and is illustrated in Fig. 18.

A diagrammatic drawing of the construction of the Giles valve is given in Fig. 19.

The basic principle is to [illegible] when the pressure rises to the required amount (say, 25 per cent. above normal value). In series with the spark-gap is the [illegible] resistance R, generally of the value of 1,600 ohms. The [illegible] are connected at the discs e^2, e^3, e^4 &c., made of non-arcing metal.

These are separated from each other and from the central [illegible] by [illegible] fibre discs f^1 and f. It will thus be [illegible] e^1e^2, e^2e^3, &c., forming between each other small spark-gaps, while each disc forms with the central rod t a small condenser to earth. The last disc e^5 is directly connected to earth. Fig. 20 illustrates the electrical connections and scheme. Assuming now that e^1e^2 are set so as to jump across at 10,000 volts, the current then flows through R and e^3 and the small condenser formed by e^3 to earth. Owing to the smallness of the current there will be a comparatively small drop in the gap e^1e^2 and R, and e^3 will assume a voltage of, say, 9,500 above earth. But e^4 is still at earth potential, and the consequence will be that there will be a discharge across the air-gap e^3e^4. This is repeated at all the other air-gaps until the bottom disc is reached when the line is directly connected to earth through all the spark-gaps, and the current flowing is limited by R. Now, the effect of having all the spark-gaps and the resistance in series is that directly the voltage falls below the value for which the spark-gap e^1e^2 has been adjusted the current ceases to flow—that is to say, the apparatus is self-extinguishing similarly to the multigap arrester. It differs, however, from the ordinary multigap arrester in being able, by virtue of the small condensers, to be set to operate and self extinguish at a voltage much nearer the normal. The difference between sparking across voltage and extinction voltage is only about

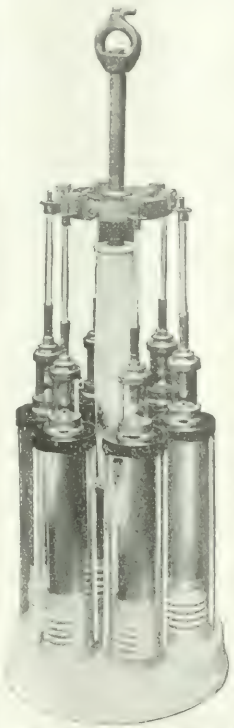


FIG. 18. [illegible] GILES VALVE.

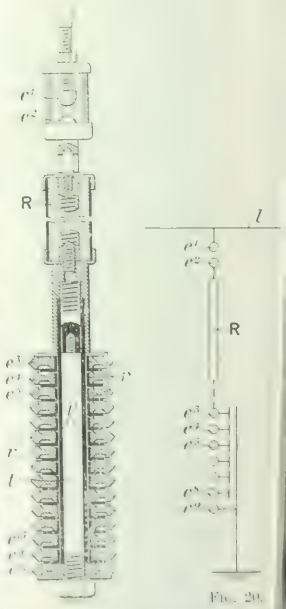


FIG. 20. [illegible] PRINCIPLE OF OPERATION OF GILES VALVE.

8 per cent. If, therefore, the gap be set to jump across at 1 per cent. above normal volts the arc will be extinguished when the voltage falls to 2 per cent. above normal. A setting of 25 per cent. above normal for the jumping voltage is therefore quite safe.

It is, obvious, however, the resistance R, being of 1,600 ohms, that a single column will have very little protective action on account of its small dissipating capacity. A number of columns connected in parallel are, therefore, always used, and the makers state that they can supply valves having an equivalent resistance of as low as 70 ohms. Such a valve, it is obvious, will have very large protective powers against surges.

Horn Arrester with Auxiliary Spark Gap.—On moderate and low voltages, when ordinary horn arresters are used, the gap has to be set very closely, with consequent danger of accident discharge or alteration of calibration due to formation of small

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globules of melted metal. Fig. 21 illustrates a horn arrester (Land und See Kabelwerke) designed to obviate this. The main gap is set at a good distance, say, 1 in., for 5,000 volts. The auxiliary gap, which is provided with an adjustable platinum point, is, however, set to discharge, say, at 25 per cent. above the normal voltage. If any foreign matter gets into the auxiliary gap the resulting discharge soon dies out by virtue of the high resistance in series with it. If the discharge be due to a rise of pressure, however, it will persist and ionise



Fig. 21. Horn Lightning Arrester with [illegible]

the air in the main gap, and cause the same to arc across and relieve the line. By this means a very accurate and reliable setting may be attained.

Carbon Powder Series Resistances for Horn Arresters.—In the last paragraph liquid resistances are recommended for placing in series with the horn arrester. Under certain circumstances, however, a non-liquid type may be preferred. In Fig. 22 is illustrated a horn arrester in series with a Brazil carbon powder resistance made by Messrs. Everett, Edgcumbe & Co. The makers of this arrangement recommend that the

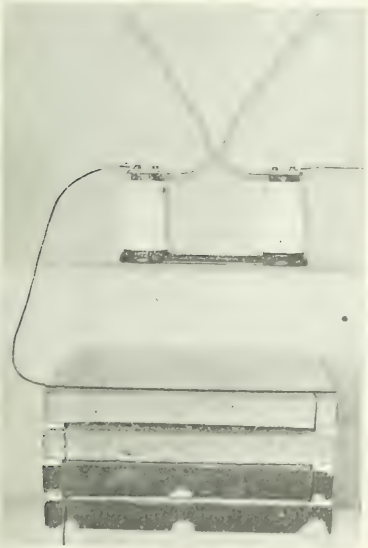


Fig. 22. Horn Lightning Arrester with Brazil Slate Resistance. (Everett, Edgcumbe & Co.)

series resistance should be high enough to limit the current which would flow due to the normal voltage to 1 or 2 amperes. This obviates any danger of surges being set up by the horn-gap discharging, but it is doubtful whether the protection afforded is material. These carbon powder resistances have a negative temperature coefficient, that is to say, the resistance decreases gradually as the current passes. If left in circuit continuously the resistance halves itself in the first 15 seconds, after that the rate of decrease is somewhat slower. Figs. 23 and 24 represent two forms of the elements, which go to the building up of Brazil

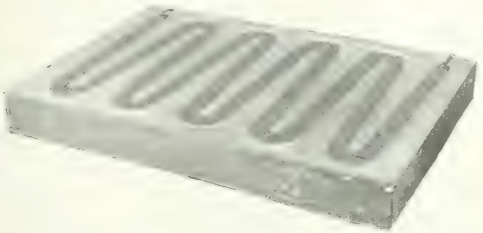


Fig. 23. Brazil Resistance for Low Frequency Discharges (Surges). (Everett, Edgcumbe & Co.).

resistances. It will be seen that the carbon powder is disposed in troughs in slabs of pottery with metal electrodes at either end. This form of resistance is used likewise as an earthing resistance for earthing the neutral points of three-phase systems.



Fig. 24. Brazil Resistance for High Frequency Discharges (Everett, Edgcumbe & Co.)

In Fig. 25 is illustrated a three-phase horn arrester for fixing to a pole. The liquid resistance in this case is comparatively low in value, as the arrangement shown is for use on 500-volt circuit, and consists of three iron-pipe electrodes, dipping into a

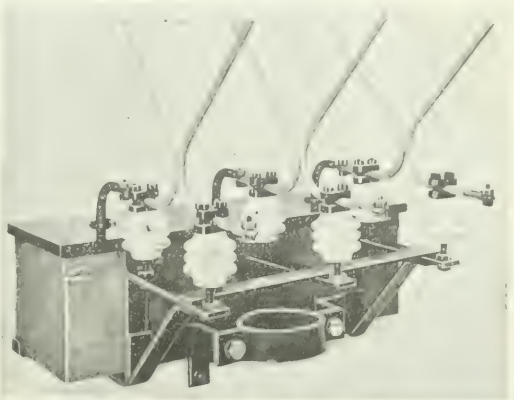


Fig. 25. Three Phase Horn Arrester, with tank form of series liquid resistance, for use on medium tension circuits and arranged for fixing to a pole. (General Electric Co., London.)

soda solution in a galvanised iron tank. The horns themselves are made of galvanised iron rods ½ in. in diameter. In order to prevent evaporation a layer of oil is poured over the top of the solution in the tank.

(To be continued.)

CONTROL OF DIRECT-CURRENT HOISTS IN IRON AND STEEL MILLS.*

BY G. A. STOLTZ AND W. O. LUM.

SYNOPSIS.—The control problem discussed in this Paper is confined entirely to a typical example of a skip hoist. An outline of the conditions existing in the case of this particular application is given in which the load on the hoist is divided into three parts, namely, the friction load, the inertia of moving parts, and the useful work in hoisting the net load. The proper cycle of operations is determined, which in turn determines the required characteristics for the motor and controller, which are together considered as a unit. The details of this direct-current skip-hoist control are described and illustrated.

In this Paper it has been decided to confine our discussion to a typical example of a skip hoist. In order to design control apparatus intelligently for an application of this kind, it is necessary for the engineer to understand fully the function of the various parts of the driven apparatus as well as the operating characteristics of the electrical machinery. We will, therefore, outline the existing conditions of this particular application, and then suggest a control which seems best to meet the definite requirements set forth.

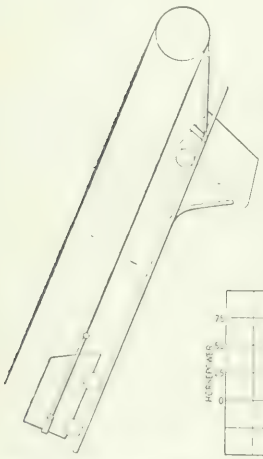


FIG. 1.—SKETCH OF TYPICAL SKIP HOIST.

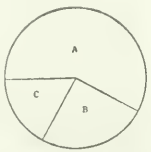


FIG. 2.—CHART SHOWING RELATIVE INERTIA VALUES OF MOVING PARTS.

A—Motor Armature.
B—Drums.
C—Gearing and Rope.

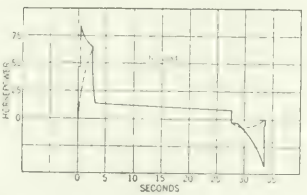


FIG. 3.

[illegible] typical [illegible] which has been selected for consideration in this Paper. The load can be divided into three parts, namely, friction load, inertia of the moving parts, and useful work in hoisting the net load.

The static friction at the moment of starting is, of course, greater than the running friction, but it is a comparatively small item, and with the machine in approximately continuous operation the static friction is not excessive, so that it is ordinary practice not to differentiate between static and running friction in calculating the load cycle. No formula can be used to determine definitely the friction, [illegible] operating conditions.

small, but its high velocity makes it an important item as is indicated in Fig. 2.

The skip will occasionally be operated empty, the cycle being approximately as indicated in Fig. 3. The normal operation of this particular skip is two loads of coke, net weight 3,000 lb. each; two loads of limestone, 3,000 lb. each; two more of coke; and four loads of ore, 6,000 lb. each. This cycle will be varied to obtain satisfactory distribution of the material in the furnace, but is sufficiently near the average operating conditions for our purpose. Occasionally a load of scrap weighing 9,000 lb. will be hoisted, but this is rare and need not be taken into consideration except as an overload for a few seconds. Fig. 4 graphically illustrates the load cycle when hoisting a 3,000 lb. load. During the accelerating period the dash line AB represents the actual mechanical output of the motor, but, since we are interested in the current taken from the line, all energy values will be expressed in the horse-power equivalent of torque. The area enclosed in the triangle ABC represents the energy dissipated in the starting resistors during the accelerating period. This is one-half of the total input while coming up to full speed, as indicated in Fig. 5. It will be noted in Fig. 4 that the initial peak is only 66 H.P., whereas we would naturally expect it to be 105 H.P. This is the result of lifting the top skip off its track.

Before dynamic braking was introduced, with magnetic control, it was necessary to lift the skip 2 in. to 4 in. off the track when hoisting light loads to make sure the heavy loads would rise to a sufficient height to dump. At present dynamic braking can be made severe enough practically to stop all loads at one position. There is nothing to gain by doing this, and the rope is, therefore, adjusted normally to lift the top car off the track a few inches. This utilises the whole car as a counterbalance and helps to land the skips more carefully. When the cars are again started the top skip still acts to its full capacity as a counterbalance and reduces the initial current peak accordingly.

On a vertical hoist the line CB would be straight, the difference in height of the two points being due to the transfer of the weight of the rope from the load to the counterbalance side of the hoist. During the acceleration period the top car comes down over the knuckle,

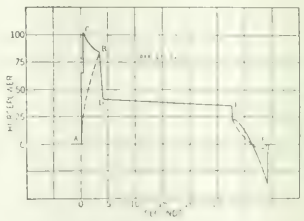


FIG. 4.

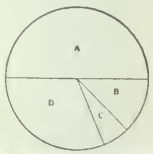


FIG. 5.—CHART SHOWING DISTRIBUTION OF ENERGY WHEN ACCELERATING 3,000 LB. LOAD.

A—Resistance Loss.
B—Inertia.
C—Friction.
D—Useful Work.

which charges its effect as a counterbalance and accounts for the shape of the curve CB. The line DE represents the load when hoisting at constant speed. As the loaded car rises and the empty skip lowers, the net weight of the rope gradually favours the counterbalance and decreases the energy taken from the line.

During the period EF it is proposed to operate the control to obtain a gradual slow-down. When the loaded car goes up over the knuckle and starts to dump, very little energy is required to continue its travel, as indicated by the shape of the slow-down curve. During this period we have friction and net weight acting against the inertia of all moving parts. If the latter is sufficient to carry the car to its destination the motor will take energy from the line. Just before the cars reach their final position, dynamic braking should be introduced to bring the apparatus to a stop, at which time the line switches should be opened and the holding brake applied.

Fig. 6 represents the 6,000 lb. ore load, and Fig. 7 the occasional 9,000 lb. scrap load. Both are developed in the same manner as Fig. 4. The time of acceleration [illegible] with the load, as the series switches will not operate so rapidly as with light load.

The interval of time between hoisting varies considerably, but the capacity of the control installed is determined by the maximum demand which generally occurs after a breakdown. If the skip is [illegible] the cycle of the furnace may become [illegible] there has been opened to bring the furnace back to normal condition. [illegible] should therefore, be based on the [illegible] lifting the 3,000 lb. and 6,000 lb. [illegible] an average interval of [illegible] eight seconds. The

apparatus will then be somewhat liberal for ordinary operating conditions, but this is a point which should be received with favour, as low maintenance and continuity of operation are important in an application of this type.

The root-mean-square current will determine the carrying capacity of the switches with reference to heating. For the different loads these values, as well as the maximum values, are as follows:—

Load, lbs.	R.M.S. values.		Maximum values.	
	H.P.	Current.	H.P.	Current.
9,000	76	300	128	500
6,000	57	240	110	430
3,000	42	182	102	400
Friction ...	24	116	83	334

The average heating current taken from the line during the heaviest cycle of hoisting the 3,000 lb. and 6,000 lb. loads is 210 amperes, and the maximum is 430 amperes. The accelerating switches can open immediately after the last switch is closed so that they only need to carry an average current of 380 amperes for a short time during each cycle. The slow-down switches should be designed to handle the current adequately during this period of the cycle. The values actually obtained depend somewhat on the method employed of bringing the apparatus to rest. Resistance will be required during the starting and retarding periods. An average of 220 H.P. seconds must be absorbed during the starting period of each cycle, and 600 H.P. seconds when retarding. Fig. 8 shows a sequence of control, starting at rest and accelerating the motor to full speed, then the slow-down and stopping of the load. The acceleration of the motor is controlled by a current-limiting device. For this reason the amount of current taken by the motor on the first notch must be sufficient always to start the motor with the maximum load of 9,000 lb. This means that the starting current should be something more than the value required to start the load under ordinary conditions, so as to take care of tight bearings and other variations in the load.

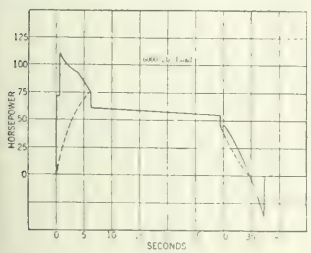


FIG. 6.

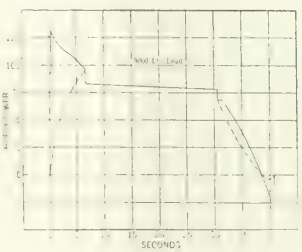


FIG. 7.

The number of accelerating points required will be determined by the maximum permissible current peaks, and will also depend upon the characteristics of the particular motor used. It has been found that six accelerating switches usually give satisfactory results on hoists of this character, with motors of 100 H.P. to 200 H.P. Series windings may be used for all but the last accelerating switch. This last notch should be a shunt switch or its equivalent. It is used for short-circuiting the series field of the motor, and it is very important that the switch remain closed after the motor has been brought up to full speed. There are conditions of operation which may cause the motor to regenerate, which will reverse the current and cause the series switch to open.

After the skip has reached full speed and approaches the end of its travel, the motor must be slowed down in order to make an accurate [illegible] opening all of the accelerating switches, which inserts the series field [illegible] [illegible] [illegible]

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HIGH-VOLTAGE CONTINUOUS-CURRENT TRACTION.

At one time, and not [illegible] ago, it looked as though the continuous-current system of traction would never obtain a trial on any important line of railway, or that, at any rate, the trial would be long delayed. The single-phase alternating-current system was cleverly engineered, and it made its appearance at a time when probably anything electric would have been regarded by the railroad financier as preferable to the low-voltage and expensive continuous-current system. It is patent to most people that many of the advantages of the single-phase system only hold good so long as continuous-current implies low voltage on the trolley. Given satisfactory high-voltage continuous-current machines, the conditions are more or less reversed, and the disadvantages of the single-phase system are brought into greater prominence.

A careful study of the problem of commutation has resulted in a three-fold augmentation of generator voltage, and in consequence during the last few years the trolley potential has been increased from 500 volts through successive stages—1,200 volts, 1,500 volts, 2,400 volts up to 3,000 volts. By providing the generators with interpoles and compensating windings, good commutation can be ensured at all loads, and the machines can be designed to take momentary overloads 300 per cent. greater than their normal rating.

The appearance of the high-voltage dynamo and motor has resulted in considerable progress in the development of the high-voltage continuous-current system of electric traction. It will be remembered that earlier in the year the electrification, at 3,000 volts continuous-current, of an important section of the Chicago, Milwaukee and St. Paul Railway was announced. This electrification may be regarded as an experiment that will definitely settle many of the engineering and other problems connected with main line electric traction. These problems have been under discussion for a number of years, and their solution

will certainly be welcomed by railway managers and electrical engineers alike.

The contracts placed by the above-mentioned company are now nearing completion. They provide for the electrification of a length of 113 miles of main line, and this forms one section of a 440-mile length which it is intended to equip for electric working during the next two and a-half years. Should the operating results prove as satisfactory as is anticipated, it is probable that the electrified portion of the system will be extended to 850 miles. The whole of the power for working the line is to be purchased from the Montana Power Co. at a contract rate of 0·27d. per kilowatt-hour, based upon a load-factor of 60 per cent., and with such favourable terms there should be a very great reduction in the cost of power for operating the locomotives. The immediate electrification of the 113 miles of main-line necessitates the provision of four sub-stations containing step-down transformers and synchronous motor-generator sets for converting 100,000-volt, 60-cycle, three-phase alternating current to 3,000-volt continuous current. It has been stated that the selection, by the Chicago, Milwaukee and St. Paul Railway Co., of the 3,000-volt continuous-current system is due, in large measure, to the excellent performance, during the past two years, of the 2,400-volt continuous-current equipment installed on the adjacent Butte, Anaconda and Pacific Railway. In the case of the latter railway, test records, based on six months' steam and electric operation, show a net saving of more than 20 per cent. on the total cost of electrification. The records also show that with electric operation the tonnage per train has been increased by 35 per cent., while the number of trains has been decreased by 25 per cent., with a saving of 27 per cent. in the time required per trip.

The initial contract, placed with the General Electric Co., of America, calls for 12 electric locomotives. These are described on another page of this issue. Nine of the locomotives are to be used for goods, and three for passenger service. Apart from minor details, the locomotives are alike mechanically and electrically, with the exception of the gear ratio, which is 4·56 in the one case and 2·45 in the other. This interchangeability of all parts, and the adoption of a uniform type of locomotive will reduce maintenance charges, and will also promote economical handling of the traffic. The goods locomotives are designed to haul a 2,230-ton train on all gradients up to 1 per cent. at a speed of 15·25 miles per hour. Including the locomotive of 232 tons, the gross train weight of 2,462 tons will require a tractive effort of approximately 72,000 lb. on a 1 per cent. ruling grade. The same load will be carried over ruling gradients up to 2 per cent. with the assistance of a second locomotive acting at the rear-end of the train, multiple-unit control being provided for the purpose. At the summit of the gradient, arrangements are being made for coupling the rear locomotive to the head-end of the train to permit electric braking on the down grade. Each of the passenger locomotives will haul a load of 715 tons over all gradients of the road except upon the 2 per cent. gradient. Even on this gradient a 516-ton train can be hauled by a single locomotive.

Of the total locomotive weight no less than 77 per cent., or 179 tons, is carried by the driving wheels. The eight motors for the complete locomotive are of the commutating-pole type. They are arranged for forced ventilation from a motor-driven blower located in the cab. Each motor is twin-geared to its driving axle, and has a normal one-hour rating of 430 H.P., with a continuous rating of 375 H.P. The locomotive, therefore, has a one-hour rating of 3,440 H.P. and a continuous rating of 3,000 H.P. Motors and starting resistances have been so designed as to permit of a tractive effort of 120,000 lb. being maintained by each locomotive for a period of five minutes.

As the result of an extensive series of experiments carried out on the test tracks at the maker's works a double collector is being used. These tests indicate that a collector of this type bearing against twin trolley wires is capable of collecting a current of 2,000 amperes at speeds as high as 60 miles per hour. The twin trolley wires are suspended side by side from the same catenary by independent hangers alternately connected to each trolley wire. The advantage of this ingenious construction is due partly to the greater contact area, and partly to the flexibility of the wires. As already indicated the several sections of the work are nearing completion, and probably before the end of the year the first section of the line will be in operation. We hope the railway company, the power company and the electrical contractors will meet with all the success they anticipate, and which they deserve. If this should prove the case, main-line railway electrification in all parts of the world, where cheap water-generated power is available, will receive an immense impetus from the enterprise of the Chicago Company. Before, however, a definite opinion can be expressed upon the relative merits of continuous and alternating current for main line working an authoritative statement is desirable as regards the cost of maintenance. As to first cost, three-phase generation gives an advantage to continuous current, whereas single-phase has the advantage in sub-stations and overhead equipment. These differences lend themselves easily to estimation. But in actual working the collection of large continuous currents at 3,000 volts as against smaller alternating currents at higher voltages presents greater difficulty, and is likely to be more destructive. On this account we should like to see authoritative figures published showing the cost of maintenance.

REVIEWS.

[Copies of the books mentioned in this section may be obtained from The Electrician Offices, post free, at the prices stated, or at such other price as may be quoted for them under the Act, 10 per cent. for abroad or for foreign books.]

Electrical Practice in Collieries. By David Burns, M.Inst.M.E. 4th ed. London: Chas. Griffin & Co., Ltd. Pp. xvi + 716. 21s. net.

The difficulties of satisfactorily reviewing a technical work are greatly simplified when the author makes known the particular class of readers for whom he writes. The revision and consolidation of the many Acts of Parliament which culminated in the Coal Mines Act of 1911 has had, and will continue to have, far-reaching effects. Among these the change in the methods of conducting examinations for colliery managers' certificates, and the resultant higher standard of attainment which is now

required to obtain a pass, has had a direct influence upon the production of suitable text-books.

The prospective colliery manager of an earlier day had little to do but prove the possession of a competent knowledge of mining mechanics and surveying to the satisfaction of a not too exacting board of examiners. His acquaintance with electrical engineering, and even of such an important subject as the chemistry of coal-mine gases, was nearly always of the most rudimentary description. To-day he is required to be thoroughly "sound" in, literally, a score of subjects, and consequently the laborious memorising of the contents of one or other of the cyclopædic text-books once so popular is no longer a safe preparation for the ordeal of a colliery managers' examination. The student must now approach his life's work through the medium of specialised text-books, coupled with much more closely inspected evidence of practical experience in the mine. The extraordinary progress which has been made during the last five years in the application of electricity to mining purposes has compelled the budding colliery manager to acquire a really competent knowledge of this subject, and it is only by way of such text books as that under review that such competency can be developed.

The present volume is the work of a professor who is well known to all mine workers north of the Tweed and to colliery people in other mining districts. In the course of 10 chapters it deals with units of measurement, theory of the dynamo, motors, lighting, and specific applications such as pumping, haulage, coal cutting and underground coal conveyors. A final chapter on miscellaneous applications, with an appendix containing the General Rules relating to the Use of Electricity in Mines, brings to a close a volume which, from the very fact of its having passed into a fourth edition, is evidently suited to the requirements of those for whose use it has been prepared.

Probably the most useful sections to the student are those devoted to the calculation of horse-powers and sizes of motors, &c., for various applications. The sets of questions at the end of each chapter afford useful practice to those who are reading for examinations.

As an introduction to electrical theory as applied to practice, this volume fulfils requirements adequately, but if it is required to be considered as a guide to practice in itself it is likely to prove disappointing. The illustrations, for instance, and necessarily the text relating thereto, seem to belong to the period of the first edition, which appeared in 1903. The students themselves must needs recognise the fact that most of the machines, switchgear and electrically-operated mining plant of which examples are given in this volume are now obsolete.

This does not, however, seriously detract from the value of the book, as every mining student is necessarily in touch with current practice, and will recognise the extreme difficulty of keeping a text-book up to date in a period of such rapid change as that through which we have recently passed.

When a fifth edition is called for the author will no doubt entirely rewrite and rearrange all the "practical" chapters, and aim at preserving those features which have been found to meet a want, while at the same time widening the scope of the work so as to make it serviceable also to those who have passed the student age, but who seek in a volume possessing the qualities of a student's text-book a discriminative record of the different kinds of electric mining plant which are in use, or about to be used, in the collieries of to-day and to-morrow. That a work published by Messrs. Griffin is well printed and well [illegible]

W. MAURICE.

Electro-Thermal Methods of Iron and Steel Production. By [illegible] With an introduction by Dr. J. A. [illegible] Pp. xviii. 239. 8s. 6d.

Authors of text-books on technical subjects are in the habit of touching very lightly upon the question of costs, if, indeed, they [illegible] with the subject altogether. This avoidance of a difficult subject is quite intelligible, and in [illegible] as it is obvious that costs must depend almost entirely on local conditions, and unless these conditions can be very clearly defined any figures relating to costs are liable to be misleading. In a new industry these difficulties are specially prominent, and in none perhaps are they more formidable than in the electrical production of iron and steel. From time to time, however, Papers are read before scientific societies and articles contributed to the technical press giving particulars of certain installations which are of great value. Unfortunately, these scattered contributions are never available when they are wanted, and usually necessitate a lengthy search through volumes of periodicals.

Mr. Kershaw in his "Electro-thermal Methods of Iron and Steel Production" has collected a large amount of information on various installations, and has presented it in a form in which it is readily available for reference. He does not claim to have written a text-book. "The theoretical side of the subject," he says, "has not been dealt with more fully, because the handbook is intended for the men actually engaged in the steel industry rather than for the designers and constructors of large furnaces. It has seemed to the author that full details of actual installations, and of methods of operation of the various types of furnace described, with summaries of working costs and tests of the raw materials and finished steel, would be more valuable to the practical steel-maker than a more extended treatment of the theoretical and mathematical side of the subject, especially as many of the data required for electric-furnace calculations require verification or are altogether non-existent."

After dealing with the better-known furnaces used in the production of iron and steel, a chapter is devoted to the less well-known furnaces which are passing through the experimental stage, and for which few figures are available.

An appendix contains a classified list of all the electric furnaces for iron and steel production in operation or under construction, and also abstracts and notes from several valuable Papers on electric steel refining. In addition, the titles and dates of the more important British patents are given, together with the text of those British patents which are of special interest.

THE THEORY OF OSCILLATION VALVES AND GAS RELAYS.

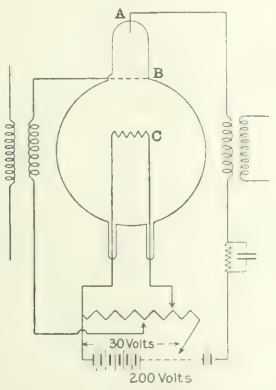
BY R. S. WILLOWS, M.A., D.SC.

In THE ELECTRICIAN for November 21, p. 286, 1913, Dr. Lee de Forest describes an improved form of "Audion" valve for use as a detector in wireless telegraphy; a very similar apparatus is described by E. Reisz in THE ELECTRICIAN for February 6, 1914, p. 726. The physical principle is the same in both cases, although the arrangements differ in details. To a Fleming oscillation valve a third electrode, B, is added near the incandescent filament C (*see* figure); this electrode is a gauze or grid of fine wire. The primary of an oscillation transformer is connected to the aerial, while the terminals of the secondary are joined to B and C. In the Reisz form this secondary is in series with a battery of about 30 volts, B being connected with the positive pole. The end terminals A, C, of the valve are connected to a battery of 200-300 volts in series with a telephone, or with another oscillation transformer. The oscillatory P.D. between B and C is found to produce marked variations in the telephone current. As the explanation of its action given by the authors is not altogether satisfactory, the theory developed below may be of interest.

The Fleming valve is frequently spoken of as if it were merely a current rectifier, and this is a correct description when a polarising battery is not used with it; but when it is polarised the negative ions from the filament may produce others by collision, and the oscillating E.M.F., when it is negative on the filament, can then produce a current out of all proportion to the applied P.D., thus giving a relay effect. The gas relays mentioned above differ in principle from the Fleming form only in the fact that the oscillatory E.M.F. is applied where it can most advantageously produce ionisation by collision, when acting in one direction, but is without effect in the other. De

Forest uses as the electrode C the incandescent filament of a lamp, while Reisz, following Willows and Hill (THE ELECTRICIAN, Dec. 1, 1911), takes advantage of the large emission of negative ions from heated lime. When the currents are very small they are carried entirely by these negative ions and the arrangement acts as a rectifier; but with larger currents other ions, positive and negative, are produced by collisions with neutral molecules, and a very small E.M.F. between B and C may produce a very large increase in current when B is positive. The reason for this is clear from a series of experiments by Prof. J. S. Townsend and his pupils, collected in book form under the title "The Theory of Ionisation of Gases by Collision."

The current is dependent on a plentiful supply of negative ions from the neighbourhood of the cathode. Now the negative ions move faster than those of opposite sign and are, therefore, the more rapidly removed by the electrodes; there results an excess of positive charge in the gas, which is most pronounced just in front of the cathode, as has been shown experimentally by H. A. Wilson. This causes the electric field at this point to be more intense than in other parts of the tube, so that it is possible here for *positive* ions also to produce others, of each kind, by collisions with neutral gas or by bombardment of the cathode surface. With a hot lime cathode the field is never so large as when a plain, cold, metal electrode is used. Evidently any further increase of the field in this neighbourhood will bring about a large increase of current. In the gas relays under consideration the field near the cathode is artificially augmented by the potential applied to the electrode B,



and, applied here, the oscillatory P.D. is at its maximum efficiency for the production of new ions. This has been shown both experimentally and theoretically by Townsend. Thus in the volume mentioned above (p. 70) an experiment is described where three electrodes were placed in a tube as in the figure, except that C was not heated; B was a piece of gauze and C was connected to the negative pole of the main battery. When 100 volts were applied between B and C the sparking potential between A and C was 700 volts, but when 240 volts were used on B-C the sparking potential was reduced to 550. Hence, if a constant voltage were to be applied at the ends of the tube, a large increase of current would be produced by a concentration of the field just in front of the cathode. This is what is done by applying the oscillatory E.M.F. to B C in the Reisz relay.

Reisz finds the apparatus works better when the gas in the bulb is replaced by mercury vapour; this is probably due not only to the smaller ionisation potential of the vapour but also to a chemical interaction between the mercury and the lime. While this may make it pass greater currents it will, according to my experience of lime cathodes, cause great variations in activity. It may also be noted that lime cathodes are constantly emitting or absorbing gas, thus making it difficult to maintain anything like constant sensibility; even after a few hours' rest their activity is frequently found to have decreased greatly. (For particulars *see* a Paper by Willows & Picton, "Proc." Phys. Soc., 1911, p. 257.) For these reasons it may be predicted that a hot carbon or metal filament will be found more trustworthy, although possibly less sensitive.

THE CHICAGO, MILWAUKEE & ST. PAUL LOCOMOTIVES.*

BY A. H. ARMSTRONG.

The flexibility in design and operation of the electric locomotive afforded by the use of electric motors renders this type of motive power especially well suited to the hauling of trains, either high-speed passenger or slow-speed freight. In fact, the electric locomotive possesses inherent qualifications for haulage service that are becoming more fully appreciated as constituting the fundamental reasons for bringing about the change from steam to electricity, and interest in any new projected electrification, therefore, largely centres in the characteristics of the locomotives proposed. Work has progressed upon the Chicago, Milwaukee & St. Paul locomotives at the Schenectady and Erie works of the General Electric Co. to such an extent as to make available certain facts as to construction and capacity that are of especial interest owing to the magnitude of the problems involved in this extensive electrification.

The general data applying to the St. Paul freight locomotives are given in Table I.

Table I. *General Data on Chicago, Milwaukee & St. Paul Freight Locomotives.*

Type of locomotive	3,000 volts d.c.
Length over all	112 ft.
Total wheel base	103 ft.
Rigid wheel base	10 ft. 6 in.
Total weight	520,000 lb.
Weight on drivers	400,000 lb.
Weight on driving axle	50,000 lb.
Weight on guiding axle	30,000 lb.
Diameter of driving wheel	52 in.
Diameter of guiding wheel	36 in.
Number of driving motors	8
Total output (continuous rating)	3,000 H.P.
Total output (one hour rating)	3,430 H.P.
Tractive effort (continuous rating)	71,000 lb.
Per cent. of this tractive effort to weight on drivers...	17·75
Speed at this tractive effort at 3,000 volts	15·75 m.p.h.
Tractive effort (one hour rating)	85,0000 lb.
Per cent. of this tractive effort to weight upon drivers...	21·2
Speed at this tractive effort at 3,000 volts	15·25 m.p.h.

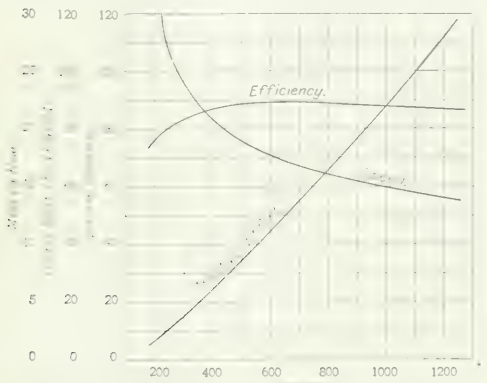
A very exhaustive series of tests has just been completed upon the first sample motor built at Schenectady, and has demonstrated that it has ample capacity to meet the heavy demands that will be placed upon it under service-operating conditions. The motors are wound for 1,500 volts and connected two in series for 3,000 volts. The power axles are driven by twin gears, in this respect being similar to the drive on the Great Northern, Detroit Tunnel, B. & O. and Butte, Anaconda & Pacific, except that springs are used in the axle gears. On account of the high voltage for which the motors are wound, the commutator width is small, thus allowing more space for armature iron and copper, with the result that the motor has a continuous capacity of 375 H.P. In fact, special interest attaches to the large continuous capacity of the St. Paul locomotives, as this is the first instance where such a liberal motor capacity has been required and provided for, and it should be noted that this large capacity is secured in an axle motor without departing from well known and thoroughly tried out forms of construction. The characteristic curves of one of the locomotives are given in Fig. 1.

A study of the train despatchers' sheets covering performance on mountain grade divisions of our steam railways shows that it is general practice to assign such a trailing tonnage to a locomotive [illegible] as to demand a tractive effort of the driving [illegible] approximately 18 to 19 per cent. of the weight upon the drivers. In other words, [illegible] coefficient of adhesion of from 18 to 19 per cent., leaving the difference between this value and the slipping point of the driving wheels as a margin with which to start on ruling gradients. Under like track conditions, the uniform torque of the electric motor should make available some 10 per cent. more tractive effort than is possible with the reciprocating drive of the steam locomotive having the same weight upon the drivers. Total adhesion operating experience is available, however, to prove that an electric locomotive can be rated at 20 per cent. coefficient of

* From the "Electric Railway Journal" of America.

adhesion. A seems reason[illegible] to refer to the present steam practice of a somewhat lower value. The St. Paul locomotive, therefore, with its continuous motor capacity of 17·75 per cent. and a one-hour rating of 21·2 per cent. of weight on drivers, gives ample assurance of ability to handle its assigned tonnage under all service conditions.

The St. Paul freight locomotive is guaranteed to have a hauling capacity of 2,500 tons trailing load on all gradients up to 1 in 100, and its heaviest duty will be to haul this load from Lombard to Summit over the Belt Mountains, a distance of 49 miles with a ruling grade of 1 in 100 and an average grade of 1 in 143 over the entire distance. Including the locomotive of 260 tons, the gross train weight of 2,760 tons will require a tractive effort of approximately 72,000 lb.



[illegible] M. & St. P. Electric Locomotive. Characteristic Curves.

on the 1 in 100 ruling grade, based upon a train resistance of 6 lb. per ton. This practically corresponds to the continuous rating of the locomotive, as tabulated above, and brings out the interesting fact that these locomotives are so proportioned as to motor capacity that they cannot be abused under normal service operation.

The necessity of rating main line electric locomotives upon a practically continuous basis is still further emphasised in the case of the St. Paul locomotives by the introduction of electric regenerative braking. The heavy demands upon the motors when operating up-grade may be nearly duplicated during the following down-grade hauling the same tram up a 1 in 50 gradient. Hence, the need of making provision for a practically continuous motor capacity in the St. Paul locomotives in order to meet the service requirements of the broken profile over which they are designed to operate.

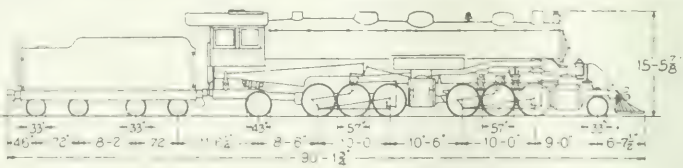
It is interesting to compare the relative capacity of the new electric locomotives and the Mallet engines they will replace. This is shown in Table II.

Table II.—*Comparison between Mallet and Electric Locomotives* (Fig. 2).

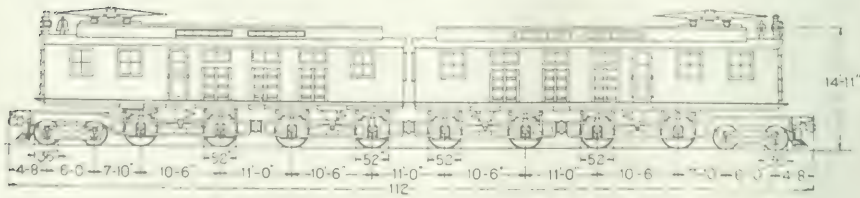
	Mallet.		Electric.
Total weight	555,700 lb.	...	520,000 lb.
Weight on drivers	324,500 lb.	...	400,000 lb.
Rated tractive effort	76,200 lb.	...	85,000 lb.
Per cent. of weight on drivers	23·5 per c.	...	21·2 p.c.
Rated tonnage 1 per cent. grade	1,800 tons.	...	2,500 tons.
Tractive effort for above tonnage	54,000 lb.	...	71,700 lb.
Per cent. adhesion	16·7 per c.	...	17·9 p.c.
Wheels per guiding truck	2	...	4
Weight per driving axle	54,000 lb.	...	50,000 lb.
Total weight on one rigid wheel base truck	162,000 lb.	...	100,000 lb.

Under favourable conditions the Mallet engine can haul 2,000 tons on 1 in 100 grade, thus bringing its tractive effort up to 59,000 lb. and the coefficient of adhesion on its drivers up to 18·3 per cent. The electric locomotive weighs 94 per cent. of the combined weight of Mallet engine and tender and has a tonnage rating of 23½ per cent. greater, based upon using the same coefficient of adhesion in each case—that is, 17·9 per cent. This comparison indicates that the electric locomotive has a hauling capacity one-third greater than the steam engine and tender of the same total weight, has less weight per axle, is provided with four-wheel guiding truck in place of two-wheel, requires no turn-table as it operates equally well in either direction, and finally eliminates the necessity for stopping to take on coal and water.

The same type of locomotive is used for both freight and passenger service, the only difference between the two being the gear ratio which is 4·56 for freight and 2·45 for passenger service. This interchangeability of parts of the freight and passenger locomotive and the adoption of one uniform type for all classes of service should be reflected later in the low cost of maintenance of the locomotive as well as prove of great benefit in the economical handling of the traffic. For facility in shop repairs the locomotive is constructed in halves, and, in fact, each half can be provided with draft gear in place of the articulated joint and operate singly in service up to its capacity. One passenger locomotive will haul a trailing load of 800 tons over all gradients of the road without assistance except upon the 1 in 50 grade section over the main divide of the Rocky Mountains. Even on this grade a 600-ton train can be handled without assistance. This illustrates the exacting [illegible] of mountain railroading, which



Weight, with tender, 555,700 lb.; weight on drivers, 324,500 lbs.; tractive effort, 76,200.



Weight, total, 520,000 lb.; weight on drivers, 400,000 lb.; tractive effort, 85,000.

[illegible] Comparative Mikado & St. Paul Locomotives.

[illegible] Comparative Data of Compound Electric and Mallet Compound Steam Locomotives.

running when regenerating, thus giving small chance for the time [illegible] demands in this instance that the passenger locomotive shall have the necessary motor capacity and smooth running qualities to successfully haul an 800 ton tram at 60 miles per hour on level track, and also operate over 20 miles of 1 in 50 up grade. Add to this the regenerative braking feature and steam heaters for train heating, and the broad nature of the problem of designing an electric locomotive for main line mountain service becomes very apparent. The loco[illegible]

motive superstructure contains space for two oil-fired steam heaters, together with ample provision for storage of oil and water. All passenger locomotives and a certain number of freight locomotives intended as reserve passenger units will be equipped with heater boilers.

A departure from the roller current collector of the Butte locomotive has been made in the St. Paul locomotives as the result of numerous experiments made upon the test tracks at Schenectady and Erie. These tests indicate that a double-pan collector bearing against twin conductor trolley wires is capable of taking off a current of 2,000 amperes at speeds as high as 60 miles per hour. This is several times the demand upon one collector of the St. Paul locomotives, and the double pan was adopted in place of the roller collector, although the latter has been giving excellent results, reaching a life of nearly 30,000 miles in the passenger service of the Butte, Anaconda & Pacific Railway.

Provision has been made in the control to enable two locomotives to be run together in multiple unit, but the enormous starting effort of two such locomotives, 240,000 lb. tractive effort at 30 per cent. coefficient of adhesion, makes such a combination of use only when it acts as a pusher on the rear of a train. The motors and starting resistances are designed to permit of a starting effort of 120,000 lb., being maintained on one locomotive for a period of five minutes without destructive heating, and in this connection the thermal capacity of the heavy slow-speed motors will be of great assistance.

The first completed St. Paul locomotive will probably be placed upon the test tracks at Erie during September, and shipment of these locomotives commenced soon thereafter. The construction work upon trolley and sub-stations of the first engine division between Three Forks and Deer Lodge has been so far completed as to give promise of being finished and ready for the trial runs of the locomotives as soon as they are received. Ample provision has been made for power and transmission line facilities by the Montana Power Company, so that electrical operation of the Chicago, Milwaukee & St. Paul Railway should soon be an accomplished fact.

TESTING TRANSFORMER FOR 500,000 VOLTS.

During the last few years a number of testing transformers for pressures from 200,000 to 250,000 volts, for use in connection with the testing of cables and porcelain insulators have been constructed

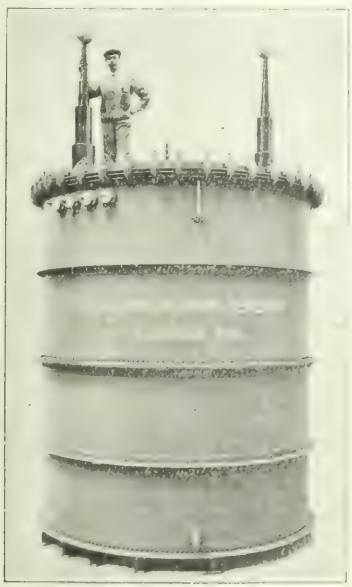


Fig. 1.—500,000-volt Testing Transformer.

by the Oerlikon Company. These transformers have given remarkably good results in service in every respect. An Oerlikon testing transformer for a pressure of 300,000 volts is in course of construction, while recently an order has been placed with the same firm for a 500,000-volt testing transformer.

The high pressures of 100,000 volts, and upwards, for long-distance transmission, which are being introduced more and more in the large Continental and American power stations, have created the necessity of having testing transformers for still higher pressures, in order to

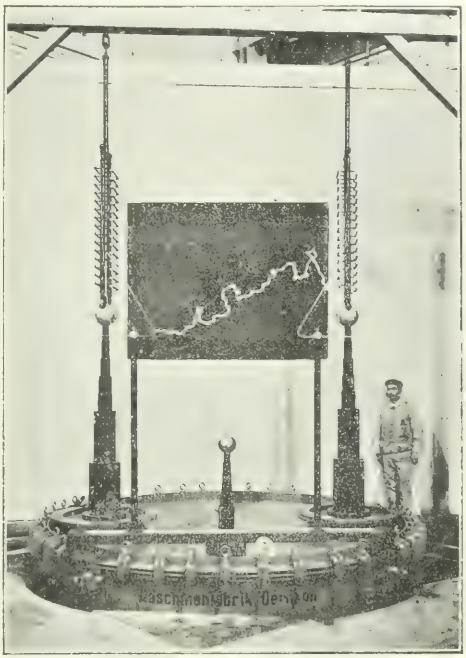


Fig. 2.—500,000-volt Testing Transformer in Operation.

take into account the enormous excess voltages which arise on circuits such as those in question.

Figs. 1 and 2 show a testing transformer for 500,000 volts, built by Messrs. Ateliers de Construction Oerlikon. With this transformer a spark gap of 1,600 mm. can be obtained, the apparatus being intended for the high-pressure testing shops of the Oerlikon Company's works. This transformer serves principally for the making of various tests in connection with high pressures, and for

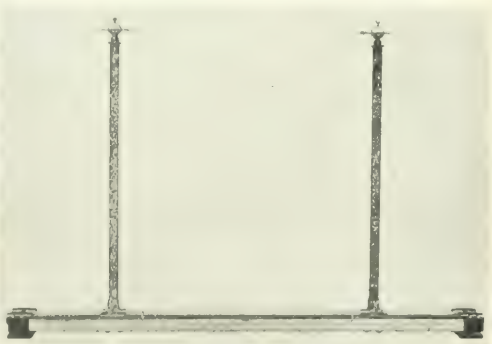


Fig. 3.—Calibrated Spark Gap.

the testing of various kinds of insulating material, porcelain insulators and cables, also for insulation resistance tests of completed electrical machinery, transformers and other electrical apparatus.

The data of this 500,000 volt transformer are as follows :—

Approx. continuous output	500 k.v.a.
Primary pressure	500 volts.
Secondary pressure	250,000 and 500,000 volts.
External diameter of oil tank	3·3 m.
Height of oil tank	3·6 m.
Height of transformer (including conductor tubes and sphere conductors)	5·75 m.
Height up to suspension frame	8·9 m.
Approx. weight of transformer proper	10,000 kg.
Approx. weight of oil tank	5,200 kg.
Approx. weight of oil	19,000 kg.
Approx. total weight of complete transformer	34,000 kg.

The transformer is so designed that its pressure can be raised to 600,000 volts ; furthermore, the output can be increased momentarily to 2,000 k.v.a. without excessive heating of the windings. As the two halves of the primary winding can either be connected in

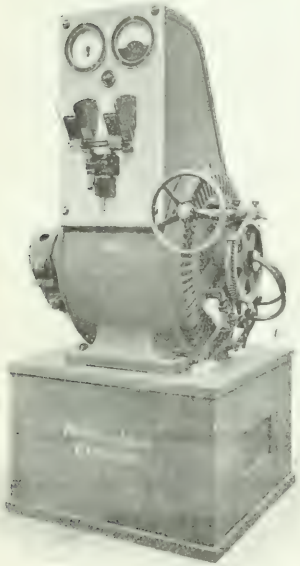


Fig. 4.—Transformer Equipment.



Fig. 5.

series or in parallel, the transformation ratio can be 500/250,000 or 500/500,000 volts. One pole of the primary winding is always connected to earth. The neutral terminal of the high-pressure winding is brought out, and, under normal conditions, connected to earth, but for special tests, up to a pressure of 200,000 volts, the earth connection need not be made.

Generally the secondary voltage is measured by the spark gap between the poles by means of a graduated calibrated scale, Fig. 3 visible on the oil tank of the transformer (Fig. 2), the object of providing this scale being to eliminate errors of observation, which arise when a voltmeter is used in the primary circuit.

The following figures show the relation between the length of the spark gap and the effective pressure :—

Length of spark gap in m/m.	Effective pressure, volts.
214	100,000
341	200,000
454	300,000
1,050	400,000
1,250	500,000
1,420	600,000
1,610	700,000

In all tests a series resistance is connected between the spark gap and the secondary terminals of the transformer, in order to prevent any damage being done on account of the discharge current being short-circuited by the arc produced. The resistance are screwed into the sphere conductors and are suspended with them by means of insulating tubes from the iron suspension frame, this constituting a compact arrangement (Fig. 5).

The variations in the primary pressure before and during the arcing over are indicated by the oscillograph record shown in Fig. 6. In this diagram E_1 is the primary pressure before the arcing over ; E_2 is the primary pressure during the arcing over ; and I is the primary current during the arcing over.

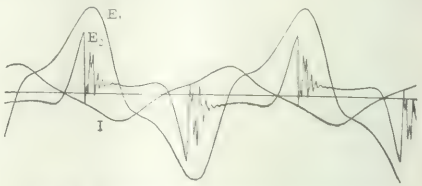


Fig. 6.—Current and Pressure Oscillograms.

The regulation of the excess pressure is effected by an induction regulator, Fig. 4, in the primary circuit of the transformer. By rotating a switch handle the requisite pressure regulation is obtained without interruption of the circuit, from 0 to 500,000 volts.

In the case of tests on cables and insulators having a high capacity, the capacity current can be entirely balanced by connecting up an adjustable choking coil (Fig. 7) to the terminals of the primary side

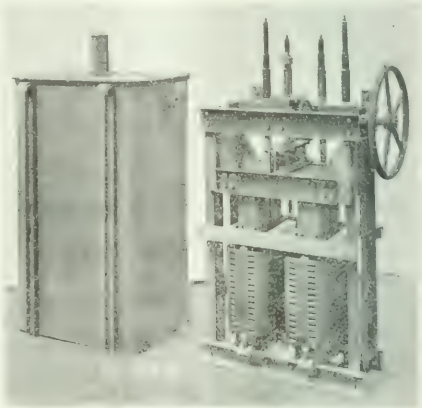


Fig. 7.—Adjustable Choking Coil.

of the transformer, in parallel, so that the regulator or the line has only to furnish the necessary current to compensate for the losses. In this case, therefore, it is not necessary to provide a regulator rated for the full capacity of the transformer, but merely for a capacity corresponding to the losses.

CORRESPONDENCE.

CHARGING FACILITIES FOR ELECTRIC VEHICLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I am much amused by Mr. Kemp's criticism of my letter addressed to Mr. Axton on the subject of "Charging Facilities for Electric Vehicles," which you published last week.

It is, perhaps, unfortunate that you did not publish the first paragraph of the latter, which would have indicated how the subject came to be opened with Mr. Axton ; it read as follows :

"I have pleasure in enclosing herewith a cheque for £1. 1s., being my Committee's annual contribution to the fund of the Electric Vehicle Committee."

Mr. Kemp's challenge of my statements, and his championship of the Birmingham supply department led to but their merit is his experience is all subsequent to the date of mine.

Mr. Kemp has profited by the experience obtained when I took a vehicle to Birmingham, and I am very glad to hear that there has been such improvement.

Although, according to Mr. Kemp, my sense of observation was distorted, it may surprise him to know that it was not sufficiently distorted to prevent me from discovering that the charging plug was connected up the wrong way round (*i.e.*, with the centre pin positive instead of negative—and that I personally reversed the connections at an ironclad switch lying on the floor in the presence of the Birmingham representative of the Edison Company. Further, I would point out that very few people who go to Birmingham or have vehicles in Birmingham will be in the happy position of Mr. Kemp of having been a one-time official of the supply department, and therefore to a large degree familiar with the general run of things.

As one of those who listened to the remarks of the chairman of the Electric Vehicle Committee at the recent meeting of the I.M.E.A. in London, when he asked for subscriptions to enable the work to be carried on, I was disappointed to find things as I did, and I therefore felt no compunction in informing Mr. Ayton fully on the matter. After all, it is the general public we have to look to for business in the supply of current for electric vehicle charging, and for the "electric" to become thoroughly popular it must be as easy to pick up a charge as to get refilled with petrol.

Whilst, perhaps, it would not pay a large number of stations to lay down a booster especially for the purpose, it is exceedingly likely that nearly every station has some piece of plant that could be made available, such as the battery-charging booster of a balancer booster set in a three-wire station or a small steam balancer. Every station could afford a length of cable and a charging plug; it could be determined in advance the maximum output that could be given for vehicle-charging purposes, and this information could be passed on to the Electric Vehicle Committee, which information, after all, is just as vital as, if not more so than, the price.

The Commercial Motor Users' Association publishes a handbook of night shelters, &c., in which information is given as to where petrol, oil, coal, coke and water can be picked up, tyres repaired, &c., and if the Electric Vehicle Committee would collect and publish their information in the same way the supply authorities would hold themselves ready to give what they had stated, and the user would feel that he could rely upon it.

The prospective purchaser of a vehicle is asked to pay what I consider is a fancy price for a vehicle as compared with a petrol chassis for the same duty, and, if he is to be persuaded to lay out nearly double the money, the least we are called upon to do is to make things go perfectly smoothly as far as charging is concerned after he has got it.—I am, &c.,

Loughborough Corporation Electricity Dept., Aug. 16. W. H. ALLEN.

EDUCATIONAL NOTES.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Priest, M.A.

Heriot Watt College, Edinburgh. The college provides theoretical and practical training for mechanical, electrical and mining engineers, chemists, &c. There are complete courses of instruction, extending over four years, for those who are studying for the fellowship of the Institute of Chemistry. An entrance bursary of £25 per annum is offered for competition on Sept. 20. Prospectus of courses, fees, &c., from the Clerk (Mr. R. Mossman), 8 S.C., Heriot Trust Office, Edinburgh.

City & Guilds Technical College, Finsbury. The day courses at this college are adapted to the needs of various students, including pupils from secondary schools above the age of 15 who desire to receive a practical and scientific training, and young men who, having previously served a pupilage or apprenticeship, desire to go through a more systematic training. Programmes from the Registrar.

Northampton Polytechnic Institute.—The session 1915-16 will commence on October 4 next. In the engineering day college there are full-day courses in the theory and practice of civil, mechanical and electrical engineering.

The courses in civil and mechanical engineering include specialisation in automobile and aeronautical engineering, and those in electrical engineering include specialisation in radio-telegraphy. (These courses include periods spent in commercial workshops and extend over four years. They also prepare for the degree of B.Sc. in engineering at the University of London.) The entrance examination will take place on Sept. 28 and 29. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examination in Sept., 1915.

In technical optics there are full and part-time courses in all branches, and instruction is given in specially equipped laboratories and lecture rooms. An Atchison scholarship (value £30) will be offered in this department at the entrance examination. Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to the principal, Dr. R. Mullineux Walmsley, St. John-street, London, E.C.

University of Bristol.—The Session in the Faculty of Engineering will commence on Sept. 14 and in the Faculties of Arts, Science and Medicine on Oct. 1. There are complete courses of instruction in civil, mechanical, electrical and automobile engineering. There are well-equipped laboratories and good facilities for practical and research work. Prospectuses and full particulars may be obtained from the Registrar, Mr. James Rafter, M.A.

University of Birmingham.—The new session commences on Tuesday, Oct. 5. At this university there are full courses of instruction in mechanical, civil and electrical engineering. The courses extend over four years, and students who enter after matriculation, and pass successfully the examinations at the end of each year will be entitled to the degree of Bachelor of Science in the branch of engineering to which they devote themselves. There are good facilities for practical and research work. Syllabus, giving particulars of university regulations, lecture and laboratory courses, fees, &c., may be obtained from the secretary.

University of Manchester.—The new session commences on Oct. 7. In the Faculty of Science complete theoretical and practical training is given to students preparing for the higher positions in the electrical engineering profession. At the end of a three years' course students may obtain either the ordinary or an honours degree of B.Sc. in electrical engineering. There is also a special course extending over three years in preparation for the certificate in electrical engineering. The John Hopkinson laboratories have been recently extended, and the equipment added to. The laboratories are fitted up with modern electrical machinery and testing appliances, and excellent facilities are given for educational and research work.

Imperial College of Science and Technology, South Kensington, London. The City & Guilds (Engineering) College, the engineering section of the Imperial College, provides complete courses of instruction leading up to and including the highest specialised instruction for students, with the object of fitting them for leading positions as civil, mechanical or electrical engineers, scientific advisers, &c. The departments are: Mechanical engineering and motive power (under the direction of Prof. Dalby); civil engineering and surveying (Prof. Dixon); electrical engineering (Prof. Mather); mechanics and mathematics (Prof. Forsyth). Application must be made by the first Monday in September for admission to the courses qualifying for the diploma of Associate of the City & Guilds of London Institute, and candidates must pass the entrance or matriculation examination of the College held in September or have passed the matriculation of the University of London in certain subjects. The diploma of the Imperial College is granted for advanced specialised or fourth year work. Prospectuses, &c., from the Registrar.

Merchant Venturers' Technical College and the War.—Arrangements have been made to liberate, for the period of the war, Mr. W. Morgan, B.Sc., Professor of Automobile Engineering in the Faculty of Engineering of the University of Bristol, which is provided and maintained in the Merchant Venturers' Technical College. Mr. Morgan will be engaged in important work in connection with the production of munitions of war, and he will resume his professional duties at the end of the war.

South-Western Polytechnic (London).—This Polytechnic will re-open on Sept. 27 for day and evening classes. The engineering courses include lectures in electrical and mechanical engineering, physics, chemistry and mathematics, and practical instruction in the fully equipped laboratories of the Institute.

Students are prepared by recognised teachers of the University of London for the B.Sc. degree in engineering of the university, for the examination for admission to the various engineering societies and the examination of the City and Guilds of London Institute. The evening courses include, in addition to the engineering courses, shorter classes

in electrical wiring, building construction, and other trade subjects. In the electric wiring department an advanced course has been arranged for the preparation of candidates for the final wiremen's examination of the City and Guilds of London Institute. The laboratories and workshops of the institute may be inspected by intending students. Arrangements have been made for placing students who have passed satisfactorily through the three years' course day in positions with large engineering firms, and hitherto such firms have offered more vacancies than the Institute has been able to fill with its students. Prospectus may be obtained from the secretary, Manresa-road, Chelsea, S.W.

LEGAL INTELLIGENCE.

Marking the Voltage on Electric Lamps.

In the City of London Court last week Judge Rentoul, K.C., heard a summons brought by Mr. George Braulik, 8, Lambeth-hill, E.C., against Mr. G. H. Banning, of Birmingham, for £3. 14s. 8d. for electric lamps and accessories supplied. Defendant had paid £1. 0s. 11d. into Court, but disputed the balance. He had returned some of the lamps on account of the voltage having been marked upon them in ink, instead of in printed letters as usual, and said his customers would not have them so marked.

Counsel for plaintiff said many electric lamps were sold without any voltage being stamped upon them.

Defendant denied this, and Judge Rentoul found for the defendant, with costs.

J. W. Russell v. Hunter.

Last week at Watford County Court plaintiff sued Mr. C. Hunter for the recovery of £41. 17s. for electrical work done.

For plaintiff it was stated that he had wired defendant's house and had sent in his account in April, but defendant refused to pay until the electrical department of Watford Council had passed the installation. The Council would not pass the job until the pendants and fittings were all fixed. He had not applied to the Council to pass the work because defendant would not get her fittings out of store. It was not his job to put up any fittings.

The chief electrical engineer to Watford Council (Mr. A. W. BARHAM) said that a cable was laid to defendant's house ready to connect. The installation was not complete until the fittings were up and the light ready to be used. When he inspected the work he found it was work that could be passed. The work was done according to the Council's rules, but it had not been passed because the installation was not complete. The work could not be passed until the whole of the fittings in the house were finished.

Mr. S. DUNCAN (for defendant) submitted that the whole house was a unit and the work should be tested and passed by the Council before payment. That was a condition of receiving payment, and unless the test was passed defendant was justified in withholding payment.

For plaintiff Mr. PREEDY said that it was never a condition of contract that plaintiff should get the installation passed. All plaintiff had to do was to get the work done in accordance with the Council's rules.

His HONOUR held that plaintiff had performed his contract so far as it could be done, and gave judgment for the amount claimed, with costs.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

[illegible]

driving reciprocating devices. (Addition to 12,436/11.)

[illegible]

automatic telephone systems. (20/12/12. Patent of addition not granted.)

[illegible]

1914 SPECIFICATIONS.

134 KRAUSHAAR. Electric safety lamp terminals. (7/1/13.)

11,052 SIEMENS BROS. & CO. & BAKER. Telephone instruments.

11,102 VON LEFEL. Methods of [illegible] electric oscillations.

Method of producing electric oscillations of high frequency from a direct-current source by partially discharging a condenser by means of an auxiliary condenser of the same order of capacity, the charge of which is periodically reversed, the charging current being tuned relatively to the frequency of the spark discharge, so that the voltage across the [illegible] at the moment of discharge is approximately twice that of the direct-current source.

11,112 MEIROWSKY & Co. & MEIROWSKY. Manufacture of stratified fibrous materials, especially for chemical and electric-insulating purposes.

11,212 SIEMENS BROS. & Co. (Siemens & Halske Akt.-Ges.) Circuit arrangements for [illegible] apparatus. (Addition to 27,458/09 and 18,356/12.)

11,408 OSTERREICHISCHE SIEMENS SCHUCKERTWERKE & REGAL PATENTS GES. Appliance for electrical Jacquard or card punching or like machines. (10/5/13.)

11,561 OTTO. Apparatus for converting alternating current into pulsating direct current. (24/5/13.)

A rotating member is provided with two contact segments, each extending through an angle of about 90 deg., and co-operating with a system of four contacts spaced 90 deg. apart, of which each pair of contacts diametrically opposite each other are respectively connected to the two poles of the Rontgen tube or the like, and to the source of alternating current, and, further, has an auxiliary system of four contacts likewise spaced 90 deg. apart, which are connected conductively to those of the main system, and which can be adjusted relatively to the main contact system.

14,513 BATTLE. Method of and apparatus for use in and in connection with electrolytic and metal-cleaning processes.

14,514 BATTLE. Recovery and electro-deposition of tin. (Cognate application 15,602/14.)

14,798 INTERNATIONAL ELECTRIC Co. (Akt.-Ges. Mix & Genest.) Telephonic transmitters and receivers.

14,899 MOIR. [illegible] Controlling motors from a distance.

One of the leads of each motor reverser is connected in one position of the master reverser to one main for carrying energising current over one solenoid of the motor reverser, and in the other position of the master reverser is connected to the other main for completing the curcuit of the accelerating switches.

15,767 BELLAMY. [illegible] ignition for internal-combustion engines. (30/12/14.)

16,696 BRAIN & HODGSON. Railway block telegraph signalling apparatus.

16,776 OXIL. Apparatus for producing galvanic or electrolytic deposits. (15/7/13.)

17,131 KAHAN. (Yapolsky.) Methods for producing devices consisting of substances liable to changes in their ohmic resistance under the action of light; especially electric light-sensitive preparations and the like.

17,317 BRITISH THOMSON-HOUSTON Co. (G.E. Co.) Electrical measuring instruments.

The armature spindle carries a damping member influenced by the greater part of the flux of the permanent magnet, the magnetic armature being controlled by the stray flux, which is capable of adjustment.

17,391 C[illegible] & C[illegible] [illegible] heating apparatus.

17,424 EVANS. (Allgemeine Elektricitats Ges.) Protecting device for the accessories of electrical meters and measuring instruments.

17,425 EVANS. [illegible] Furnace electrode.

17,426 EVANS. (Elektrochemische Werke Ges.) Method of and apparatus for producing flows in the molten masses of electrical furnaces.

17,437 LONGBOTTOM & FARRAR. Junctions or connections for electrical conduits and other pipes.

17,894 BRITISH THOMSON-HOUSTON Co. & HASTINGS. Electric motor control.

Consists in providing on each of the contactor switches, not fitted with interlocking switches, a device which assists the switch to close so that a premature change-over cannot take place.

20,133 IGRANIC ELECTRIC Co. (Cutler-Hammer Mfg. Co.) Electrical contacts.

20,871 BELFIELD. (Doyle & Hedley.) Electric coupling mechanism for use on railway vehicles.

21,190 GES. FUR ELEKTR[illegible] Electrosmotic impregnating process. (7/1/14. Addition to 19,849/14.)

21,921 FORRESTER. (International Callophone Corpn.) Loud-speaking telephone apparatus.

22,989 BURDON. (Siemens-Schuckertwerke Ges.) Controlling arrangements for electric motors.

23,293 VARVEL. Electrical water-heater.

23,572 KUJIRAI. Frequency-changing transformers.

23,686 KOCSIS & LUCO. Driving arrangements for dynamos.

23,884 MELLERSH-JACKSON. (Commonwealth Electric Tool Co.) Electrically-actuated [illegible]. (Divided application on 18,738/14. Aug. 17.)

24,078 BURDON. (Siemens Schuckertwerke Ges.) Construction of laminated slot-keys for dynamo-electric machinery.

1915 SPECIFICATIONS.

121 LEITNER & OSBORNE. [illegible] starting torque on a continuous current motor with a relatively small starting current.

275 WESTERN ELECTRIC Co. (Western Electric Co.) Electric wave amplifying apparatus.

Apparatus in which amplifying elements of the unidirectional type are employed and in which divided input and output circuits are provided, and an amplifying element is included in each branch of such circuits, whereby both the positive and negative portions of waves alternating in polarity may be amplified.

831 SIEMENS-SCHUCKERTWERKE GES. Stray-wave protective devices for electric circuits. (20/1/14. Addition to 17,532/13.)

4,761 BRITISH INSULATED & HELSBY CABLES (LTD.) & BROTHERTON. Electrical cables specially applicable to cables having a protective sheathing of rubber.

8,561 FORRESTER. (International Callophone Corpn.) Loud-speaking telephone systems and apparatus. (Divided application on 21,921/14. Nov. 3.)

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

June 26, 1915.

9,373 MAURICE. Electric-lamp holders and incandescent lamps for the same.

9,374 HALLIWELL. Method of and means for producing undamped or persistent high frequency electrical oscillations for telegraphic and like purposes.

9,386 HAMILTON & FERRANTI LTD. Casings for electricity meters.

9,396 A[illegible] Telephone systems. (27/6/14. U.S.)*

9,399 TOLKOWSKY. Electrical communication systems.

June 28, 1915.

9,411 KILNER. Bell operated electrically.

9,428 B.T.-H. (G.E. Co., U.S.) X-ray apparatus.

9,442 WOODFORDE. Electric induction motors.

June 29, 1915.

9,447 WILSON & WILSON. Electric hand grenade or shell.

9,477 FRANKFURTER MASCHINENBAU AKT.-GES. VORM. POKORNY & WITTEKIND. Means for cooling electrically-operated tools. (30/6/14. Germany.)*

9,481 [illegible]

9,484 U[illegible] Telegraphic systems and apparatus.*

9,487 W[illegible] (13/7/14. U.S.)*

9,511 K[illegible]

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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PETROL VEHICLE DUMPING.

Under the strenuous conditions arising out of the war a large number of manufacturers, both in this country and America, have extended their existing plants with the object of increasing their production in order to cope with Government orders. Many of these extensions are of a "permanent-temporary" character, but they have necessitated considerable capital expenditure, not so much on buildings as on the actual productive machinery. In the motor vehicle industry the mortality of vehicles employed for transport purposes, both at home and at the front, is alarmingly high, a fact which is straining the productive powers of the makers of these vehicles to the utmost. There can be no question whatever about this; and American makers of automobile material have never been so busy at any previous time.

Our American contemporary, the "Electrical World," is keenly alive to the danger which the sudden increase in the facilities for the production of automobile material presents to the electric vehicle industry, and recently called attention to the situation which has arisen in the United States. We quote a portion of our contemporary's remarks: "The European war has given a tremendous impetus to the building of gasoline-engine-driven trucks in the United States. The demand for these trucks has induced manufacturers in this country to add to their investment in buildings and equipment. When the war is over they will turn to the domestic market to provide an outlet for the increased product which war conditions have made possible. This will undoubtedly mean that the merchandising ability of the gasoline-truck manufacturers will be turned to the marketing of trucks in a way never before attempted. The prospective purchaser of an automobile truck will have forced upon his attention the merits of the gasoline-driven machine as its maker sees them. It is apparent, therefore, that now is the strategic time for every manufacturer of electric-truck equipment, and every central station engineer to focus the attention of the users of electric vehicles upon the advantages of the electric truck." We believe, with our contemporary, that there is a real danger in this development. Despite the marked advantages which the electric vehicle has to offer, its commercial value will be considerably discounted if the selling price of petrol vehicles is reduced much below the present figures. The same remark applies should there be an invasion of inexpensive commercial petrol vehicles from the States in conjunction with an overstocking of the home market by the products of British firms whose factories have also been extended, and who will, after the war, be anxious to secure a return on the outlay in production plant.

We think there lies in this prospective development the elements whereby the danger may be satisfactorily met. A noteworthy feature of automobile material production at the present time is the amount of specialisation. One firm will devote its attention entirely to the chassis frame, another produces ball and roller bearings, another will concentrate upon a certain type of back-axle, or perhaps a special pattern of front-axle; then, again, such accessories as steering-columns, brake-gear, wheels, carburetters, and so forth, have come to be the product of specialised firms who turn them out in vast quantities. In so far as the chassis is concerned, the electric vehicle industry may take advantage of the low cost of production of these parts and purchase them in sufficient quantities to enable them to build up complete machines at prices which could be considered as fairly competitive with the petrol vehicle. The motors and controllers could be the product of specialisation, and although they are only available at the moment, in quantities at any rate, from the United States, there is no reason why they should not be turned out in this country. It is, perhaps, a little early to prophesy accurately what will happen in this field, but it is certainly safe to assume that there will be a glut of petrol vehicles after the war, and that the existence of this surplus will, unless precautionary measures are taken, prove very harmful to the electric vehicle movement.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Aug. 9, 1915, to Aug. 14, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible] enumerated, 31 pkgs.

[illegible]

LIVERPOOL.—*Spain:* Unenumerated, 171 pkgs. *U.S.A.:* Insulating wire and cable, 193 pkgs.; insulated cable, 155 reels; insulated wire, 41 cases; unenumerated, [illegible] materials, £883; lamp parts, £1,944; elec. wire and cable, £56; unenumerated, £2,371—304 pkgs. *Switzerland:* Carbon candles, £610; elec. lamps, £18; lamp parts, £9; unenumerated, £40. *Holland:* Elec. lamps, £389—486 pkgs.; wire and cable, £420; unenumerated, £400. *France:* Elec. carbon candles, £773; elec. lamps, £1,413—46 pkgs.; unenumerated, £120. *Denmark:* Elec. machinery, £587; unenumerated, £305. *Norway:* Telephone material, £33. *Italy:* Wire and cable, £1,596; unenumerated, 46 pkgs. *Bombay:* Elec. cables, 8 drums. *Sweden:* Lamp parts, £117.

MANCHESTER.—*U.S.A.:* Unenumerated, 36 pkgs.

SOUTHAMPTON.—*France:* Unenumerated, 7 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £395. *Melbourne:* Elec. machinery, £2,018; wire and cable, £1,414; unenumerated, £715. *Sydney:* Elec. machinery, £57; wire and cable, £1,000; unenumerated, £837. *Wellington:* Elec. machinery, £236; wire and cable, £2,340; unenumerated, £605. *Brisbane:* Elec. machinery, £144; unenumerated, £736. *Adelaide:* Wire and cable, £266; elec. machinery, £20; unenumerated, £313. *Christchurch:* Unenumerated, £91. *Perth:* Wire and cable, £107; unenumerated, £206. *Hobart:* Unenumerated, £85. *Launceston:* Unenumerated, £175. *Dunedin:* Unenumerated, £86. *Cairns:* Unenumerated, £50. *Lyttelton:* Elec. machinery, £21; wire and cable, £21; unenumerated, £65. *Hobart:* Elec. machinery, £1,160. *Wanganui:* Unenumerated, £124.

AFRICA.—*Durban:* Elec. machinery, £170; unenumerated, £2,162. *Port Elizabeth:* Elec. machinery, £257; unenumerated, £693. *Cape Town:* Wire and cable, £46; elec. machinery, £81; unenumerated, £746. *East London:* Unenumerated, £224. *Mauritius:* Unenumerated, £75. *Beira:* Unenumerated, £120. *Moji:* Unenumerated, £23. *Mossel Bay:* Unenumerated, £28. *Zanzibar:* Telegraph material, £52.

EGYPT.—*Alexandria:* Unenumerated, £300. *Aden:* Unenumerated, £66.

SPAIN.—*Barcelona:* Unenumerated, £40. *Alicante:* Unenumerated, £50. *Cartagena:* Unenumerated, £1,025. *Manilla:* Unenumerated, £1,079.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £2,181; elec. machinery, £4,306; unenumerated, £3,115. *Colon:* Unenumerated, £18. *Pernambuco:* Telegraph cable, £12,000. *Monte Video:* Unenumerated, £142. *Valparaiso:* Unenumerated, £10. *Pelottas:* Elec. wire, £225. *Rio de Janeiro:* Unenumerated, £462. *Santanilla:* Telegraph material, £77.

JAPAN.—*Kobe:* Unenumerated, £10. *Nagasaki:* Unenumerated, £44. *Tokio:* Unenumerated, £1,825. *Yokohama:* Unenumerated, £485.

CHINA.—*Shanghai:* Unenumerated, £470. *Honkong:* Wire and cable, £35; unenumerated, £34.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £165; elec. machinery, £670; unenumerated, £675. *Calcutta:* Wire and cable, £168; elec. machinery, £997; unenumerated, £3,017. *Madras:* Elec. machinery, £449; wire and cable, £356; unenumerated, £72. *Singapore:* Elec. machinery, £50; unenumerated, £588. *Bankok:* Unenumerated, £12. *Penang:* Wire and cable, £26. *Kilindini:* Telegraph material, £50; unenumerated, £38. *Karachi:* Elec. machinery, £50; unenumerated, £320. *Sourabaya:* Unenumerated, £349. *Ceylon:* Wire and cable, £92; elec. machinery, £18; unenumerated, £28.

CANADA.—*St. John's:* Telegraph apparatus, £700. *Toronto:* Unenumerated, £61. *Vancouver:* Unenumerated, £129.

FRANCE.—*Paris:* Elec. machinery, £11; unenumerated, £1,442. *Boulogne:* Unenumerated, £46. *Nantes:* Elec. machinery, £35; wire and cable, £132. *Dieppe:* Unenumerated, £21. [illegible]

GIBRALTAR.—Elec. machinery, £95.

SAINT HELENA.—Unenumerated, £28.

PORTUGAL.—*Oporto:* Unenumerated, £53. *Lisbon:* Elec. machinery, £27; wire and cable, £1,508; unenumerated, £607.

HOLLAND.—*Amsterdam:* Wire and cable, £1,610; unenumerated, £170. [illegible] cable.

DENMARK.—*Copenhagen:* Wire cable, £15,260.

NORWAY.—*Christiana:* Wire and cable, £4,950 [illegible] Elec. horns, £552; wire cable, £381; unenumerated, £2,196.

FOREIGN GOODS (duty paid and free).

Melbourne: Unenumerated, £88. *Amsterdam:* Unenumerated, £94. *Adelaide:* Unenumerated, £1,400. *Alexandria:* Unenumerated, £42. *Boulogne:* Unenumerated, £51. *Brisbane:* Unenumerated, £72. *Cape Town:* Unenumerated, £27. *Copenhagen:* Unenumerated, £29. *Ceylon:* Unenumerated, £25. [illegible]

NOTE.—The large number of items in these official returns under the [illegible] heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

[illegible] has removed [illegible] to Edgecumbe, 1, Wellington Road, North Acton, [illegible]: [illegible] London"; telephone: Chiswick [illegible].

The system for the "Century" single-phase motors has been [illegible] by the Scottish General Electric (1914), Limited, Norfolk House, [illegible] and the London Agent of "Century" motors, [illegible] the company's control. The department is being [illegible] by Mr. P. A. Murphy, who for many years has represented the Century Company in the United Kingdom.

Patent Development.—The proprietors of patent No. 20,357 of 1912, for "Improvements in or relating to electrical connections," desire to make arrangements for exploiting the patents in this country. Communications to Messrs. Hasseltine, Lake & Co., patent agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

LIQUIDATIONS, &c.

Claims against Conway Jenkins, Ltd., in voluntary liquidation, are to be sent to Mr. H. J. de C. Moore, the liquidator, 2, Gresham-buildings, Guildhall, London, E.C., by Sept. 4.

ELECTRICITY SUPPLY.

EXTENSIONS.

Ilkley.—As stated in our last issue (p. 719), the electric supply undertaking was formally inaugurated on the 9th inst.:—

The supply is on the d.c. three-wire system, 460 volts on the outers. The installation consists of two 200 B.H.P. Garrett superheated steam semi-stationary engines with jet condensers. Each engine drives by means of a Hans Renold's silent chain a Phœnix dynamo. There is also installed a 400 kw.-hour Tudor battery. The station has been specially designed to run on low fuel costs and minimum of labour. It is expected that the works will show a lower fuel cost than any gas or Diesel engine installation of similar size. The engines, dynamos and switchboard are all in one room, the dynamos being upon the switchboard platform, and the firing floor is on the ground-floor level. Thus, one man with a youth on the switchboard can easily run the works. The engines will always be run on efficient load, as when there is a small amount of lighting the batteries will absorb the extra current. It is not anticipated that a continuous running of machinery will be necessary for some time. A large distribution network has been laid down, together with feeders, which has absorbed from about £12,000 to £14,000, and the whole installation has cost from £21,000 to £22,000, including steel framework building with brick panels. The site is conveniently situated on the gas works estate, and there is a cooling pond with cooling jets for condensing purposes. Mr. S. H. Bill, who acted as clerk of works, has been appointed resident engineer. Owing to the original engines being commandeered by the Government, the opening of the works has been long delayed, and the second engine plant will not be completed until about the middle of September.

Ipswich.—At the recent meeting of the Corporation, the Electric Supply and Tramways Committee reported that in September, 1913, the Council applied to the L.G. Board for sanction to borrow £33,500, and in February, 1914, to borrow a further sum of £4,000 for the electric supply undertaking.

In due course the Board sanctioned these sums, less certain small deductions, but omitting sums amounting to £7,350, the estimated cost of the sub-stations and works connected therewith. The Board stated that those items would be dealt with when the actual expenditure had been more closely ascertained. Full details had now been furnished to the Board, showing an actual expenditure of £8,760, and the Committee asked that that amount should be substituted for the £7,350 above mentioned. The Board were prepared to sanction the borrowing of the larger amount on receiving a formal resolution of the Council applying for leave to borrow it. Formal resolutions were accordingly passed by the Council.

Nottingham. The City Council has been recommended to erect a special electrical station in order to give a supply of power to the projected new National Engineering factory to be erected by the Government.

GENERAL

Barnes. The electrical engineer (Mr. C. S. Davidson) recently secured prices for the supply of 440 yds 0·10 sq. in., 0·05 sq. in., 0·10 sq. in. three-core distributing cable, the prices ranging from £171 to £198.

The last lot of this class of cable was purchased at £105 for a similar quantity, and on Mr. Davidson's suggestion the purchase has been deferred for a month, as there is a probability of a decline in the price of copper.

Dartford. The Council have increased the charges for electric current by 20 per cent. The revised charges are estimated to produce £1,145 extra in the current year.

Ely. At the last meeting of the Ely & District Ratepayers' Association it was reported that the Board of Trade had written that, having regard to all the circumstances, the Board had decided not to proceed with the application of the Ely Gas Co. for a provisional electric lighting order.

Greenock.—The Electricity Committee have unanimously recommended an increase of £100 to the salary of the burgh electrical engineer, Mr. Frank H. Whysall, who was appointed about a year ago

to succeed Mr. Robertson, now of Salford. Mr. Whysall's first financial report shows a surplus profit of about £10,000.

Keighley Provisional Electric Lighting Order.—A special report has been made by the Board of Trade stating the grounds on which they have dispensed with the consent of the Urban District Council of Haworth to the breaking up of certain roads in Haworth Urban District for the purposes of the Keighley Electric Lighting (Extension) Order, 1915.

Keighley Corporation applied for a provisional order under the Electric Lighting Acts to extend their area of supply under the Keighley Electric Supply Order (1899), so as to include the Urban Districts of Oakworth, Haworth and Oxenhope and the Rural District of Keighley. The Urban Councils of Oakworth and Oxenhope and the Rural Council of Keighley gave their consents to the application, but with regard to Haworth the Urban Council themselves applied to the Board of Trade for a provisional order under the Electric Lighting Acts, and the Corporation of Keighley withdrew that district from their application. The Corporation, however, had inserted a clause in their draft order to empower them to break up certain scheduled streets in Haworth Urban District for connecting the urban district of Oxenhope with the remainder of the area of supply. The Urban Council of Haworth refused their consent to these streets being broken up, and the Corporation requested the Board of Trade to dispense with such consent. The Board of Trade invited representatives of the parties to a meeting at this office at which the Corporation satisfied the Board that there was a demand for electricity in Oxenhope, and pointed out that they already had power to break up the scheduled streets in Haworth for working trackless trolley vehicles in Haworth and Oxenhope under the Keighley Corporation Act, of 1912. The Corporation also represented that the mains used for working the trackless trolley vehicles could also be utilised for the electric supply to Oxenhope. The chief reasons urged by Haworth Urban Council were that the scheduled streets were in parts very congested by existing mains and pipes, and that if the District Council found it desirable to construct a generating station for the purposes of operating their own electric lighting order they would require to lay mains in these streets, and might be hampered in doing so by the existence of mains laid by the Corporation. The Urban Council also suggested an alternative route for the Corporations' mains in another part of the urban district. The Board of Trade were satisfied that the Urban Council of Oxenhope were desirous of being supplied with electricity by the Corporation of Keighley, and that the most convenient method for giving the supply was by mains laid along the scheduled route through the Urban District of Haworth. They did not consider that the reasons given by the Urban Council were sufficiently strong to justify them in refusing the powers sought by the Corporation, particularly as the Corporation already had powers to break up the scheduled streets for trackless trolley purposes. The Board therefore decided to dispense with the consent of the Urban Council of Haworth, and to insert in the order a power to break up the scheduled streets in question.

Southend. The Electric Lighting Committee has postponed the laying of a branch main into the East [illegible] pending the erection of a [illegible] station.

In view of the postponement of the erection of the Thorpe Bay sub-station, negotiations have been opened with the Burgess Trustees for the retention of the site already agreed upon.

Stockton-on-Tees.—For the quarter ended June there was a reduction of 11 per cent. in the units sold for lighting, an increase of 14 per cent. in the units sold for power, but almost an entire cessation in the revenue from public lighting.

The question of increasing the price of electricity has been deferred for the present.

Wrexham.—Rengeal Parish Council have decided not to consent to the application of the Corporation for a provisional electric lighting order for the rural area, because "the chief buildings have already installed acetylene lights."

POWER & HEATING NOTES.

Dewsbury. A sub-committee of three has been appointed to [illegible] the more efficient lighting of the parish church.

Droitwich. A new Lotton manufactory, which has been equipped at Droitwich by Messrs. E. Standen & Sons, of Droitwich, and [illegible] and will be driven entirely by electric power and the [illegible] will also be lighted by electricity.

Gravesend.—A sub-committee of the Electric Committee is negotiating with W. J. Hedges, Belgrave Works, Gravesend, the Empire Portland Cement Co. in regard to the supply of power.

The committee has resolved that no further [illegible] power supply be entered into without a three months' notice being given to the Council upon one and half months' notice of coal. It has also been decided that an assessment be made of all Corporation property, with the exception of the electricity, at the same capital value as the last assessment, against damage by storm.

Hayes Middlesex. The Urban Council have referred the Works Committee to report on the question of public lighting by electricity or gas.

School Lighting. The Northamptonshire Education Committee have decided to adopt electric lighting for the Rushton Council school.

TRACTION NOTES.

Birmingham.—Mr. W. F. Richardson, an inspector of the Corporation tramways department, has received a commission in the 18th Service Battalion of the Middlesex Regiment.

Hove.—Last week the Council decided to dismantle the electrical overhead equipment which was erected in part of the main thoroughfare in connection with the experiment to determine the system to be adopted for the proposed joint service of trolley omnibuses for Brighton and Hove.

The Council will have to pay about £600 to the contractors for the erection of the wires and posts, but this payment will be taken into account should circumstances in the future permit of a revival of the scheme. The two towns have mutually agreed to defer further progress with the undertaking until six months after the war.

Ilford.—The Council propose to make a charge of ½d. for heavy parcels carried on the trams.

A recent census of the goods conveyed by the cars during one week showed that some of the "parcels" consisted of perambulators, bicycles, dustbins, lawn mowers, pail of whitewash, a piano frame, carcases of meat, manure and monkeys in cages.

Manchester.—Over 2,000 of the men and boys employed in the tramways department of the Corporation have joined the Colours, and the general manager (Mr. J. M. McEloy) has prepared a Roll of Honour, which contains the names, grades and addresses of all who are serving with the Colours.

Southend.—Members of the National Guard are to be permitted to travel at half-fare on the tramcars when proceeding to or from duty.

Tokens are to be issued at face value to private firms in the Borough for the use of their employees. Scholars are permitted during the period of their summer vacation to use their passes enabling them to purchase tickets at half-fares upon the cars.

Women Tramcar Conductors.—Among those who now employ women conductors on the tramways are Accrington, Birmingham and Ipswich Corporations.

EMPIRE NOTES.

Canada. At a recent meeting of Class A Members (Companies) of the Canadian Electrical Association, the president (Col. D. R. Street) reported on the work of the past year.

About 50 companies were represented. It was stated that the results of the method of co-operative purchasing were most satisfactory, and the secretary (Mr. Alan Sullivan) was instructed to secure special price on further requirement of member companies. An account was given of the formation of the Electrical Employers' Association, as an off-shoot of the Canadian Electrical Association. The new body is now accepted by the Government as representative of the entire electrical industry, appoints an inspector, who makes periodical visits to power and light plants, and also to manufacturing establishments, investigates accidents, their causes and possible avoidance, &c.

Calgary Municipal Council recently entered into a fresh contract with the Calgary Hydro-Electric Power Co. for the supply of electrical energy. Hitherto the Council have been purchasing 5,000 H.P. from the company at $26 per horse power per year, which gave the company a load factor from 85 to 95 per cent., according to the seasons. The additional power required by the city, varying from 2,000 H.P. in summer to about 5,000 H.P. in winter, and generally having a load factor of less than 50 per cent., has been generated by the city's steam plant. The municipal steam plant is modern, and is over 12,000 H.P. capacity, but the Council found it cheaper to generate the excess power over that contracted for. The service given during the past 18 months by the company was of a very satisfactory nature, but the company desired to supply the whole of the city's requirements. After the first 5,000 H.P. the price decreases by $1 per 1,000 H.P. The company will pay the expenses of a nucleus staff and all coal and gas to be used in firing the boilers to keep up a supply of steam at all times, sufficient to protect the down-town district, and in the event of any longer interruptions the company agrees to meet all expense in starting up the whole plant. The new contract is for one year.

The Alberta Hydro-Electric Co. have since submitted lower terms for the supply of a minimum of 1,000 H.P. and a maximum of 10,000 H.P. for five years. They offer the first 1,000 H.P. at $22 per horse-power-year, next 1,000 H.P. at $21, next 1,000 H.P. at $20, and for all over 3,000 H.P. at $19 per horse power per year. The company proposes building a series of low head dams on the Bow River within the city limits, and proposes to have the first one ready by May 1, 1916, and supply the city with the excess power over and above the Calgary Power Co.'s contract (which is 5,000 H.P.). At the expiration of the Calgary Company's contract they offer to take over the whole of the city's business, and in the event of any diminutions of power during the low-water periods will pay for operating the city's steam plant.

The Electrical News states that the Grand Trunk Pacific dry dock, Prince Rupert (B.C.), which is now nearing completion and has cost

$2,500,000, will be electrically equipped. The power house contains two 1,000 kw. turbine generators and a steam-driven air compressor of 1,500 cubic ft. capacity. There are also six 400 H.P. water-tube boilers supplied with automatic chain-grate stokers. A system of underground electrical conduits has been installed throughout the shipyard. On the dock three air compressors of 500 cubic ft. each and 12 24 in. centrifugal pumps are electrically driven. Each shop and the power house are equipped with a 15-ton electrical overhead crane.

Port Sudan.—This town, as well as harbour and quays, are now lighted electrically.

On the quays there are four 3-ton pedestal electric cranes, a 7-ton electric gantry crane, four electric coal transporters, which are specially designed to handle ordinary cargo as well as coal, and an electric coal re-handling bridge plant. Two 5-ton and four 1-ton electric capstans also facilitate the handling of shipping and of railway trucks. The dockyard workshops are also driven electrically.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Municipal authorities of Lincoln (Province of Buenos Ayres) and the representatives of the Gasmotoren Fabrik Deutsch have entered into an agreement whereby the company takes a lease for five years of the electric light and power stations and waterworks of the Municipality.

The "Review of the River Plate" states that Senor P. Yourke has applied to the Municipality of Cosquin (Province of Cordoba) for a concession for electricity supply works and for the public lighting service.

The electrical department of the Government of the Province of Buenos Aires has reported favourably upon the recent application of Senor Marcelino S. Romero for an electrical concession at Punta Alta (Bahia Blanca), but several modifications of details will be necessary.

Campana Municipal Council and the local electric lighting company are in conflict. The Municipality refused to pay its June lighting bill unless the company (Compania Industrial Holando-Americano) first paid $3,000 claimed by the Municipality as fines. As the Municipality persisted in its refusal to pay electric current was cut off on July 17. The Mayor then took forcible possession of the power station and found electricians who turned on the supply after half-an-hour's delay.

In regard to the offer of Messrs. A. Rafael Langone & Co. to the Municipality of Buenos Aires to undertake the entire electric lighting of the city at 20 per cent. less than present prices, utilising a new secret system of their own, the Municipal authorities required the proposers to present their application on stamped paper (value $500 m/n.) The firm also offered to contract for the lighting service for 12 years, making over all their installations to the Municipality on the expiry of the period. The legal advisers of the Council are of opinion that the Municipality is not in a legal position to consider the proposal, however advantageous it might be, having regard to its existing lighting contracts.

The report of the directors of the Cia Alemana Transatlantica de Electricidad for 1914 states the crisis which prevailed in the South American Republics became further accentuated by the outbreak of the European war, which prejudiced several of the subsidiary enterprises of the company. The gross revenue increased to 23,370,000 marks against 31,360,000 in 1913. Taxation expenditure increased to 3,380,000 marks (3,190,000), debenture service accounted for 5,400,000 (5,080,000) and amortisation for 7,070,000 (6,670,000), so that the net profit (including amount from previous year) amounted to 14,800,000 marks (14,730,000). Owing to the increase to 30,000,000 marks of the 5 per cent. preference shares the dividend on the 120,000,000 marks of ordinary shares had to be reduced to 10 per cent. against 11 per cent. in the two preceding years. In Buenos Aires the production of electric current increased from 227,190,000 units in 1913 to 239,880,000 in 1914, and the sales of electric energy from 179,460,000 to 191,320,000, increase of 6·6 per cent. (against 10·3 per cent. in 1913), or the lowest annual increase recorded in the history of the company. The equivalent of the connections increased by 27,916 kw. to 195,735 kw. The number of consumers increased from 64,395 to 80,786; the length of cables laid within the city and its suburbs was 4,630,000 metres (4,110,000), the capacity of the power stations increased from 121,000 kw. to 125,000 kw. The Compania Argentina de Electricidad is again applying its entire gross profits ($171,763 paper) to amortisation, mainly on high-tension distribution. The Empresa de Luz y Fuerza en Buenos Aires y Mendoza will in all probability make no application to the Government that profits which amounted to $597,200. The company had proposed the construction of a new hydro-electric station of 12,000 H.P. on the Mendoza River which should have been completed in 1916, were it not that the company had recently been charged with contractor-work at other interested parties have sustained the invalidity of the concession, their contention having been upheld by the Supreme Court, the company's case having been heard. The company has now taken the matter to appeal. The Chilian Electric Tramway & Light Co. made a distribution on its preference shares (all [illegible] Accounts [illegible] payment on [illegible] The net profit of the company was [illegible] 1913, the dividend being [illegible] The Tramvia Electrico de Valparaiso [illegible] paid [illegible] 5 per cent. for 1913, [illegible] $1,100,000 Chilian gold against $1,100,000 [illegible] Uruguayan Electric Power Co. will pay no dividend. Its profit has amounted to $482,490 gold against $456,293, and there are applications for debenture service. The [illegible] of the municipality of Buenos Aires has increased to 210,570,000 marks (from 202,480,000) and that of the power house in Santiago de Chile to 15,510,000 marks (from 13,190,000). The book value of participations amounts to 24,740,000 marks (as against 27,960,000) comprising: £650,000 in preference shares and £494,700 in ordinary shares of the Chilian Electric Tramway & Light Co.; 5,000,000 marks in shares of the Tranvia Electrico de Valparaiso; $1,690,000 Uruguayan gold in the Transatlantica en Montevideo Co.; $128,690 m/n. in ordinary and $189,550 in preference shares of the Cia Argentina de Electricidad en Buenos Aires; $835,000 in shares and $138,100 in 6 per cent. debentures of the Empresa de Luz y Fuerza en Mendoza. Advances made to these five subsidiary companies have increased to 70,790,000 marks, against 61,320,000, being thus greater than the amount of the share holdings.

Cuba.—The following persons have been authorised to instal and work electricity generating plant:—

Señores Francisco Diego Madrazo (at Remedios, Province of Santa Clara), Antonio Ramos Valderas (Pedro Betancourt, Province of Matanzas, and Báez, Province of Santa Clara), Antonio and Francisco Fernández (Fomento, Province of Santa Clara), and E. Cuervo (Viñales and other towns in Province of Pinar del Rio). The "Gaceta Oficial" giving particulars may be consulted at the Board of Trade, 73, Basinghall-street, London, E.C.

Italy.—A circular recently issued by the British Chamber of Commerce in Genoa gives some particulars of the position of Germany in the industry and commerce of Italy.

It is pointed out that, though Italians would like to see British trade in Italy developed, there are two almost insurmountable obstacles at present, viz., high prices and terms of payment. For certain machines, produced in Italy at 100 lires, for instance, Germany does not hesitate to quote the same price, while British firms will ask about 250 lires. Such enormous differences exist for hundreds of articles in which superiority of quality does not always justify the highness of the price. The Germans nearly always allow a certain amount of credit, while British firms ask for immediate payment, difficult to carry out in times like the present; they would like Italian buyers to deposit a large sum at a bank in England, to be drawn on against presentation of documents. This is, therefore, payment in advance, a thing quite impossible for a country like Italy, in which, for certain goods, even payment on delivery of the goods appears impracticable. Great Britain should (it is stated) adapt herself to the requirements and needs of the Italian market, applying thereto the methods employed by the Germans. For many years almost the only article imported from Great Britain that has shown an important increase is coal, while Germany prevailed and imposed herself. The British must (it is pointed out) make a radical change if they want to go ahead in Italy. The system of weights and measures used in England should be replaced by the metric system without further loss of time, at any rate as far as catalogues for Italy are concerned. The mode of payment insisted on by British firms must be modified. This obstacle could in a great measure be removed by the establishment in Italy of a British bank, and then it would be possible to foster British trade in Italy; without such a financial organisation, which should be really commercial and look after Anglo-Italian trade, progress would be very difficult, if not impossible.

German Export Trade.—Among the German wireless news items on the 14th inst. was the following:

The world-known Allgemeine Elektricitäts-Gesellschaft have decided upon a huge financial and industrial transaction. The managers explain that the temporary restriction of general foreign trade in consequence of the war makes an extension of home activity advisable. A splendid opportunity is offered by the fact that the Berlin Electric Co.'s works have been bought by the city of Berlin. The company, which owns large coalfields near Bitterfeld, is thus deprived of part of its former business of supplying Berlin with electric current. Both companies were formerly closely connected, and it is now the time to make a still closer connection. The A.E.G., therefore, proposes to the stockholders of the Berlin Electric Co. to exchange four of their shares against three of the A.E.G., the latter increasing its capital from 155,000,000 m. (£7,750,000) to 191,000,000 m. (£9,550,000), thus becoming the second largest German industrial corporation.

Russia.—In a circular issued by the British Pro-Consul at Petrograd Mr. G. Dobson it is pointed out that there is an increasing openings for increasing British trade with Russia.

Germany has exported to Russia trade products of the value of between 500,000,000 to 600,000,000 roubles annually, and he suggests that if British firms will adapt themselves properly they can capture the greater part of this. Many firms (he writes) are hesitating until after the conclusion of peace, when they think they will be better able to take advantage of this splendid opportunity. Mr. Dobson thinks this is a mistake, for meanwhile other nations are alert and active. Competition is being vigorously organised by Americans, Canadians, Swedes and Danes, and Germans are pouring into Scandinavia to resume their old game of the "honest broker" between England and Russia. Thousands of Germans who are now interned will return to their Russian business as soon as peace is proclaimed as if nothing had happened. No time, therefore, should be lost by British exporters in getting into touch with Russian buyers, whose usual supplies from Germany are now cut off. Russian inquirers after British goods cannot (says Mr. Dobson) afford to wait until Englishmen become linguists. The plan of the London County

Council to teach the Russian language will probably only tend to swell the ranks of candidates for situations in Russia as clerks and tutors, who already represent a supply for which there is no adequate demand. It fails to provide available men and means for pushing British trade in Russia. It is a mistake to suppose that Germany's commercial success in Russia has been due in any great measure to the study of the Russian language. German trade in Russia has been built up through the aid and co-operation of hundreds of thousands of German settlers there, who are born Russian subjects, and whose forebears have belonged to Russia for ages. They are obliged to learn Russian at school, but keep up their German at home. German schools also flourish in their midst. These Russian Germans prefer, of course, to deal with their kith and kin across the border. To such an extent has this factor operated in favour of German commerce that before the war the German language had almost become the business medium in all the great centres of Russian trade. This was wisely encouraged by the German Government. Every facility was given for German residents abroad to retain or resume their German nationality, and thus to Germanise the world. Mr. Dobson says: "It is much to be regretted that the British Government has been doing just the very reverse. There are at least 3,000,000 British subjects in foreign countries, most of them as loyal and patriotic as anybody in the British Isles, and amongst these voluntary exiles, whose sons are joining Kitchener's Army and fighting the nation's battles, our authorities are carrying on a veritable persecution. On Jan. 1, 1915, a most incomprehensible Act of Parliament came into force whereby the second generation of foreign-born Britishers are indiscriminately deprived of their national birthright. Such an extraordinary measure must have been completely overlooked by the British public. The wording of the Act is most obscure, but this interpretation is adopted by the British authorities. It was bad enough before, when children of the third generation born abroad of British parents were made outcasts by the action of the British Government. This curtailment of British nationality turns the children of faithful British subjects into aliens before they are old enough to choose for themselves, and, as regards Russia in particular, it makes outlaws of infant Britons whom the Russian Government very properly refuses to accept as Russian subjects. It is to be hoped that the short-sighted policy of the British Government in repudiating Britons abroad will not be followed by British manufacturers and merchants, who, on the contrary, should make use of their fellow-countrymen in Russia. This can only be properly done by means of a permanent museum of British goods at Petrograd, and a yearly exhibition of samples at the great fair at Nijni-Novgorod. The question of a museum at Petrograd requires negotiation, but arrangements for the exhibition at Nijni-Novgorod are actually ready and available.

Siam.—In a report by Mr. Acting Consul Donnithorne Read on the commerce of the consular district of Senggora for the year ended March 31, 1914, it is stated that there was an increase of £80,000 in the imports of iron, steel and machinery in Monthon Chumporn, but the imports into Monthon Nakon Soitamarat were somewhat less than in the previous year.

Considerable progress has been made with the construction of the Southern Railway during the year, and, with the extension of the railways, the telegraph service will also be extended and improved.

Spain.—The Ministerio de Fomento has authorised Don Furio Roldán Cuenca to carry out works for utilising the water of the Rio Mundo (Ayne) up to 3,000 litres per second for industrial purposes. Work must be commenced within six months of the approval of the plans and must be completed within two years.

MISCELLANEOUS NOTES.

Electrical Trades' Benevolent Institution.—Owing to the war, the annual festival of this Institution will not be held this year. In view of this decision, which will doubtless be endorsed by the subscribers to the Institution, the Committee confidently rely upon subscribers to renew their contributions, and hope that the urgency of the claims made upon the fund will bring a large influx of new subscribers. There is a continuous and steady call upon the fund at the present time, and it is feared that this call will be heavier as time goes on, requiring a large addition to the invested funds of the Institution.

Electricians' Wages in London Area.—Sir David Harrel has now issued his award in the arbitration proceedings between the London Electrical Masters' Association and the Electrical Trades Union.

On March 9, 1915, application was made by the London district secretary of the Electrical Trades Union to the London Electrical Masters' Association for an advance of wages from 10½d. to 1s. per hour, and a reduction of the working hours to 48 per week. The Employers' Association intimated that they were unable to accede to the request, and the matters were, therefore, considered at a meeting of the joint committee of representatives of the parties on April 30 and at a general meeting of the Electrical Masters' Association on May 10, but no agreement was arrived at. On June 10 application was made to the Chief Industrial Commissioner by the secretary of the men's union for the appointment of an arbitrator to decide upon the application for an advance of wages, it being subsequently explained that the question of the reduction of hours was unreservedly withdrawn. The Employers' Association concurred in the reference of the matter to arbitration, and the Chief Industrial Commissioner appointed Sir David Harrel to act as arbitrator, and the representatives of the parties were heard on the 5th inst., and Sir David Harrel has issued his award (dated Aug. 11) as follows:

I hereby award that the existing rate shall be raised from 10½d. to 11½d. per hour, with pro rata advances to electricians' labourers and assistants, such advanced rate to come into operation as from the beginning of the first pay-day following the date hereof, and the advance now awarded to be regarded as war wages and recognised as due to and dependent on the existence of the abnormal conditions now prevailing in consequence of the war.

Fatality. On the 10th inst. a man named A. Hemingway was killed while cleaning a tramcar in the Halifax tramway shed.

A thunderstorm seems to have damaged one of the insulators on the car, and when Hemingway touched a part of the trolley standard he received a fatal electric shock.

Roll of Honour.—Capt. Herbert Bailey, electrical engineer, son of Mr. J. H. Bailey, Blackburn borough treasurer, has been wounded in the Dardanelles. Capt. Bailey was in China when war broke out.

Private Wm. Thomas, of the Irish K.L.R., recently employed at the Blackpool electricity works, is in Rouen hospital, as the result of being hit in the neck with a piece of shrapnel.

War Relief Funds.—The employés of the India Rubber, Gutta Percha & Telegraph Works Co. (Ltd.), have since September last been contributing to the Nation's Relief Fund, British Red Cross Society and Belgian Relief Fund, and this week the total reached £1,002. A sum of £500 has been sent to the first-named fund, £250 to the Red Cross Society and £225 to the Belgians, leaving £27 in hand.

TENDERS INVITED.

Turbo-Generators, Condensing Plant, &c.

Shanghai Municipal Council invite tenders for the supply and delivery f.o.b. French port of one Turbo-generator set of less than 5,000 kw. capacity, with Condensing Plant, &c.; (*b*) one or two Turbo-generators of about 10,000 kw. capacity, with Condensing Plant, &c. Copies of specifications and forms of tender from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, Westminster, S.W., to whom tenders (in duplicate) should be returned, Friday, Sept. 24. *Standard advertisement.*

Turbo-Alternators, Dynamo, Eattery, Wiring, &c.

Bristol Corporation Electrical Committee invite tenders for a 6,000 kw. Three-phase Steam Turbo-Generator, with Condensing Plant. Specifications and forms of tender from the chief engineer and general manager, Mr. H. Lansley Procter, to whom tenders by noon Monday, Aug. 23.

Johannesburg Municipal Council invite tenders by Sept. 25 for supply and erection of two 3,000 kw. Turbo-Alternators, Condensing Plant, Switchgear, &c. Specifications from the Controller of Stores, and tenders to the Town Clerk, Municipal Offices, Johannesburg. Copies of specifications may be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

Telegraph Wire and Insulators.

The Deputy Postmaster-General, Brisbane, Queensland, invites tenders until Oct. 6 for supply of Tinned Copper Wire (schedule 357) and Porcelain Pothead Insulators (schedule 360) for the Australian Commonwealth, Postmaster-General's Department. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *Standard advertisement.*

Steam Tubes and Fittings.

The Commissioners of H.M. Works invite tenders for the supply of Steam Tubes and Fittings. Tenders by 11 a.m. Sept. 2 to the Secretary, Storey's Gate, London, S.W.

Electrical and Tramway Stores.

The directors of the Powell Duffryn Steam Coal Co. invite tenders for the supply of Electrical Goods. Tenders to company, 101, Leadenhall-street, E.C., by 10 a.m. Sept. 8.

West Ham Guardians invite tenders for the supply of Electrical Fittings, &c. Tenders to the Clerk, Board Room, Union-road, Leytonstone, London, N.E., by 10 a.m. Sept. 2.

Portsmouth Tramways Committee invite tenders by 10 a.m. Aug. 31 for Tramway Materials, including Overhead Line Material, Oils, Castings, Finger Pad-bars, &c. Specifications from the Electrical Engineer.

Electric Cranes, &c.

Tenders are invited until noon Sept. 6 by the Direccion General de Obras Publicas, Ministerio de Fomento, Madrid, for various work at the Port of Mutilla y Sporo, including supply of Electric Cranes, Rails, &c. The "Gaceta," of July 25, containing particulars, may be seen at 73, Basinghall-street, E.C.

Electric Motors, Pump, &c.

SYDNEY (N.S.W.) Council require tenders by Sept. 13 for supply of a.c. and d.c. Motors during two years (contract 382). Specification from the City Electrical Engineer.

The Metropolitan Board of Water Supply, &c., SYDNEY (N.S.W.), want tenders by 2 p.m. Sept. 6 for Centrifugal Pump and Electric Motor for Richmond pumping station. Specification, &c., from 341, Pitt-street, Sydney.

Telegraph and Telephone Material, Wire, Instruments, &c.

The Deputy Postmaster-General, Perth (W. Australia), requires tenders by Sept. 29 for Telephone Switchboards, &c.

Tenders are required by 2 p.m. Sept. 1 for Condensers, Resistance Testing Sets, Relays, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept.

The Postmaster-General's department of the Commonwealth of Australia invites tenders (until Sept. 23) for the supply of Condensers, Galvanometers, Relays and Sundries, and for Incandescent Electric Lamps, and (until Oct. 6) for the supply of Poles (iron or steel) and Fittings. Tender forms, &c., from the Commonwealth offices, 72, Victoria-street, S.W.

The Deputy Postmaster-General, Melbourne, invite tenders until 3 p.m. Aug. 31 for Switchboard parts (schedule 1239) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specifications, from the Deputy Postmaster-General.

Wiring and Fittings.

AYLESBURY Urban Council invite tenders for wiring the Town Hall. Specification, &c., from the Electrical Engineer.

TENDERS RECEIVED AND ACCEPTED.

SHEFFIELD.—The following tenders have been accepted by the Electric Supply Committee :—

A. Reyrolle & Co., switchgear, £240 ; Stewart & Lloyds, steam pipes ; Lea Recorder Co., water recording apparatus ; Wragg & Biggin, mason-work, £40 ; Sharpe & Co., water pipes, £200.

READING.—The Council have ordered from Dick, Kerr & Co. new motors and controllers for six tramcars, comprising 12 motors and 12 controllers. The price quoted was £105 each for the firm's standard 40 H.P. interpole traction motors, complete with gears, pinions and gear cases ; and £28 each for their standard type "K" controllers, making a total of £1,596 net.

BARKING.—The following tenders have been accepted by the Urban Council :—

Brush Electrical Engineering Co., for a turbo-alternator and condenser (£6,180), and cooling tower (£1,392) ; Babcock & Wilcox, circulating water pipes (£268) and steam pipes (£257) ; General Electric Co., converting plant (£1,402. 10s.) and switchboard (£626) ; Pirelli (Ltd.), h.t. cable, &c. (£2,550) ; and E. Green & Son, economiser (£1060).

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

HOVE. The annual statement of accounts of the electric supply department was approved by the Council last week.

The capital expenditure to March 31st last was £42,875. 16s., which had been defrayed out of capital. During the year under review the capital expenditure during the year was £3,005, of which £1,785 was for new mains. The total expenditure to March 31 last was £82,749. The total capital raised to March 31 last was £81,128. The income during the year was £23,499, the bulk of it coming from sale of current (1,115,168 units). £21,422, and rental of meters, &c., £1,610. The annual expenditure was £9,295, and the interest on capital was £4,204. After paying interest (£7,191), instalment of principal (£377), income tax (£609), &c., the balance was £3,023. 18s. 9d. On the Aldrington section the capital expenditure was £11,052. 12s. 7d., including £294 spent during the year, the total being £53 in excess of the capital raised. The annual income was £1,325, of which £1,203 was from sale of current. The purchase of electricity in bulk (79,718 units) cost £570 and its distribution £162. The surplus was £506. 1s. 10d., which was applied in payment of interest (£308) and repayment of instalment of principal (£346), so that there was a deficit of £148, thus reducing the balance to £2,875. 16s.

The chairman of the Lighting Committee (Councillor Payne) said the ratepayers had cause to congratulate themselves on taking over the electricity undertaking. It was unfortunate that during the first year of working they should have found themselves engaged for seven months in a great war. Nevertheless, the Council could get encouragement from the lighting accounts, for the results under unfortunate circumstances were far better than they had expected. The total income for the year was £23,499, which, after deduction of working expenses, interest, &c., left a balance of £3,023. The total reductions given to consumers during the first year of the Corporation's working amounted to £1,157. Thus, the consumers and ratepayers had benefited to the extent of £4,180. Where the Corporation had taken over a going concern they could not predict such a result for the current year, but they had every reason to look forward to keeping up the present standard.

Mr. Read said that the Committee had received the report of the Town Clerk and the Borough Surveyor on the question of the Council undertaking the supply of electricity to the whole of the borough. The Committee were of opinion that it would be unwise to undertake the supply in the outlying districts at present. The number of persons who had been employed by the Corporation had been reduced by 50 per cent. The Committee had decided that it was not to the interest of the travelling public that an increase of fares should be made. There were about 180 women conductors at present, and, speaking generally, they had done exceedingly well. It was expected that a further large number of men in the department would join the colours, and that would necessitate the employment of more women. They had now 17 motor omnibuses and six more were on order. In the very near future the number of motor omnibuses would be greatly increased on the various routes, because the Committee found that they were very popular and supplied a great public want. The result of the year's working was very satisfactory. They would have a large expenditure in providing for the dependents of men who had joined the colours, amounting to between £11,000 and £12,000, and the cost of materials was still going up. Still, he thought that, with economy of working, at the end of the current year they would be able to hand over to the Finance Committee a sum equal to what they gave this year.

A discussion ensued, and a resolution was moved in favour of appointing a committee to consider the desirability of using all or a portion of the profits of the Tramways Committee, for one or more years, for the purpose of building houses at rentals within reach of the working classes.

Councillor NEAL, who opposed the proposal, pointed out that the margin of reserve which protected the tramway undertaking from becoming a charge upon the rates was very small—only £2. 13s. 1½d. per cent. upon the capital expenditure.

Ald. HOBSON also pointed out that the profits on the tramways had been allowed for in the district rate that had been fixed for this year. If they diverted them to the purpose proposed they would either have to impose a distinct rate to replace them or to borrow money. The chief reason why rents had risen was the increase in the rates, but that the building of cottage houses had ceased to be an attractive proposition to the capitalist, either large or small.

An amendment instructing the Estates Committee to consider what steps (other than those already taken) could be found for dealing with the matter was carried.

COMPANIES' MEETINGS AND REPORTS.

COUNTY OF DORSET ELECTRIC SUPPLY CO (LTD.).—At the recent meeting, the chairman (Mr. J. A. Hankey) said that the company's progress from its commencement had been uniformly steady and satisfactory. The cost of generation due to the increased price of coal, &c., had gone up, and necessarily increased the running expenses, and the restricted lighting orders considerably reduced the amount normally used, especially for shop lighting. In spite, however, of all adverse factors, the company had largely increased the number of consumers ; in fact, during the war period they had added 86 new consumers and 1,325 30 watt lamps. The

record of last month showed the largest increase in any month since the four companies had been in operation, as during the month lamps to the equivalent of over 1,000 30-watt lamps had been connected. An important factor in their progress had been the Dorchester prisoners' camp. That had recently doubled in capacity, and if it was still in use during the winter its requirements in the way of electricity should be more than double that used last winter. The gas companies had found it necessary to raise their prices, and that also made the prospect of obtaining new consumers for electricity much better during the present half-year. With regard to the increase in the cost of coal and general materials, he was pleased to say that, owing to foresight and careful provision in buying and making contracts, the company had suffered comparatively slightly in that respect. The works cost per unit had been less than half the cost per unit for the same period last year, and their engineer reported that he hoped to have still better results during next winter. The company was producing current at prices which compared favourably with supply stations several times as large. For instance, at Dorchester, for January, the cost per unit generated, including coal, oil, waste, stores, water and wages came out at only 0·601d. per unit generated. As to progress in revenue earnings, the figures enabled him to make a good report for the half-year since the date of the balance-sheet. At June 30 the receipts equalled fully two-thirds of the total for the previous whole year, while against a debit balance of £160 the company had a net profit of £222. Given the proportionate increase for the next half-year, the debit balance of previous years should practically disappear.

BROUGH ELECTRIC LIGHTING CO. (LTD.)—At the recent meeting the chairman (Mr. J. E. Reynoldson), in moving the adoption of the report, congratulated the shareholders on the excellent results. The number of householders who were using the electric light had far exceeded their most sanguine expectations. He was glad to be able to announce a 5 per cent. dividend, and a substantial amount had been placed to depreciation fund. To meet the demand for electric light, the directors had made arrangements for the installation of another dynamo and oil engine.

NEW COMPANIES.

DUROGLASS (LTD.) (141,263)—Reg. Aug. 13, capital £50,000 in £1 shares, to acquire business of glass works erected or in course of erection at Walthamstow by Baird & Tatlock (London), Ltd., and to carry on the same and the business of glass manufacturers and dealers, metal workers, manufacturers of enamels, machinery and glassware, makers, fillers and sealers of glass bulbs and other receptacles for scientific and other purposes, &c. Private company. First directors are D. H. Baird, T. B. Allan, Dr. M. W. Travers, F.R.S., and F. W. Crailsham. Secretary: J. T. Evans. Reg. office: 14, Cross-street, Hatton-garden, E.C.

ELECTRIC SAFETY HOISTS (LTD.) (141,264)—Reg. Aug. 13, capital £500 in £1 shares, to take over the business of a dealer in patent electric safety hoists and all electrical appliances, manufacturer, and engineer of electrical plant, machinery and stock, manufacturers' agent, electrical and mechanical engineer, &c., carried on by A. H. Colley at Liverpool as the Star Electrical Co. Private company. First directors are A. H. Colley (permanent managing director) and L. H. Wright. Reg. office: Seaton-buildings, 17, Water-street, Liverpool.

KILLORGLIN ELECTRIC LIGHT & POWER CO. (LTD.)—(4,268)—Reg. in Dublin on Aug. 11, capital £1,650 in £1 shares, to carry on at Killorglin, co. Kerry, the business of an electric supply company. First directors are D. M. O'Sullivan, D. Murphy, J. O'Regan, J. Regan, W. Crowley, T. O'Donnell, P. O'Shea and E. L. Cantwell. Reg. office: Power House, Killorglin, co. Kerry.

PATENT LIGHTING CO. (LTD.) (141,238)—Reg. Aug. 10, capital £100 in £1 shares, to carry on the business of manufacturers of and dealers in appliances connected with the lighting or heating (by gas, electricity or otherwise) or ventilating of railway carriages, tramcars, ships, &c. First directors are W. B. Rickman, A. Hall, C. P. Whitcomb and F. C. Fairholme. The Board of Trade has authorised the acquisition by the company of the undertakings of Pintsch's Patent Lighting Co. and Pintsch's Electric Mfg. Co., the books and documents of which are [illegible] 2 [illegible] 1914.

CITY NOTES.

MEMORANDA (Aug. 19).—Bank rate 5 per cent. since Aug. 8, 1914. Consols 65. Consols Pay Day Sept. 1. Stocks and Shares Ticket Day Aug. 26 for Sept. 9. Pay Day Aug. 27 and Sept. 10. Price of silver, 22¾d.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CORPN. (LTD.)—The directors have declared an interim dividend on the [illegible] Aug. 30 to holders on the ordinary shares of record [illegible] and on the preference shares of record [illegible] annum (less tax).

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of members will be closed from the 23rd inst. to Sept. 6 inclusive.

ELECTRO-BLEACH & BY-PRODUCTS CO. (LTD.)—A dividend of 3½ per cent. has been declared on the preference shares for the year ending Dec. 31 next.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The directors have declared an interim dividend on the preference shares at the rate of 4½ per cent. per annum (less tax) and on the ordinary shares at the rate of 10 per cent. per annum (less tax) for the half-year ended June 30 last, both payable on 1st prox.

RUBBER STOCK INVESTMENTS.—Doubtless when the war comes to an end, perhaps earlier, if any indication should show a likely termination of the conflagration, there must come a heavy demand for rubber for many manufacturing and industrial purposes, and the heavy stocks that have accumulated owing to transport and other difficulties will come to be released. The effect on the rubber market will doubtless be considerable. This fact, and the general popularity of the rubber market as a field for investment (we ought, perhaps, to add speculation), gives increased interest to the publication by the "Financier," 49-57, Wool Exchange, London, E.C. (price 2s. 6d. net, 2s. 10d. including postage) of "The Financier Rubber Share Handbook." In this work, which consists of over 800 pages, a list is given of all the chief rubber-owning and producing companies. This is the 12th edition of the Handbook. In a review of the general rubber situation, it is stated that the estimated output for 1915 is some thousands of tons in excess of 1914, and the prospect of future years is that a very large area of plantation rubber will come into bearing. With regard to market prices, the prognostication is made that these will be maintained at the present comparatively low level, which is given at 2s. 3¼d. per lb. average. The particulars given of the various companies and their undertakings includes all capital items, directorates, location of properties, outputs ascertained and estimated, and other information indispensable to investors and speculators in this class of joint-stock enterprise.

MATHER & PLATT (LTD.)—The directors have declared an interim dividend on the ordinary shares of 3 per cent. for the half-year ended June, being at rate of 6 per cent. per annum.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The net earnings (including those of the Rand Mines Power Supply Co.) for the quarter ended June 30 amounted to £170,465.

WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS (LTD.)—The directors have declared an interim dividend at 2½ per cent. (less tax) on the issued share capital in respect of the half-year ended July 31.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Aug. 18. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shares of	Last Dividend	NAME.	Price, Wed. Aug. 18.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9¼	7 5 8	Mar. Sept
10	4½ „	Do. 4½% Cum. Pref.	9	4 17 6	Feb. Aug
10	5%	Do. 5% Cum. 2nd Pref.	12⅛	5 17 3	Feb. Aug
5	10 „	Brompton & Kensington Ord.	5⅜	5 - -	Mar. Sept
St.	4%	Central Elec. Supp. G. Deb. St	¾	4 - -	.. ..
St.	4%	Chamberlain & Hookham's Westminster & City Debs...	93	4 6 10	Jan. July
5	2 3	Do. 4½% Pref.	4⅜	5 1 7	.. ..
5	..	Do. 6%	..	6 - -	Aug. Feb
10	9%	City of London Elec. Lt. Ord.	13	7 - -	Feb. Aug
10	6/0	Do. 6% Pref.	12½	4 17 6	Mar. Sept
St.	5%	Do. 5% Deb. St.	110	4 10 11	Jan. Dec
10	7%	County of London Ord.	10¾	6 11 10	Mar. Sept
10	6%	Do. 6% Pref.	9	6 13 4	Feb. Aug
St.	4½%	Do. 2nd Deb.	97	4 12 -	May Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs...	97	5 10 6	Jan. July
5	7%	Kensington and Knightsbridge Ord. ..	7¾	6 9 2	Feb. Aug
St.	4%	Do. Deb. St.	86	4 13 11	Jan. July
5	3 0	London Elec. Supp. 6% Pref.	5⅞	5 14 1	.. ..
St.	4%	Do. 4% Deb. St.	86	4 11 11	Jan. July
5	3½	Metropolitan E. Supp. Ord.	5	7 - -	May. Aug.
St.	4½%	Do. 1st Mort. Deb. St.	97	4 13 -	.. ..
St.	..	Midland Elec. Corpn., 1st Mort. Deb. St.	..	.. - -	.. ..
..	..	Newcastle & Dist. E.L. 6% 2nd Dbs ..	½	6 11 -	May Sept
St.	5%	Newcastle-on-Tyne E.S.5%2d Mt. Db. St.	103	.. ..	May Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1⅝	4 - -	April Oct
St.	5%	South London E.S. 1st Mort. Debs. .	..	.. ..	Jan. July
St.	4½%	Charing Cross, Euston & Hampstead 1st Mort. Deb. St.	94	4 15 -	April Oct
..	..	Waste Heat & Gas Elec. Gen. Stations	..	.. ..	Aug. Feb
5	..	Westminster E.S. Corp. Ord.	..	.. ..	May. Nov
5	12 „	Yorkshire Electric Power	17	14 -	Jan. July
		Electric Railways & Tramways.			
St.	5%	Barnsley & District	..	.. ..	April Oct
St.	6%	Do. 6% Cum. Pref.	..	.. ..	Feb. Aug
1	4 „	Bristol Tramways	10	11 ..	.. ..
..	..	Do. 6% Pref.	..	.. ..	.. ..
..	..	Do. Deb. St.	..	.. ..	.. ..
St.	..	Cardiff Electric Traction Deb. St.	..	4 14 -	.. ..
..	..	Do. 5% Pref.	..	.. ..	.. ..
1	1 „	Lancashire Electric Power	1⅜	.. ..	Jan. July
1	1 „	Lancashire Tramways	1⅜	.. ..	Jan. July
St.	4%	Do. 4% Deb. St.	..	.. ..	May. Nov.
St.	4%	Do. 4% Deb. St.	..	4 14 1	Jan. July
St.	4%	Metropolitan Elec. Tramways	..	4 - 1	Feb. Aug
St.	3½%	Do. 3½% Deb. St.	74	4 11 1	Feb. Aug
St.	3½%	Do. 3½% Deb. St.	74	4 11 1	Jan. July
St.	3½%	Do. 3½% Deb. St.	74	4 11 1	Jan. July
St.	4%	Metropolitan, Dist. Ry. Ord.	11	.. ..	Feb. Aug
St.	4%	Do. 4% Deb. St.	92	4 7 0	May. Nov

†Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share.	Last Dividend	NAME.	Price, Wed., Aug. 18.	Rate per cent. Yielded.	£ s. d.	Dividend Due.
		Electric Railways and Tramways—*cont.*				
St.	4½%	Metropolitan Dist. Ry. 4½% First Pref	69½	6 9 4		Feb, Aug
Stock	6%	Do. 6% Perp. Deb.	12⅞	4 12 8		Jan, July
Stock	4%	Do. 4% Deb.	72	5 11 1		Jan, July
Stock	4%	Do. 4% Debs. (1903-5)	87½	4 11 7		Jan, July
St.	4%	Do. 4% Cons. Stock	75½	5 6 0		Mar, Sept
10	..	Underground E. Rys. of London Shares.	1½	..		..
1/0	..	Do. A Ord.	½	..		..
St.	6%	Do. 6% Inc. Debs.	104	5 15 3		Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 15....	7⅛	8 2 0		Mar, Sept
..	4½%	Do. 4½% Bds.	95⅛	4 12 4		Jan, July
5	..	Yorkshire W. Riding Ord.	⅛			March
5	6%	Do. Pref.	4½	7 1 8		Jan, July
		Electric Manufacturing, &c.				
1	4%	Babcock & Wilcox Ord.	2½	6 4 5		Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 17 0		Mar
100	5%	Do. Prior Lien Debs.	93½	5 5 6		Jan, July.
1	6%	Do. 6% Pref.	½	6 12 5		Jan, July
5	15%	Brit. Insulated & Helsby Ord.	13⅛	7 1 2		Aug, Feb
5	3.0	Do. 6% Cum. Pref.	5⅛	5 9 1		Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅞	6 0 4		Mar, Sep
2	7½%	Brit. Westinghouse Pref.	13	9 4 7		Apl, Oct
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 6		Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5 9 4		Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10⅛	6 16 4		Jan, July
5	2/6	Do. 5% Pref.	4⅛	6 1 2		Feb, Aug
1	15%	Castner Kellner	3½	4 16 2		May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	7 13 7		Sept
..	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..		Feb, Aug
1	6%	Elec. Construction Ord.	⅞	9 4 7		May
1	7%	Do. 7% Cum. Pref.	1	7 0 0		Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6		Jan, July
10	6%	General Electric 6% Pref.	7⅛	6 7 2		Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13	7 13 10		Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4½	5 0 0		..
St.	4½%	Do. 4½% Do.	91½	4 18 4		Jun, Dec
10	15%	India Rubber, G. P. &c., Ord.	8½	5 17 8		Feb, Aug
10	5%	Do. Pref.	8⅜	5 16 6		Apl, Oct
100	4%	Do. 4% Debs.	98	4 1 8		Apl, Oct
12	20/0	Telegh. Con. & Main. Co.	30½	7 17 4		Mar, July
100	4%	Do. 4% Debs.	93	4 6 0		Jan, July
1	7½%	Vickers Ord.	1⅛	4 14 1		May, Aug
1	6d.	Do. 5% Pref.	⅛	5 14 3		May, Aug
St.	4%	Do. 1st Debs.	77	5 1 6		Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	100	4 10 0		Jun, Dec
		Telegraphs.				
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3		Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	97⅛	6 2 11		Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21½	7 0 0		Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	6⅛	6 1 1		Ja.Ap.Jly,O
10	5%	Cuba Submarine Ord.	6⅛	5 13 6		May, Nov.
10	10%	Do. 10% Pref.	15⅛	6 11 2		..
5	5.0	Direct Spanish 10% Pref.	7⅞	6 3 4		..
10	4%	Direct United States	5⅛	6 16 2		Ja.Ap.Jly,O
St.	7%	Eastern Tel. Co. Ord.	115½	6 1 3		Ja.My.Jly,O
St.	17/6	Do. 3½% Pref.	65	5 2 11		Ja.My.Jly,O
St.	4%	Do. 4% Debs.	81	4 13 1		May, Nov
10	4%	Eastern Extension Tel. Co., 4% Debs.	78½	5 1 9		Feb, Aug
10	7%	Do. Ord.	11⅜	6 6 6		Ja. Ap.Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8....	31⅛	7 13 4		Ja, My, Jly
25	13%	Indo-European	54	6 0 4		May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 3 3		April
1	7%	Do. 7% Pref.	1⅞	3 18 7		July
10	9d.	West India & Panama Ord.	1⅜	8 17 9		May Nov
10	6%	Do. 1st Pref.	6½	7 1 2		May, Nov
10	3/0	Western Telegh. Co.	11⅛	6 1 9		Mr,Jly,O.Dec
St.	4%	Do. 4% Deb. St.	83	4 16 5		Jun, Dec
..	4½%	Western Union 5% Bds.	98	4 11 9		May, Nov.
		Telephones.				
..	$2	American Telephn. & Telgh. $100 Cap.	134	6 7 6		Ja.Ap.Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	77⅛	6 9 0		Jan, Jly
1	7½%	Monte Video Telephn. Ord.	⅝	5 12 5		Nov.
..	4½%	New York Telephone 4½% Bds.	97⅛	4 11 9		May, Nov
1	10%	Oriental Telephone Ord.	1⅜	5 1 8		Apl, Oct
St.	4%	Do. Db. St.	86½	4 12 6		Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 8		Jan, July
5	8%	United River Plate Ord.	5⅝	7 13 7		Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅛	6 3 3		Jan, July
St.	4½%	Do. Deb. St.	90	5 0 0		Jan, July
		Financial and Investment.				
10	6%	GlobeTeleg. & Trust	9⅛	6 3 1		Sp.Dc,Mr,Jn
10	6%	Do. 6% Pf.	10	6 0 0		Sp.Dc,Mr,Jn
100	5%	Mackay Postal Telegraph	80	6 5 0		Ja, Apl, Jly,O
..	4%	Do. 1st Pref.	60½	6 15 6		Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	125⅛	4 15 7		Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.				
St.	5%	Anglo Argentine Trams. 5% Debs.	99⅛	7 1 0		Jun, Dec
St.	4½%	Do. 4½% Do.	69	6 12 6		Jan, July
St.	4%	Do. 4% Debs.	69	5 14 6		Jan, July
5	2/0	Do. Ord.	4⅝	6 17 6		Jan, July
5	2/0	Do. 5% Pref.	3⅞	7 12 6		Jan, July
100	5½	Brazilian Traction Ord.	45⅜	12 5 6		Fb,M.A.u.N
100	5½	Do. Pref.	81	7 2 11		Ja.Ap.Jly,O
5	5%	Buenos Ayres Tramways	5⅞	7 13 3		May
5	2/6	Do. Pref.	4⅜	5 5 7		May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	100	6 15 0		..
5	7%	Calcutta Elec. Trams. Ord.	7⅜	6 1 8		Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	47⅛	10 13 1		Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	6	6 0 0		..
100	5%	Manaos Trams 5% Debs.	69	7 4 11		Jan, July
..	..	Mexican Tramways	3⅛	..		Fb.M.Aug.N.
..	..	Do. Pref.	8	8 16 5		Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)..	97	4 13 3		Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 50 yr. Bds	70	7 2 2		Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds.	97	4 17 6		Feb, Aug
		Colonial and Foreign Electric Supply, &c.				
5	3/0	Anglo-Colombian Elec. Pref.	5⅛	5 13 7		Mar, Sept
St.	5%	Do. Deb. St.	99	5 1 2		Jun, Dec
1	..	Buenos Ayres Electric	1⅛	5 14 3		..
..	..	Do. Pref.	7⅛	7 10 1		May, Nov
..	..	Do. Def.	3⅜	7 4 3		Mar, Sept
St.	5%	Buenos Ayres Gt. Southern 5% Debs.	110	5 0 0		Ja.Ap.Jly,O
St.	5%	Mexican Electric Light Debs.	77	6 9 0		June, Dec
..	..	Do. Pref.	4⅛	6 1 2		April
..	..	Spanish River Pulp & Paper 6% Bds.	94	6 7 8		Jan, July
St.	4½%	Toronto Power Co. 4½% Bds.	84	5 5 1		Ja,Ap,Jly,O
St.	4½%	Trinidad Electric 4½% Debs.	87	5 3 4		Jan, July
1	..	Do. 4½% Cum. Pref.	80	5 12 3		May, Nov
..	5%	Victoria Falls & Transvaal P. Co. 6% Pf	91	..		Jan, July
..	5%	Do. 5% 2nd Mort. Debs.	84	6 8 4		Jan, July

† Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Carnham & Sons, 132, Upper Thames-street, London, E.C., quote under date August 18, the following as the present basis prices of

New Metals.	per lb.	Old Metals:	per ton.
Solid Drawn Brass Tubes	13½d.	Clean Scrap Copper	£63 0 0
Solid Drawn Copper Tubes	13½d.	Brazlery Copper Scrap	£57 0 0
Brazed Copper Tubes	13½d.	Clean Scrap Brass	£51 0 0
Brazed Brass Tubes	13½d.	Old Lead	£17 10 0
Brass Wire	13½d.	Old Zinc	£30 0 0
Copper Wire	13½d.	Hollow Pewter	£110 0 0
Rolled Brass	13½d.	Black Pewter	£80 0 0
Brass Sheets	13½d.	Gun Metal	£59 0 0
	per ton.		
Copper Sheets	£98 0 0		
Spelter	£62 0 0		

	per ton.		per ton.
English Lead	£21 0 0		
Antimony	Nominal.		

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date August 17, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£75 0 0	Gun Metal	£60 0 0
Clean Mixed Brass	£80 0 0	Old Lead	£18 10 0
Clean Copper	£64 0 0	Tea Lead	£17 0 0
Clean Copper Cuttings	£67 0 0	Hollow Pewter	£110 0 0
Clean Copper Wire	£67 0 0	Shaped Black Pewter	£80 0 0
Brazlery Copper	£58 0 0		

Mr. Joseph can supply solder at the following prices per ton; Plumber's Solder (in bar or strip), £70; Commercial Tinman's Solder, £90; Blowpipe Solder, £110.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	Aggregates. No. of weeks.	Aggregates. Amount.	Aggregates. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 11	1,879	— 162	10	19,418	— 513
Anglo-Argentine	.. 12	83,489	— 1,737	32	1,633,875	— 141,940
Ashton-under-Lyne	.. 14	1,569	— 30	20	9,755	+ 267
Ayr Corporation	.. 14	526	— 16	13	6,530	— 202
Bath Electric Trams. Ltd	..	..	..	..	..	..
Birkenhead Corporation	.. 15	1,419	+ 97	20	27,134	+ 1,514
Birmingham Corporation	.. 7	15,240	..	19	247 462	..
Blackburn Corporation	.. 11	1,308	— 386	20	27,054	— 662
Blackpool Corporation	.. 12	4,390	+ 1,720	20	35,509	— 6,968
Blackpool and Fleetwood	.. 13	2,343	+ 632	32	22,450	— 3,525
Bolton Corporation	.. 14	2,657	— 459	20	53,207	— 3,812
Bournemouth { Trams	.. 11	2,895	— 387	19	41,340	— 1,305
Bournemouth { Buses	.. 11	57	— 14	19	547	— 162
Bradford Corporation	.. 14	6,579	+ 96	19	131,320	+ 3,390
Brighton Corporation	.. 13	1,577	+ 301	20½	22,915	— 1,533
Bristol Trams { Trams	.. 13	4,976	+ 370	32	150,903	— 1,023
Bristol Trams { Buses, &c.	.. 13	5,430	+ 1,144	32	154,335	+ 25,531
Burmah E. Trams & Ltg.	.. 14	R4,021	— R248	32	R111,601	+ R1,083
Burnley Corporation	.. 13	1,590	— 18	20	46,486	— 10
Burton Corporation	.. 15	312	— 11	20	5,798	— 381
Bury Corporation	.. 13	1,445	— 478	20½	27,514	— 953
Calcutta Tramways Co.	.. 14	R68,745	+ R607	..	..	..
Camborne-Redruth	.. ..	..	..	..	..	..
Cardiff Corporation	.. 7	3,036	— 284	18	50,647	— 4,222
Cork Electric Trams Co.	.. 12	800	+ 46	32	15,419	— 296
Coventry Corporation	.. ..	..	..	..	..	..
Croydon Corporation	.. 6	2,480	+ 459	18	351,151	+ 1,176
*Derby Corporation	.. 14	1,119	— 6	19	20,971	— 59
Dover Corporation	.. 7	431	+ 56	18	5,929	+ 966
Dublin & Lucan Railway	.. 13	151	— 6	6	1,046	— 114
Dublin United	.. 13	6,215	+ 8	32	195,566	+ 5,738
Dundee Corporation	.. 11	1,355	+ 87	13½	17,377	+ 184
East Ham Council	.. 14	1,335	+ 74	19½	26,172	+ 4,575
Exeter Corporation	.. 13	449	+ 78	19	7,621	+ 183
Glasgow Corporation	.. 14	21,416	+ 1,103	..	230,862	+ 12,597
Glossop Trams	.. 14	136	— 10	33	4,015	— 122
Gloucester Corp.	.. 11	370	— 42	19	6,520	— 176
Halifax Corpn. { Trams	.. 13	2,562	— 261	19	43,961	— 28?
Halifax Corpn. { Buses	.. 10	71	..	19	994	— 7
Hastings Elec. Trams Co.	.. 12	1,621	+ 245	32	29,686	+ 1,675
Huddersfield Corpn.	.. 14	2,927	+ 328	20	53,707	+ 5,851
Hull Corporation	.. 14	2,931	+ 4	19	59,855	+ 3,328
Ilford District Council	.. ..	..	..	..	..	..
Ilkeston Corporation	.. 11	141	+ 22	19	2,546	— 4
Ipswich Corporation	.. 14	597	+ 219	18	11,111	+ 1,20
Isle of Thanet Co.	.. 14	1,142	— 60	45½	17,456	— 9,58
Kilmarnock Corporation	.. 14	168	— 4	13	2,324	— 6
Lanarkshire Trams Co.	.. 12	2,103	+ 288	32	61,072	— 7
Lancaster Corporation	.. 11	1,739	+ 160	32	55,045	+ 2,1
Leeds Corporation	.. 14	8,574	+ 857	20	177,895	+ 8,1
Leicester Corporation	.. 13	3,059	+ 384	33	97,156	+ 2,7
Leith Corporation	.. 13	324	— 17	13	10,457	+ 1,
Lincoln Corporation	.. 13	151	+ 45	20	2,776	+ 7
Liverpool Corporation	.. ..	..	..	..	..	..
Llandudno&Colwyn BayR	.. 13	651	+ 209	32	11,544	+ 38
London County Council	.. ..	..	..	..	..	..
Lowestoft Corporation	.. 13	234	— 63	15½	8,000	— 1,69
Maidstone Corporation	.. 12	250	— 33	19	4,367	— 5
Manchester Corporation	.. 14	17,000	— 551	19	353,049	+ 1,25
Nelson Corporation	.. 14	201	— 3	13	3,861	— 4
Newcastle-on-Tyne Corpn	.. 13	6 410	+ 1,308	23½	123,357	+ 17,2
Newport (Mon.) Corpn.	.. 7	961	+ 242	19	15,773	..
Northampton Corporation	.. 13	1,000	— 98	19½	15,040	— 3,1
Nottingham Corporation	.. 12	2,013	+ 441	19	72,971	+ 3,1
Oldham Corporation	.. 13	2,317	— 63	21	48,124	— 3
Portsmouth Corporation	.. ..	..	..	..	..	..
Preston Corporation	.. 11	1,082	— 109	19**	18,478	+
Rhondda Corporation	.. 14	1,274	— 236	14½	34,387	+ 1,7
Rotherham Corporation	.. 11	1,216	+ 199	19	21,827	+ 2,1
Salford Corporation	.. 14	5,136	— 98	20½	104,418	+ 2,1
†Sheffield Corporation	.. 17	9,037	+ 1,694	20½	179,186	+ 17,6
Southampton Corpn.	.. 11	1,715	+ 190	19	28,664	+ 1,1
Southend Corporation	.. 11	1,415	— 32	19	17,123	— 5,8
South Shields	.. 7	1,041	— 71	31	15,035	— 2
St'lyb'dge, Hyde, &c., Jt. B.	.. ..	..	..	..	..	..
Sunderland Corporation	.. 13	1,667	— 59	20	29,951	— 1,2
Sunderland District	.. ..	..	..	..	..	..
Swindon Corporation	.. ..	..	..	..	..	..
Tynesides Tram Co.	.. 4	811	+ 42	5	3,441	+
Wallasey Corporation	.. 14	1,475	— 1	19‖	26,369	—
Walsall Corporation	.. 14	1,141	+ 285	33	23,484	+ 2,3
Wednesbury	.. 14	977	+ 103	20	18,878	+ 1,
Warrington Corporation	.. 12	439	+ 33	19	8,736	+
West Ham Corporation	.. 13	3,096	+ 313	19	60,612	+ 4,
Wigan Corporation	.. 12	1,496	+ 102	19	29,273	+
Wolverhampton Corpn.	.. 13	1,141	+ 141	19	21,425	+
Yorkshire W.R. Trams	.. 13	1,608	+ 28	33	52,165	+ 3,2

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses, &c. ‡ Minus 2 days. ‖ Minus 3 days. ¶ Plus 3 days.
** Compared with one week more last year.

THE ELECTRICIAN:

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NOTES.

Liability for Defective Wiring.

A BAD case of the defective wiring of premises at Belfast was recently brought to our notice. It appeared that a wiring contractor, or one of his foremen, had employed telephone wire instead of electric light wire, and although the usual test was applied by the supply department before connection, no defect was discovered, and a supply was given in due course. This is not surprising, because it may happen that a faulty installation will pass the tests under initially favourable conditions, but when improper material is used, as in the present case, it is liable to break down after being put into use. As usual, our gas friends made the most of the case, and depicted in vivid terms the awful results that might have arisen from the defective installation, while some members of the Council who were friendly to the gas interests asserted that the Corporation had incurred serious responsibility in connecting the premises to their mains. Incidentally, we may say that we think the conduct of the person responsible for the use of the telephone wire was most reprehensible, and similar practices should be brought within the ambit of the criminal law, for it is only the fear of getting a term of imprisonment that will deter certain men from endangering property. However, the liability of the supply authority is on quite a different footing from that of the wiring contractor or his employee.

THE upshot of the debate by the Council was that the matter was referred to the Town Solicitor for his opinion, and, as will be seen from our report in another column, he has now reported that the electricity department had no responsibility for defects occurring in consumer's installations after the same had been tested and found to comply with the regulations. We think this opinion to be correct, and to be in accordance with common sense. The duty of the Corporation is to give and maintain an efficient supply of electrical energy to the consumer's premises in accordance with its statutory obligations, and as it was not alleged that it had failed to perform, or had been negligent in the performance of, any of its duties, we cannot see how the Corporation could be held responsible for what occurred. It is not responsible for anything beyond the meter, and it owes no duty to a consumer to see that his wiring and fittings are in order. It is the other way about, for it is the consumer who must see that his installation is in order; but for its own safety and for the protection of its other consumers the supply authority lays down certain conditions, including the application of certain tests to the installation before supply can be given. So long as the tests of insulation resistance are satisfactorily fulfilled a supply cannot be refused. In some respects this is unsatisfactory, for larger powers are sometimes desirable, but in a case of this kind we must take the law as it stands.

Industrial Heating.

IT is interesting to note the gradual development of industrial heating involving electrical energy as the heating agent. In the United States a contract has just been made by the Willys-Overland Company to be supplied with a power of 6,000 kw. for heating their enamelling ovens. These ovens are used by the company in the manufacture of automobiles, and we think that we may safely say that this contract is a record in this particular line. As will be seen by referring to a short article which we publish in another column, the heaters in the largest ovens have a capacity of 400 kw., and the units used per heat per oven are something over 200. In this particular case electricity has displaced gas, owing to the fact that the time of making a heat can be reduced and the distribution of heat is more satisfactory. Another branch of heating which is not so novel is the use of the electric furnace in steel works. The load in such cases may run into some hundreds of kilowatts per furnace. It is sometimes thought that the character of the load is unsatisfactory, but there is no reason why it should

be so if suitable precautions are taken. Moreover, with some classes of furnace the load is particularly steady, and generally it is spread over long hours per day. Station engineers should keep these developments in mind, for we do not doubt that when the advantages of the electrical methods are fully appreciated very considerable loads will be obtainable from these newer fields of electrical enterprise.

Private Bill Procedure Methods.

The recent proceedings on the Southampton Order would naturally lead one to look more closely into our private Bill procedure methods. On investigation, it will be found that these possess many disadvantages; they are costly, cumbersome, uncertain and antiquated. The expenditure incurred in getting a contested private Bill relating to a public service, such as an electric power scheme or a railway, through both Houses of Parliament may be £10,000, or £15,000 or even more. Many local authorities spend thousands of pounds a year on private Bills when procedure by provisional order might be adopted. The promoters of a Bill have to bring a great number of local and technical witnesses to London, who are compelled to remain there for considerable periods. In turn, two Select Committees, one of the House of Commons and the other of the House of Lords, consider the details of the scheme set out in the Bill, and, although both Committees usually hear the same witnesses and the same evidence, there is no certainty that one of the Committees will not upset the decision of the other, or that a Committee will deal with two Bills concerned with similar subjects in the same way. It takes some time to induce Committees to insert a special clause in a particular class of Bill and then to convert this clause into a "standard" one; but once it is included in the "model Bill" so strong is the force of precedent that, though circumstances may have changed completely, it will take a still longer time to get the standard clause modified so as to meet the altered state of affairs.

Again, the method of choosing the members of Select Committees does not tend to efficiency. In the House of Commons a Committee on an Electric Power Bill may consist of, say, a journalist, a lawyer, a soap manufacturer and a Labour member, while in the Lords the members may be four peers from the backwoods of Wales, Ireland and Scotland. We ask, What can Committees formed on these haphazard lines know of the engineering and technical details of such a scheme, of the economics of power distribution, or of the effect of the Bill upon the economic development or welfare of the country? Now that the war has compelled us to look more closely into matters and to economise in many directions, it seems to us that our private Bill procedure could easily be improved upon and cheapened. A modification of the method employed for Scottish private Bills might be introduced, and a Joint Committee of the two Houses of Parliament should take the place of the present Committees. The members of this Joint Committee should have the power of appointing engineering assessors and calling technical and other witnesses, quite apart from the promoters or opponents of a Bill; they should hold local inquiries into the merits of schemes, and in other ways procedure might be simplified and made less costly than it is at present. At all events, it would not then be possible to say that the decision on a Bill depended on the state of the digestive organs of the members of a Committee of the Lords or upon the political idiosyncrasies of the members of a Committee of the Commons.

The Electric Furnace for Heat Treatment of Steel.

Judging from our American contemporaries, the electric furnace is growing considerably in favour in the United States for the heat treatment of steel for automobiles. This is not surprising, for the results obtained in such treatment necessarily depend upon the temperatures that are employed, and the regulation of temperature is much more easy in an electric furnace than in any other type. The actual heating of such furnaces, however, presents some difficulties. Unlike many cases of furnace work, such, for example, as in the production of carbide or in the refining of steel, the charge itself cannot be used as a resister in which the heat itself is developed. Consequently the heat must be produced in some other way. It is not always easy to find a material suitable for the purpose, and for this reason materials which become electrolytic conductors are now being tried and are being made up so as to form a lining to the furnace. In other words, it is sought to make the interior of the furnace a hollow Nernst filament on a large scale. We are under the impression that this idea is not novel, and that it has been used on a small scale in laboratory work. It is, however, a very different matter to build a furnace on these lines for commercial heat treatment; and it is a question how far such a method can be carried with success. Material which is an insulator when cold, and which becomes a conductor when heated beyond a certain temperature, suffers from lack of stability, and therefore requires to be carefully regulated with a series resistance in order to obtain any desired temperature. Further, there is a difficulty in making a good practical contact with a resister of this kind, and in all probability the thermal insulation will be more difficult. The method, however, is worth consideration, and we hope that in due time more definite information will be published showing what results have been obtained.

City & South London Railway.

Now that the City & South London Railway is taking its power from Lot's Road there disappears from the world of electric traction a unique example of power transmission. This line, which is the oldest of the London tube railways, started on the ordinary two-wire system, but later, as it became longer, a system of three-wire transmission was adopted as being the most suitable method of extension. For this purpose the up line and the down line were worked on opposite sides of the system, each on 500 volts, the rails being used as an earth return. Beyond these outers generators giving 500 volts were connected, so as to give a total pressure of 1,000 volts on either side. Power was thus transmitted at this increased pressure and supplied to motor generators in series, so that half the energy was transformed and half was used direct. It has always been

urged as an objection to three-wire traction systems that the load could not be sufficiently balanced. On this particular line, however, the headway between trains was so small that no trouble was experienced in this direction, and the system was found to work satisfactorily. Although we are sorry that a unique example of this kind should disappear, we must admit that the centralisation of power for the London tube railways is the proper policy. It is stated that in due time the Lot's Road Station will also supply power to the Central London Railway, in which case the whole network will be supplied from a single station, and power should then be generated under the most favourable conditions. We congratulate Mr. P. V. McMahon, who has been engineer to the City & South London Railway throughout its existence, on being given charge of the power station at Lot's Road in succession to Mr. J. W. Towle, who recently left the country to take up another appointment.

West of England Industrial Reserve.—The first series of classes for preparing unskilled persons to work in munitions factories has now finished. The classes have been conducted by the members of the staff of the faculty of engineering of the University of Bristol in the Merchant Venturers' Technical College, and a number of certificates have been issued.

Standardisation Rules of the American I.E.E.—The American Institute of Electrical Engineers has brought out a revised edition of the standardisation rules recommended by the Standards Committee and approved by the board of directors. This edition (which can be obtained free) represents the completion and clarification of the edition of December 1, 1914, with some important additions.

A New Protection Against Submarines.—Mr. Emile Guarini, the well-known Italian engineer, claims to have invented an electrical device for use on ships threatened by submarines, which will have the effect of causing the torpedoes to deviate from the direction in which they are launched. It will be immaterial, he contends, whether the hostile craft has knowledge or not of this means of defence, for in no case can it be overcome. The invention has been submitted to the Governments of the allied countries, and Mr. Guarini intends to carry out practical tests forthwith.

Recovery from Shock from 60,000-Volt Transmission Line.—The "Electrical News" records the case of a man who, while working on the switching tower of the Toronto Power Company at the Twenty-mile Creek, received a shock on the 60,000-volt transmission line, causing him to fall 20 ft. in an unconscious condition.

When discovered the man was apparently dead, but artificial respiration was applied and kept up with success until the doctor arrived. The injured man was then removed to a hospital, where his burns and a fractured knee are being attended to. It is stated that he will be at work again before long. The recovery is very remarkable, as a shock on a 60,000-volt line is usually considered fatal. The case emphasises the importance of immediate and skilled resuscitation to persons apparently dead from electric shock.

National Physical Laboratory "Collected Researches."—In Vol. XII. of the "Collected Researches" issued by the National Physical Laboratory there are reproduced the following Papers on subjects of electrical interest: "A Magnetograph for Measuring Variations in the Horizontal Intensity of the Earth's Magnetic Field," by Mr. F. E. Smith; "On the Measurement of Alternating Electric Currents of High Frequency," by Messrs. A. Campbell and D. W. Dye; "The Emission of Electricity from Various Substances at High Temperatures," by Messrs. G. W. C. Kaye and W. F. Higgins; "Experiments on the Heating of Screw-Socket Lamp-holders," by Mr. C. C. Paterson; "The Estimation of High Temperatures by the Method of Colour Identity," by Messrs. C. C. Paterson and B. P. Dudding; "The Unit of Candle-power in White Light," by Dr. C. C. Paterson and Mr. B. P. Dudding; "Temperature Rise in Twin Flexible Wires," by Messrs. S. W. Melsom and H. C. Booth; "Heating of Buried Cables—Summary of the Theoretical and Experimental Work already published," by Messrs. S. W. Melsom and H. C. Booth.

The Torpedo-Mine.—"Le Génie Civil" has recently given an interesting description of the "torpedo-mine" invented in 1907 by a Swedish officer, K. O. Leon, and now manufactured in a more modern form in this country. This mine has no horizontal movement like a torpedo, but it can be discharged from a tube in the same way, and has an oscillatory motion vertically from a certain depth to a few feet below the surface. A switch actuated by the pressure of the water starts (at a depth that can be adjusted) an electric motor which takes current from an accumulator and drives a vertical screw at the base of the apparatus. This causes the mine to rise till the reduced pressure of the water again actuates the hydrostatic mechanism and opens the switch, thus stopping the propeller, and allowing the mine to sink. A clockwork mechanism is also added, which can permanently break the circuit after a certain time or keep the device inactive on the bottom of the sea for a given period after discharging. A number of other uses can, of course, be made of this timing mechanism. It can, for instance, be made to keep the mine afloat when the tide is rising and let it lie on the bottom during the ebb, so that it will work its way up the estuary of a river.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. R. G. Lorkeman contributes an article on "The Field Leakage of Turbo-Alternators with Non-Salient Poles" (p. 765).

We publish some details of the direction finder in an article by Dr. E. Bellini (p. 776).

We give in full an address by Prof. H. E. Armstrong on the "Development and Control of Industry by Public Influences" (p. 762). Our Leading Article deals with the same subject (p. 774).

We publish a Paper on "Steel Mill Controllers from the Operator's Standpoint," by Mr. J. S. Riggs (p. 769).

We give in brief a Paper by Mr. A. Press on "Incremental Armature Copper Losses at No-Load and Armature Teeth Eddy Current Losses" (p. 771).

An investigation into the "Receiving-end Impedence of a Conducting Line Loaded at Both Ends," by Prof. A. E. Kennelly, appears on p. 761.

An abstract is given of a Paper by Mr. N. W. McLachlan on "The Magnetic Behaviour of Iron under Alternating Magnetisation of Sinusoidal Wave-Form" (p. 781).

OBITUARY.

Killed in Action. We regret to record the death of Capt. Thos. Porteous Black, 9th Sherwood Foresters, Registrar of University College, Nottingham, who was killed at the Dardanelles between August 7th and 11th. He was the eldest son of the late Mr. Geo. B. Black, District Traffic Superintendent, Caledonian Railway Aberdeen. At Durham University in 1898 he graduated M.A., B.Sc., and spent a year in research on radio activity. Having gained the Prince Albert Travelling Scholarship, he spent the next two years in Germany, studying at Strassburg University, where he graduated Ph.D. in physics. In 1907 he became assistant in physics at University College, Nottingham, and was appointed Registrar of the college in 1911.

We also regret to announce the death in action of Capt. Reginald Herbert Sowell, R.E., who was for some years an assistant instructor in the School of Military Engineering.

PERSONAL.

Dr. A. S. McAllister, who has for two years been editor of the "Electrical World" of New York, has now retired from that position. A luncheon in his honour was given recently by the editorial staff, at which Mr. Hugh M. Wilson, first vice-president of the McGraw Publishing Co., presented to Dr. McAllister, on behalf of the staff, a gold watch as a token of their esteem. He spoke in glowing terms of all that Dr. McAllister has done for the paper since he joined as associate editor in 1905. Dr. McAllister studied electrical engineering at Cornell University, where he received the degrees of M.M.E. and Ph.D. He has taken out several patents for alternate-current machines, and has made many notable contributions to the theory of the subject, especially with regard to the simplified circle diagram. He also made an extensive study of illumination, and was the first to expound the application of the law of conservation in the calculations appertaining thereto. His place as editor of the "Electrical World" will be taken by Mr. F. M. Feiker, who has for the last three years been chairman of the editorial board of the A. W. Shaw Company, publishers in Chicago.

On July 29, at the London offices of the Western Union cable system, 26, Old Broad-street, E.C., the occasion being the retirement of Mr. SAMUEL FENN from the position of traffic manager. Mr. S. J. Goddard, the European representative, in the presence of a committee of the subscribers and on behalf of all the members of the staff, presented Mr. Fenn with an illuminated address, a silver tea and coffee set and a grandfather's clock.

In making the presentation, Mr. GODDARD said the gifts had been subscribed for by members of the cable staff all along the line, and were representative of the whole of the staff, who felt they had a worthy object of their regard in Mr. Fenn. He trusted Mr. Fenn would live long to enjoy his well-earned pension, and would look back on his association with the cable service with pleasure.

Mr. FENN, in reply, expressed his grateful appreciation of the kind feeling shown towards him by the combined staff of the Western Union Cable System. He had received the kindest of letters from President Carlton, and from Sir James Pender, chairman of the Direct Company, the company with whom he had worked with for 37 years. He might add that, with the exception of St. Pierre, he had visited every station and was personally acquainted with the superintendents and most of the staff at each, and was proud to know that, in addition to having been their chief, many regarded him as a personal friend.

ROYAL ENGINEERS (T.F.)—The following appointments and promotions have been made:—

Electric Light Company, Renfrewshire (Fortress) Engineers: Ian C. Napier and Robt. N. Adam to be Second Lieutenants.

Electric Light Company, East Riding (Fortress) Engineers: Stanley S. Allbright and Vyvyan A. Westrop to be Second Lieutenants.

Tyne Electrical Engineers: Cpl. J. O. Baird to be Second Lieutenant. The surname of Sec. Lieut. C. A. C. Aitkens is as now described.

No. 1 Electric Lights Company, Cornwall (Fortress) Engineers: Second-lieutenant H. B. Peter to be temporary Lieutenant.

No. 5 Electric Lights Company, Devon (Fortress) Engineers: C. H. de [illegible] to be Second Lieutenant.

No. 4 Electric Lights Company, Kent (Fortress) Engineers: Pte. J. W. Kilby (from London Elec. Engineers) to be Second Lieutenant. Lieut. A. P. Isard to be temporary Captain.

APPOINTMENTS VACANT AND FILLED.

[illegible] Council electricity department. Applications to the engineer and [illegible]

A switchboard attendant is required by Blackburn Corporation electricity department. Applications by first post Sept. 3 to the borough electrical engineer, Mr. P. P. Wheelwright, Jubilee-street.

Armature and stator winders are required for railway work in [illegible]

A civil engineering assistant (salary £200 per annum), surveying assistant (£117-£120), a general permanent-way foreman (£3. 5s. per week) and foreman platelayer (£2. 5s.) are required by West Ham Tramways Dept. Applications (on official forms to be obtained from the General Manager) by noon Aug. 28.

An assistant signal engineer is required for the New Zealand Government railways. Salary £425, rising to £475 per annum. Applications to the High Commissioner for New Zealand, 13, Victoria-street, London, S.W., by Aug. 31.

Sutton Coldfield Corporation require an electrical engineer and manager. Commencing salary will not exceed £250. Applications to the Town Clerk (Mr. R. A. Reay Nadin) by Sept. 1.

The University of London is about to appoint a principal officer at a salary of £2,000 a year. Names of those desirous that their names should be considered should reach the Secretary to the Senate, University of London, South Kensington, S.W., by Sept. 15.

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply department. Salary £650, rising to £700 per annum. Applications to the town clerk (Mr. Thos. H. Nesbitt), by Sept. 13.

Mr. W. J. Blenheim has been appointed to the position of traffic manager in London of the Western Union Cable system, vacant by the retirement (after 50 years' service in telegraphy) of Mr. Samuel Fenn.

Mr. G. W. Leeder, of Runcorn, has been appointed shift engineer at Eccles in the place of Mr. A. Helliwell, resigned.

INSTITUTIONS AND SOCIETIES.

Royal Society. The Royal Society is compiling a register of scientific and technical men in Great Britain and Ireland who are willing to give their services in connection with the war. The register is classified into subjects, and will ultimately constitute a large panel of men of standing whose services will be available whenever any Government department or similar authority requires specialist assistance. The register is being co-ordinated with those independently compiled by other societies and institutions, but the Royal Society would be glad to have applications for forms from such members of the staffs of colleges and technical institutions as have not yet been registered by any society. The Royal Society is also drawing up, with the co-operation of the principal societies and institutions, a list of scientific and technical men actually on active service in his Majesty's forces. Any names, with rank and unit, for this list will be gratefully received by the secretaries at Burlington House. The task of forming this register has been much facilitated by the assistance of many universities, university colleges and scientific societies, whose help the Royal Society gratefully acknowledges.

Electrical Vehicle Association of America.—In one year and a-half this association has increased its membership from about 500 to about 1,100. Though in February, 1914, it only had two local sections (in New England and Chicago), these now number 16. Much of this prosperity is due to the efforts of the secretary, Mr. A. Jackson Marshall, who several months ago inaugurated the policy of preparing and releasing to the press informative and interesting articles dealing with all phases of electric vehicle sale and use. He recently completed an 8,000-mile Pacific Coast trip, during which time he delivered a large number of lectures, organised sections of the association and studied at first hand distribution methods. The sixth annual convention of the Association will be held on Monday and [illegible]

ARRANGEMENTS FOR THE WEEK.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

[illegible] C.B. Clay, V.D.

The following [illegible] for the week ending September 4, 1915:—

Monday.—D.H. 6.30 to 7.30 [illegible] 1. Technical instruction Sections 2, 3 and 4. Squad Drill. Miniature Rifle Shooting.

Wednesday.—No drill.

[illegible] D.H. 6.30 to 7.30 [illegible] 2. Technical instruction. Sections 1, 3 and 4. Squad Drill. Miniature Rifle Shooting.

[illegible] 2.30 Dismissal.

Members wishing to [illegible] are requested to give in their names to their Section Commanders.

Members [illegible] are being made for the various sections of the Corps to [illegible] at the Miniature Ranges in Greycoat-place. Dates and particulars will be published later in supplementary orders.

THE RECEIVING-END IMPEDANCE OF A CONDUCTING LINE LOADED AT BOTH ENDS.*

BY A. E. KENNELLY.

Summary.—A new formula is presented for the receiving-end impedance of either a simple or a composite line, when loaded at each end. This formula is nearly as easy to deal with arithmetically as the formula already known for the case of a receiving-end load only.

If a uniform conducting line BC (Fig. 1) has a total conductor resistance of R ohms and a total dielectric leakance of G mhos to ground, or to zero potential if a pair of looped lines are used, then it is well known that the line will possess, or subtend, a hyperbolic angle†

$$\theta = \sqrt{(RG)} \text{ hyperbolic radians} \angle \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and will offer, at and beyond any point, a characteristic resistance to ground of

$$z_0 = \sqrt{(R/G)} \text{ ohms} \angle \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In equations (1) and (2), as well as in those which follow, the quantities involved are "real" so long as continuous currents and E.M.F.s are employed. In dealing, however, with impressed alternating currents in the steady state, the same formulas apply, but are interpreted vectorially, the quantities being all complex. Thus R, instead of being a simple ohmic resistance, becomes a conductor impedance varying with the impressed frequency; while G, instead of being a simple mhoic conductance, becomes a dielectric admittance, also

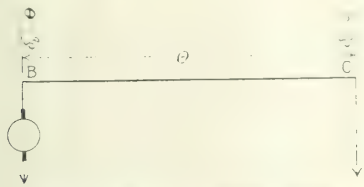


FIG. 1.—SIMPLE UNIFORM LINE WITHOUT TERMINAL LOAD.

varying with the frequency. We may, therefore, continue to discuss continuous-current cases, with the understanding that the formulas include alternating-current cases.

If the line BC is grounded, or shorted, at the receiving end C (Fig. 1) and is connected at the sending end to an E.M.F. E_b volts, then the current I_e which will flow steadily to ground through the receiving end C is

$$I_e = E_b / z_0 \sinh \theta \text{ ampere} \angle \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

so that the receiving-end impedance of any single uniform line without terminal loads is

$$Z_l = z_0 \sinh \theta \text{ ohms} \angle \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Thus, if the line has a total conductor resistance R of 4.000 ohms, and a total leakance $G = 10^{-3}$ mho, $\theta = 2$ hyps, and $z_0 = 2.000$ ohms. Consequently the receiving-end impedance is $Z_l = 2.000 . \sinh 2 = 2.000 \times 3.6269 = 7253{\cdot}8$ ohms.

If, now, the line, instead of being directly grounded at C, is connected there to ground through a terminal resistance z_r ohms, as in Fig. 2, then it is known that this load, when connected to the line, subtends an angle θ' hyps, determined by the relation

$$\tanh \theta' = z_r / z_0 \text{, numeric} \angle \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The position-angle δ_c at C is now increased by the presence of the load from 0 to θ' hyps; while the position-angle at B, or any intermediate point, is similarly increased by θ'. Thus [illegible] $\theta + \theta'$ hyps, as shown in Fig. 2. The receiving-end impedance is then known to be

$$Z'_l = z_0 \sinh \theta + z_r \cosh \theta \text{ ohms} \angle \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$= z_0 \sinh (\theta + \theta') \cosh \theta' \text{ ohms} \angle \quad . \quad . \quad . \quad . \quad . \quad (7)$$

In any alternating current case (7) is much easier to deal with arithmetically than (6), being adapted to logarithmic treatment, or, for most practical purposes, to slide-rule treatment.

Thus, in the case of the line already considered, if $z_r = 500$ ohms, $\theta' = 0.2554$, $\theta + \theta' = 2.2554$, $\sinh 2.2554 = 4.7171$, $\cosh \theta' = 1.0328$, and $Z'_l = 2{,}000 \times 4{\cdot}7171/1{\cdot}0328 = 9{,}135$ ohms. With $E_b = 100$ volts, $I_e = 0.01095$ ampere.

If, now, an impedance z_s is inserted at the sending-end of the line

* From the "Electrical World."

† "The Application of Hyperbolic Functions to Electrical Engineering Problems," by A. E. Kennelly. London, University Press. Chapter II.

(Fig. 3), between this terminal B and the impressed E.M.F., E_a at A, the impedance of the line at and beyond B is

$$R_b = z_0 \tanh (\theta + \theta') \text{ ohms} \angle \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

so that the total impedance at A of the line and sending-end load z_s is

$$R_a = z_s + z_0 \tanh (\theta + \theta') \text{ ohms} \angle \quad . \quad . \quad . \quad . \quad . \quad (10)$$

whence

$$I_a = E_a \div [z_s + z_0 \tanh (\theta + \theta')] \text{ ampere} \angle \quad . \quad . \quad . \quad . \quad (11)$$

and

$$I_b = E_a \div [z_s \cosh (\theta + \theta') + z_0 \sinh (\theta + \theta')] \text{ ampere} \angle \quad . \quad . \quad (12)$$

$$Z'_l = z_s \cosh (\theta + \theta') + z_0 \sinh (\theta + \theta') \text{ ohms} \angle$$

Equations (11) and (12), or equivalents, have usually been employed in the case of a line loaded at both ends. But a much simpler formula may be used; because (12) will be found to reduce to

$$I_b = E_a \cosh \theta' \cosh \theta'' \div z_0 \sinh (\theta + \theta' + \theta'') \text{ ampere} \angle \quad . \quad . \quad (13)$$

where

$$\tanh \theta'' = z_s / z_0 \text{ numeric} \angle \quad . \quad . \quad . \quad . \quad . \quad (14)$$

Or, the receiving-end impedance of a line with two terminal loads is

$$Z''_l = z_0 \sinh (\theta + \theta' + \theta'') \cosh \theta' . \cosh \theta'' \text{ ohms} \angle \quad . \quad . \quad . \quad (15)$$

a formula conveniently adapted to either slide-rule or logarithmic computation.

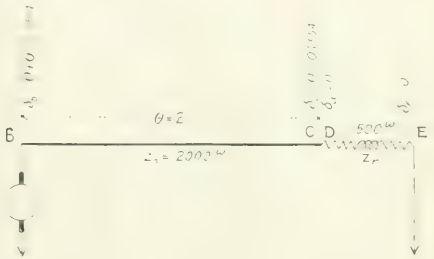


FIG. 2.—SIMPLE UNIFORM LINE WITH RECEIVING TERMINAL LOAD.

Thus, if z_s is 200 ohms, in the case already considered, $\theta'' = \tanh^{-1} 0{\cdot}1 = 0{\cdot}1003$, $\cosh \theta'' = 1{\cdot}0053$ $(\theta + \theta' + \theta'') = 2{\cdot}3557$, and $Z''_l = 10{,}066$ ohms.

As an actual alternating-current instance, for the data of which the writer is indebted to Prof. Carl Kinsley, a line subtends an angle of $\theta = 1{\cdot}871 + j1{\cdot}835$ hyps $= 1{\cdot}871 + j1{\cdot}168$, the underscored imaginary being expressed in quadrants, or radians $\times 1{\cdot}5708$. The line is shorted at the receiving end through $776{\cdot}4 \angle 86°{\cdot}55$ ohms, and there is a sending-end load of $71{\cdot}8 \angle 82°{\cdot}8$ ohms. The characteristic impedance of the unloaded line is $285{\cdot}5 \angle 45$ ohms. Then $\theta' = \tanh^{-1} \left(\frac{776{\cdot}4 \angle 86°{\cdot}55}{285{\cdot}5 \angle 45} \right) = \tanh^{-1} (2{\cdot}719 \angle 131°{\cdot}55)$ and by chart* this is



FIG. 3.—SIMPLE UNIFORM LINE WITH RECEIVING AND SENDING TERMINAL LOADS.

$\theta = 0{\cdot}23 + 0{\cdot}820$ as indicated in Fig. 3. Similarly $\theta'' = \tanh^{-1} \left(\frac{71{\cdot}8 \angle 82°{\cdot}8}{285{\cdot}5 \angle 45} \right) = \tanh^{-1} (0{\cdot}2515 \angle 127°{\cdot}8) = 0{\cdot}149 + j0{\cdot}128$, also by chart. Consequently, $\theta + \theta' + \theta'' = 1{\cdot}492 + j2{\cdot}116$. From the charts we find $\sinh 1{\cdot}492 + 2{\cdot}116 = 2{\cdot}118 \angle 108°{\cdot}8$, $\cosh \theta' = 0{\cdot}363 \angle 37°{\cdot}8$,

* "Chart Atlas of Complex Hyperbolic and Circular Functions," by A. E. Kennelly. Harvard University Press.

and $\cosh\theta''=0{\cdot}9912\ \underline{/}\ 1{\cdot}75$. The receiving-end impedance of the line with both terminal loads is, therefore, by (15),

$$Z''_1=\frac{285{\cdot}5\ \underline{/}\ 45}{0{\cdot}363\ \underline{/}\ 37{\cdot}8}\cdot\frac{2{\cdot}418\ \underline{/}\ 108{\cdot}5}{0{\cdot}9912\ \underline{/}\ 1{\cdot}75}=1{,}680\ \underline{/}\ 173°{\cdot}95\ \text{ohms}.$$

With an impressed E.M.F. of 100 volts at A, of standard phase, the current received at E would be $0{\cdot}0595\ \underline{/}\ 173°{\cdot}95$ ampere.

Finally, in the case of a composite line with a plurality of component sections, each having its own characteristic angle and impedance, as indicated in Fig. 4, the receiving-end impedance, with a load at the receiving end only, is known to be

$$Z''_1=z_1\sinh\theta\ldots\frac{\cosh\theta_2\cdot\cosh\theta_3\cdot\cosh\theta}{\cosh\theta_1\cdot\cosh\theta_2\cdot\cosh\theta_3}\ \text{ohms}\angle\ .\quad .\quad (16)$$

If now a load z_p be added at the sending end, as in Fig. 4, and $\tanh\theta''=\frac{z_p}{z_1}$; then

$$Z''_1=z_1\frac{\sinh\theta_1+\rho\cdot\cosh\theta_1\cdot\cosh\theta_2\cdot\cosh\theta_3\cdot\cosh\theta}{\cosh\theta_1\cdot\cosh\theta_2\cdot\cosh\theta_3\cdot\cosh\theta}\ \text{ohms}\angle\ .\quad .\quad (17)$$

Formula (17) bears the same relation to (16) as (15) does to (7), and if in (17) we make $z_1=z_2=z_3=z_0$, or reduce the composite line to a simple line (17) becomes identical with (15).

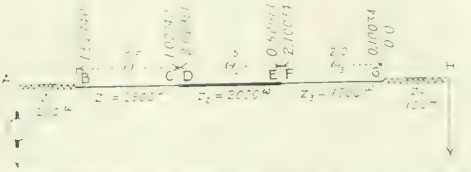


Fig. 4.—Composite Line of Three Sections with Receiving and Sending Terminal Loads.

In the case presented in Fig. 4, when an E.M.F. is impressed at A, the current is constant from A to B and again from G to H. Between B and G, in each section, the current at any point is directly proportional to the cosh of the position angle of the point. The voltage falls steadily by Ohm's law from A to B, and again from G to H. Between B and G in each section the voltage at any point is directly proportional to the sinh of the position angle of the point.

With $\theta_1=0{\cdot}5$, $\theta_2=1{\cdot}5$, $\theta_3=2{\cdot}0$, $z_1=2{,}500\omega$, $z_2=2{,}000\omega$, $z_3=1{,}000\omega$, $z_p=100\omega$ and $z_2=200\omega$, the position angles of the section junctions are shown in Fig. 4. We then have $\theta''=0{\cdot}08017$ hyp. and $Z''_1=52{,}890$ ohms.

THE DEVELOPMENT AND CONTROL OF INDUSTRY BY PUBLIC INFLUENCES.*

BY HENRY E. ARMSTRONG.

Of late our chemical industries have been the subject of benevolent criticism at all hands. It may be that wisdom will ultimately come of the multitude of counsellors, though present appearances serve rather to justify the adage uncomplimentary to a superabundance of cooks. Everybody wants either to do something or see something done; but as nobody knows exactly what to do, everybody wants someone to set the ball rolling. The worst sign of all is the constant request for Government intervention. Nobody seems to realise that our urgent need is common sense, the extent to which we lack courage and enterprise, how greatly the spirit of co-operation is wanting in us; in particular, how destitute we are of the German supervice, the cause of our present plight, power of looking ahead and organising forces—that especially we need to take down [illegible] card in too many of our public departments and in the bedrooms of [illegible]

lessons of the war. The Board of Trade would have none of it recently when dealing with an essentially scientific problem; the War Office still listens to scientific counsel with wadded ears.

The fault is largely in the body scientific—we do not push our own interests sufficiently; I much fear that the one service that will remain unorganised to the end is our own body—the body scientific. Seemingly, we are too hopelessly individualistic to organise ourselves. The Royal Society, which should be the supreme authority in science, declined the task early in the year, and it is not likely that those who know us not, our masters the politicians, will seek to bring us together, even for their own ends, as they have no understanding of the use to which we might be put in their service. It is, as Longfellow tells us of "the secret of the sea," only those "that brave its dangers understand its mystery." Indeed, the one chief lesson of this terrible war is the need of bringing home "the idea of science" to the public at large—experts they can never be, but some respect for it they can acquire. Our clear duty is to persist in urging its infinite value, and to insist that it be used regularly and systematically in the service of our country.

All this by way of introduction, just to make obvious my one thesis: *that charity begins at home; that this body needs to wake up and intervene actively in the promotion and protection of chemical industry.* Almost supine hitherto, you have allowed others to tinker with matters which primarily should be your concern.

The chaos is indescribable. The Royal Society has attempted to do something, as much as a body without leaders can be expected to do, perhaps, yet what it has done is as nothing compared with what it might do if the spirit of co-operation were evoked in its Fellows. But lessons may be learnt from its partial activity. It appointed three War Committees towards the end of last year. I cannot speak of the Physicists' Committee; the Chemists' Committee, I know, had not been allowed to do anything effective up to a recent date; but the Engineers' Committee, originally a small one, has been enlarged from time to time, and we are assured has rendered really important service to the Government. Why the difference? Is it not that engineers, like Brutus, are not only honourable, but honoured, men, in the sense that they are a professional body, better said perhaps, a body of professionals, accustomed to work together, having learnt that it often pays men to work together? "Union is strength" is their motto. Medical men occupy a similar position; lawyers also: both professions are organised on trade-union lines. But those who rate themselves scientific—the academic party as a whole—are an unorganised rabble, so individualistic, self-centred and unsympathetic that what is one man's meat is almost necessarily another man's poison. This is both our strength and our weakness; but we shall never win through until we can combine strength with weakness. The lesson of the moment, the lesson a lifetime has taught me, is that chemists, too, must become professionals, and, like others, sell their services, not give them. We have not yet learnt the lesson of the world—that people only appreciate that which they pay for, that the value of a thing is not appreciated until it has been sold freely. Academic chemists ought not merely to be allowed and encouraged, but almost required to work for payment as consultants, like the engineers. The professor pure and simple should disappear. His present rating is too clearly indicated by the action of the American who, when in difficulty how to address the celebrated negro Brooker Washington, feeling that it would not be right merely to dub him *Mister* and unwilling to say *Sir*, as he said, just called him *Professor*.

I am raising a burning question I know. The academic party, the professors, are asking to be consulted on industrial problems, to have their work linked with yours. Academic schools are coming into existence, colleges of technology and technical schools, which claim to serve the purposes of industry. But do they? The academic mind is not what you want, the academic mind must be fertilised by contact with practice before it can be of service to you, and the only way is to fertilise it with fees if you wish it to furnish good fruit. Before long this will be the only way of saving the situation; otherwise there will be few purely academic chemists of worth, chiefly because no proper respect is paid to the calling of teacher, because there is too much restriction of the teacher's liberty of action, too much regulation attempted of his activities by those who have no expert understanding of the office, its cares, duties and responsibilities. No one who has sense and ability will take up a purely academic career, the attraction, the rewards, the opportunities of industry are so much greater; besides which the control of boards of governors and councils will be regarded as insufferable by men of parts.

One main reason why we are so much behind in some of the chemical industries is that the instruction given in our schools has been far too academic in character, in no way in touch with practice. It is all very well for us to speak in their praise in the newspapers, but where are our English chemists? Not yet quite to be reckoned

with the proverbial snakes in Ireland, but dangerously few in number. It cannot be said too definitely, either too loudly or too widely, that chemistry has not attracted gentlemen—men of generous mind, good presence and real ability—in sufficient numbers into its ranks during many years past. We want much of the material that now degenerates into briefless barristers. Such material, properly trained, would be of worth and command good pay. Our schools have been overfed with schola ships and scholars have been selected on inadequate tests. Too often—indeed, almost always—they have been persons of acquisitive power only, destitute of imagination and without breadth of outlook. Examinations like those of the University of London have encouraged the wrong type of man ; not a few good men have lost their individuality and failed to develop under the narrowing influence of the course of cramming to which they have been forced to submit. It is to be hoped that the exportation of 1851 scholars abroad will be stopped in future. The depletion of our English schools in the past of their best material has been not the least among the causes which have operated against their development and the consequent lack of men of parts. One public influence which this body should seek to gain over is that of the University of Oxford. I verily believe it to be the greatest in the country. To this end our Society should support the scheme put forward by Prof. Perkin, to make research an integral part of the honours degree course, so that men may grow up with a forward outlook and a consuming desire to consider the inner meaning of things and extend the bounds of knowledge. Our schools generally must be favourably influenced if such a measure be passed.

Since the outbreak of war action has been taken in various ways to promote the interest which this body has at heart. First in order comes the Board of Trade Committee appointed August 25, 1914, with the Lord High Chancellor as chairman, charged to consider the best means of obtaining supplies of chemicals for the use of British industries. This Committee appointed a sub-committee, of which Lord Moulton was chairman. Apparently the tail soon ran away with the dog. As a result of the report presented by this sub-committee a meeting was held of industrial firms, and this was followed by the mysterious appointment of the extraordinary committees which ultimately negotiated the well-known dye scheme, so universally derided within and without Parliament, which this Society allowed to pass into being without one single word of protest.*

The primary mistake was in appointing lawyers to controlling positions on these committees. Such men, however able and eminent, cannot have any real expert feeling on technical problems outside their own professions, and where there is no expert feeling—no proper sense of "technical effect," to use Faraday's expression—there can be no "proportionate judgment" exercised. Parenthetically remarked, it is strange that the technical members of the Committee did not give effect to their objection to the action taken by the Board of Trade by resigning. When Lord Moulton went to Manchester to advocate the scheme on December 8th last year he told his audience that our loss of the coal-tar colour industry was for no other reason than that the English dislike study. He could not have given a more complete proof that he lacked "proportionate judgment"—a more complete failure to understand the real position was impossible. Since Hofmann left us, almost to the present day, Englishmen—poor devils!—have never been allowed, let alone encouraged, to study in any effective manner either at our public schools or at the ancient universities, and the opportunities have been few elsewhere. During 40 years past Oxford has been without a chemical school : how could chemists be trained there? What is far worse, the business community have received no training at our great schools and universities which has in any way helped them to become acquainted with the idea of science. All the ability of the country that the schoolmasters could lay hands on has been forced either along classical lines or, in far fewer cases, into mathematics; the school waifs and strays have usually furnished the material for science. Here has been our surpassing blunder. Not a few of us have shown that we can study, that we do not dislike study; but the enforced studies of the majority, under university influences, have been of unreal things without the mental compass and desires of all but very few; of course, dislike of these has often been apparent. We are simply victims of the literary party, of which the lawyer-politician is the supreme development; he grips us everywhere; until we escape from his clutches and we get control by men of practical instinct who know things and not words [illegible] to respect, however little they may know of it, we shall make no satisfactory progress.

The academic party in science are first cousins to the lawyer-politicians—they too must be made human by the touch of practice, if we are to maintain and develop our scientific and industrial position.

The interests of this Society were touched when the question of Government assistance for industrial research was raised in memorials presented by a recent academic deputation, nominally representing the Royal Society and Chemical Society, to the Presidents of the Board of Trade and Education. (A report appears on the "Journal" of May 15th.) Besides further expenditure on research, the deputation advocated the formation by Government of a standing committee of chemists to advise manufacturers—but no manufacturer is going either to display his business or bring it under criticism before any academic committee, however appointed. Every manufacturer desires to keep and amplify his secrets, not to disclose them ; when a manufacturer wants advice, he will seek out that which is of worth to him and pay for it.

We have to bear in mind that the success of German chemical industry is due to two causes—firstly to the fact that their universities are practical institutions—not collocations of competing colleges—properly supported by the State and in touch with the educated community: the idea of science *is* abroad in Germany, though "science" is not more taught in the schools than it is here ; science, however, is respected and has acquired a money value in public eyes, because it has been made real; the company promoter has been kept in subordination and it has been shown that trust can be placed in those who undertake scientific ventures. In the first place we need not only to put ourselves on a high moral plane but to reform our universities and our university curricula; but reform must come from within to be of use ; the office of Government will be to see that the necessary funds are provided : if it interfere beyond this point, as it is seeking to do, it will only do harm. The second and true cause of German success is that the factories are in the hands of experts; moreover and especially, ample provision is made for carrying out all necessary and desirable research work in well-found laboratories within the factories, this being possible because a supply of properly trained men is to be had from the universities. Much is said of the large number of chemists employed in the German works, but it must not be forgotten that the majority act merely as foremen—the Germans having the sense to employ technically trained, expert foremen, whereas we, as a rule, employ uninstructed men who have risen from the ranks, whose ways are too often intensely conservative and obstructive of progress and who can neither take instructions couched in technical terms nor understand the operations they conduct though they are very skilful in their particular work.

When out in Ceylon last winter, in view of the great importance of the rubber industry and of the small amount which is being spent on research work in connection with it, I made the proposition that Government should levy an "insurance tax" upon all rubber produced in British possessions and require that this be applied to the full scientific study of every particular connected with the industry—the work to be done, however, under the supervision of those concerned in the industry, the task of Government to be merely that of enforcing the application of an adequate sum to scientific inquiry. ("The Times" of Ceylon, Nov. 25, 1914.)

Recently, in an introductory address on "The Extension of British trade," delivered at a conference held at Cardiff at the instance of the City Education Committee, I made a similar suggestion with regard to the coal and iron industries.

(*Note.*—"For the study of many of the problems connected with coal, I think a tax should be imposed upon the industry and that the proceeds should be devoted entirely to research work, under competent control. I should tax the iron industry in a similar way, at least until it had discovered how to make a cheap, rustless iron, an absolute need in countries such as Australia, where artesian bores are of vital importance. I made a similar proposition with regard to the rubber industry recently when in Ceylon. When zinc is 'burnt' in an electric battery the output of electrical energy is almost theoretical; if we could 'burn' coal effectively, so as to convert the energy stored up in it directly into electricity, we should increase its fuel value to a very great extent ; our present methods are extraordinarily wasteful. The problem is one of surpassing difficulty, but there is no reason to regard it as insoluble ; it is one that we should attempt to solve by serious and systematic inquiry, at public cost. Such matters need to be made the subject of exhaustive inquiry by a *competent* national commission.")

I would extend this proposal to all industries in which the maintenance of research departments is necessary. One part of the tax should be applied to the upkeep of proper works laboratories, another part to the development of research work in places of higher instruction. In cases in which the industry was alive to its own interests and maintained a proper scientific establishment, due allowance would be made and the contributions exacted would only be those required for public purposes in support of technical education. The

* The Letters of the [illegible] to their Lordships [illegible] 1914, Sept. 4th, the Meeting [illegible] 20th, 22nd, 24th, [illegible] 15th, 20th, 27th, March 1st, 12th, 13th, 15th.

necessary interlocking of industry and education would at once follow from such a course of action; Government intervention would be reduced to a minimum; and all sensible manufacturers who desired not to go under would make due provision for the scientific control of their industry.

To continue my argument, not only are the Royal and Chemical Societies seeking to advise you but the voice of the excellent President of the Society of Public Analysts has also been heard; moreover, an attempt has been made to establish an Institute of Industry and Science which is to do all sorts of wonderful things by way of bringing science and industry into closer co-operation; it is even provided with a Research Committee, on which figure two chemists, though the rest are mostly persons to whom probably the word research is meaningless. Then there is an Institution of Chemical Technologists which is to put all the different bodies connected with chemistry in their place, to overlord them all; apparently it holds but a poor opinion of this Society, and I am informed that members have joined it because they despair of overcoming your inertia.

And the Institute of Chemistry must not be forgotten. Though this is a body whose constitutional function is no more or less than that of issuing a certificate of average competency to embryo chemists it is seeking to acquire merit by thrusting its tentacles into all sorts of quarters where it has no real place. To give it its due, however, in connection with the manufacture of glass and the supply of pure chemicals for laboratory use, it has shown more enterprise and real activity than all the other bodies put together. It is also preparing a comprehensive register of chemists.

The Chemical Society also has recently started a register and has constituted its Council as a consultative and advisory body to deal with all propositions that may be brought forward; I am glad to say, however, that it has the intention of consulting all persons to whom it can refer with advantage.

We are at the moment, in fact, threatened with an overwhelming outbreak of registration fever. Not only the Government but various societies, from the Royal downwards, are sending out circulars to be filled in: a new form of red-tapeworm disease is upon us—but we want instant action. Germany will not be stayed by any filling-in of forms. It is clear, indeed, that, whilst counsellors and counsel abound, unfortunately there is no evidence of any co-ordinated effort to lighten the darkness—no proper organisation of effort. The result must be chaos. Yet all such agitation is to the good, especially as evidence of desire and determination to set our untidy, ill-furnished, unregulated house in order.

Per contra, in addition to the benevolent influences, well meant if not tending to the development of industry, to which I have referred, others, insidious in character, threatening industrial liberty and to control it adversely, require attention, as showing the need of organisation for defensive as well as for constructive purposes.

The action taken by the Board of Trade in connection with the manufacture of dye-stuffs is of this order and cannot be regarded with equanimity, in view of the impassive front that was imposed by the Board of Trade to all suggestions that the scheme must be under scientific control; the complete failure of this department of Government to appreciate the situation, the entire disregard of the gravity of the issues involved, can only be attributed to blank ignorance; yet it was stated openly in the House that the scheme was Lord Moulton's, who is regarded as a scientific authority in Government circles. The action taken is to be deprecated chiefly on the ground that whatever the present worth of the arrangement as a means of increasing our output of dye-stuffs, an invaluable opportunity of developing the industry, even during the war, has been sacrificed and its future establishment arrested if not made impossible. We might so well have served our immediate purpose with greater effect and at the same time have worked with an eye to the future had we sought to develop a complete scientific organisation from the outset. Instead, our Government elected to keep up the card, "No expert need apply," all the time; had this body been alive and alert, no such policy could have been allowed to prevail.

I may now pass to a case of threatened interference with industry in which effective intervention may yet be possible—that afforded by the Report of the Departmental Committee of the Home Office appointed to investigate the danger attendant on the use of paints containing lead in the painting of buildings. The committee was appointed in January, 1911, and reported in November, 1914, though the report was issued only recently. It is impossible to make the case clear without going into it at length; this I hope to do on a subsequent occasion. Suffice it to say, the committee recommend [illegible] practically to the abolition of white lead—an English [illegible] and [illegible] substitute zinc white, which has hitherto been more costly and is not easily worked. The committee had not a [illegible] case upon it—the only remote approach to one was a medical inspector of factories—and can only be characterised as incompetent to deal either with the issues raised or to appreciate the evidence offered, still less with that which should have been required. It is clear that if legislation affecting industries is to be introduced at the instance of Government departments, the place of science in the attendant inquiries must be asserted and recognised; it is for this body to act in securing such recognition.

The repressive action of the Local Government Board, attempted probably at the instance of a single official, exercised on several occasions of late in matters requiring the fullest scientific inquiry—in the case of milk and flour, for instance—might also be referred to as further illustration of the need of effective organisation of industrial interests to secure adequate consideration prior to the exercise of control by Government.

I may point out, finally, that it will be necessary for you, sooner or later, and sooner is better than later, to move in the matter of patent laws, to consider to what extent, in future, a specification shall be a disclosure and description of the invention for which protection is sought. The oftentimes arbitrary administration of Factory Acts on purely red-tape lines will also call for consideration.

In view of the proved inability of our Government departments to deal with issues which are essentially scientific, to appeal for help, as nominally the Royal and Chemical Societies have done, to those whom we have been forced to describe as flouting science, who hold it in disrespect on account of their entire ignorance of scientific method, is a confession of failure beyond words to describe.

Our plain duty in this Society is to organise ourselves and when we are organised to claim the right to guide Government. But unless the representatives of science subordinate their individualism, sink their differences and form a complete coalition of their forces, no public impression will be made. Much as is the public wonder at scientific discoveries—when these are sufficiently sensational and talked about and made obvious—during the last few years, we have done not a little to deprive ourselves of their confidence: company-promoting schemes of the wild-cat order cannot be advanced with impunity—whether guilty or not, we shall all have to do penance on account of not a few of these.

The task before us is indeed colossal. Before the war Germany had control of the Russian market. It will be long before she will regain this and here will be our opportunity—if our schools take Latin and Greek plays out of their bill and stage Russian instead; and if they add Spanish, we may have some chance in South America also, if meanwhile the Americans do not steal the market against us. The competition we shall have to meet outside Europe, especially in the East, will be greatly intensified, because this will be the chief market open to Germans. I have seen enough recently of German organisation of trade in the East to realise that ours did not compare with it in efficiency.

Unless, however, the desire and impulse come from within no progress will be made. This country is governed primarily by and from Oxford; if the lessons of the war and public opinion do not cause Oxford to reform, we shall be forced to confess that there is no health left in us and, like the Snark, our industry will "softly and silently vanish away." Some of my friends—men such as Sir Ray Lankester—say the University cannot reform; they say the Royal Society cannot reform; they say both bodies must be reformed. Practical men, I am sure, will agree with me that this cannot be true—they will hold with me that no progress will be made unless leaders spring up within such bodies to inspire them with courage, men who will lead them to see how great is the service they can render, how essential that service is to the community.

The development of German industrial chemistry has been from within, as I have said, though it has received great assistance from public sources. The academic party in Germany has done its work thoroughly and honestly and under conditions which have made sound work possible—under conditions of freedom, of *Lehrfreiheit* and *Lernfreiheit*. Such has not been the case here—the Oxford tradition, that it is necessary to be well-read and play games in the afternoon, has dominated the situation; it has not been held that it it is necessary to be well practised. The examination fiend has come in to complete our ruin, together with a system of rewards altogether disproportionate, unnecessary and undesirable. German universities have prospered and have rendered the greatest possible service to industry without the assistance of the Honours degree with its attendant classes, also without Fellowships. The German academic party has received full recognition at the hands of the industrial party because, on the average, its products have been found to be of worth; here this has not been the case.

Government cannot help us in these matters. The industrial party will consider the academic party and consult it when the latter can do for industry what the German academic party has done for industry. The Oxford degree in chemistry has been worthless for practical purposes, because men could not get the necessary

training, as there was no proper atmosphere in the university; but the tone of the university towards science must be changed entirely if the school that is being started is to be a success. New laboratories alone will not give what is required.

The conditions at Cambridge have been better, but not satisfactory and even now far too much is attempted, the time spent in study being insufficient to give the student a practical professional outlook. In the schools dominated by the London University, the student has not been placed in a position to learn, but has been forced to cram, and during so long a period that he has suffered severely from mental atrophy and has been spoilt for practice; in few cases has the attempt been made anywhere in our country to give him that forward outlook and the desire to do something himself which is to some extent acquired by every recipient of the Ph.D. degree in Germany.

To progress we must acquire the desire to do something before we take to learning: knowledge is not power unless it be associated with the desire and power to use it.

It rests with the Royal Society, in my opinion, to give the impulse and start reform by reforming itself, waking up from its academic slumbers and playing the active part that it is possible for it to play if it only realise what it can do as a live institution. It is our scientific House of Peers; it is not only representative of all branches of experimental and observational science, but industrial science has its place in our ranks, although it is to be confessed that we are ultra-academic at present and need a far larger leaven of men accustomed to apply science to practice.

In consequence of the development of the special societies, the Royal Society is no longer of consequence as a scientific society in the ordinary sense. Unless the forces at its disposal are used effectively it will cease to be of service, and there will be little satisfaction in belonging to it. The Fellows will fail in their duty to the Empire unless the Society grasp the power which is potential in its hands and claim to be supreme as a deliberative and advisory authority in the interests of science. The voices of scientific workers in our country should be heard as that of one man through the Royal Society—we should then count for something in the National Councils; it should co-ordinate our scientific forces and link them up with our educational as well as with our industrial system—we should then play our due part in the State and the idea of science would soon be abroad. But to this end the Society must be organised as a democracy; at present it is little short of entirely in the hands of a ring of all but permanent, autocratic officials and the Fellows have but little part in its proceedings, as the Council in no way represents the desires and ideas of the Fellows.

The way before us is clear—we have but to group ourselves in sections mainly according to subjects: for example, all the chemists in one section, the physicists in another, the biologists, including medical men, in a third; hybrid sections might also be constituted, for example, one to deal with education. The policy of secrecy that prevails in the Society is merely the outcome of an attempt to retain the power in the hands of cliques, in no way worthy of the body or compatible with the proper exercise of its high office.

I claim for this Society a similar position with regard to chemical industry, and consider that your influence should be made operative in the highest quarters both directly and through your proper representation in the Royal Society. You have in no way done your duty to yourselves hitherto or rated your office and opportunities, the calls for your service, sufficiently high.

It rests with the younger men among you now to come forward and make yourselves effective as organisers. Organise your forces and use them constructively forthwith you must—the call upon you is imperative; let loose your ideas; many, I know, are afraid to speak: have courage—without it you cannot achieve victory!

THE FIELD LEAKAGE OF TURBO-ALTERNATORS WITH NON-SALIENT POLES.

BY R. C. JAKEMAN, B.SC.

The magnetic leakage of cylindrical turbo rotors is composed of two parts: firstly, that flux which passes from one pole to the next through the wedges at the top of the rotor slots and the air-gap; and secondly, that which passes from the rotor core into the end-caps enclosing the ends of the winding and back to the rotor core.

1. *The Leakage Flux Passing Through the Wedges and Air-gap.* Fig. 1 shows approximately the path of the lines of force for a particular machine having given proportions of air-gap length, width of slot, depth of wedge and slot pitch. The diagram is drawn on the assumption of magnetic wedges throughout. On studying the path of the lines of force, it is clear that in this particular case it is only the two wedges where the north and south poles join that carry any leakage flux. All the other wedges carry useful flux. Hence a very close approximation will be obtained by considering that *the outside coil of each pole* (marked A in Fig. 1) *produces only leakage flux and no useful flux whatever.* With non-magnetic wedges the path of the lines of force will alter somewhat, but this approximation will be quite close enough for practical purposes.

If the proportions of air-gap, width of slot, depth of wedge and slot-pitch are different from those shown in Fig. 1, more

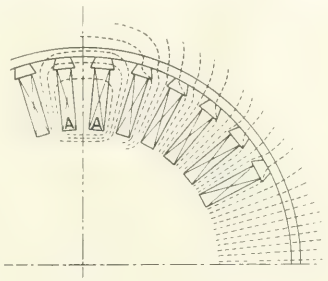


FIG. 1.—LINES OF FORCE IN TURBO-ROTOR.

of the winding than the one outside coil may produce only leakage flux. For instance, if the air-gap is larger than that shown in Fig. 1 and the slot-pitch less (*see* Fig. 2), the *two* inside coils may produce practically no useful flux. The amount of the winding which produces no useful flux can thus be best estimated by drawing a sketch of the rotor slots and gap and marking in the path of the lines of force. In some cases it may be found that the best approximation is to assume that the inside coil and half the next coil produce no useful flux, and so on. Hence, if the diameter of the wound part of the rotor is made smaller than the diameter of the unwound part, as is sometimes the case, the air-gap opposite the points where the north and south poles join becomes larger, so that the portion of the winding which produces only leakage flux is increased. Embedding the winding deeply below the surface of the rotor will obviously have a similar effect.

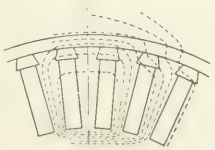


FIG. 2.—LINES OF FORCE IN TURBO-ROTOR.

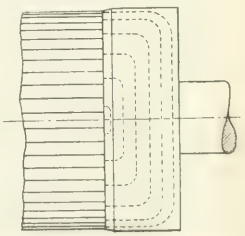


FIG. 3.—LEAKAGE FLUX IN END CAP.

Evidently it is quite unnecessary to know the value of this leakage flux, since it only exists in a very small circuit and does not produce any harmful saturation, being a negligible percentage of the total flux per pole.

2. *The Leakage Flux Passing Through the End-caps.* If the machine has non-magnetic end-caps, this leakage flux is quite negligible. If, on the other hand, the end-caps are made of steel, the leakage flux is considerable, and becomes a large percentage of the useful flux in machines with a short core.

The circuit of this leakage flux (*see* Fig. 3) consists of the joint where the end-cap registers in the core, the end-cap itself, the register at the next pole, the rotor teeth of one pole, the rotor core and the teeth of the first pole.

The reluctance of the two registers and the end-caps can be easily calculated, and it is found that even with low excitation, the M.M.F. produces very high densities in these parts. The path of the flux through the registers is small compared with that in the end-cap, and therefore the reluctance of the former may be neglected. We have, then, only to calculate the reluctance of the end-caps, and it is found that for a wide range of M.M.F., covering values obtained with quite low excitations to values for excitations well above the normal voltage, the density in the end-caps remains practically constant at about 18,000 lines per square centimetre. Hence the leakage flux per pole in the two end-caps may be at once obtained by multiplying four times the sectional area of one end-cap by 18,000.

The curve in Fig. 4 shows the value of the leakage flux per pole in one end-cap plotted against the ampere-turns per pole-pair producing it. It will be seen that the curve is very steep at first and is then practically horizontal owing to the high saturation.

Hence, for a constant sectional area of end-cap, *this leakage flux is constant for any length of machine.* In long machines it is quite a small percentage of the useful flux, but in special cases, if the machine is short, it may become a very considerable amount with regard to the useful flux. In fact, in one special machine of low output, the saturation curve of which is shown in Fig. 7, the leakage flux was over 50 per cent. of the useful flux at normal no-load pressure.

It is also clear that since the flux is constant whatever the value of the M.M.F. producing it, the leakage flux in each tooth must be practically the same, whether in the middle or the outside of the pole, a conclusion which will be required later.

If the end-caps are made in two parts, that nearest the rotor-core being of bronze and the other part of steel, the leakage-flux will be considerably reduced, since the bronze ring inserts an air-gap in the magnetic circuit.

We shall now proceed to show how these two leakage fluxes may be taken into account in the calculation of the saturation curve. The method of procedure we shall use is the "flux-per-tooth" method of calculation, which was very briefly described without considering the leakage, by Dr. S. P. Smith, in his Paper before the Institution of Electrical Engineers, "The Non-salient Pole Turbo-alternator and its Characteristics."* In this method we assume several mean densities in the air-gap (3,000, 4,000, &c., lines per cm²) and calculate the ampere-turns for the magnetic circuit, excluding the stator and rotor cores, for each mean gap-density. The mean gap-density is equal to $\frac{\text{useful flux per pole}}{\text{pole pitch} \times \text{axial length}}$, whilst the density B_x at any point x in the *stator teeth or gap* is equal to

$$\frac{\text{useful flux per pole}}{\text{area per pole at } x}.$$

Hence $B_x = \text{mean gap-density} \times \frac{\text{pole-pitch} \times \text{axial length}}{\text{area at } x}$.

The density, however, at a point y in the *rotor teeth* is equal to

$$B_y = \frac{\text{total flux per pole}}{\text{area per pole at } y}$$

$$= \frac{\text{useful flux per pole} + \text{leakage flux per pole}}{\text{area at } y}$$

$$= \text{mean gap-density} \times \frac{\text{pole-pitch} \times \text{axial length}}{\text{area at } y} + \frac{\text{leakage flux}}{\text{area at } y}.$$

For the sake of convenience in calculating, we may write,

$$\text{Leakage mean gap-density} = \frac{\text{leakage-flux per pole}}{\text{pole-pitch} \times \text{axial length}},$$

and now we obtain for the density at y in the rotor teeth,

$$B_y = \text{total mean gap-density (useful + leakage)} \times \frac{\text{pole-pitch} \times \text{axial length}}{\text{area at } y}.$$

This is clearly a great simplification, for since, as we have shown above, the leakage flux is approximately constant for a given machine, the leakage mean gap-density is also constant. Suppose, for example, the leakage mean gap-density is 400 lines per cm², then the densities in the stator teeth and gap must be calculated with mean gap-densities of 3,000, 4,000, &c., and in the rotor teeth with mean gap-densities of 3,400, 4,400, &c.

A curve can now be drawn showing ampere-turns per pole-pair against mean gap-density. If the centre of the pole is different from the wound slots, a separate set of calculations must be made for this part and a second curve drawn.

Having now obtained these curves, the gap-density opposite each tooth can be read off for any value of the ampere-conductors per slot in the rotor. Taking the example given in Dr. Smith's Paper, we have 13 slots per pole in the rotor, of which 10 are wound. Assuming, then, 1,500 ampere-conductors per slot, the four middle teeth per pole have 15,000 AT per pole-pair acting on them, the next two (one on each side of the centre) 12,000 AT, the next two 9,000, the next 6,000, then 3,000, and finally the last tooth has no M.M.F. acting on it.

The calculation will now be identical with the example given in Dr. Smith's Paper, *except that, in accordance with the above argument, the teeth* on which the 3,000 AT per pole-pair are acting *are assumed to carry only leakage-flux*, and, therefore, to contribute nothing to the production of E.M.F.

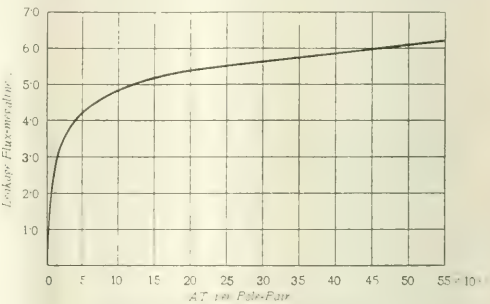


Fig. 4.—Leakage Flux in End Caps.

The calculation may, therefore, be shown in tabular form, thus :—

No. of teeth affected. M.	AT acting.	Mean gap-density from curve B_g.	$M \times B_g$.
1	0	0	0
2	3,000	Leakage flux only	0
2	6,000	3,000	6,000
2	9,000	4,300	8,600
2	12,000	5,250	10,500
4	15,000	5,800	23,200
			$\Sigma(M \times B_g) = 48,300$

The curve given by plotting B_g against the respective teeth over a pole-pitch will give approximately the shape of the flux-wave, and the area of this curve multiplied by the axial length will give the useful flux per pole of the machine. The area, however, is equal to the mean ordinate multiplied by the pole-pitch, and since the mean ordinate B_m is equal to

$$\frac{\Sigma(M \times B_g)}{\text{teeth per pole}} = \frac{48,300}{13} = 3,700,$$

the flux or voltage can be obtained at once for an excitation of 1,500 AC slot. The process can then be repeated for different values of the AC/slot.

Up to the present we have not taken into account the ampere-turns necessary for the stator and rotor cores. The rotor core usually has a considerable effect in two-pole machines owing to the comparatively high densities, and the stator core also may not be neglected owing to the length of the magnetic path, especially in 25-cycle machines. Hoock and Hellmund* show a method of calculating the ampere-turns necessary for induction motor cores, which gives very good results in practice.

* Journal I.E.E., Vol. XLVII., page 579.

* Beitrag zur Berechnung des Magnetisierungsstromes in Induktionsmotoren. "Elektrotechnik und Maschinenbau," Heft 36, 1910.

Table I.

B_m in stator.			4,000.			5,000.			6,000.		
Part.	Area.	Length.	B	AT/cm.	AT.	B.	AT/cm.	AT.	B.	AT/cm.	AT.
Stator teeth	Max. 6,200 Min. 4,300	14	8,500 12,300	4 10	100	10,600 15,400	27 25	250	12,800 18,400	10 120	1,000
Air-gap	10,300	3·5	5,100	...	14,300	6,400	...	18,000	7,700	...	21,600
B_m in rotor			4,460			5,460			6,460		
Rotor wedge	Max. 5,600 Mean 4,600 Min. 3,600	3·2	10,500 12,800 16,300	20 30 100	130	12,800 15,600 20,000	25 70 600	480	15,200 18,500 23,600	55 300 1,450	1,450
Rotor teeth	Max. 5,150 Mean 3,860 Min. 2,570	19·3	11,400 15,300 22,800	22 62 1,130	4,500	14,000 18,600 28,000	30 320 2,400	12,000	16,500 22,000 33,000	110 1,030 3,800	26,000
ΣAT		...	...	...	19,030	...	...	30,730	...	...	50,050

Table II.

B_m in stator.			5,000.			7,000.			8,000.		
Part.	Area.	Length.	B	AT/cm.	AT.	B.	AT/cm.	AT.	B.	AT cm.	AT.
Stator teeth	Max. 6,200 Min. 4,300	14	10,600 15,400	7 25	250	15,000 21,500	20 360	2,800	17,000 24,500	60 1,300	11,000
Air-gap	11,200	35	5,900		16,500	8,250	...	23,000	9,400	...	26,300
B_m in rotor			5,460			7,460			8,460		
Rotor	Max. 9,000 Mean 7,500 Min. 6,000	22·5	8,000 9,600 12,000	12 16 25	390	11,000 13,100 16,400	20 32 100	930	12,400 14,900 18,600	27 52 430	2,500
ΣAT		...	...	...	17,140	...	...	26,730	...	...	39,800

and may be used here since the flux is sinusoidally distributed over the pole-pitch. The method takes into account the fact that opposite the centre of the pole the density in the core is very much less than opposite a point between the poles.

Working in the same way with the rotor core, it is easy to see that for a two-pole machine the density is practically constant from one pole to the other and is equal to the total flux divided by the area across a diameter, making an allowance for the spreading of the flux into the shaft. The length of path is then the diameter of the core below the slots.

We shall now proceed to calculate the saturation curve of a machine, of which the particulars are given in Arnold ("Die Wechselstromtechnik," Band IV., page 574). The data of this machine are as follows :—

Normal voltage		6,600
No. of poles		2
Stator :	Outside diameter of core	134 cm
	Bore	70 cm
	Pole-pitch	110 cm
	Total axial length	120 cm
	No. of vent ducts, each 10 mm.	24
	Length of iron	96 cm
	Active length	86·5 cm
Air-gap :		17·5 mm
Rotor Laminated :		
	Outside diameter	66·5 cm
	Total axial length	115 cm
	No. of vent ducts, each 15 mm	16
	Length of iron	91 cm
	Active length	86·5 cm

60 open slots in stator 20 mm wide × 70 mm deep.

28 open slots in rotor, arranged 1/36 of the circumference apart, 22 mm wide × 112·5 mm deep, including 16 mm wedge. Centre of pole unslotted.

Stator winding :

10 slots per pole and phase.

4 conductors per slot.

Flux corresponding to 6,600 line volts = 45 megalines.

Consider first the leakage-flux through the end-caps. The sectional area of the caps is not given, but this is not very important, since the machine in question is comparatively long. We will assume an area of 85 cm² for each cap, so that the leakage flux in the two end caps will be $1 \cdot 85 \times 1 \cdot 1000 = 6 \cdot 1$ megalines. Secondly, on drawing a sketch of the slots, it will be seen that the best approximation for the leakage flux between poles is to assume that the *two* inside coils of each pole produce only leakage-flux.

We shall now proceed to calculate the curves connecting the mean gap-density B_g with ampere-turns. The leakage mean-gap-density is equal to

$$\frac{\text{leakage flux per pole}}{\text{pole-pitch} \times \text{axial length}} = \frac{6 \cdot 1 \times 10^6}{110 \times 120} = 460 \text{ lines per cm}^2.$$

We therefore calculate with mean gap-densities of 5,000, 6,000, &c., in the stator teeth and gap and with 5,460, 6,460, &c., in the rotor teeth.

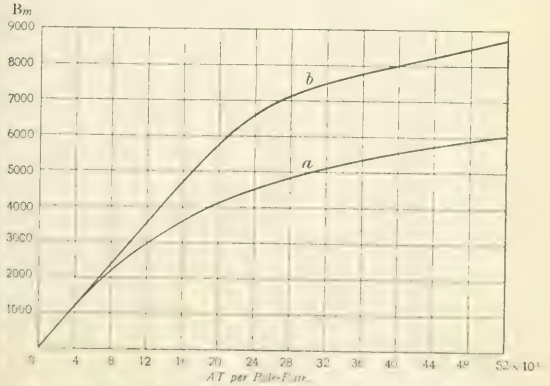


Fig. 5.—Curve of Mean Gap Density against AT per Pole-Pair for Machine published in Arnold.

Table I. shows how to calculate the AT necessary for the slotted portion of the rotor for several values of B_m, and Table II. for the unslotted portion.

From these tables we can now draw at once curves connecting AT with B_m for the slotted and unslotted portions of the rotor. These are shown in Fig. 5, *a* and *b* respectively.

Table III.

AC/slot.	1,000.			2,000.			3,000.		
No. of teeth affected, M.	AT acting per pole-pair.	Bg from curve.	M × Bg.	AT.	Bg.	M × Bg.	AT.	Bg.	M × Bg.
1	0	0	0	0	0	0	0	0	0
2	2,000	} Leakage flux only.		4,000	} Leakage flux only.		6,000	} Leakage flux only.	
2	4,000			8,000			12,000		
2	6,000	1,750	3,500	12,000	3,000	6,000	18,000	3,900	7,800
2	8,000	2,200	4,400	16,000	3,700	7,400	24,000	4,500	9,000
2	10,000	2,650	5,300	20,000	4,150	8,300	30,000	4,950	9,900
2	12,000	3,000	6,000	24,000	4,500	9,000	36,000	5,350	10,700
2	14,000	4,200	21,000	28,000	7,200	36,000	48,000	8,300	41,500
Σ(M × Bg)	.....		40,200	.....		66,700	.....		78,900
$B_m = \frac{\Sigma(M \times Bg)}{\Sigma M}$	.....		2,240	.....		3,700	.....		4,380
Flux in stator $B_m \times \tau L$ .....=	.....		$29{\cdot}6 \times 10^6$	.....		$48{\cdot}9 \times 10^6$	.....		$57{\cdot}9 \times 10^6$
Flux in rotor = flux in stator + leakage flux ($6{\cdot}1 \times 10^6$) .....=	.....		$35{\cdot}7 \times 10^6$	.....		55×10^6	.....		64×10^6
AC slot for stator core .....=	.....		20	.....		40	.....		60
AC slot for rotor core .....=	.....		50	.....		100	.....		400
Total AC/slot .....=	.....		1,070	.....		2,200	.....		3,400
Total AT per pole pair = AC/slot × 14...=	.....		*15,000*	.....		*30,800*	.....		*47,600*
Phase-pressure .....=	.....		*2,500*	.....		*4,130*	.....		*4,900*

Taking, now, certain values of the ampere-conductors per slot we can obtain from these curves the flux-density in each tooth and so obtain the value of the total flux, as shown above.

The only thing that remains, therefore, is to calculate the AT necessary for the stator and rotor cores, and we have enough

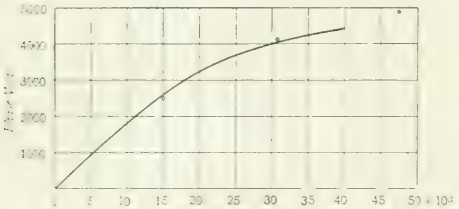


Fig. 6.—Saturation Curve published in Arnold.

data to draw the saturation curve of the machine. Table III. shows these final figures.

Fig. 6 shows the saturation curve published in Arnold, the circles being the points calculated above. It will be seen that the calculated and test figures agree very closely.

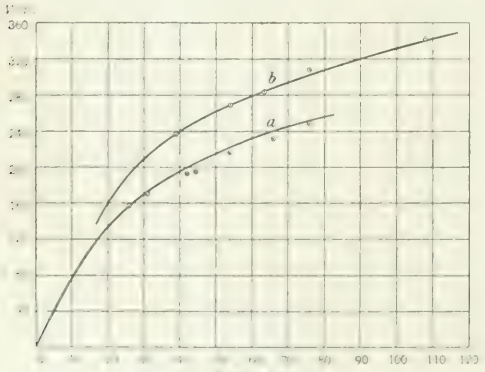


Fig. 7.—Saturation Curve of Machine 60 cm Diameter by 25 cm Long.

The saturation curves in Figs. 7, 8 and 9 are further examples. In each case the curve represents the calculated figures and the circles the values obtained on test.

Fig. 7 shows the saturation curves of a special machine 60 cm diameter and only 25 cm long. The lower curve is for th machine as originally built with empty slots in the middle

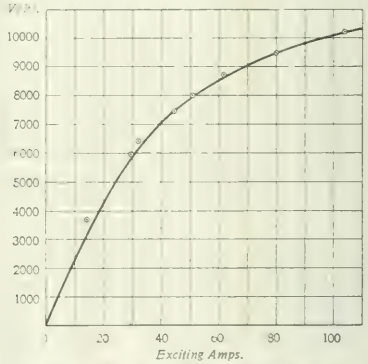


Fig. 8.—Saturation Curve of Machine 60 cm Diameter by 90 cm Long.

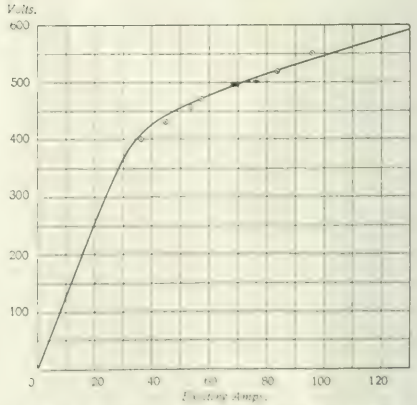


Fig. 9.—Saturation Curve of Machine for 25 Cycles.

the poles and the upper curve is for the same machine with unwound slots filled with steel.

Fig. 8 shows the curve for a machine of the same diame and rotor slotting, but 90 cm long, and Fig. 9 for anoth

machine of about the same size, but built for 25 cycles. In the latter the densities in the stator core were comparatively high.

In the machine of Fig. 7, the leakage flux through the end-caps was 56 per cent. of the useful flux at normal no-load pressure, and, therefore, was $25/90 \times 56$ per cent.$=15{\cdot}5$ per cent. of the useful flux in Fig. 8 (assuming the same useful flux per centimetre length at normal no-load pressure), since the leakage flux is constant for any length of machine with the same sectional area of end-cap.

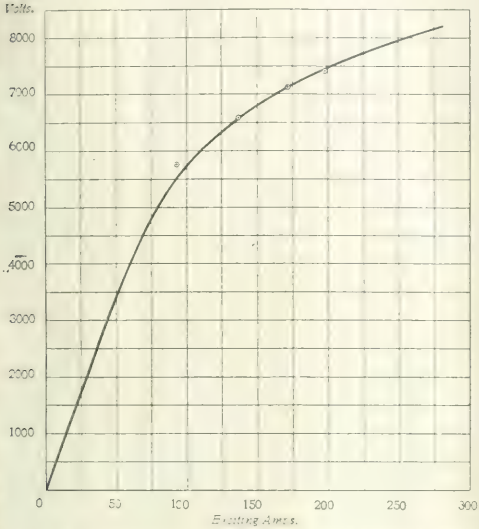


Fig. 10.—Saturation Curve of Four-pole Machine with Laminated Rotor.

Fig. 10 is the curve for a four-pole machine with laminated rotor. It will be noticed how remarkably close the calculated values are to the test results in each case.

It has been suggested that once the design has been worked out for a machine with a given diameter of rotor for any required output, the same design will hold good within certain limits for any other output, merely by altering the length of the core in proportion to the output required; that is to say,

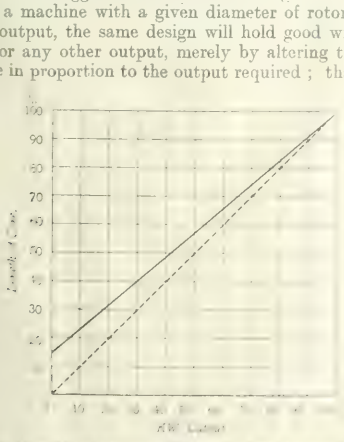


Fig. 11.—Curve showing Effect of Leakage [illegible]

[illegible] the useful flux per centimetre length of core could be kept the same for any output. The above consideration of the leakage flux in the end-caps, however, shows that this is not the case. Assuming that the armature AC ohms and the [illegible] losses in the rotor teeth are kept constant, then it is the total flux in the rotor per centimetre length which remains constant and not the useful flux in the gap per centimetre length. Since, therefore, the output is proportional to the useful flux and the length of core to the total flux, the output and length are no longer proportional. Fig. 11 is a curve illustrating this. If the output were proportional to the length, the curve, of course, would be a straight line inclined at 45 deg., passing through the origin, as shown dotted.

STEEL MILL CONTROLLERS FROM THE OPERATOR'S STANDPOINT.*

BY J. S. RIGGS.

Summary.—The author discusses control problems from the operator's standpoint, in connection with bloom mill and rolling mill machinery. The requirements of the different classes of machinery are tabulated, and from this tabulation it is shown that the control can be standardised in four distinct types, one or the other of which will meet all conditions of mill equipment. In conclusion, the author points out that the conditions to be met and their solution should be kept as uniform as possible, and the aim should be towards simplicity. The expense of duplication would be avoided by standardisation of parts, and this would also permit comparison of different makes of apparatus on an equal basis.

The purpose of this Paper is to describe the forms of electrical control peculiar to steel mill service, "from the operator's standpoint." It is possible and probably usual to treat the subject by averages, to make statements as the result of many opinions. In this Paper the other general procedure will be followed in that the ideas are as the writer sees them. The plan has been adhered to purposely in the hope that this method will provoke constructive criticism, all to the end of definite recommendation.

The steel mill is distinct in many ways from any other manufacturing industry, and one of the most important of these distinctions is that no provision for emergencies can be made; that is, when an ingot, bloom or billet leaves the furnace for the rolls it has to be kept moving until it reaches the cooling beds. Any delay or interruption in this cycle means scrap material and loss of time.

Considering the above service requirements and operating conditions, the equipment must stand up to the service, and be as nearly fool-proof as it can possibly be made. The full magnetic controller, in my opinion, meets the above requirement better than any other type, and also has several additional advantages which may be briefly enumerated as follows:—

(*a*) Superior ability to handle heavy currents at a minimum of maintenance cost and delays.

(*b*) Inherent current-limit acceleration feature. Taking acceleration entirely away from the operator.

(*c*) Can be operated by a small master-controller which is easy to handle, thus eliminating the element of fatigue of operator.

(*d*) Limit switches and automatic cut-out switches can be applied in any position so that "slow-down" dynamic brake stop, as well as any other automatic feature required, can be obtained.

(*e*) Complete remote-control circuit-breaker protection at a very slight additional cost.

(*f*) "Safety first," removes all arcs from immediate vicinity of operators. In fact, with magnetic-control, the operator is insulated from all live parts.

In order to being out clearly the different equipments with their control in, for example, a bloom mill and a rolling mill, the following outline sketches and tables may be of assistance.

The control for the following outlined equipment, which covers practically all typical mill equipments, can be standardised in four distinct constructions, as follows:—

(1) Full reverse, single-speed type.
(2) Full reverse, multi-speed type.
(2A) Full reverse, multi-speed type, dynamic braking.
(3) Non-reverse, push-button type.

(1) The full reverse, single-speed type, should contain the following apparatus: Four reverse switches, mechanically interlocked; three or four accelerating series or back-out switches (three switches up to 75 H.P.; above 75 H.P. to 200 H.P., four switches), one main line contactor, two overload double-coil relays; one main line switch double pole, single throw, safety type, one control switch, double pole, single throw and three, one terminal board, one angle iron or pipe frame, one resistance, to be mounted on [illegible] frame below panels, one angle-speed master radial-arm type with overload reset in off position. This controller will take care of at

* Paper read before the American Institute of Electrical Engineers, slightly abbreviated.

least 50 per cent. of mill work, and can be used on the following equipment: All roller tables, screw-downs, rollers on tilting table and soaking-pit covers.

Limits can be used with this control in any place where conditions may require them.

(2) and (2A) Full reverse, multi-speed type, should contain the following apparatus: Four reverse switches, with mechanical interlocks; four or five accelerating switches, shunt type series accelerating relays (four switches up to 75 H.P.; above 75 H.P. to 200 H.P., five switches); one main line contactor; one dynamic brake switch; two overload double-coil relays; one main line knife-switch, double-pole, single-throw, safety type; one control switch, double-pole, single-throw and fuses; one terminal board; one angle iron or pipe frame; one resistance to be mounted on rear of frame below panel; one multi-speed master radial-arm type with overload reset in off position.

This type of controller can be used wherever conditions are such that a single-speed equipment, even with the plugging feature, will not meet them. For instance, this type of controller should be used where varying loads obtain, where refinement of control is required, where dynamic braking or slow-down features are desired, and can be used on the following equipment: Kick-off; dogs or drags on transfer tables, hot-bed, &c.; furnace pushers; tilting tables, hoist-lowering; hot-metal mixers, and open-hearth floor type charger, bridge, hoist, trolley and reel.

No.	Equipment operated.	Type of control	Reverse Non-rev.	Type master.	Limits.	Special features.
	Reversing Mill.					
1.	Soaking-pit covers	Magnetic	Full rev.	One-speed	2-way	...
2.	Ingot del. table		..	..	...	...
3.	Mill appr. table		..	..	...	...
4.	Mill rev. table		..	..	...	...
5.	Two-high mill—					
	A. Screw-down		..	..	...	...
6.	Mill rev. table		..	..	...	...
7.	Shear appr. table		..	..	...	...
8.	Shear		Non-rev.	Push-button	...	...
9.	Shear del. table		Full rev.	One-speed	...	...
	A. Kick-off		..	Multi-speed	2-way	Slow down
10.	Hot-bed, A Drags or dogs		..	..	...	..
	Reversing M.					
1.	Furnace pushers	Magnetic	Full rev.	Multi-speed	2-way	Slow down
2.	Furnace feed tables		..	One-speed	...	...
3.	Furnaces		...	...	...	...
4.	Furnace discharge table		..	One-speed	...	...
5.	Tilting tables—					
	A. Bridge		..	Multi-speed	...	...
	B. Hoist		..	..	2-way	Dyn. brake
	C. Rollers		..	One-speed	...	Lowering
6.	Tilting tables		...	...	...	...
7.	Tilting tables Same as 5		...	..	...	...
8.	Hot-saw appr. table		Full rev.	One-speed	...	...
9.	Hot-saw		Non-rev.	Push-button	...	...
	A. Hot-saw feed		Full rev.	Multi-speed	2-way	*
10.	Hot-saw del. table		..	One-speed	...	...
	A. Hot-saw kick off		..	Multi-speed	2-way	Slow down
11.	Hot-bed					
	A. Hot-bed tipper		..	..	..	..
	B. Hot-bed drags		..	..	..	..
12.	Straightener appr. table		..	One-speed	...	...
13.	Straightener		..	Push-button	..	..
14.	Shear appr. table		Full rev.	One-speed	...	...
15.	Shear		Non-rev.	Push-button	...	...
16.	Shear del. table		Full rev.	One-speed	...	...
	A. Shear kick-off		..	Multi-speed	2-way	Slow down
	B. Transfer dogs		..	..	..	..
17.	Cold saw appr. table		..	One-speed	..	..
18.	Cold saw		Non-rev.	Push-button	..	..
	A. Cold saw feed		Full rev.	Multi-speed	2-way	*
19.	Cold saw del. table		..	One-speed	..	..

* Multi-speed reversing solenoid relay.

† Accelerating field relay.

[illegible] control circuit knife-switch feature is also suitable for the following: Tilting furnaces, tilting table bridge.

[illegible] so long as the controller is not provided with overload relays, but if [illegible]

grounded and the reversing switches will be powerless to disconnect the grounded field winding from the line.

Moreover, certain combinations of grounds, in case but one overload relay and no extra main-line contacts are used, may result in short-circuiting that relay and the consequent loss of overload protection without such condition coming to the attention of either the operator or the motor inspector. The only way absolutely to protect the equipment against short-circuits and overloads is to instal two relays, one in each side of the line and also instal a contactor in that side of the line which feeds the motor field winding, which arrangement gives the most complete protection possible to obtain. Each control panel should also include a main-line knife switch for the motor circuit, this knife switch to be so equipped that it may be locked open by safety padlocks, thus protecting men working on the control equipment or the associated machinery.

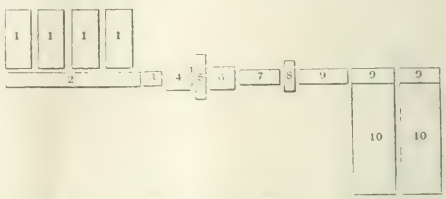


FIG. 1.—BLOOM MILL.

1. Soaking-pit [illegible]
   A. S[illegible]
2. Ingot [illegible]
3. Mill approach table.
4. Mill reversing table.
5. Two-high mill.
   A. Screw-down.
6. [illegible]
7. Shear approach table.
8. Shear.
9. Shear delivery tables.
   A. Kick-off.
10. Hot-bed.
    A. Hot-bed drags.

Each control panel should include a control circuit knife switch and fuses for protecting the control circuit, as it is obvious that if the overload relay on the panel is set high enough to protect the motor, a very destructive short-circuit may occur in the control system, without taking sufficient current to trip the main overload relay. The fuses guard against this contingency and make it possible to connect the control circuit outside the main line knife switch so that whenever the motor inspector desires to test the out-control system, he may pull the main line knife switch and operate all contactors without running the motor.

(3) The non-reverse, push-button type should include the following apparatus: One main line contactor; three or four accelerating switches, series or lock-out type; three switches up to 50 H.P., four switches from 50 H.P. to 200 H.P. (the last accelerating switch to hold

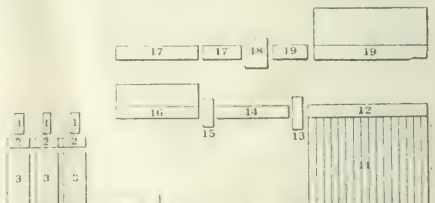


FIG. 2.—ROLLING MILL.

1. Furnace pushers.
2. Furnace feed-roller tables
3. Furnaces.
4. [illegible]
5. Tilting table.
   A. [illegible]
   B. Hoist.
   C. Rollers.
6. Rolls.
7. Same as 5.
8. [illegible]
9. [illegible]
10. Hot-saw delivery table.
11. Hot bed.
    A. Hot-bed tipper.
    B. Hot-bed drags.
12. Straightener approach table.
13. Straightener.
14. [illegible]
15. Shear.
16. Shear discharge table.
    A. [illegible]
17. Cold saw approach table.
18. Cold saw.
19. Cold saw discharge table.

[illegible] protect against current; one overload double-coil relay; one main line double-pole, single-throw knife switch and fuses; one terminal board; one shunt field protective relay (not considered necessary below 30 H.P.); one angle iron or pipe frame; one resistor mounted on rear of frame; and one push button "start," "stop" and reset.

Additional to the above where variable speed is required, as for motors on straighteners: One voltage-drop field relay; and one field [illegible]

The above type of controller without the additional features can be used on furnace fans, shears, cold saws, and hot saws.

In fact, this type of controller is suitable for the majority of constant-speed mill equipments.

No attempt has been made to give horse-powers for any of the equipment mentioned because of the wide range and the power required by mills, due to different size mills and local conditions, but it would be my recommendations in laying out a mill to keep to as few different sizes of motors as possible throughout. This will not only keep down motor spare parts, but will cut down to a minimum the number of sizes of controllers required, and in this way cut down the total amount of spare parts required for permanent stock.

I would recommend control panels being made up of an assembly of slates containing the various pieces of apparatus which go to make up the controllers.

I will touch briefly on a few points which I think would help the operator. If there were some standardisation so that he could compare different makes of apparatus on an equal basis, these items will be of assistance.

1. Contactors: Area of contacts; pressure between contacts; and rating per unit area of contact.

2. Resisters: Standard ratings; cross-section; contact area; spacing; and type.

Contactor coils should be interchangeable on the same size apparatus of one manufacturer. Use external resistance when coils have to stand continuous service rather than a special coil.

In conclusion, the point attempted at the introduction is emphasised. (*a*) Make the conditions to be met as uniform as possible. (*b*) Solve these both from the manufacturing and the operating standpoints by uniform methods. (*c*) Strike for simplicity; and (*d*) save the expense of duplication. These, I believe, to be engineering fundamentals peculiar to the subject.

INCREMENTAL ARMATURE COPPER LOSSES AT NO-LOAD AND ARMATURE TEETH EDDY-CURRENT LOSSES.*

BY A. PRESS, B.SC.

When any solid conductor passes through a variable magnetic field the various lateral portions of the conductor have slightly different voltages induced in them, thereby giving rise to eddy-current losses. A result of this will be that the observed no-load input to overcome the losses in a locked unwound rotor of an induction motor will be manifestly different from the observed losses with the same locked rotor having a solid open-circuited bar winding.

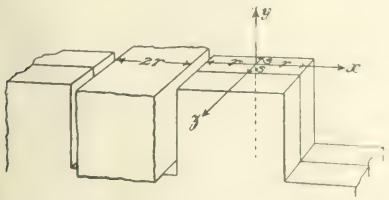


FIG. 1.

In the case of a dynamo, in addition to an eddy-current loss set up by the self-induction field† at right angles to the main field, there is an eddy-current loss set up by the main field itself; the latter loss is independent of any load and is only dependent upon the main-field [illegible] in slots and the speed of rotation.

The object of this Paper is to give formulæ and curves for estimating this incremental copper loss so that such data may be available for the designers in dealing with very small and also very large armatures.

As a first approximation it will be assumed that the flux enters the slots perpendicularly. Moreover, since the same method is really applicable to the determination of the eddy-current losses induced in the teeth themselves (assuming constant permeability), the one solution can be made available for both cases.

* Abstract of a Paper published in the Journal of the Institution of Electrical Engineers.

† This loss was first investigated by A. B. Field. [illegible] Slot-wound Conductors," Transactions of the American Institute of Electrical Engineers, Vol. XXIV., p. 761, 1905. Also W. Rogowski, "Über eine elektrische Kupplung zu [illegible] Archiv für Elektrotechnik," Vol. II., p. 81, 1913-14.

If δ_z, δ_x are the eddy-current densities in amperes per square centimetre in the corresponding directions z and x of the laminations or the slots (Fig. 1), we have, employing the Heaviside operator, $q^2=\frac{4\pi\mu}{10^9\rho}\frac{d}{dt}$

$$\frac{d^2B}{dx^2}+\frac{d^2B}{dy^2}=q^2B=kipB.$$

Since B is a sine function of the time,

$$i=\sqrt{-1}=\frac{1}{p}\frac{d}{dt}, \text{ and } k \text{ stands for } 4\pi\mu/10^9\rho.$$

The boundary conditions to be satisfied are dependent on the fact that at the periphery of the laminations the flux density must be that of the corresponding air-gap. That is, the flux density B_y must be such that would prevail were the material of the laminations (or the copper of the slots) of infinite resistivity ρ. Thus where ζ is the pole-pitch,

$$x=\pm r: \quad B=B_1 \sin(pt-\pi r/\zeta)$$
$$z=\pm s: \quad B=B_1 \sin(pt+\pi s/\zeta).$$

If then we adopt a Fourier series to satisfy these conditions the solution is

$$B=B_1\Bigg[\frac{4}{\pi}\sin\frac{\pi r}{\zeta}\cos pt\sum_{1,3,5\ldots}\frac{1}{n}\frac{\sinh\left(q^2+\frac{n^2\pi^2}{4s^2}\right)^{\frac{1}{2}}x}{\sinh\left(q^2+\frac{n^2\pi^2}{4s^2}\right)^{\frac{1}{2}}r}\cos\frac{n\pi}{2s}z$$

$$+\frac{4}{\pi}\cos\frac{\pi r}{\zeta}\sin pt\sum_{1,3,5\ldots}\frac{1}{n}\frac{\cosh\left(q^2+\frac{n^2\pi^2}{4s^2}\right)^{\frac{1}{2}}x}{\cosh\left(q^2+\frac{n^2\pi^2}{4s^2}\right)^{\frac{1}{2}}r}\cos\frac{n\pi}{2s}z$$

$$+\frac{2}{\pi}\left\{\left(1+\cos\frac{2\pi r}{\zeta}\right)\cos\frac{\pi r}{\zeta}+\sin\frac{2\pi r}{\zeta}\sin\frac{\pi r}{\zeta}\right\}$$

$$\sin pt\sum_{1,3,5\ldots}\frac{np}{n^2-\frac{4r^2}{\zeta^2}}\frac{\cosh\left(q^2+\frac{n^2\pi^2}{4r^2}\right)^{\frac{1}{2}}z}{\cosh\left(q^2+\frac{n^2\pi^2}{4r^2}\right)^{\frac{1}{2}}s}\cos\frac{n\pi x}{2r}$$

$$+\frac{4}{\pi}\left\{\left(1-\cos\frac{2\pi r}{\zeta}\right)\cos\frac{\pi r}{\zeta}-\sin\frac{2\pi r}{\zeta}\sin\frac{\pi r}{\zeta}\right\}$$

$$\cos pt\sum_{1,3,5\ldots}\frac{jn}{\frac{n^2}{r}-\frac{4r}{\zeta}}\frac{\cosh\left(q^2+\frac{n^2\pi^2}{4r^2}\right)^{\frac{1}{2}}z}{\cosh\left(q^2+\frac{n^2\pi^2}{4r^2}\right)^{\frac{1}{2}}s}\sin\frac{n\pi x}{2r}\Bigg]$$

[The symbol j is used here as equivalent to $\sqrt{-1}$, though having no operative functionality.]

The eddy-current losses sought could now be obtained indirectly by means of the integral $\int_{rs}\delta^2\,dx\,dz\,dt$. We can, however, make use of an expedient discussed later on that will avoid the very considerable difficulties involved. To this end it is necessary to obtain the effective flux passing through the rectangle $2r\times 2s$ at any instant of time.

$$\int_{rs}B\,dx\,dz=4rsB(R_1T_N+R_2T_M)\sin pt=4rsB(R_1\mathfrak{C}_N+R_2\mathfrak{C}_M)\cos pt$$
$$=F_s\sin pt-F_c\cos pt=F_R$$

provided we write

$$\frac{8}{\pi^2}\cos\frac{\pi r}{\zeta}=R_1$$

$$\frac{4}{\pi^2}\left\{\left(1+\cos\frac{2\pi r}{\zeta}\right)\cos\frac{\pi r}{\zeta}+\sin\frac{2\pi r}{\zeta}\sin\frac{\pi r}{\zeta}\right\}=R_2$$

$$\sum\frac{1}{n^2}T_N=T_N;\qquad\sum\frac{1}{n^2}\mathfrak{C}_N=\mathfrak{C}_N;$$

$$\sum\frac{1}{n^2-\frac{4r^2}{\zeta^2}}T_N=T_M\qquad\sum\frac{1}{\frac{n^2}{r}-\frac{4r}{\zeta}}\mathfrak{C}_N=\mathfrak{C}_M.$$

$$\frac{\tanh\left(q^2+\frac{n^2\pi^2}{4s^2}\right)^{\frac{1}{2}}s}{\left(q^2+\frac{n^2\pi^2}{4s^2}\right)^{\frac{1}{2}}s}=T_N+\mathfrak{C}_N.$$

$$\alpha=\frac{\pi}{2\sqrt{2}}\sqrt{\sqrt{\left(\frac{16\mu p}{10^9\rho\pi^2}\right)^2+1}+1};$$

$$\beta=\frac{\pi}{2\sqrt{2}}\sqrt{\sqrt{\left(\frac{16\mu p}{10^9\rho\pi^2}\right)^2+1}-1}.$$

with similar expressions for the "n" subscripts by the interchange of r and s.

The expression F_R is the resultant flux passing into the rectangle $2r \times 2s$ at any instant of time. To get the flux that would be passing into the same rectangular area of the laminations on the assumption of infinite resistivity but with normal permeability we have

$$2s \int_{-r}^{r} B \sin\left(pt + \frac{\pi x}{\tau}\right) dx = B \frac{4s\tau}{\pi} \sin\frac{\pi r}{\tau} \sin pt = F_0 \sin pt.$$

The above two expressions for the fluxes enable us to obtain the eddy-current losses quite simply.

It is only necessary to obtain the voltage, and current in phase with the voltage, in a peripheral circuit about the lamina $2r \times 2s$, such that they will give the same effective flux reactions that the actual eddy-current circuits give. The above peripheral voltage

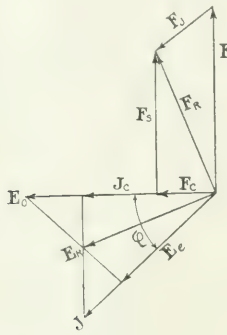


Fig. 2.

multiplied by the corresponding current in phase will then be the measure of the eddy-current losses in the volume $4rs$ cubic centimetres of the material of the laminations. In both cases the mechanical activity to overcome the eddy-current losses is dissipated into the same quantity of Joulean waste.

To simulate entirely the flux reactions, a resistance and reactance can be assumed intercalated into the peripheral circuit. A vector diagram (Fig. 2) will serve to clarify the ideas expressed.

Let F_0 = open-circuit peripheral flux, setting up
E_0 = open-circuit voltage at right angles to F_0,
F_R = actual resultant flux passing through the closed peripheral circuit, setting up
E_R = actual resultant voltage in peripheral circuit, setting up
J = actual current in peripheral circuit, with proper amount of resistance and reactance intercalated into the circuit, to produce the mechanically-equivalent flux reactions.
E_e = actual component of voltage E_R in phase with the current J of the peripheral circuit.
F_J = component of flux set up by, and in phase with, the current J, combining with the open-circuit flux F_0, to give the actual resultant threading flux F_R.

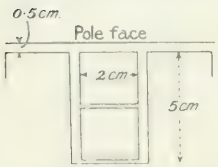


Fig. 3.

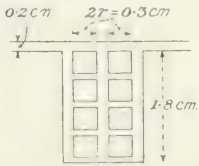


Fig. 4.

The eddy-current loss in watts per [illegible] cubic centimetres, using consistent E.M.S. values, is evidently given by JE, but this can be [illegible] to the relation J E$_e$.

Hence $W = J_e E$.

Here W is the watts per cubic centimetre of the laminations, J is the [illegible] current necessary to set up the amplitude of flux F_0, and E_e is the effective voltage set up in the peripheral circuit with the [illegible].

Consequently to set up the flux F_0 to thread the peripheral circuit to [illegible] reactance

$$L = \frac{E_0}{10^8 \times 2\pi f \times J} = \frac{E_0}{\mu},$$

or by substitution for the component F_0

$$J = \frac{10}{4\pi\mu\sqrt{2}} \cdot B\,(R_1\tau_S - R_2\tau_M).$$

The effective volts on the other hand, E_0, are given by

$$E_0 = \frac{F_0 \times 10^{-8} \times p}{\sqrt{2}} = \frac{p}{\sqrt{2}} \cdot B \cdot \frac{4s\tau}{\pi} \cdot \sin\frac{\pi r}{\tau} \cdot 10^{-8}.$$

Hence the eddy-current loss per cubic centimetre of the laminations is given by

$$W = \frac{B^2}{4\pi\mu} \cdot \frac{\tau}{r} \cdot \sin\frac{\pi r}{\tau} \cdot (R_1\tau_S - R_2\tau_M) 10^{-7}.$$

The formula simplifies greatly when it is observed from Fig. 1 that for the case of the slot copper, $2r$ in the formula is to be taken as the

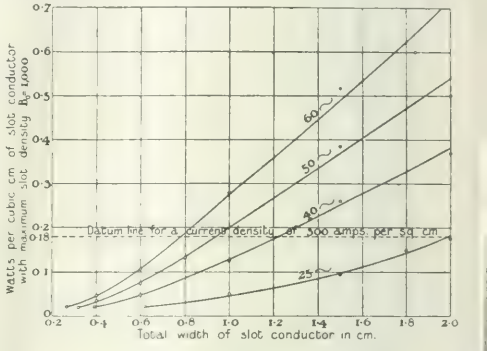


Fig. 5.

width of any individual conductor in the slot, and $2s$ as practical approaching infinity in value. In this case

$$a_n = b_n = \frac{\pi}{2} \sqrt{\frac{10}{10^8 \rho\pi}}$$

$$a_n b_n = \infty : \tau_n = 0 - \tau_M$$

and the term $R_2\tau_M$ disappears since it approaches zero.

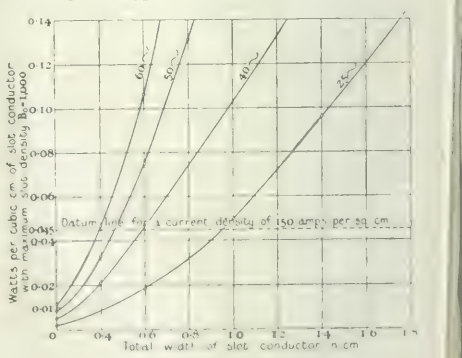


Fig. 6.

Thus finally the formula for the slot conductor losses due to [illegible] main field is per cubic centimetre

$$W = \frac{B^2}{\rho} \cdot \frac{\tau}{r} \cdot \sin\frac{\pi r}{\tau} \cdot \frac{2a_n}{2} \cdot \frac{1}{2} \cdot \frac{\sinh 2a_n - \sin 2a_n}{\cosh 2a_n - \cos 2a_n} 10^{-7}$$

where a_n as before is given by

$$2a_n = \frac{\pi}{\sqrt{2}} \cdot r \cdot \sqrt{\frac{8\cdot2\mu\times}{10^8\rho}}.$$

It can be shown for all practical purposes of design that

$$2a_n = 0{\cdot}44 \cdot 2r \sqrt{\frac{\mu}{\rho}} \cdot \frac{2}{\tau}$$

$$\frac{2r}{\tau} = 0{\cdot}2.$$

Then with an error of less than 2 per cent. we have

$$W = \left(\frac{B}{1000}\right)^2 \frac{(2a_n)^2}{240\left[1 + (2a_n)^6/24\right]}$$

Applications.

Example 1.—Assuming the slot and conductor dimensions as illustrated in Fig. 3 with $\alpha = 40$, $2r = 2$ cm., and air-gap density $B_A = 10{,}000$. The density in the slot will approach the value

$$B_s = 10{,}000 \times \frac{0{\cdot}5}{5{\cdot}5} = 910,$$

as against the 1,000 of the standard curves shown in Figs. 5 and 6.

From the curves for $40°$ and $2r = 2$ we have $W = 0{\cdot}38$, which, when corrected for the slot density, gives

$$W = 0{\cdot}38 \times (0{\cdot}91)^2 = 0{\cdot}315.$$

Thus, if reference is made to a normal full-load current density of 300 amperes per square centimetre, the total full-load loss factor would be

$$1 + \frac{0{\cdot}315}{0{\cdot}18} = 2{\cdot}71 = K_L.$$

At no-load the amount of the actual copper loss in the slot copper due to the main flux eddy-current effect alone would be $K_N = \frac{0{\cdot}315}{0{\cdot}18} = 1{\cdot}71$ times a hypothetical full-load current loss.

Example 2.—Assume in Fig. 4,

Air-gap density $B_A = 12{,}000$; $\alpha = 60$.

Then $B = 12{,}000 \times \frac{0{\cdot}2}{2} = 1{,}200$, and $2r = 0{\cdot}3$ cm.

From the curves it is seen that $W = 0{\cdot}026$ for $B_0 = 1{,}000$.

Hence for the actual case it will be

$$W = 0{\cdot}026 \times (1{\cdot}2)^2 = 0{\cdot}0374.$$

If then with a normal full loading of only 150 amperes per square centimetre the full-load factor would be

$$K_L = 1 + \frac{0{\cdot}0374}{0{\cdot}045} = 1{\cdot}83,$$

and on no-load the armature copper-loss factor in terms of full load would be $K_N = 0{\cdot}83$, in spite of the fact that no actual armature current was being delivered to the mains.

ELECTRIC ENAMELLING IN MOTOR CAR MANUFACTURE.

A heating load of 6,000 kw. will be provided by the new electrical equipment of the Willys-Overland Company for the enamelling ovens in their automobile factory at Toledo, Ohio, U.S.A. The change from gas and steam heating to electric was decided on partly because of the better quality of the enamel surface obtained, and also because, though the cost of heating is increased by about 35 per cent., the shorter time required for baking increases the production by about 50 per cent. Other savings are effected by lower labour charges, economy in floor space, and reduced insurance rates, the latter being due to the greater safety from explosion and fire as compared with gas heating.

Interesting details of the plant have been given by the "Electrical World," from which the accompanying tables and diagrams are reproduced. Table I. gives the chief particulars of the installation when complete, and Table II. contains the results of tests carried out on the ovens already finished. These were old ovens in which the gas heaters were merely replaced by the radiators, but the latest ovens to be remodelled should give still better results, as the walls are to be made of 1 in. sheets of "Nonpareil" high-pressure block covered with No. 20 gauge sheet iron.

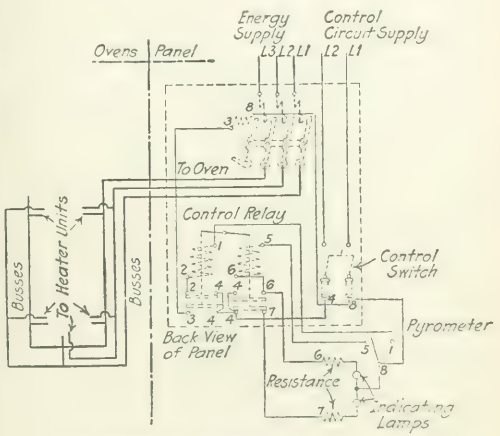
Table I.—*Miscellaneous Data on Overland Electric Enamelling Ovens.*

Total number of ovens to be electrically heated	20
Total cubical content of ovens, in cubic feet	52,400
Total weight of metal in all ovens per bake, in lb.	70,000
Metal to be handled per day (8 hours)	175
Total connected load, in kilowatts	6,000
Inner sizes of largest ovens, in feet	19 to 20 by 7·5
Rating of heaters in largest ovens, in kilowatts	160
Inner sizes of smallest ovens, in feet	12 to 14 by 7
Rating of heaters in smallest oven, in kilowatts	240

Table II.—*Comparative Test Data on Ovens.*

	Heated by gas.	Heated by electricity.
Oven inner sizes, in feet	21 to 21 by 7·5	21 to 21 by 7·5
Pieces per load (approximate)	1,150	1,150
Time of each bake (from start to finish)	1 hr. 30 min. to 1 hr. 45 min.	1 hr. 00 min. to 1 hr. 05 min.
Time of actual bake (from start to finish of cooling)	2 hr. 30 min. to 2 hr. 45 min.	1 hr. 30 min. to 1 hr. 50 min.
Gas used per load, in feet	2,340	
Gas used per hour, in feet	3,340	
Electricity used per load, in kilowatt-hours		420
Electricity used per hour, in kilowatt-hours		240
Total gas used, in cubic feet	1,850	
Total electricity used, in kilowatt-hours		170

Each group of ovens is fed from 440-volt three-phase 25-cycle mains through a special contactor control panel, the circuits of which are shown in the diagram. The 110-volt control circuit for working the main three-pole contactor is kept operative at all times by a reversing contactor; and there is a contact-making pyrometer instrument to adjust the temperature automatically. Besides the control knife-switch there are in the control circuit door switches (not shown) to prevent the heater from being energised when the oven is open. In the pyrometer is a six-volt auxiliary circuit (also not shown) for the needle make-and-break contacts. The heaters, composed of 11 kw. units, are placed on the floor down the sides and in the centre of the ovens, and take up very little space. They were supplied, with the rest of the electrical equipment, by the General Electric Co. of America.



Connections for Electric Enamelling Oven.

Portable Car-Testing Set.—In the "Electric Railway Journal" of America a description has recently been given of a very compact car-testing set that has been used at Purdue University for the last two years. It consists of three graphic recording instruments and three watt-hour meters mounted on a test stand, on the legs of which are felt pads to minimise vibration. The graphic meters are supported on a spring-suspended shelf; and the watt-hour meters (of the Sangamo railway type with special reset dials) are mounted on a board, behind which is the wiring. Owing to its small size, the set can be used on cars operating in regular service. Esterline graphic meters are employed, one to measure the line voltage and another [illegible] to measure the speed of the car. The third is an ammeter to measure the motor current or the total car current as may be desired. By [illegible] needle can be [illegible] higher speeds being useful in studying starting operations. The [illegible] can also be [illegible] desirable [illegible]. One of the watt-hour meters is used for the motor [illegible] and of the others one is [illegible] in the compensator circuit, while the third measures the input to the remaining [illegible] apparatus.

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THE DEVELOPMENT OF INDUSTRY.

Of late public opinion has been roused to such an extent on questions dealing with research, inventions and industrial development that the Government, in its wisdom, has thought fit to seek the aid of the Royal Society. To set the mind of the public at rest, the latter body has appointed committees and sub-committees to deal with the several questions. A movement was launched about a year ago with the object of capturing enemy trade. In these days beyond the teaching of Russian to school-children, the twelve-month old schemes for capturing the trade of the enemy are dying of inanition. We venture to think that the British public is not so easily deceived as to imagine that committees appointed by the Royal Society, at the instance of the Government, will do anything effective towards the development of industry. Assuredly the *manufacturers* and *workers* of this country are not deceived by the activity of committees so appointed. In the past, the Royal Society has contributed nothing to industrial development, nor has such contribution been expected. To many of the Fellows such considerations are sordid and commercial, and they must, therefore, be left to the man of business to tackle.

It is a curious fact that in none of the schemes proposed has any attempt been made to look at the matter from the point of view of the manufacturer; yet any scheme for the development of industry which leaves the manufacturer out of consideration must be futile and of no avail. Should any reader doubt this, let him put the question to any manufacturer of his acquaintance. The fact is that practically every industry in the country, from the technical point of view, is already organised, hence there is no need to discuss the Gilbertian situation of a society appointing itself when asked by the Government to appoint advisory boards to deal with widely different subjects. Our industries are organised in so far as each is formed into a society for the discussion and investigation of technical and practical problems connected with the industry. The "Trade

actions" of these several societies constitute a record of industrial research and achievement of which we have every reason to be proud. The combined efforts of these societies has had a profound effect, not only on industrial developments, but on mankind. We do not overlook their influence in the present war. We owe our safety to them no less than to our Army and Navy, and this the public would do well to remember. On the members of these vigorous societies, and on nobody else, must we rely for the future development of our industries.

Were it not for the fact that the agitation in the lay press might divorce pure and applied science, criticism could very well be ignored for the time being; but in the past the relations between the two sections have been far too strained—at times almost to the point of rupture—even within the walls of the Royal Society itself. This accounts for much of our so-called deficiency. Close co-operation between the two is the sole remedy, and such co-operation can only be secured by all the learned societies working in concert.

Elsewhere in this issue we reproduce in full an address by Prof. HENRY E. ARMSTRONG on "The Development and Control of Industry by Public Influences." With much of this we are in entire agreement, but there are certain sections to which we must take exception. We agree that learned societies must claim the right to guide Government. Likewise do we agree that unless the desire and impulse come from within, no progress will be made; but such desire must come from the manufacturer.

For the study of many of the problems connected with coal, Prof. ARMSTRONG would impose a tax upon the industry, and he would devote the proceeds entirely to research work, under competent control. In a similar way would he tax the iron industry, and, in fact, every industry in which the maintenance of a research department is necessary. One part of the tax would be applied to the upkeep of proper works laboratories, another part to the development of research work in places of higher instruction. In cases in which the industry was alive to its own interests and maintained a proper scientific establishment, Prof. ARMSTRONG would make due allowance, and the contribution exacted would only be that required for public purposes in support of technical education.

In this section of his able address it seems to us that Prof. ARMSTRONG is less sure of his ground than in the other sections, and we much doubt the value of the suggestions. No industry in the country is worked on sounder commercial lines than that of coal mining. Is it for this reason that he would impose a tax upon the industry? The study of many of the problems connected with coal is neither of interest nor value to the coal-owner. The industries in greatest need of protection are those which, in normal times, are just able to keep going. We have many such industries. The immediate result of imposing a tax on these industries would be to wipe them out.

In practice every member of a community derives some benefit from industrial development and consequent prosperity. Every member of the community must, therefore, contribute according to his means to ensure such prosperity. There is nothing novel in the suggestion. Not without complaint we already pay taxes for services of which we never avail ourselves, and which are of no use to many of us. We pay because we are a law-abiding people. In the same way we should grumble at a tax imposed for the purpose of conducting industrial research, particularly if we derived no direct benefit from the results of such research—but we should pay.

The problem is one of many difficulties and the principles involved are complex. Our position as a commercial nation has been, and is, unique. We owe it to our captains of industry and to our workers, and with every confidence we look to them for a solution. In the words of CARLYLE:—

> It is to you, ye Workers, who do already work, and are ready to work, noble and honourable in a sort, that the whole world calls for new work and nobleness. Subdue mutiny, discord, wide-spread despair, by manfulness, justice, mercy and wisdom. Chaos is dark, deep as Hell; let light be, and there is instead a green flowery World. O, it is great, and there is no other greatness. To make some nook of God's Creation a little fruitfuler, better, more worthy of God; to make some human hearts a little wiser, manfuler, happier,—more blessed, less accursed! It is work for a God. Sooty Hell of mutiny and savagery and despair can, by man's energy, be made a kind of Heaven; cleared of its soot, of its mutiny, of its need to mutiny; the everlasting arch of Heaven's azure overspanning *it* too, and its cunning mechanisms and tall chimney-steeples, as a birth of Heaven; God and all men looking on it well pleased.
>
> Unstained by wasteful deformities, by wasted tears or heart's-blood of men, or any defacement of the Pit, noble fruitful Labour, growing ever nobler, will come forth,—the grand sole miracle of man; whereby Man has risen from the low places of this Earth, very literally, into divine Heavens. Ploughers, Spinners, Builders; Prophets, Poets, Kings; Brindleys and Goethes, Odins and Arkwrights; all martyrs, and noble men, and gods are of one grand Host; immeasurable; marching ever forward since the Beginnings of the World. The enormous, all-conquering, flame-crowned Host, noble every soldier in it; sacred, and alone noble. Let him who is not of it hide himself; let him tremble for himself.

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Lichtmessungen mit Selen (Selenium Photometry). By Dr. W. JAENICHEN. (Nikolassee, Berlin: "Zeitschrift für Feinmechanik.") Pp. viii + 76., 22 figs., 5 plates. 3 Marks.

The various methods of employing selenium for photometric purposes are enumerated and described in sufficient detail. The methods are classified under two main divisions, in the first of which selenium is used as a standard by itself (methods of Rolls, Siemens, Giltay, Morize, Monasch, Wulf and Lucas, Torda, Hoecken, Albrecht, Nisco, Minchin and Pohlakoff), whereas the methods of the second division are null methods in which two illuminations are compared (Haub, Presser, Ruhmer, Timar). Of the former, the most promising is that of Nisco, who illuminates the selenium for half-minute intervals alternating with half-minute darkness. This kind of exposure works quantitatively in faint illuminations, the amplitude being simply proportional to the illumination, whereas the final increase of conductivity is proportional to its square root. Thus the errors due to the previous history of the selenium are eliminated, as an equilibrium between photo-ionisation and recombination of ions is soon attained.

But for ordinary photometry it is necessary to eliminate the lag in the light action altogether, and this is best done by one of the many methods devised by Presser. In the best of these a lens with one-half blacked off is rotated about its optical axis in front of two plates of parallel surfaces, each illuminated by one of the sources to be compared. The selenium is thus exposed to the two sources alternately, and in such a manner that the transition is quite gradual. If the two sources give

equal illumination, a galvanometer placed in circuit with the selenium and a battery shows no variation. The author himself adopts a modification of this method, and alternates his exposures at intervals ranging from 2 to 12 seconds. He thus obtains errors of the order of $\frac{1}{2}$ per cent., which is about the limit of the best visual methods. But this assumes that the colour of the two sources is the same within those limits. Since most selenium bridges and selenium cells have a pronounced maximum of sensitiveness in the extreme visible red, and their sensitiveness falls to about one-tenth in the greenish-blue, it is impossible to compare coloured sources without taking the spectrum to pieces and integrating the luminosity afterwards. This, it may be admitted, is also the only device which is ultimately effective, even in visual photometry. Something also could be done by devising coloured screens to compensate the predilection of selenium for seeing red. It is doubtful whether selenium can be usefully employed in practice for comparing coloured sources. It would be better worth while to develop its extreme sensitiveness, which is capable of appreciating differences of illumination as small as $\frac{1}{1000}$ per cent., whereas the eye has to be content with $\frac{1}{2}$ per cent.

E. E. Fournier d'Albe.

Text-Book on Wireless Telegraphy. By Rupert Stanley. London: Longmans, Green & Co.). Pp. xi.–344. 7s. 6d. net.

This book does not lay claim to meet the wants of advanced students, but rather of "those attending classes with the intention of becoming wireless operators," and of those "many amateurs who are quite expert in the ordinary manipulation of radio apparatus," but who "do not understand the fundamental principles." But the book professes, as the preface more or less explicitly states, and the text frequently implies, to be a scientific work educating the student in fundamental principles rather than a mere rule-of-thumb manual.

Now, the reader of a book which makes these claims, and which has the size and cost of the present volume, is entitled to expect a more or less scholarly treatise in which the theory, however elementary, of the subject is set forth consecutively, consistently and logically. Whether the author is or is not quite in touch with the commercial practice of the art—and of few professional teachers could this be expected—is relatively unimportant; for commercial applications, after indicating the directions in which theoretical discussions should go, should provide illustrations to the lessons rather than constitute their main theme.

The present volume suffers from lack of perspective in practical matters, but more especially does it fall short of the standard one must demand of a text-book of elementary science. This is the more regrettable in that the author intends the book to cover an initial course in general electricity as well as wireless in particular, because, he says, there is at present no satisfactory elementary text-book on electricity and magnetism which he can recommend to students of wireless.

Of the first 70 pages, which contain the whole of the introduction to electricity and magnetism in general, nothing need be said, except that it appears to us quite hopeless to expect a student to obtain from them anything like an adequate initiation.

The treatment of wireless proper begins with Chapter VIII. (p. 75), on "Oscillatory Discharges." The remaining 12 chapters need not be enumerated. In none of them is to be found any [illegible] or treatment of [illegible] point of view. Never, indeed, have we read a less inspiring work of the kind. The binding, paper, printing, diagrams and index are all [illegible] the questions at the end of each chapter are a [illegible] In these circumstances the reviewer's task is an unpleasant one. The book is full of obscure phrasing, of inaccuracies, errors, even contradictions, and it is hard to make a selection for profitable detailed criticism.

Throughout the book references to quenched and unquenched [illegible] systematically interwoven, and thus [illegible] the essential [illegible] on [illegible] a complete [illegible] 70 per cent. [illegible] apparently [illegible] quenched [illegible]

The value of the Marconi synchronous discharger is not properly estimated. Quenching by enlargement of the gap is attributed to it even at short wave-lengths such as 600 metres; but a calculation of the duration of a wave-train—which is, in fact, made in the book—will show that such action cannot take place. Control of the phase-instant of sparking, which is its chief virtue, at any rate with short waves, is hardly mentioned. On the other hand, the redundant overstatement, under seven heads, of the virtues of the quenched-spark system reminds one of advertisements of the type of "twice the value at half the cost." Nevertheless, the quenched gap does not receive fair treatment. Its function is not to introduce high resistance into the spark circuit, but to *go out* at the first opportunity. The author unconsciously and wrongly condemns it when he says: "The energy given to the aerial circuit . . . . may be the largest damping effect in the primary circuit, except where quenched spark gaps are used."

We may help the student-reader by telling him that there must be *some* capacity across the telephones in a crystal receiver, whether it is added externally or merely contained in the windings; that the high-frequency pulses do *not*, as is stated to be the case with continuous waves, pass through the telephones; that the function of the telephone condenser is *not* to suppress disturbances due to harmonics in the ether waves; that the separation of some Marconi sending and receiving stations is *not* on account of their high power, but to permit duplex working; and that direct or conductive coupling is *not* the same thing as "plain aerial," and is *not* forbidden by the British Post Office.

The treatment of Poulsen and Goldschmidt apparatus is particularly unsatisfactory. As expounded, Goldschmidt's tone wheel obviously would not work; and Pedersen's high-speed transmitter might be an ordinary Wheatstone.

On page 148 a wild formula is derived for radiated energy, the effective current in the spark circuit being taken as $1/\sqrt{2}$ times the maximum current.

Slight misprints occur on pages 34, 236, 259, 324 and 337, and the following proper names are misspelled: Round, Wien, Norddeich, Kiebitz, Scheveningen. The wireless Society of London is referred to as the London Radio-telegraphic Society, and the Advisory Committee on Wireless Telegraphy (1913) by three different and inaccurate titles. L. B. T.

SOME DETAILS OF THE DIRECTION FINDER.

BY E. BELLINI, D.SC.

In The Electrician, Feb. 28, 1908, was published the description of the Bellini-Tosi radiogoniometer. This instrument is essentially formed of two equal windings at right angles, each connected to a Brown or Blondel directive aerial situated in the same vertical plane. The aerials, as well as the windings, are one inside the other as two meridians of the earth. A third coil, placed in the centre of these windings (exploring or movable coil) can be turned round about the polar axis, and is connected to the oscillation generating or receiving apparatus. The receiving radiogoniometer, the aerials and the accessory apparatus allow one to determine the direction of a wireless transmitting station, hence the simpler and more comprehensive name of "Direction Finder."

It is easy to demonstrate that, for small aerials, if the reaction of the movable coil upon the fixed coils is negligible, the direction of the transmitting station coincides with the direction of the exploring coil giving the maximum intensity of reception. As the maximum is not sharp enough to allow exact bearings to be taken, the maximum must be found as the mean of the two limit directions of the exploring coil, beyond which the reception ceases.

The apparatus was largely experimented both on land or at sea with satisfactory results, especially when the apparatus was installed in coast stations. The most important application of it is to ships, to enable them to find the directions of coast stations and so to make their way in foggy weather. The

commercial organisation that Capt. Tosi and myself had thought to give to the direction finder consisted in installing some special sending stations (radiophares) in some convenient points of the shore, the wave-length radiated by them being of 100 metres. In this case each of the directive aerials had to be of the type shown in Fig. 1. Wooden and iron frames were required to hold the four harps.

At the beginning of the year 1912 the Marconi Company took over the enterprise of the direction finder. The ideas upon the commercial organisation of it changed, and, consequently, the apparatus was modified in some details. The aim of this article is to make them known.

The Marconi Company thought that the use of the 100 metres wave-length presented difficulties from the commercial point of view. First, it was necessary to instal and to work the "radiophares," which would necessitate an expense in installation and in handling that most States would not accept; secondly, it was necessary to instal on board of the ships, for their reciprocal direction finding, sending stations radiating the same wave of 100 metres, whence there would be supplementary charges for the shipping companies.

The Marconi Company estimated that it was more convenient to give to the syntonising devices of the direction finder such an amplitude that the commercial waves of 300 and 600 metres could be received. So, all the existing shore and ship stations became immediately available for the use of the direction finder and no special transmitting stations, either on the coast or on the ships, except in exceptional cases, were required. In these exceptional cases the "radiophares" could conveniently radiate a wave-length of 450 metres.

This solution had from another point of view a considerable advantage on the constitution of the directive aerials. As a matter of fact, as the aerials on board must have limited dimensions, closed-top aerials, as Capt. Tosi and myself had already used,* were more favourable than aerials open at the top, and, moreover, the former do not require to be multiple, but they can equally well be formed of only one wire. All the aerial installation on board was therefore reduced to four wires suspended to a special porcelain insulator and stretched so as to form the edges of a pyramid with a square base. The aerial installation became therefore of a primitive simplicity and did no harm to the esthetics of the ship.

The tuning appliances were accordingly changed with the change of aerial. Fig. 2 shows the arrangement for one of the directive aerials. At the middle point of the fixed coil BB is inserted the variable tuning condenser C.

The chief difficulty of the condenser synchronisation was found in the construction of the two condensers. These must practically have the same capacity, especially in the case of low damped waves. If the condensers are not equal, the phases of the currents in the two aerials and connected fixed coils do not coincide, and the ratio of their intensities is not what it should be. Hence, inside the fixed coils an elliptical rotating field is obtained, instead of an alternating field of constant direction. The reception takes place, more or less, for every position of the exploring coil; the determination of the direction of the sending station is, therefore, uncertain and the errors can consequently be large. Moreover, the two condensers must be acted upon at the same time, by turning only one handle. Good results were obtained using condensers of the plane sliding plate type.

The Coupling of the Circuits.—It has been observed for a long time that the coupling of the directive aerials with the detector circuit had a certain influence upon the exactness of the bearings given by the direction finder. This influence was small in the case of open-top aerials, but with closed-top aerials the influence of coupling is much more important. In this last case, the error in the bearings can be large if the coupling is too close.

Experiments were, therefore, made to find the condition giving satisfactory results. For this purpose, reception diagrams were taken using the Round potentiometer method.

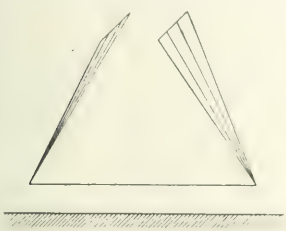


Fig. 1.

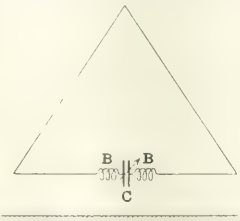


Fig. 2.

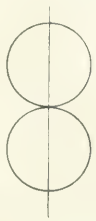


Fig. 3.

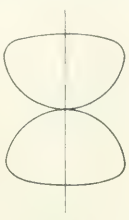


Fig. 4.

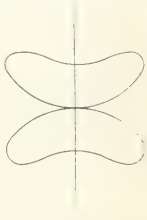


Fig. 5.

Diagrams obtained with only one directive aerial connected are shown in Figs. 3 to 5, the degree of coupling rising from the first to the last.

These diagrams show that, when the coupling is not closer than a certain value, the diagram of the intensity of the current is normal, viz., it is formed by two tangent circles (Fig. 3), if the coupling is too close, the diagram is formed by two tangent flat curves (Fig. 4), and if the coupling is excessively close, the diagram is formed by two tangent curves of the form of a crescent (Fig. 5).

This result is easy to explain, as it is known that, for certain waves, primary and secondary decrements, a most favourable degree of coupling exists, and that the intensity of the current in the secondary circuit varies according to linear law only for loose couplings.*

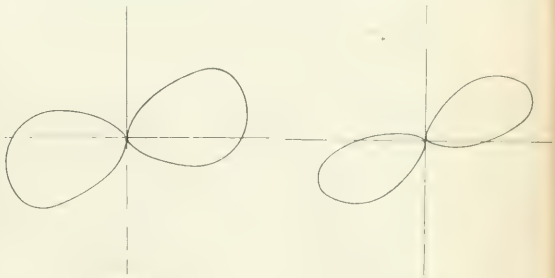


Fig. 6.

Fig. 7.

The experiments with both directive aerials showed changes in the forms of the diagrams of the same kind, though less accentuated; but, what is far more important for the exactness of the bearings, the diagrams were more or less distorted, according to the direction of the sending station (Figs. 6 and 7). This distortion is bound to produce changes in the bearings according to the sensitiveness of the detector. Table I. shows

Table I.

Angular width of the zone of reception.										
79°	81°	105°	110°	111°	123°	126°	135°	136°	165°	168°	169°	170°
Bearings.										
68°30′	69°30′	67°30′	71°	70° 30′	71°30′	73°	74°30′	75°	78°30′	79°	79°30′	80°

* The Electrician, loc. cit.

* Fleming, "The Principles of Electric Wave Telegraphy," 1st edition, p. 232.

that this is so. The first row of figures shows the values of the angular width of the zone of reception, which grows with the sensitiveness of the detector; this sensitiveness was changed by varying the adjustment of the potentiometer of the detector. The second row shows the bearings indicated by the apparatus; these vary by 11° 30′, which is inadmissible.

The construction of the direction finder was, therefore, modified in its dimensions so as to give good results for all the waves and for all aerials met with in practice.

The Connecting Wires.—In the ship installations of the direction finder it is sometimes difficult to find room for the aerials and the radiogoniometer. It would, therefore, be convenient to be able to place the radiogoniometer far from the aerials if necessary. Experiments were made to ascertain if this was possible.

These experiments were made between two land stations. The transmitting station, of the Marconi type, could radiate waves of either 300 or 600 metres. The aerial of the receiving station was formed of two triangular closed-top aerials of the following dimensions :—

Slope sides ..... 15 metres.
Horizontal sides ..... 18 metres.

The aerials were connected to the radiogoniometer by four equal wires, the lengths of which were changed.

The first set of experiments was made, using as connecting leads of each aerial stranded cables of the type used for light installations. The capacity between the two wires was of 0·00014 mfd. per metre. The Round potentiometer method was employed also in this case to obtain the diagrams of the intensity of the received current.

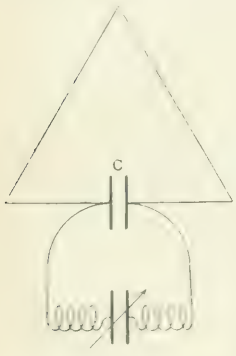


Fig. 8.

With only one directive aerial connected, the diagram was of the type of Fig. 3, when short connecting wires were employed; but it changed to the forms shown in Figs. 4 and 5, when these wires became longer and longer; a length of 50 metres gave already a diagram of the shape shown in Fig. 5.

It is possible to explain this result with the observation that the capacity C of the cable conductors forms an electric coupling between the aerial and the fixed coil of the radiogoniometer, as shown in Fig. 8. In the case of a larger value for C the coupling between the aerial circuit and the secondary circuit of the radio-goniometer being too close, bad diagrams are obtained.

The intensity of the reception diminishes when the length of the connecting wires increases. The diminution was less pronounced for 600 than for 300 metres wave length.

The second set of experiments was made, using wires far apart one from another, placed so as to form the edges of an ideal square-based prism, two opposite wires being connected to the same directive aerial. In this case, when the side of the square exceeds some centimetres, no deformation of the diagram is experienced, but the diminution of the intensity of the reception takes place. The most favorable value of the side of the square is about 50 cm. It was therefore convenient to use the [illegible] possible to the aerial installation; and, in any case, that the [illegible] be placed at the edges of a square-based [illegible]

[illegible] Fessenden [illegible] It had been remarked [illegible] they [illegible] ground by the [illegible] installed in land stations were generally more [illegible] than those used for the same apparatus placed on ships. A first explanation was found by the indirect action of the oscillations which are necessarily [illegible] It is sufficient, however, to disconnect the aerial from the earth during the observations at the direction finder to suppress this cause of error. But other causes remained which were difficult to ascertain, as it was necessary to make methodical experiments upon ships manœuvring only in view of these experiments. As this was very difficult to obtain, a long time elapsed before positive results were obtained.

These causes of error were evidently due to the presence of the metallic masses of the ship, such as masts, funnels, turrets, &c. Without entering into the details of the experiments, which present no special interest in themselves, the results obtained were the following :—

1. The metallic masses of the ship situated behind the directive aerials influence the bearings so as to shift them towards the axis of the ship. These masses act then as reflecting mirrors for the component of the bearing parallel to the axis of the ship.

2. The metallic masses situated before the directive aerials act in the opposite manner. They act, therefore, as screens for the component of the bearing parallel to the axis of the ship.

3. When the metallic masses are equal and symmetrically placed, these actions are equal.

These results show that it is possible to eliminate the influence of the metallic masses of the ship by putting the aerials at equal distance from the two classes of masses, when these are equal, or, more generally, in the centre of gravity of them, when they are not equal. As a matter of fact, all the ship installations made according to this rule have given, as far as I know, good results.

The following example of the s.s. "Eskimo," of the Wilson Line, making the service between Hull and Christiania, given in Table II., shows the exactitudes of the bearings given by a well-placed direction finder. The estimation of the centre of gravity of the metallic masses is not difficult; with a little practice one is able to obtain it with sufficient exactitude.

Table II.

Sending station.	Distance, sea miles.	Bearing given by the D.F.	Bearing given by the chart.	Difference.
Tjomo	26	33° Starboard	35° Starboard	2°
.. ..	26	33 30 ..	35° ..	−1°30′
.. ..	20	35° ..	38 30′ ..	3°30′
.. ..	20	35°30′ „	38 30′ ..	−3°
.. ..	10	43 30′ ..	43° ..	+30′
.. ..	10	41° ..	43° ..	−2°
.. ..	10	42 ..	43° ..	1
.. ..	7	42 30 ..	43° ..	−30′
.. ..	7	48 ..	50° ..	−2°
.. ..	7	46° ..	50° ..	−4°
.. ..	7	48° ..	50° ..	−2°
.. ..	55	177°30′ „	177°30′ „	0
Gothenburg	130	41 30 ..	39° ..	+2°30′
.. ..	130	41° ..	39° ..	+2°
.. ..	130	40 30′ ..	39 ..	+1 30
.. ..	130	41 30′ ..	39° ..	+2°30′
Flekkerö	44	12 30 ..	12°30′ „	0
.. ..	33	20 ..	23° ..	−3°
.. ..	33	21 30′ „	23° ..	−1°30′
.. ..	33	20 ..	23° ..	−3°
S.S. Salmo ...	25	51 30 Port	51° Port	+30′
.. ...	25	50 30 ..	51° „	−30′

ELECTRO-CHEMISTRY AND ELECTRIC HEATING AS APPLIED TO THE METALLURGICAL INDUSTRY.*

BY DR. F. FOERSTER.

Probably half the entire output of copper that comes into the market of the world is electrolytically refined; huge workshops with multitudes of electrolytic baths are used for this sole purpose. The anodes consist of impure copper, containing about 98 or 99 per cent. of the metal, and the purest copper is deposited on the kathode. It once appeared as a fair estimate that 100,000 tons of copper are electrolytically refined every year, containing 0·2 per cent. of silver and 0·002 per cent. of gold. These are at any rate effect a saving of 800,000 kg. of silver and 8,000 kg. of gold, worth more than four millions sterling, until the method of refining copper was put in practice, the whole of this silver and gold was lost. A further

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft. 36, 1914. Paper read before the Elektrotechnische Verein.

advantage is, of course, that we obtain copper of the highest electric conductivity. The silver and gold are, moreover, very conveniently separated by electrolysis. The anode residues are melted up and treated as anodes in a weak solution of silver nitrate. The silver deposits itself in the form of loose crystals on the kathode, while the gold remains on the anode, and copper and other impurities are dissolved in the electrolyte. Finally, the gold is also refined in the same way in order to free it from small quantities of silver, and from the platinum group of metals. Other metals are similarly refined by electrolytic processes on a commercial scale. Thus, lead is separated from bismuth, and iron can be freed from sulphur, silicon and carbon.

The preparation of metals from their ores is another branch, but aqueous processes are not very common. The ores of copper and nickel can be treated till a solution of the sulphate is obtained, from which the metals can be separated, using an anode of lead peroxide. Nickel is obtained of a purity of 99·5 per cent., but there seems to be no demand for a metal of such purity. Zinc is a difficult metal to work; electrolytically, it is possible to obtain it of a purity of 99·9 per cent., but here again the demand for such a product is not great. Electrolytic processes are best known in connection with the lighter metals, but fused electrolytes are used. As anodes, carbon is almost always used; the making of these carbons has become a great industry, and there is a demand for carbons more than 1 metre in diameter. The preparation of aluminium from cryolite is, perhaps, the best known process. Since 1890, the price of this metal has sunk from 2s. 6d. to 9d. per lb.; the purity used to be between 96 and 98 per cent., now it is between 99·5 and 99·7 per cent. In 1912, 61,000 tons of aluminium were produced electrolytically, of a value of £5,000,000. Factories for this class of work are continually being extended; it is a metal which finds many applications. The firm of Heraeus has a very successful process for soldering sheets of aluminium, and a very large trade is done in this class of work for chemical works and specially for breweries. Magnesium is also obtained from the fused chloride, and the difficulties in connection with the obtaining of calcium from the fused chloride have been overcome, but there appears to be no technical demand for the latter metal. Sodium is also prepared from fused caustic soda—*i.e.*, by the very process by which Davy first prepared the alkalis. The electrolytic treatment of solutions of sodium chloride might be expected to produce sodium, but this reacts very violently on water, and thus the end-products are hydrogen and caustic soda. But Stroof at the Griesheim chemical works, builds the carbon anodes in boxes, which consist of porous plates of Portland cement; these are put in iron pans, which form the kathodes. This process is now worked on an extended scale. Besides the cement diaphragm other sorts are used, such as horizontal layers of barium sulphate, which are used successfully in the Billiter process. A slow flow of the electrolyte through the baths from the anode to the kathode allows the horizontal arrangement of the electrodes in the electrolysis of the alkaline chlorides; mercury is also used as the kathode with which the sodium forms an amalgam. It is probably a low estimate to say that 55,000 kw. is being used at the present moment for the electrolytic preparation of chlorine and the caustic alkalis. On the Continent, the old Leblanc process has almost disappeared. Chlorine plays an important part as a bleaching and disinfecting agent; and hydrogen, which is of the nature of a by-product, is usefully employed in airships. The uses of the alkalis are well known, all these products are now furnished mainly by electrolytic processes.

Electric heating has played an important part in the preparation of phosphorus. Formerly it was prepared by strongly heating a mixture of calcium phosphate and carbon in retorts from the phosphorus distills off. The yield of phosphorus is only complete in the presence of silica, but this causes the [illegible] are heated from outside, as the reaction takes place at about 1,200°C. But if the heating is effected by an electric arc, the difficulty vanishes. Germany used to buy its phosphorus from England and France, but now it supplies itself by this process, which is worked at the Griesheim factory, and there is also a considerable export trade. One might also be prepared from a mixture of zinc ores and carbon by a similar process, but there are still certain difficulties to be overcome. The preparation of some of the rarer [illegible] is now carried on in the electric furnace on a considerable scale; the furnaces usually employed for this purpose are either the Héroult arc furnace or the induction type of Rocking Electric [illegible] furnace made by Siemens, by Keller consisted of a pan lined with basic bricks, which formed the [illegible] crucible by the [illegible] were easily objectionable [illegible] by Fleming Rodenhauser furnace [illegible] Kjellin's, and has no electrodes. Thus, the risk of impurities in the [illegible] owing to the presence of carbon electrodes [illegible] the Héroult system it has been found [illegible] the risk on the score. On these plans there [illegible] gas and slag, and the same applies to sulphur and phosphorus; a product of definite composition is possible on a commercial scale. Furnaces holding as much as 25 tons are now at work, turning out a product of excellent quality. Very important, too, are alloys, such as ferro-silicon, ferro-chromium, ferro-tungsten and ferro-vanadium, which require a higher temperature than can be produced in a blast furnace; all these are much used in the preparation of certain kinds of steel. Tantalum and tungsten are also worked into something of the nature of small ingots by electric heating, preparatory to the drawing process. Iron alloys are prepared in a furnace, which may be roughly described as having two carbon electrodes, of which the upper is movable, and is raised as the fused metal collects. An arc passes at a voltage between 50 and 80, the current amounting to thousands of amperes. The temperature is so high that the chemical reactions take place, and the products are fused; in this way the alloys are produced. Carborundum is produced in what may be called a resistance furnace; it consists primarily in a reduction of silica by carbon, and, secondarily, in a combination of the free silicon with carbon. Quartz vessels are also prepared in a somewhat similar way. On the other hand, carborundum decomposes at high temperatures into graphite and silicon vapour; in this way, ordinary carbon, mixed with quartz, clay, or other refractory oxides, is formed into rods or plates, and then treated in a resistance furnace. The result is that a plate or rod of graphite remains, which has excellent properties for use as an anode. Work of this kind is carried out on a large scale at Niagara; long furnaces receive 1,500 kw. for 24 or 36 hours, and turn out 6½ or 7 tons of crystalline carborundum or graphite. As the work proceeds, the pressure has to be lowered from 220 to 75 volts by means of regulating the transformers. But the most important product of the arc furnace is calcium carbide. A start was made with small single-phase furnaces, taking a few hundred kilowatts; now, there are single-phase furnaces taking between 1,000 kw. and 1,200 kw., and there are other types with two or three arcs. Of these latter, the Helfenstein type is worked by three-phase current. There is a common hearth, and above it in three separate partitions are three arcs, each carrying 3,000 kw., making 9,000 kw. in all. These large furnaces are much more economical than the smaller ones. In these large units, each group of electrodes carries 30,000 to 40,000 amperes at voltages between 75 and 90. Bigger sizes than this are also at work, and since 1907 an immense amount of work has been done at Hafslund, in Norway. Carbon monoxide is produced in the reaction by which calcium carbide is formed, and the usual plan has been to allow this to pass into the atmosphere, carrying with it clouds of dust. The carbon in this way is not completely oxidised, and there is a large loss, corresponding to the heat which would be developed by the combustion of the gas. Lately, Helfenstein has done much work in the way of improving methods of working with a closed combustion space. Furnaces taking 9,000 kw. are now at work on this plan, making calcium carbide and also ferro-silicon; a trial has also been made with the ordinary blast furnace, producing pig iron. The work of Frank and Caro is developing methods by which calcium carbide is able to fix about 20 per cent. of nitrogen, and has led to a great extension of the carbide industry. At first the process was not found to be easy, but Polzenius recommended the addition of calcium chloride to the carbide, and Carlson suggested calcium fluoride; on these plans about 120,000 tons of cyanamide are made annually. Calcium cyanamide can be used directly as a manure, or in the nearly related form of ammonium sulphate. And it is interesting to note that urea, which Wöhler was the first to make synthetically, and which thus opened the way to the synthetic preparation of organic compounds, is now made quite easily out of calcium cyanamide. Serpek has worked out a process by which a mixture of alumina and carbon is heated in an atmosphere of nitrogen at a temperature between 1,600°C. and 1,800°C. A reaction takes place, the nitrogen combines with the aluminium, and the product is easily converted into ammonia. But there are still certain technical difficulties to overcome before the process can be worked commercially. The direct fixation of the nitrogen of the atmosphere by the arc, and the conversion of free nitrogen and oxygen into a nitrous oxide is a very [illegible] problem. Birkeland, in Norway, passes an alternating current are between two neighbouring horizontal electrodes, and deflects it by means of a magnet in the direction of a vertical sheet of flame, which is about 2 metres in diameter. This is surrounded by flat circular furnaces, each of which takes about 3,000 kw. at 3,500 volts. There is atmospheric [illegible] obtained containing about 1 per cent. of nitric oxide. Schönherr, at the Badische Anilin Fabrik, has worked out a process in which there are two electrodes, ranged at a considerable distance apart, one above the other, between which electric flames, 8 metres high, burn in vertical iron tubes. The air is circulated out to the length, and admitted horizontally and tangentially at the bottom of the vertical tubes,

It travels up the tubes in a sort of spiral fashion, while the axis of the tube contains an almost steady column of air and carries the current. Each of these furnaces takes 1,000 kw. at 4,000 volts; the outflowing air carries with it about 1·5 per cent. of nitrous oxides. By treatment in aqueous solutions it is possible to get a 40 per cent. nitric acid, and a basic calcium nitrate can be obtained, which is useful as manure.

DIFFERENTIAL METHOD FOR THE DETERMINATION OF LOSSES IN COILS.*

BY AUGUST HUND.

Some time ago the writer published† a Paper in which a differential method for measuring the dielectric losses in condensers was described. A differential arrangement of the same kind is also applicable to the measurement of losses in coils, not only at low frequencies‡, but also at very high frequencies. The object of this article is to point out the application of this method to such measurements.

The self-induction and effective resistance at high frequency are usually determined by the ordinary Wheatstone-bridge method, or the power loss is determined directly by tuning the circuit for resonance and measuring the current and voltage by means of a hot-wire ammeter and voltmeter respectively. At frequencies as low as 500 cycles per second such methods are to be recommended for commercial use, but at higher frequencies, particularly when the voltage is over 100, the reading of the hot-wire voltmeter may be very inaccurate. For instance, at frequencies of from 50,000 to 100,000 cycles per second it sometimes happens that the readings are inaccurate to such an extent that the power-factor calculated from these readings is greater than unity. For very high-frequency measurements, when the voltage is over 100, it is usually more advisable to calculate the voltage from the impedance and current than to use a hot-wire voltmeter. The differential method here

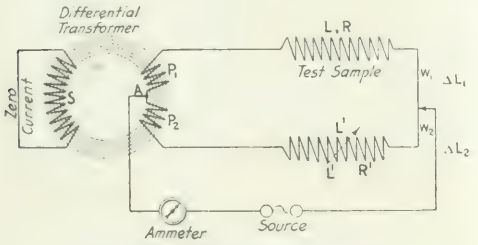


Fig. 1. Test Circuit Arrangement.

described overcomes these difficulties and gives a simple as well as an accurate means of measuring both the effective resistance and the effective inductance.

Principle of the Differential Method. The principle of the method may be readily understood from the diagram shown in Fig. 1. The differential transformer consists of two equal primary coils, P_1 and P_2, wound in opposite directions and symmetrically placed with reference to the secondary coil S. When the currents in the two coils are equal in effective value and are in phase, their inductive effects on the secondary coil will exactly neutralise each other, and no voltage will be induced in the secondary. Any kind of alternating-current detector connected across the terminals of the secondary will then give a [illegible] when the currents in P_1 and P_2 are equal and in phase.

With the connections shown and the currents in P_1 and P_2 equal and in phase, the total resistance of P_1, the test sample, and the resistance w_1 must be equal to the total resistance of P_2, the reference coil, and the resistance w_2, and the self-inductions of these two [illegible]. The resistances w_1 and w_2 are formed by a short length of non-magnetic high-resistance wire, and the [illegible] being zero. By altering the self-induction of the reference coil and [illegible] the contact B, the condition of no current in the secondary coil may be established. For this adjust-

[illegible]

$$R + w_2 = R' + w_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

* Read before the Faraday Society.

† A. Hund, "The Measurement of Dielectric Losses," ELECTRICIAN, Vol. 73, No. 8, 1914; also Hund, "Dielectric Losses in Condensers," Jahrbuch der drahtlosen Telegraphie und Telephonie, No. 4, page 61, Berlin, 1911; Verhandlungen der Deutschen Physikalischen Gesellschaft, 1910.

Similarly for the inductances,

$$L - \Delta L_1 \quad L' - \Delta L_2$$

or

$$L = L'\left(1 + \frac{\Delta L_2 - \Delta L_1}{L'}\right) \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The self-induction of the short high-resistance wire will usually be small compared with that of the test sample, and therefore to a first approximation $\Delta L_2 - \Delta L_1$ may be neglected, in comparison with L', in which case $L = L'$.

It is to be noted that the difference of the resistances is not affected by inductive effects of the resistances w_1 and w_2. This is a decided advantage of the differential method, in comparison with the usual bridge arrangements, where inductive effects of the resistances introduce considerable errors.

The skin effect in an ordinary variable inductance coil is appreciable at high frequencies, and consequently the resistance R′ will depend on the frequency, unless a specially designed variable inductance is used. This difficulty may be avoided by using the arrangement of Fig. 2. The currents in the two branches of the parallel circuit can then be brought into phase by adjusting this capacity to such a value C that

$$\omega^2 LC = 1. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where ω is 2π times the impressed frequency. To make the currents equal in effective value, the relation between R and R′ will then be the same as before, viz.,

$$R \quad R' + w_2 - w_1. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Equation (3) gives the value of L in terms of C when the frequency is known, but when the frequency cannot be measured accurately L may be determined by using the connections shown in Fig. 2. The non-inductive resistance in series with condenser is made equal to the resistance R of the test sample, previously determined by the method just described, and the capacity C is kept at the same value as before.

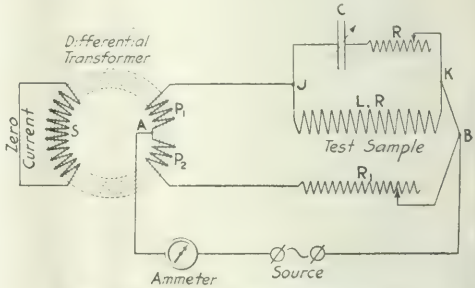


Fig. 2.—Modified Circuit Arrangement.

so that equation (3) still holds. Under these conditions the parall circuit from J to K is in resonance with the impressed frequency, a therefore this circuit as a whole is non-inductive, having an equivale resistance R_1 such that

$$\frac{1}{R_1} \quad \frac{R}{R_2 + (\omega L_2)^2} + \frac{R}{R^2 + \frac{1}{(\omega C)}} \quad \frac{2R}{R_2 + (\omega L)^2}$$

Hence

$$R_1 \quad \left(R + \frac{(\omega L)^2}{R}\right)/2$$

$$\left(R + \frac{L}{RC}\right)/2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad .$$

For no current in the secondary the resistance in series with [illegible] primary P_2 must then be made equal to this value, and the value [illegible] L is then, from equation (3),

$$L \quad RC(2R_1 - R). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad .$$

After having determined L from equation (6) the frequency f [illegible] then be calculated from equation (3), viz.,

$$f = 1/2\pi\sqrt{(LC)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad .$$

No Current Detector. For frequencies between 500 and 2,000 cy per second a telephone receiver is the simplest and most depend indicator. When the test sample has an iron core, the wave for the currents in the two primaries will not be the same, and co quently absolute silence in the telephone cannot be obtained. U such conditions it is advantageous to insert a condenser in s with the receiver and the secondary and tune this circuit for re ance with the fundamental frequency. When a vibration galv meter is available it may be used as a current detector and

condenser may be dispensed with. When large currents can be used in the test sample and parallel circuit an ordinary thermocouple connected to a galvanometer may be used, although a thermo-cross-bridge* will be found preferable.

It is of interest to note that maximum sensitiveness is obtained when the secondary of the differential transformer is so designed that its total reactance ωL_2 (measured with the primary coils open) is equal to the impedance $\sqrt{\{(R+r_2)^2+\omega^2L^2\}}$, where R is the resistance of the no-current indicator, L the inductance of the no-current indicator, and r_2 the resistance of the secondary coil. This may be proved as follows: The two primary coils may be treated as a single coil carrying the differential current $i=i_1-i_1'$, where i_1 and i_1' are the currents in the two primary coils. This current will induce in the secondary coil an E.M.F. equal to $-\frac{Mdi}{dt}$, where M is the coefficient of mutual induction between one primary coil and the secondary coil. The effective value of the induced secondary E.M.F. is then $E_2=\omega MI$, where I is the effective value of the differential current I, and ω is 2π times the frequency. The secondary current is then

$$I_2=\frac{\omega MI}{\sqrt{\{(R+r_2)^2+\omega^2(L+L_2)^2\}}}.$$

If there is no magnetic leakage, the mutual induction, M, is directly proportional to the secondary turns, and the self-induction of the secondary coil, L_2, is proportional to the square of the secondary turns. Hence $M=k\sqrt{L_2}$, where k is a constant. Hence the expression for I_2 may be written

$$I_2=\frac{k\omega\sqrt{(L_2)}I}{\sqrt{\{(R+r_2)^2+\omega^2(L+L_2)^2\}}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

The value of L_2 which will make this a maximum is found by equating to zero the derivative of I_2 with respect to L_2, for k, ω and I constant. This gives

$$\frac{dI_2}{dL_2}=\frac{k\omega I[2\omega^2L_2(L+L_2)-(R+r_2)^2-\omega^2(L+L_2)^2]}{(R+r_2)^2+\omega^2(L+L_2)^2}=0,$$

or

$$\omega L_2=\sqrt{\{(R+r_2)^2+\omega^2L^2\}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

When the no-current indicator is non-inductive this becomes $\omega L_2=R+r_2$. When a condenser of capacity C is inserted in series with the detector the expression for the secondary current is

$$I_2=\frac{k\omega\sqrt{(L_2)}I}{\sqrt{\left[(R+r_2)^2+\left(\omega(L+L_2)-\frac{1}{\omega C}\right)^2\right]}} \quad . \quad . \quad . \quad (10)$$

When the capacity of the condenser is adjusted for resonance with $(L+L_2)$ the second term under the radical in the denominator becomes zero, and the maximum value of I_2 is then obtained when L_2 is made as large as possible.

Construction of the Differential Transformer.—Three differential transformers for measurements with frequencies of from 50 cycles to 2,500 cycles per second have been constructed by the writer. In one the iron core was built up with fine soft iron wire in the form of a toroid. The dimensions are shown in Fig. 3. Before winding the coils the iron core was thoroughly insulated. Three layers of enamelled copper wire (0·15 mm. diameter) were then wound on it, each layer being insulated from the next by parattined paper. Each layer had 1,293 turns. The total length of the wire in the secondary coil was 147 metres, giving an ohmic resistance of approximately 9 ohms. The last layer was insulated with tape, and upon it were wound 154 turns of enamelled wire strand (four wires per strand, each 0·35 mm. diameter), this strand forming the two primary coils. The total length of the strand was 7·775 m, each wire having a resistance of 1·2 ohms. The other two differential transformers were of similar design, but with ratios of 1:4 and 1:8 respectively.

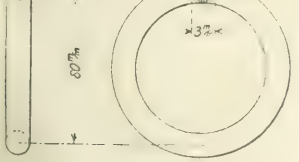


FIG. 3.—TRANSFORMER CONE.

For measurements at high frequencies, such as are used in wireless work, an air transformer was used. In order to keep down the losses of the transformer only six turns, wound on a wooden core, were used for each primary coil, the diameter of the wire being approximately 0·15 mm. For the secondary coil nine turns were chosen, although it is usually advisable to use the number required for maximum sensitiveness, according to formula (9).

Applications.—The differential method above described has been used by the writer to measure the variation with frequency of the resistance and inductance of a choke coil, for frequencies ranging from 588 cycles to 1,845 cycles per second and for currents ranging from 0·205 amperes to 0·737 amperes. For this purpose the iron-core differential transformer was used.

The differential method was also used to compare the high-frequency resistance of a woven copper strand, a copper strap built up of thin ribbons and a solid copper strap. These tests were made for wave-lengths ranging from 320 m. to 1,825 m., and at a current of 0·5 amperes.

THE MAGNETIC BEHAVIOUR OF IRON UNDER ALTERNATING MAGNETISATION OF SINUSOIDAL WAVE-FORM.*

BY N. W. MCLACHLAN, B.SC.

When iron is subjected to alternating magnetisation which produces a sine wave of E.M.F. in the electric circuit the value of the flux density, for a given value of the true magnetising current, is the same as that obtained ballistically (with an equal magnetising current which produces a static field), provided that the electromagnetic action of eddy currents is negligible. For frequencies of 50 periods per second or less this holds good when the iron consists of thin sheets, such as are used in modern transformer construction—*e.g.*, "Stalloy."

The present Paper gives the results of an investigation when the magnetisation of the iron was effected by an alternating current of sinusoidal wave-form. The brand of iron under test was "Lohys" (mild steel), supplied by Messrs. Joseph Sankey & Sons.

Two cases were investigated:—

1. A core composed of strips bent to a circular shape round a former, being held in place by an endless spiral spring. The strips were first cut to length approximately and then shellaced. When the shellac was dry each strip was cut so that the ends butted together as nearly as possible, the joint being situated at approximately equal angular intervals round the core. Thus, from the magnetic standpoint, the joints were equivalent to lap joints. The bending of the strips produced a large permanent set, causing a stress in the fibres near the skin of the strip, considerably in excess of the stress at the

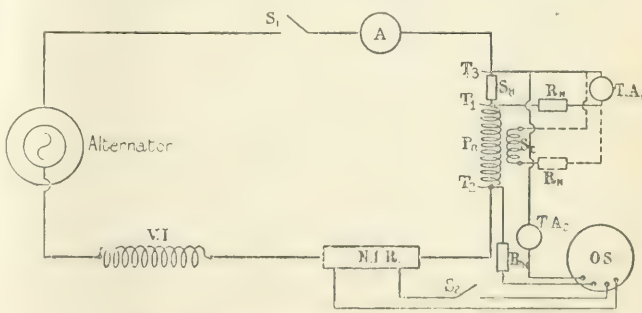


FIG. 1.—ARRANGEMENT OF CIRCUIT FOR OBTAINING OSCILLOGRAMS FROM THE PRIMARY OF A TEST RING.

A = Hot-wire ammeter.
N.I.R. = Non-inductive resistance.
V.I = Voltmeter.
S = Switch.
Sw = Switch.
Sh = Shunt.
P1 = Primary coil.
O.S. = High-frequency oscillograph.
Rh = Non-inductive resistance boxes.
T.A1 and T.A2 = Thermoammeters.

* A. Hund, THE ELECTRICIAN, p. 458, Jan. 8, 1915; Duns, "Karlsruhe"; "General Electric Review," October, 1915; "Electrical World," Jan. 30, 1915; "Arbeiten aus dem Elektr. Institut Karlsruhe," Vol. III.

* Abstract of Paper published in the "Journal" of the Institution of Electrical Engineers.

"yield point." Tests were made on a core of this form to ascertain what effect the bending of the iron had on its magnetic qualities.

2. A core composed of complete discs of almost the same thickness [illegible]. The rough edges resulting from the stamping out were removed, and [illegible] shellac.

Full details of the rings are given in the original Paper. In ring 1 the number of strips was 23, cross-section of core 0·76 sq. cm., mean diameter 10·1 cm. In ring 2 the number of discs was 28, cross-section 0·962 sq. cm., mean diameter 9·21 cm. The B-H curve for static fields was then determined ballistically by the method of reversal.

A sine wave of current was obtained by using the circuit shown in Fig. 1. The alternator was designed to give a sine wave of E.M.F. *within* 5 per cent. up to a load of 10 amperes,* inductive or non-inductive. This being so, it was possible to obtain a sine wave of current by putting a large variable inductance in series with the primary of one of the test rings, each of which was designed to have a comparatively small inductance even at high flux densities.

In measuring the magnetising current† the energy component due to hysteresis and eddy currents was included, because the author had not an instrument which would indicate such low powers as those absorbed by the test rings. For the range of values of B used in the experiments the energy loss does not [illegible] alteration.

Method of Obtaining the Maximum Flux Density (B_{max}).

The R.M.S. voltage on the terminals of the secondary of a test ring is given by the expression

$$V_{R.M.S.} = 4f_m B_{max} a f n \times 10^{-8}, \quad \ldots \quad (1)$$

where

f_m = the form factor of the voltage wave, $\left(\frac{\text{R.M.S. value}}{\text{Mean value}}\right)$.

a = cross-sectional area of iron core,
f = frequency in periods per second, and
n = number of turns on secondary of test ring.

Since a and n are fixed, it is essential to know the values of $V_{R.M.S.}$ and f_m in order to determine B_{max} for a given supply frequency.

To measure the R.M.S. value of the voltage, a thermo-ammeter and a non-inductive resistance box were connected in series with the secondary of a test ring, as shown by the dotted connections in Fig. 1. The form factor was found by using a Duddell high-frequency oscillograph having a free period of 1/10,000 second. From the records so obtained prints were taken after development, the voltage wave being carefully pricked off on accurate squared paper and enlarged several times full size. B_{max} was then calculated by substituting for the various quantities in equation (2).

The oscillograms of voltage wave-form for the smallest value of [illegible] could not be [illegible] in these cases the secondary voltage was insufficient to give a suitable amplitude. The error introduced by IR pressure drop is of no account, for the reactance of a coil (for the values of the current now under consideration) is more than 20 times its resistance (including Sh).

[illegible] grams from the primary of a test ring. The ammeter A does not read the apparent magnetising current, but the total current through the circuit—*i.e.*, the vector sum of the apparent magnetising current and the current taken by the oscillograph. When dealing with [illegible] be taken into account. It must also be borne in mind that, in [illegible] currents are different. Another complication arises as the outcome [illegible] two components, different in phase and in wave-form. These com- [illegible] the oscillograph is not the apparent magnetising current in either

In order to determine the value of the apparent magnetising current a non-inductive manganin shunt of 1/9 international ohm [illegible]

When $T.A_1$ had been read it was disconnected from T_1T_3, and put in the secondary circuit to ascertain the pressure drop. This was the drop due to the apparent magnetising current, the wave-form of which was not, as stated previously, a pure sine curve. In order to find whether the shape of the wave affected the R.M.S. voltage materially, the oscillograph was disconnected and the pressure-drop measured by $T.A_1$ when a sine wave of current was sent through the circuit equal in value to that passing through the primary at the time the oscillograms were taken. The difference in voltage was found to be between 2 and 3 per cent., being larger when the current was [illegible].

Results of Experiments.

When the magnetisation is produced by a steady current the flux density in the iron, for the same value of H, is greater when the core consists of complete discs free from mechanical stress due to bending

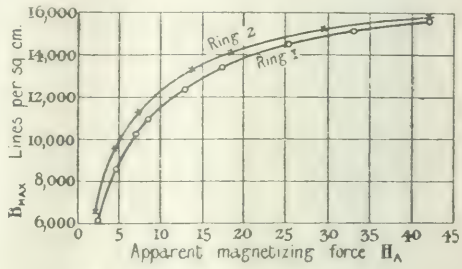


Fig. 2.—B-H Curves for Strip Rings.

than when the core is built up of strips, the ends of which butt together. The diminution in flux density is to be attributed chiefly to the small air-gaps at the extremities of the strips. This statement also holds good when the magnetisation is due to an alternating current of sinusoidal wave-form. The difference in flux density is most marked when the apparent magnetising force is small, but for large values the difference is slight (*see* Fig. 3.).

In order to demonstrate that the hysteresis loss affects the apparent magnetising current at low inductions, the following experiment was carried out: A sine wave of current (measured by the thermo ammeter $T.A_2$) was sent through the primary of each ring in turn. This wave consisted of two components at 90 deg.—viz., the true magnetising current and the energy current—the latter balancing

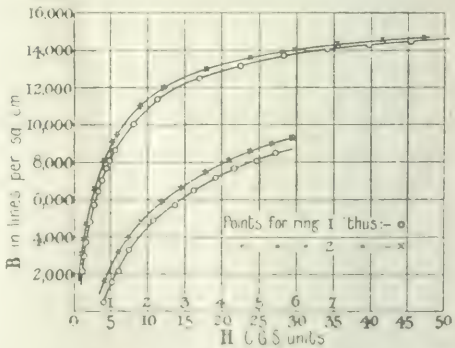


Fig. 3.—B-H Curves for Annular Rings.

[illegible] low inductions in such thin sheets are very small. Owing to the shap[illegible]

f=50 *Periods per Second.*

No. of ring.	H_{max} apparent.	B_{max}	
		Static (apparent).	Alternating.
2	0·84	1,600	1,420
2	0·61	520	690
1	0·83	570	740

B_{max} for alternating magnetisation. Using the figure of loss as ven in Messrs. Sankey's curves, it was found that the same mag- tising current produced a larger flux density than the corresponding g steady current. The last two sets of readings show that a point s been reached at which the hysteresis loss does not affect the parent magnetising current sufficiently to cause an apparent minution in $B_{max.}$ for alternating fields. This is due to the fact that e value of H to produce a certain value of B is comparatively large the neighbourhood of the point of inflection of the B-H curve ving to small permeability). Thus the value of B being com- ratively small, a correspondingly small energy current is required. This phenomenon is exhibited by both cores at all the flux sities attained in the tests. The increase in flux density due to ernating-current magnetisation would be still greater if the energy nponent of the current had been subtracted, for this would have minished H, and therefore B_s, too. An inspection of Figs. 2 and hows that the relationship between the B-H curves for static ds is very similar to that for alternating fields.

n both cases the R.M.S. voltage plotted against $B_{max.}$ yields a ve which is concave upwards. These curves are almost coinci- t, showing that the R.M.S. voltage has not been affected by chanical stress due to bending. It is shown that between certain its the form factor may be expressed in terms of the maximum density.

t became evident from an inspection of the oscillograms that for values of B the form factor is augmented by hysteresis, and for values of B by hysteresis and eddy currents, especially the latter. form factor for the same value of $B_{max.}$ is very similar for rings 1 2. For large values of $B_{max.}$ the form factor for ring 2 is somewhat er than for ring 1, owing in all probability to increased eddy- ent effect brought about by the difference in the thickness of plates, as the plates in ring 2 are 9 per cent. thicker than those in 1. There is an increase in the R.M.S. and maximum voltages the same quantities obtained when the magnetising current uces a sine wave of voltage. Curiously enough the *voltage* wave er the type of magnetising current used in the present experi- ts is somewhat similar in shape to the *current* wave when the age is sinusoidal. An inspection of oscillograms of current e-form producing a sine E.M.F. shows that when the voltage is ne neighbourhood of its maximum value* the rate of change of current ($di/d\theta$) is small compared with that when the current is soidal, and vice versa. Thus, the value of dB/dH being almost same for both modes of magnetisation, it follows a priori that $\frac{di}{d\theta}$ is larger when the current wave is a sine curve. Hence voltage wave is peaked, and its R.M.S. and maximum values arger than the corresponding quantities when the voltage wave ine curve.

owever, it is peculiar to find that the value of $B_{max.}$ is greater sinusoidal magnetising current than for the corresponding ly current. Analyses of voltage wave-forms indicate the nce of higher harmonics which are absent, or at least of little rtance, when the voltage is sinusoidal. The phase displace- s and frequencies of these harmonics may be such that they is to augment the value of $B_{max.}$ and give rise to larger values e form factor and R.M.S. voltage.

om oscillograms showing the voltage wave-forms corresponding rious flux densities it appeared that, at low flux densities, the mum voltage is shifted backward due to hysteresis. The [illegible] symmetrical about a vertical axis through the [illegible] When the flux density is [illegible] the maximum [illegible] the centre of the half wave length, the [illegible] symmetrical about a vertical axis through the [illegible] each half wave has two points of inflection [illegible] when the voltage passes through zero, and [illegible] These occur till when the voltage is small [illegible] is large.

[illegible] the shape of the current wave depended [illegible] the voltage wave to the secondary dropped to [illegible]

ne tests were also carried out at higher frequencies up to [illegible]

* I.e. [illegible]

EDUCATIONAL NOTES.

University of Bristol.—The Session in the Faculty of Engineering will commence on Sept. 14 and in the Faculties of Arts, Science and Medicine on Oct. 1. There are complete courses of instruction in civil, mechanical, electrical and automobile engineering. There are well-equipped laboratories and good facilities for practical and research work. Prospectuses and full particulars may be obtained from the Registrar, Mr. James Rafter, M.A.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

Heriot Watt College, Edinburgh.—This college provides theoretical and practical training for mechanical, electrical and mining engineers, chemists, &c. There are complete courses of instruction, extending over four years, for those who are studying for the fellowship of the Institute of Chemistry. An entrance bursary of £25 per annum is offered for competition on Sept. 20. Particulars of courses, fees, &c., from the Clerk (Mr. R. Macnaughton, S.S.C.), Heriot Trust Office, Edinburgh.

Northampton Polytechnic Institute.—The session 1915-16 will commence on October 4 next. In the engineering day college there are full-day courses in the theory and practice of civil, mechanical and electrical engineering.

The courses in civil and mechanical engineering include specialisation in automobile and aeronautical engineering, and those in electrical engineering include specialisation in radio-telegraphy. (These courses include periods spent in commercial workshops and extend over four years. They also prepare for the degree of B.Sc. in engineering at the University of London.) The entrance examination will take place on Sept. 28 and 29. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examination in Sept., 1915.

In technical optics there are full and part-time courses in all branches, and instruction is given in specially equipped laboratories and lecture rooms. An Aitchison scholarship (value £30) will be offered in this department at the entrance examination. Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to the principal, Dr. R. Mullineux Walmsley, St. John-street, London, E.C.

Aitchison Memorial Scholarship.—The last day for receipt of applications from candidates who desire to be examined at a local centre is Sept. 1, and for those who wish to be examined in London Sept. 15.

The scholarship is tenable at the Northampton Polytechnic Institute, Clerkenwell, E.C., and applications should be made to the hon. secretary of the trustees (Mr. H. F. Purser), 35, Charles-street, Hatton-garden, E.C.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

[illegible] at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

[illegible]

1,452 VON KANDO. Overhead conductors of electric railways.
2,424 STEPLING TELEPHONE & ELECTRIC CO. (Telephon-Fabrik Akt.-Ges. vorm J. [illegible]
3,209 GLADITZ. Manufacture of incandescent electric lamps.
3,311 VON KANDO. Protection of electric circuits against the influence of alternating current.
3,658 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckertwerke Ges.) Working or [illegible]
4,188 REICH. Electric signalling systems for burglar and fire alarms.
[illegible]
(6,513. Patent of addition not granted.)
11,261 BARTH VON BATORIEZ UND VRBINKHAZ. Machine for cutting electric bulbs for [illegible]
[illegible] electric oscillations, particularly for radio-telegraphy and [illegible]
15,539 H [illegible]
17,455 [illegible]

17,511 Crossley. Electrically-operated fastenings for railway carriage doors and the like.
17,628 Bunte & Remmler. (Firm of.) Electrical fuel suction apparatus. (2/8/13.)
17,920 Opling & Opling's Telegraph Instruments Syndicate. Telegraph circuits. (Cognate application, 23,167/14.)
18,149 Greinacher. Arc rectifier and incandescent lamps. (5/8/13.)
18,202 Sir W. G. Armstrong, Whitworth & Co. & Waddingham. Steam-motor mechanism suitable for starting electric motors.
18,353 Siemens Bros. Dynamo Works & Schupp. Starters for electric motors. (Addition to 5,514.14.)
A motor-starter arrangement for asynchronous induction motors in which the rotor short-circuiting and brush-lifting gear is electrically interlocked with the starter switch, the interlocking circuit being connected to the brushes instead of to special contacts.
18,465 Siemens-Schuckertwerke Ges. Excess voltage devices for protecting electrical circuits and apparatus. (21/8/13.)
18,751 B.T.-H. Co. (G.E. Co., U.S.) Coherers.
A coherer comprising a vertical tube having a main portion and two branches at its lower end, an electrode in each branch and a mass of metallic granules filling said branches above said electrodes and a part of the main portion of the tube.
20,137 Bloxam. (Telepantograph Ges.) Circuit arrangements for writing telegraphs.
20,322 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Control of electric motors.
20,409 Grossmann. Fusible filling and insulating material for electrical purposes.
21,463 Kerr. Electrically-operated alarm device for use in connection with door locks and catches.
21,676 B.T.-H. Co. (G.E. Co., U.S.) Squirrel-cage windings of dynamo-electric machines.
A squirrel-cage winding for a dynamo-electric machine, comprising conductor bars and annular members engaging the inner and outer periphery of said bars.
21,766 Holt. Electric concertina.
22,150 Wheelock. Electric water heater.
22,248 Imray. (Siemens-Schuckertwerke Ges.) Electric transformers.
24,496 Nolan. Apparatus for cooling electric motors. (2/2/14.)

1915 Specifications.

1,006 Imray. (Siemens & Halske Akt.-Ges.) Register circuits for telephone systems.
1,973 Stille. Electro-optical cells. (6/2/14.)
1,995 Imray. (Siemens & Halske Akt.-Ges.) Means for setting selecting devices by electric current impulses.
2,093 Western Electric Co. (Western Electric Co.) Electric wave-amplifying apparatus. (Addition to 275/15.)
2,462 Fried. Krupp Akt.-Ges. Arrangement for the practically sparkless interruption of an electric circuit. (19/2/14.)
3,213 Foster. Device for anchoring or attaching unarmoured electric cables and wires to apparatus and fittings.
4,353 Elektrotechnische Spezialkonstruktionen Ges. Thermic telephones. (24/3/14.)
6,805 Biles. Apparatus for the electric transmission of the energy of a heat motor to the driving wheels of a vehicle or the like. (Divided application on 17,275/14. Apr. 25.)

APPLICATIONS FOR PATENTS

Note.—The undermentioned Applications (except those marked ‡ *are not open to public inspection until after acceptance of Complete Specifications. Those marked* † *are open to inspection twelve months after the date stated hereto, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is inserted.*

June 30, 1915.

9,519 Payne. Magneto ignition devices for internal-combustion engines.
9,522 Robinson. Electrical water-heater.
9,527 Shortt. Electric clocks.
9,535 Painter. Apparatus for Morse signalling.
9,543 Brodsky. Signalling apparatus.
9,557 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
9,573 O'Neil. Device for recording the position of an engine telegraph at any given time.
9,582 Automatic Telephone Manufacturing Co. & Bates. Telephone systems.
9,584 Elmen, Salisbury & Talbot. Electric fluid-heaters. (26/12/14, U.S.)*

July 1, 1915.

9,627 Fortuny. Dry batteries.*
9,628 B.T.-H. Co. (G.E. Co., U.S.) Electric welding and apparatus therefor.
9,635 Cassel. Transmission of power to electrically-driven machines.*

July 2, 1915.

9,682 Oesterreichische Daimler-Motoren Akt.-Ges. Electrically-operated change-speed gear. (14/7/14, Austria.)*
9,690 B.T.-H. Co. (G.E. Co., U.S.) Electron discharge apparatus and method of operating the same.

July 3, 1915.

9,697 Dullingham. Holders for electric lamp shades and lamps.
9,706 Electric & Ordnance Accessories Co., Langrish & Hodgson. Spring-return mechanism for electric motor controllers and for other purposes.
9,715 Cohen, Cohen & Trowell. Magneto-electric machines.
9,720 B.T.-H. Co. (G.E. Co., U.S.) Wireless signalling systems.
9,725 Harris. Electrical transmitting apparatus.

July 5, 1915.

9,740 Thompson. Actuating signals on and communicating with trains. (Addition to 13,443.14.)
9,748 Howard, Wilson & Williams. Safety device for control of trains to prevent over-running of signals when at danger.
9,777 Holland & Becker. Signalling apparatus for use in collieries and other mines.*
9,792 Soc. Anon. pour L'Eclairage Electrique des Vehicules. Starting arrangement for internal-combustion engines. (30/7/14, France.)*

July 6, 1915.

9,794 Wilkinson & Marsh. Gong-striking mechanism.
9,797 Sumner. Opening and closing electrical circuits at a certain temperature.
9,806 Steven. Switches for controlling lift or other motors.*
9,809 Brooks & Holt. Self-regulating dynamo-electric machines.*
9,820 [illegible] Apparatus for Taximeters.
9,823 Bell. Railway signalling.
9,829 [illegible] Apparatus.
9,834 Rigby. Electric mine lamp.
9,836 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control systems.
9,845 Siemens Automatic Telephone Co. & Bennett. Impulse transmitters for telephone systems and the like.

July 7, 1915.

9,861 Wilson. [illegible]
9,865 [illegible]
9,870 [illegible]
9,874 [illegible] Brakes.
9,878 [illegible] Apparatus. (Addition to 15,539/14. Jan. 28, 1915.)*
9,881 [illegible]

July 8, 1915.

9,934 Telegraph Construction & Maintenance Co. & Mallett. Submarine cables.*
9,938 [illegible] Apparatus.*
9,942 B.T.-H. Co. & [illegible] Valves.
9,946 [illegible]
9,972 Redding. Storage battery element and method of making the same. (10/7/14, U.S.)*
9,981 Read. Electric clock.*

July 9, 1915.

9,993 Crockatt. Combined locking device and shade support for electric incandescent lamps.
10,006 Pilkington. Telephone and other diaphragms.
10,026 Scholes. Electric junction box.
10,050 Aktieselskabet Elektrisk Bureau. Impulse-senders for subscriber apparatus in automatic exchange systems. (14/7/14, Norway.)*
10,054 Lavalley. Telephone locks.*

July 10, 1915.

10,059 Brown. Vibrating make-and-break devices for use in electric signalling.
10,067 Horstmann & Horstmann Gear Co. Clockwork time switches and the like.

July 12, 1915.

10,117 Butterfield. Manufacture of tungsten.
10,121 Casotti. Incandescent electric lamp of two zig-zag metallic filaments gi three grades of light.*
10,130 British Westinghouse Electric & Mfg. Co. Electrically-controlled ele circuit breakers. (11/7/14, U.S.)*
10,131 British Westinghouse Electric & Mfg. Co. Supplying electrical energ direct-current electric motors. (11/7/14, U.S.)*
10,133 Marino. Electrolytic deposition on all metals of aluminium, tin, nickel, co zinc, iron, steel, or alloys thereof.*
10,134 Marino. Electrolytically depositing either lead or tin on galvanised iron o alloy of zinc-lead or zinc-tin on iron or steel surfaces.
10,137 Wilkinson. Primary cells.
10,140 Pollak. (Chemische Fabrik Griesheim-Elektron, Germany.) Regeneratic mercury catalysts.*
10,151. Baker Impregnation of salt with radio-active material.

July 13, 1915.

10,199 Wright. Electrical apparatus for producing hot and cold currents of air.

July 14, 1915.

10,214 Walsall Electrical Co. & Delebecque. Casings of ammeters and voltm (Divided application on 9,023/15. June 19.)
10,219 Gostelow. Automatic fog-signalling apparatus.
10,226 Wollenmann. Inter-connecting the electrical conduits of two railway cars.*
10,228, 10,229 Srnka. Telegraph systems. (15/6/14, Austria.)*
10,231 Beattie. Vibrators for induction coils and the like.
10,238 Stancliffe, Leckie & Leckie. Signalling devices.*
10,251 Wilson. Electric condensers. (Addition to 19,506/14.)*
10,270 Roothaan, Higgs & Ferranti Ltd. Connection of electrical instruments.*
10,272 Roberts. Amplification of wireless signals.*

July 15, 1915.

10,276 Woodward. Electrically-operated relays and the like.
10,301 Rae & Berry. Preventing the over-running of signals on railways.
10,325 Hamilton. Electrically-driven luggage truck.
10,334 Suwa. Electric bells.*
10,337 Pring. (Partly communicated by Urlyn Clifton Tainton, S. Africa.) El deposition and refining of zinc.

July 16, 1915.

10,350 Fildes. Electric light fittings.
10,354 Climie, jun. & Less. Ignition apparatus of gas engines.*
10,370 B.T.-H. Co. (G.E. Co., U.S.) Centrifugal compressors.
10,373 Stratford-Andrews. Detectors for wireless signalling.
10,374 Gould. Insulation testing devices for electric lighting and power installati

July 17, 1915.

10,420 Shuttleworth. Electric transmission systems for motor vehicles.*
10,421 Roothaan & Ferranti Ltd. Insulators.*
10,422 Wood, Furlong & Ferranti Ltd. Electrical connections.*

July 19, 1915.

10,433 Callaghan. Automatic electrical human target.
10,438 Hibbert. Half-stroke check lock for motor starters.
10,443 Lethbridge. Illuminated sign.*
10,453 Siemens-Schuckertwerke G.m.b.H. Electrical driving of spindles. (20 Germany.)*
10,454 B.T.-H. Co. (G.E. Co., U.S.) X-ray apparatus.
10,485 James. (A. H. Annand, ——.) Electro-magnetic recording apparatus fo graph circuits.*

July 20, 1915.

10,518 Giandinoto & Scuderi-Scuderi. Semi-static transformer. (21/7/14, It
10,521 Tomlinson-Lee. Electrical element for heating machine tools.
10,535 Clarke, Chapman & Co. & Harris. Arc lamps.*
10,552 Scott. Holder or gallery for securing gas and electric shades and the like.

July 21, 1915.

10,560 Chaplin. Armouring of electric cables for motor cars and similar purposes.
10,585 Williams. Ignition apparatus for use with internal-combustion engines.
10,598 Roothaan & Ferranti Ltd. Rheostat switches and the like.*
10,604 Nelson. Electrolytic cells. (17/8/14, U.S.)*
10,605 Nelson. Method of electrolysis. (17/8/14, U.S.)*
10,611 Renault. Automatically controlling the lead of the ignition of an in combustion engine.*

July 22, 1915.

10,639 Doherty & Underwood. Portable telegraph and telephone apparatus.
10,667 Morse & Indo-European Telegraph Co. Electric alarm or calling device in receiving apparatus and more particularly in wireless receiving apparat
10,668 Deutsche Schweissmaschinen-Bau-und-Vertriebs G.m.b.H. Electric w machines. (22/7/14, Germany.)*
10,669 Stille. Telephonic reproducers. (Addition to 9,644/13.)*
10,672 Stewart & Little. Wireless type printing telegraph systems.
10,676 Landis & Gyr Akt.-Ges. Ampere-hour electricity meters. (22/7/14, Germ
10,680 Hastings & Fiorentino. Couplings for armoured or protected cables and e conductors for use under water and elsewhere.
10,681 Bachelet. Utilising electric energy.

July 23, 1915.

10,706 Moll & Moll. Electrically operated intermittent motion in cinemat apparatus.
10,709 Eastern Telegraph Co. & Phillips. Automatic telephone transmitters.*
10,711 Mond. (Maschinenfabrik Oerlikon, Switzerland.) Cooling or ventilating for dynamo-electric machines.*
10,722 Nobbs, Srn. & Nobbs. Electrical heating and cooking apparatus.
10,726 Bechelet. Electromagnetic levitating apparatus.*
10,730 Parsons & Birmingham Central Supply Co. Screw fittings for electric holders, ceiling plates and the like.

July 24, 1915.

10,739 Wall. Generating high-frequency electric currents.
10,745 Allen & Co., Robinson & Larmuth. Points for tramways, railways a like purposes.
10,751 Harries. Railway signalling.
10,752 Schoner, Travis & Walton. Electric motor starters and controllers.
10,755 Wade. (Joseph Robert Leeson, U.S.) Coil for electrical purposes, and of winding same.*
10,759 Drysdale. Signalling on submarine cables and other telegraphic circuits.
10,762 B.T.-H. Co. & Pollock. Dynamo-electric machines.
10,765 Soc. Anon. des Etablissements L. Bergeon. Securing or locking particularly applicable to the securing of lamp glasses or holders to (31/7/14, Belgium.)*
10,774 Sterling Telephone & Electric Co. & Miller. Crystal detectors parti for wireless signalling.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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SWITCHING CONTROL DEVELOPMENTS.

Although a quarter of a century has passed since the troduction of the two-way switch, there is an extremely nall percentage of electric lighting installations in this untry in which it is employed. So far as we are able to ther from published statistics, the use of this switch on e Continent and in America is almost unknown. Great ritain is essentially the home of the tumbler switch, and is in this form that convenient switching controls can be ost readily devised and developed. The Continent and nerica have favoured the rotary switch, one of the most convenient and clumsy accessories for even the least exnsive lighting installations.

Strange as it may appear, the installation section of the ctrical industry has taken but slowly to convenient thods of switching. One would have thought that so nple and inexpensive a feature of electric lighting would ve been turned to the utmost commercial account by ring contractors. There are scores of electricity users day who stand amazed when they are informed that one more lights in landings, long passages, halls, &c., can be rned on and off from a number of positions. They are mystified that immediately their minds turn to thoughts complicated mechanism, and even to the agency of reless, for accomplishing what seems to them so marlous a thing. If the truth were known, the general blic would be attracted more towards electric lighting for its convenience in switching than for its cleanliness and hygienic value. They would realise that in convenient switching they were obtaining something which no amount of ingenuity could furnish with gas.

The progress of the improved switching movement is slow, but we are confident that it is persistent and sure. The excellent literature and examination papers which have been prepared and are being widely distributed by a prominent firm of switch-makers is exercising a helpful influence. The certificates which are awarded to successful students in the switching competitions ought to have a distinct technical and commercial value, and one which should be recognised by central station engineers up and down the country. The keenness with which competitors have entered for the various classes of certificates is also a good sign. It indicates an improvement in the class of the young men of the present day, who will be the wiring contractors and electricians of to-morrow. The installation industry has, if anything, suffered from the quality rather than the quantity of its representatives, and the infusion of certificated wiremen into the present sadly ignorant mass of such workmen is bound to raise the standard above its now deplorably low level. At one time the improved switching movement was held up to ridicule, but all the facts go to prove that it is justifying its existence in every way. For one thing, the cost of the switches is less than formerly owing to standardisation in production, and also to the improved demand. From a psychological point of view there is also a noticeable difference in that the contractor who understands the problems is not afraid to put forward a switching scheme. At one time he was too scared about losing the order to suggest any improvements or "luxuries," as he considered them, which would increase the initial cost of the installation. Now it is the certificated wireman who can be expected to "sail in" and get the business with the switching improvements offered as an extra inducement to the customer to give him the order. Of one thing we feel sure, the electricity user with switching control is a consumer for all time, and that fact should encourage contractors to standardise in switching methods.

National Electrical Contractors' Association.—The fifteenth annual convention of the National Electrical Contractors' Association of the United States was held at San Francisco, Cal., on July 21-24.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Aug. 16, 1915, *to Aug.* 21, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible] materials, £234; lamp parts, £95; elec. wire and cable, £20; elec. lamps, £120; unenumerated. £2,722—187 pkgs. *Switzerland:* Carbon candles. £602; unenumerated, £161. *Holland:* Elec. lamps, £2,577—9 pkgs.; elec. machinery. £110. *France:* Elec. machinery, £34; carbon candles, £478; elec. lamps, £760; lamp parts, £58; unenumerated. £52—24 pkgs. *Denmark:* Unenumerated, £324. *Italy:* Wire and cable, £940; elec. machinery, £740—69 pkgs.; elec. fans and wire, 87 pkgs.; carbon candles, £110. *Sweden:* Unenumerated, £20. *Canada:* Telephone materials, £88. *Spain:* Elec. machinery. £75; unenumerated, £18.

EXPORTS.

To Australasia.—*Auckland:* Elec. machinery. £158; wire and cable, £2,659; unenumerated. £324. *Melbourne:* Elec. machinery, £143; wire and cable, £1,965; unenumerated, £1,453. *Sydney:* Elec. machinery. £338; unenumerated, £388. *Wellington:* Unenumerated, £11. *Brisbane:* Elec. machinery, £245; wire and cable, £483; unenumerated, £170. *Christchurch:* Wire and cable. £187; unenumerated, £144. *Perth:* Wire and cable, £262; unenumerated, £60. *Dunedin:* Unenumerated, £104. *Fremantle:* Unenumerated, £60. *Bundaberg:* Wire and cable, £211.

Africa.—*Durban:* Elec. machinery, £215; wire and cable, £2,365; unenumerated, £1,116. *Port Elizabeth:* Unenumerated, £120. *Cape Town:* Wire and cable, £27; elec. machinery. £75; unenumerated. £306. *East London:* Wire and cable, £6; elec. machinery, £67. *Beira:* Elec. machinery, £93; unenumerated, £65. *Delagoa Bay:* Unenumerated. £32. *Mombasa:* Unenumerated, £18.

Egypt.—*Port Said:* Unenumerated. £31.

South and Central America.—*Buenos Ayres:* Wire and cable, £406; unenumerated, £289. *Rosario:* Unenumerated, £26.

Japan.—*Kobe:* Unenumerated, £359. *Yokohama:* Unenumerated, £85.

China.—*Honkong:* Unenumerated, £120.

[illegible] £2,388; unenumerated, £544. *Calcutta:* Wire and cable, £2,401; elec. machinery, £40; unenumerated. £878. *Madras:* Unenumerated, £87. *Karachi:* Elec. machinery, £70; wire and cable, £162; unenumerated, £190. *Ceylon:* Unenumerated, £80. *Bankok:* Unenumerated,£139. *Port Harcourt:* Unenumerated,£669. *Samarang:* Unenumerated,£10.

Canada.—*Montreal:* Unenumerated, £253.

West Indies.—*Bermudas:* Unenumerated, £51.

France.—*Boulogne:* Elec. machinery, £765; unenumerated, £88. *Dieppe:* Unenumerated, £62.

Malta.—Unenumerated. £121.

Mauritius.—Unenumerated. £134.

Spain.—*Cassablanca:* Unenumerated. £70.

Portugal.—*Lisbon:* Unenumerated, £4,022.

Italy.—*Genoa:* Unenumerated. £116.

Sweden.—*Stockholm:* Unenumerated. £50.

Norway.—*Christiana:* Unenumerated. £2,206.

Russia.—*Petrograd:* Unenumerated, £197.

FOREIGN GOODS (duty paid and free).

Sydney: Unenumerated, £138. *Bombay:* Unenumerated. £385. *Boulogne:* Unenumerated. £85. *Buenos Ayres:* Unenumerated, £291. *Calcutta:* Unenumerated, £31. *Hong Kong:* Unenumerated. £63. *Malaya:* Unenumerated, £84. *Christchurch:* Unenumerated, £405. *Stockholm:* Unenumerated, £39.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Mr. G. E. C. Cosway, chief engineer of the British Columbia Electric Railway Co., has resigned in order to [illegible] consulting engineer at Toronto.

The Alexander Electrical Engineering Co. have removed their [illegible] commercial lighting, Queen Victoria Street, London, E.C., with additional [illegible] in Bride Lane, Goldsmith-square, W. The Telephone number remains Gerrard 1701.

The partnership between [illegible] Drennan, Jr., R. Cooper and Alfred Cockerill, trading as the Ilford Motor Co., Limited, Ilford-road, Stretford, has been dissolved. Debts by Messrs. Drennan & Co.

BANKRUPTCIES, LIQUIDATIONS, &c.

[illegible] Liquidation Committee [illegible] the discharge of Vernon Cecil Hemming, of Kingston-on-Thames, electrical engineer, Bankruptcy, was granted on [illegible] 24th inst.

The estate of Archibald H. Gillespie, electrical engineer, 499, Great Western Road, Aberdeen, has been sequestrated. Meetings to elect trustee and commissioners will be held on Aug. 30 at the Douglas Hotel, Market-street, Aberdeen.

The Phœnix Electric Heating Co. (1914) (Ltd.) is being wound up voluntarily. A meeting of creditors will be held on Sept. 1 at the office of the liquidator, Mr. A. E. Tilley, 8, Staple Inn, London, E.C.

A meeting to receive an account of the winding up of the Turbine Development Co. (Ltd.) will be held on Sept. 22 at Finsbury Pavement House, London, E.C.

A meeting to receive an account of the winding-up of the Leskol Co. (Ltd.) will be held on Sept. 27 at 31, Great James-street, London W.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Dublin.—The Electric Supply Committee reports that at June 3 the credit balance on capital account for loans stands at £40,08 and that it will be necessary to conserve the balance as much as possible in view of the impracticability of raising loans for some time.

The committee have available for short extensions, house services and meters, £6,500, which will carry them on to the end of the year, and they think that the limited amount of capital should be spent only on consumers who bring in a paying load to the station, and that applications which no remunerative profit can be made on the capital expended either owing to the [illegible] of the demand or the small size of the installation in comparison with the cost of connections, should be discouraged. No connections will be made except on a guarantee of consumption of [illegible] per annum.

Rhos. The Council have approved of the proposal of Wrexham Corporation to extend their area of electricity supply to Rhos and the [illegible] districts.

Rhyl. The Council have approved an expenditure of £2,500 for the extension of electricity supply to Kinmel Camp, but the greater part of this will be refunded by the War Office.

St. Helens.—An inquiry was held here yesterday (Thursday) in the Council's application for sanction to borrow £15,000 for extensions of the electric supply undertaking.

GENERAL

Belfast. It will be remembered that a few weeks ago a question arose as to the liability of the electricity department for having passed an electric lighting installation which complied with the regulations at the time of the test but was subsequently found to be defective.

In the particular case it was stated that the wiring contractor had no telephone wire, and the question of the legal responsibility was referred to the solicitor to the Corporation. The latter has now reported that "The electricity department has no responsibility whatever for defects occurring in consumers' installations after the same has been tested and found to comply with the regulations."

Flaxton (Yorks.)—The Rural Council have decided to adhere to their decision not to allow York Corporation to erect overhead wires for the supply of electricity to Old Earswick. There is a demand for the supply of electricity for private lighting in Earswick, and it is anticipated that supply would be available next winter.

Hindley. The Lancashire Electric Power Co. has been authorised to supply electric current to the Swan Lane Colliery Co., Messrs. Crompton & Shawcross and the Hindley Field Coal Co.

King's Lynn.—Mr. F. H. Lowe, a shift engineer, has enlisted and as the chief assistant has had to take shift duties notice has been given that there may be delay in attending to outside work.

London Municipal Loans. The Treasury has issued further instructions as to limitation of local loans. However, in cases where extensions of electricity supply undertakings are imperative in order [illegible] the Treasury have empowered the Local Government Board to [illegible] the London County Council to dispense with many of the usual preliminaries, so that the Council can grant loans without delay, but only on the condition that the extensions [illegible] to meet the requirements of firms engaged on work [illegible] for the War Office or the Admiralty.

Mansfield. The Electricity Committee have decided to recommend the erection of a number of tubes in the other [illegible] at a cost of £170.

A supply of current to the local military camp was commenced on the 30th inst.

Meltham. The Urban Council have appointed a deputation of three members of the Council and the Clerk to wait upon the Electricity Committee of Huddersfield Corporation with reference to the supply of electric current in the district.

Stretford.—The Trafford Power and Light Supply (1902), Ltd., have informed the Council that they have increased the charge for current for lighting by 10 per cent. and for power 15 per cent.

Westminster.—The liquidators of the Electrical Power Storage Co., which held a contract for the maintenance of the storage batteries at Hendon infirmary at £60 per year, have notified the Guardians that the company had amalgamated with Messrs. Pritchetts & Gold and had gone into voluntary liquidation.

The contract will expire on Nov. 2, 1919, and the Guardians have agreed to continue the contract with the new company if they should be willing to undertake it on the same terms and conditions as the E.P.S. Co.

LIGHTING & POWER NOTES.

Belturbet (co. Cavan).—A special meeting of the Council has been called to consider the question of the electric lighting contract for the ensuing three years.

Bidford-on-Avon.—At the instance of Mr. Stor Dorset Council a special meeting of the Parish Council will be held to consider the proposed electric lighting of Bidford.

As the chairman (Mr. A. G. Phillips) thought that before the parish meeting was called there should be sufficient time to enable the promoters to hold a demonstration of the electric lighting, the meeting will be held on or about Oct. 13.

Crayford.—The Parish Council has obtained tenders for the lighting of Barnes Cray and Northumberland Estates.

The West Kent Electric Light Co. offered to erect at intervals of 60 yds. lamps of 80 c.p. at £2. 8s. 9d. per lamp per annum, and 100 c.p. at £2. 12s. 10d. per lamp. For Barnes Cray estate it was stated that 3,600 yds. would have to be lighted with about 60 electric lamps, or about 40 gas lamps 80 yds. apart. Sixty electric lamps would cost £146 per annum, and 40 gas lamps £149. 13s. 4d. per annum. On the Northumberland Heath estate about 1,220 yds. required lighting, and the necessary 23 electric lamps would cost £55. 19s. 4d., and 16 gas lamps £55. 17s. 4d. It was stated that they would get a maximum of 6000 c.p. from the gas lamps, against 4,800 c.p. from the electric lamps.

After discussion the Council decided to meet in Committee on a date to be fixed and inspect the specimen lamps which the companies should be asked to erect in the meantime.

Electricity in Colliery Work.—The directors of the Main Colliery Co. report that, for the year ended June 30, considerable expenditure is required in connection with additional ventilating machinery, safety lamps and electrical and other developments at the collieries, and a large sum will shortly be required for renewal of plant and works. The directors have placed £8,500 to reserve for these developments and renewals and no dividend is recommended.

Lerwick.—The question of obtaining electric lighting powers for the burgh will be considered at the next monthly meeting of the Council.

Reigate.—The Highways and Works Committee recommended that 23 gas lamps be superseded by electricity lamps, but the Council have decided to defer the work until the months of February and March next.

TRACTION NOTES.

Belfast.—A long discussion took place at last week's special meeting of the Corporation on a proposal to alter and extend the existing

Excepting the penny fare, it was proposed by the Tramway and

existing revenue. The Committee were instructed to investigate the

Bournemouth.—On the recommendation of the Tramways Committee the Council have granted a fortnight's holiday with pay to

To those receiving over 30s. a week, 2 weeks; to those receiving between 20s. and 30s. 2s. 6d. a week; and to all under 18 years of age, 1s. a week. The estimated total cost per annum of the holidays is £1,731. 12s.

Glasgow.—The tramway shelter erected at Battlefield by the Corporation Tramways Committee was formally inaugurated on the 19th inst. by the convener, ex-Bailie Kirkland, in the presence of several representatives of the Corporation and of a good number of the general public.

L. & S.W. Railway.—It is announced that the newly-electrified line between Waterloo and East Putney will be opened on the 6th prox.

The complete electric traction scheme of the company provides for an electric service between Waterloo and Wimbledon by way of Richmond and Kingston, Waterloo, and Shepperton by way of Twickenham, and Waterloo and Windsor by way of Twickenham and Staines, and also to Guildford, and possibly to Reading. It will be some months before the full service can be provided, although it is hoped that by the end of Sept. the Wimbledon route will be opened to the public.

Manchester.—Out of a total of 5,000 employés of the tramways department at the beginning of the war 2,013 have joined the Army or Navy.

Of these who have enlisted 1,124 are married men and 889 single men (including 245 trolley boys). The cost to the department of making the allowances to the men who have enlisted or their dependents is £70,000 per annum.

The Tramways Committee have given the general manager (Mr. J. M. McElroy) permission to engage women as conductors.

Women Tramcar Conductors.—At present Salford Corporation employ 55 tramcar conductors, and it is stated that they are performing their duties in a very satisfactory manner.

At Huddersfield and Manchester the Corporations have also decided to engage women tramcar conductors.

EMPIRE NOTES.

Australasia.—Dunedin (N.Z.) Corporation propose to ask for sanction to a loan of £26,000, of which £20,000 is required for new tramcars and alterations to the existing traction plant.

The question of the construction of a trunk telephone line from Sydney to Brisbane is being considered.

Canada.—At the recent meeting of the Montreal Light, Heat & Power Co. the president (Sir H. Holt) claimed that Montreal was getting the cheapest light, heat and power of any city of importance on the American continent.

Toronto was paying 65 per cent. more than Montreal for street lighting alone. Electrical energy generated by water power had played an important part in the industrial development of Quebec. Sir H. Holt said that over 80 per cent. of the power used in the Province was obtained from water-power.

The Public Service Corpn. of Quebec has been recently incorporated in order to supply electrical energy for light and power in the cities of Quebec and Three Rivers and in several of the adjoining counties. The Shawinigan Water & Power Co. will supply electric current in bulk, and the undertaking of the Dorchester Electric Co. has been purchased.

It is announced that a plan to develop 2,000,000 H.P. by damming the lower Niagara River, is to be taken up with Sir Adam Beck, chairman of the Ontario Hydro-electric Commission. Already the Commission is supplying over 800 rural industrial enterprises and distributes over 100,000 H.P. Sir Adam Beck recently stated that, apart from the benefit of cheap power to industries, the Province of Ontario would soon have 1,000 miles of publicly-owned electric railroads and those would pay from the day they started operations. In some districts electric power is being applied to farm work. Farmers are cutting their ensilage and filling their silos by electricity and are commencing to use electrically-driven threshing machines. More even power was being secured than a steam engine could provide and fewer men are required for the work. The farmhouses, barns and stables are also lit by electricity, and power was used for domestic purposes such as washing and ironing.

Ontario Hydro-Electric Power Commission.—The seventh annual

Owing to the very extensive use of power by the Municipalities it was found necessary to duplicate the transmission line from Niagara Falls to Dundas (50 miles). About 260 miles of l.t. wood-

Falls for the supply of the Beaverton-Canning district, and negotiations

The construction work completed included the

duplication (over 50 miles), also seven distribution stations, and work is

former station was finished, the 110,000-volt apparatus for the fifth bank of three-phase, 3,500 k.v.a. transformers and two lines have been installed, and the two 46,000-volt, 10,500-k.v.a. transformer banks and three of the four 46,000-volt lines referred to in the last report are now in use, while switching equipment has been installed for two lines as spares. The total capacity of the transformer and distribution stations of the Niagara system is 183,440 k.v.a., of the Severn system 2,900 k.v.a., of the Wasdell's Falls system 1,650 k.v.a., of the St. Lawrence system 600 k.v.a. and of the Port Arthur system 5,250 k.v.a., making a total of 193,840 k.v.a. The total capacity of the station transformers purchased for municipalities and commission was 17,425 k.v.a. and particulars are also given of the switching equipment, &c., purchased during the year. A spare feeder, supplied by the Canadian British Insulated Co., was placed in service in April, 1914, and five more feeders of the same capacity were subsequently installed, two to supply the two 10,500 k.v.a. 46,000 volt transformer banks, a third to supply the 10,500 k.v.a. 110,000 volt bank, the fourth and fifth being used temporarily as spares. A contract has been let for a second and independent conduit system from the Ontario Power Co. The Union Carbide Co.'s plant at Welland is now being supplied with three-phase power at 46,000 volts over three transmission lines from Niagara station. The Welland Co.'s equipment consists of switching apparatus for controlling four incoming three-phase, 46,000 volt lines and five feeders. One feeder supplies three single-phase 400 k.v.a. 26,400/220 volt transformers and three feeders are connected to three-phase 4,500 k.v.a. transformers and the fifth feeder supplies three single-phase 3,000 k.v.a. transformers. The Commission is also supplying power at 46,000 volts to the Electric Steel & Metals Co. at Welland. Among the extension works was the extension of the Toronto transformer station which has been completed and an additional bank of three 2,500 k.v.a. single-phase 110,000 "Y"/13,200 "delta" volt, oil insulated water-cooled transformers having been installed, making a total of 25,000 k.v.a., 110,000 volt transformers installed. The equipment for the 110,000 volt lines from London to Woodstock and St. Thomas was also placed in service in August. Particulars of the extension work at other transformer stations, &c., are also given.

On Oct. 31, 1914, there were completed or under construction 800 miles of l.t. transmission lines of voltages varying from 46,000 to 2,200. The mileage includes 609·68 for the Niagara system, 60·77 for the St. Lawrence, 80·15 for the Simcoe and 49·19 miles for the Wasdell's Falls system. In the construction of these lines 5,600 miles of wire weighing 3,450,000 lb., 33,000 wood poles and 383 steel towers were used. Of the tranmission line poles 685 miles of single circuit telephone line has been erected for use in operating the system. 2,915·87 miles of aluminium cable of 1,977,065 lb. weight are in use, also 254·67 miles of copper (634,166 lb.), 1,399·92 miles copper-clad steel wire (235,396 lb.), 39·90 miles gal. iron wire (10,374 lb.), 754·65 miles gal. steel cable (478,448 lb.) and 255·21 miles reinforced aluminium wire (121,007 lb.)

Electric current is now being supplied to 59 municipalities, 13 having been added during the year. At the head of the list is Toronto which took 21,508·5 H.P. (increase of 3,511 H.P. over 1913) and at the bottom New Toronto with a load of 10 H.P. The total expenditure on the Niagara system is $5,960,856·60; the annual receipts for the year ended Oct. 31, 1914, were $994,253·98, and the disbursements $851,600·70, leaving a surplus of $142,653·28. The total capital expenditure on the whole of the systems is $10,130,048·83 and the annual expenditure during 1914 was $4,390,836·53. The Commission assists municipalities in investigating power conditions, in preparing estimates of costs, &c., and a long list of places is given for which this work was performed during the past year. Municipalities have invested in distributing plants to the extent of $15,249,203; the annnal charges for interest and sinking and were $661,949 and the surplus was $1,601,167, of which $850,618 was allowed for deferred maintenance due to general decay and obsolescence.

South Africa.—Cape Town Electricity Committee propose to borrow £75,000 for electricity supply extension purposes during the next two years.

FOREIGN NOTES.

Mexico. The Commercial Intelligence Branch of the Board of Trade has received a telegram from H.M. Consul at Mexico City that communications have been restored with Vera Cruz by rail, but it is apparent would be preferable to defer shipments of British merchandise for the present except by advice of local agents. Communications between the city and the northern frontier is still interrupted.

United States and Hydro-electric Work.—The "Electrical World" announces that information regarding hydro-electric development in [illegible] has been obtained by the Department of Commerce.

The [illegible] of various sizes in Bahia (Brazil), Singapore (Straits Settlements), Gothenburg (Sweden), Seville (Spain), Zambezi and Transvaal (Mashonaland). The data have been gained by [illegible] and cover many matters connected with [illegible] the Scottish Water Power Association and Canadian Power Association, trade in electrical materials, methods employed by Germany in capturing up a market for electrical apparatus and appliances in Russia, possibilities for extension of American trade in Madagascar, &c. The reports (in manuscript) are being exhibited in turn at various cities and towns of the United States, and they can be inspected by all those engineering firms and exporters interested in hydro-electric work.

MISCELLANEOUS NOTES.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade have published lists 32 & 33 of articles whose sources of supply or markets have been interfered with by the war, and copies may be obtained by United Kingdom manufacturers and exporters of British goods from 73, Basinghall-street, London E.C. The articles wanted included electrical apparatus and accessories, electric cables, felt tape for insulated wire covering, &c.

Radiotelegraph Note.—The first direct public wireless telegraphic service between Japan and foreign countries was recently inaugurated via Ochiishi, on the east coast of the Hokkaido, to Petropavlovsk, in Kamchatka. It is announced that a public service is now available. Public messages are to be dispatched from any post office in Japan to Petropavlovsk at 48 sen (1s.) per word.

Fire.—A fire occurred at Belfast Corporation electricity works on Sunday last.

The outbreak is attributed to the spontaneous combustion of coal in the bunkers over the boilers. The coal conveyor was damaged and will not be available for use for a month. Parts of the roof were also damaged but the damage is covered by insurance. The supply of current for lighting and traction is not affected.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during July, 1915, and (*b*) the aggregate figures from Jan. 1 to July 31, with the increases or decreases compared with the corresponding periods of 1914:—

Electrical machinery, (*a*) £111,290 (including generators and motors other than for aeroplanes, motor cars and cycles, £24,372, and electrical machinery unenumerated, £86,918) (decrease £105,595), (*b*) £1,022,452 (including generators and motors other than for aeroplanes, motor cars and cycles, £166,019, and electrical machinery unenumerated, £856,433) (increase £29,693); telegraph and telephone cables other than submarine, (*a*) £1,963 (decrease £4,011), (*b*) £16,901 (decrease £25,853); telegraph and telephone apparatus, (*a*) £7,578 (decrease £7,603), (*b*) £42,753 (decrease £103,760); other electrical wires and cables, rubber insulated, (*a*) £14,629 (decrease £25,436), (*b*) £56,865 (decrease £162,188); with other insulations, (*a*) £4,328 (decrease £8,298), (*b*) £20,868 (decrease £36,147); carbons, (*a*) £13,735 (increase £3,633), (*b*) £72,226 (decrease £21,310); glow lamps, (*a*) £11,853 (increase £855), (*b*) £79,995 (decrease £11,461); arc lamps and electric searchlights, (*a*) nil (decrease £266), (*b*) £1,586 (decrease £867); parts of arc lamps and searchlights (other than carbons), (*a*) £11,867 (increase £5,118), (*b*) £53,739 (decrease £2,249); primary and secondary batteries, (*a*) £6,758 (decrease £4,298), (*b*) £67,887 (increase £8,176); meters and measuring instruments,* (*a*) £3,965, (*b*) £18,315; switchboards,* (*a*) £515, (*b*) £4,015; electrical goods and apparatus unenumerated, (*a*) £21,013, (*b*) £118,306. Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £98,248 decrease £41,098), (*b*) £553,456 (decrease £390,535).

Exports.—The exports of electrical machinery, material, &c., (*a*) during July, 1915, and (*b*) from Jan. 1 to July 31, with the increase or decreases compared with the corresponding periods of 1914, were as follows:—

Electrical machinery, (*a*) £110,207 (including railway and tramway motors, £4,433, generators and motors other than aeroplanes, motor cars and cycles £73,998 and electrical machinery unenumerated £31,776) (decrease £89,069), (*b*) £827,073 (including railway and tramway motors £86,434, generators and motors other than for aeroplanes, motor cars and cycles, £391,632, and electrical machinery unenumerated, £349,007) (decrease £700,043); telegraph and telephone cables, submarine (*a*) £42,573 (decrease £93,986), (*b*) £227,952 (decrease £202,760); other than submarine, (*a*) £35,996 (increase £12,162), (*b*) £263,250 (increase £50,026); telegraph and telephone apparatus, (*z*) £16,751 (decrease £4,091), (*b*) £116,158 (decrease £49,159); other electrical wires and cables, rubber insulated, (*a*) £28,220 (increase £569) (*b*) £169,329 (decrease £46,702); with other insulation, (*a*) £40,551 (decrease £8,037) (*b*) £246,193 (decrease £13,775); carbons, (*a*) £1,559 (increase £1,021), (*b*) £4,929 (decrease £1,114); glow lamps, (*a*) £13,306 (increase £11,263), (*b*) £81,721 (increase £11,864); arc lamps and searchlights, (*a*) £297 (decrease £391), (*b*) £2,338 (decrease £6,625); parts of arc lamps and searchlights (other than carbons), (*a*) £2,620 (increase £96), (*b*) £10,792 (decrease £8,992); primary and secondary batteries, (*a*) £13,207 (increase £5,405), (*b*) £116,138 (increase £8,352); meters and measuring implements,* (*a*) £13,458, (*b*) £90,515; transformers,* (*a*) £3,983, (*b*) £43,271; switchboards,* (*a*) £5,981, (*b*) £36,743; electrical goods and apparatus unenumerated, (*a*) £43,549 (decrease £45,043), (*b*) £339,720 (decrease £221,229). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £262,051 (decrease £92,354), (*b*) £1,749,049 (decrease £309,585).

* Not enumerated separately in previous years.

TENDERS INVITED.

Switchgear, Transformers and Cables.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. British port of e.h.t. Switchgear suitable for 22,000 volts working pressure; e.h.t. Static Transformers (22,000 to 6,600 volts) of 4,200 k.v.a. and 2,000 k.v.a. single phase and 3,000 k.v.a. and 1,250 k.v.a. three phase; and Armoured Three-core Cable for 22,000 volts, with Boxes. Specifications, with general conditions and forms of tender, from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders are to be delivered by noon of Wednesday, Sept. 29. *See also an advertisement.*

Turbo-Generators, Boilers, Condensing Plant, &c.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. British port of (*a*) one Turbo-generator of not less than 5,000 kw. capacity, with Condensing Plant, &c.; (*b*) one or two Turbo-generators of about 10,000 kw. capacity, with Condensing Plant, &c. Copies of specifications and forms of tender from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, Westminster, S.W., to whom tenders (in duplicate) should be delivered by noon, Sept. 24.

JOHANNESBURG Municipal Council invite tenders by Sept. 25 for supply and erection of two 3,000-kw. Turbo-alternators, Condensing Plant, Switchgear, &c. Specifications from the Controller of Stores, and tenders to the Town Clerk, Municipal Offices, Johannesburg. Copies of specifications may be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

JOHANNESBURG Council require tenders by noon Sept. 30 for Two (or, alternatively, One) Water-tube Boilers, with Superheaters, Mechanical Stokers and Draught Plant. Specifications from the Controller of Stores, Municipal Offices, Johannesburg.

Electrical and Tramway Stores.

The directors of the POWELL DUFFRYN Steam Coal Co. invite tenders for the supply of Electrical Goods. Tenders to company, 101, Leadenhall-street, E.C., by 10 a.m. Sept. 8.

WEST HAM Guardians invite tenders for the supply of Electrical Fittings, &c. Tenders to the Clerk, Board Room, Union-road, Leytonstone, London, N.E., by 10 a.m. Sept. 2.

PORTSMOUTH Tramways Committee invite tenders by 10 a.m. Aug. 31 for Tramway Materials, including Overhead Line Material, Oils, Castings, Engine Packings, &c. Specifications from the Electrical Engineer.

Electric Motors, Pump, &c.

SYDNEY (N.S.W.) Council require tenders by Sept. 13 for supply of a.c. and d.c. Motors during two years (contract 382). Specification from the City Electrical Engineer.

The Metropolitan Board of Water Supply, &c., SYDNEY (N.S.W.), want tenders by 2 p.m. Sept. 6 for Centrifugal Pump and Electric Motor for Richmond pumping station. Specification, &c., from 341, Pitt-street, Sydney.

Generating Plant.

The AUSTRALIAN COMMONWEALTH Department of Defence require tenders by noon Oct. 25 for Power-station Plant and Equipment for the Naval Dockyard Cockatoo Island, Sydney, N.S.W., and by noon Oct. 27 for Machine Tools. Specifications from Director of Navy Contracts, Navy Office, Melbourne.

Wiring and Fittings.

KIRKCALDY Town Council require tenders [illegible] for Electric Light Installation [illegible] buildings of the Fever Hospital. Specification [illegible] the Burgh Electrical Engineer.

ISLINGTON (London) Guardians want tenders by Sept. 7 for six months' supply of Electrical Fittings and Sundries, Ironmongery, &c. Forms of tender from the Clerk, St. John's-road, Upper Holloway, N.

Electric Cranes, &c.

Tenders are invited (until noon Sept. 6) for the Direccion General de Obras Publicas, Ministerio de Fomento, Madrid, for various work at the Port of MELILLA (Spain), including supply of Electric Cranes, Rails, &c. The "Gaceta," of July 25, containing particulars, may be seen at 73, Basinghall-street, E.C.

Transformers, Relays, Fuse Blocks, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Sept. 8 for Transformers and Relays for Point Indication for Automatic Signalling (contract 28,918); and Electric Point and Lock Detectors (28,951) during five years; and by 11 a.m. Sept. 29 for 5,000 Fuse Blocks, 5,000 Spare Porcelain Bases and 10,000 Spare Fuse Clips (29,080). Specifications from the Commissioners' Offices, Spencer-street, Melbourne, Australia.

The Deputy Postmaster-General, Melbourne, invites tenders by 3 p.m. Sept. 7 for Telephone Parts (schedule 1,243), and by 3 p.m. Sept. 14 also for Telephone Switchboard Parts (schedule 1,220) for the COMMONWEALTH Postmaster-General's Dept. Specifications from High Commissioner, 72, Victoria-st., London, S.W.

Telegraph and Telephone Material, Wire, Instruments, &c.

The Deputy Postmaster-General Brisbane, (Queensland), invites tenders until Oct. 6 for supply of Tinned Copper Wire (schedule 357) and Porcelain Pothead Insulators (schedule 360) for the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department.

The Postmaster-General's department of the Commonwealth of Australia invites tenders (until Sept. 23) for the supply of Condensers, Galvanometers, Relays and Sundries, and for Incandescent Electric Lamps, and (until Oct. 6) for the supply of Poles (iron or steel) and Fittings.

Tender forms, in all cases, from the Commonwealth offices, 72, Victoria-street, S.W.

The Public Service Stores Tender Board, Wellington (N.Z.), require tenders by 4 p.m. Sept. 4 for (1) 92 miles of Air-spaced, Paper-insulated, Lead-covered Telephone Cable, and (2) 100 miles of Insulated and Braided Wire. Particulars may be obtained from the Controller of Stores, Post and Telegraph Dept., Wellington; the District Store Keeper, Post and Telegraph Depts., Christchurch; or the Telegraph Engineers, Auckland or Dunedin.

TENDERS RECEIVED AND ACCEPTED.

BARKING.—As [illegible] on our last page, the Council have placed order for a 1,000-kw. turbo-alternator, condensing plant, piping, stoker, economiser, &c. The following tenders were received for the turbo-alternator [illegible]:

Brush Electrical Engineering Co. (*accepted*), £6,180; Willans & Robinson (Vickers' alternator), £6,170 and (Siemens' alternator) £6,112; *Dick, Kerr & Co., £6,339; D. Adamson & Co., £6,499; Richardsons, Westgarth & Co. (Siemens' alternator) £6,635; Maschinenfabrik Oerlikon, £6,320 and £6,995; British Thomson-Houston Co. (Worthington condenser) £6,215, (Willans' condenser) £6,406; Jas. Howden & Co., (Vickers' alternator and Worthington condenser) £6,516; British Westinghouse Co.,† £6,250, (Cole-Marchent condenser) £6,595, and (Worthington condenser) £6,711; B. Bliss & Morcom, (Siemens' alternator) £6,591, (G.E.C. alternator) £6,530, and (Vickers' alternator) £6,640; C. A. Parsons & Co., £6,964; Fraser & Chalmers, (Vickers' alternator, Cole-Marchent condenser) £6,559 and £6,896, ditto, Worthington condenser) £6,924, (Brown, Boveri alternator and Worthington condenser) £6,697, (ditto, Cole-Marchent condenser) £6,682, (G.E.C. alternator, Worthington condenser) £6,665, (Siemens' alternator, Worthington condenser) £7,018, (ditto, Cole-Marchent condenser) £7,003.

For the supply of high-tension cable, &c., the following tenders were received: Pirelli (Ltd.) (*accepted*) £2,550; Macintosh Cable Co., £3,064; Union Cable Co., £2,975; Western Electric Co., £2,865; Siemens Bros. & Co., £2,860; W. T. Henley's Telegraph Work Co., £2,782.

RAILWAY LAMPS.—Spencer Bros. Dunedin Works have received an order for the supply of Wotan lamps to the Great Central Railway.

SYDNEY (N.S.W.).—The Council have received the following orders:

N. Guthridge, 18 5,000-volt feeder panels, £2,520, and 30 5,000-volt transformer panels, £3,438; British Genl. Elec. Co., 22 415-volt transformer panels, £1,019. 14s., 28 415-volt distributor panels £1,274, and 8 415-volt summation panels £575 4s.; Australian Gen. Elec. Co., l.t. d.c. feeder panels, 2 5,000-volt feeder panels, 2 5,000-volt transformer panel, 2 11,000-volt transformer panels and 2 415-volt distributor panels, £814; Noyes Bros., 2 10,000-volt feeder panels and 2 70,000-volt transformer panels, £662; 36 5-amp., 25 10-amp. and 10 25-amp. Ferranti meters.

* Incomplete. † Not to specification.

Government Contracts.—The following tenders were accepted by the British Government Departments during July :—

War Office.—Bernard Instrument & Hydrometer Co., cell jars; Callender's Cable & Construction Co., W. T. Glover & Co., A. Green (Ltd.), W. T. Henley's Telegraph Works Co., Hooper's Telegraph Works, India Rubber Works, Liverpool Electric Cable Co., Midland Electric Wire Co., Siemens Bros. & Co., and Ward & Goldstone, electric cable and wire; Austin Motor Co., parts of generating sets; Croggon & Co., Houghton-Butcher Mfg. Co., Messrs. Brown and H. W. Sullivan, signalling lamps; Crys-Tal (Ltd.), General Electric Co., Pope's Electric Lamp Co., and Yorkshire Incandescent Electric Lamp Co., electric lamps; Western Electric Co., telephone sets; Drake & Gorham, electric lighting, St. Anthony; Henley's Telegraph Works Co., electric lighting, Devonport; Edmundson's Electricity Corpn. and A. V. Gifkins & Co., wiring at Salisbury Camp; W. J. Furse & Co., electric lifts, Whalley; Mann, Egerton & Co., electric light and power installation, Park Royal.

Crown Agents for the Colonies.—Siemens Bros. & Co., submarine cable.

India Office.—Marconi's Wireless Telegraph Co., aeroplane transmitters; Siemens Bros. & Co., cells; Taylor, Tunnicliff & Co., and Buller's (Ltd.), insulation cups; Callender's Cable & Construction Co., wire.

H.M. Office of Works.—Pinching & Walton, electrical work, Eastcote alien camp.

Post Office.—Creed, Bille & Co., and Gell Telegraphic Appliances Synd., telegraph apparatus; Automatic Telephone Mfg. Co., British Insulated & Helsby Cables and Peel Conner Telephone Works, telephone apparatus; Johnson & Phillips, Siemens Bros. & Co., and Union Cable Co., telephone cable; A. C. Cossar (Ltd.), telephone lamps; F. Smith & Co. (inc. in London Elec. Wire Co. & Smiths), copper wire; Chloride Electrical Storage Co., batteries to be delivered to Central (London) Exchange.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Huddersfield. The tramway accounts for the year to March 31 show total capital expenditure £477,919 (increase £19,041). £34,392 of debt has been extinguished and the consolidated loans fund and sinking fund account to £140,207.

Revenue was £127,060, working expenses were £70,380, war service allowances required £1,599, interest £15,639 and sinking fund £13,467, leaving net profit £22,237, of which £15,575 has been placed to reserve or renewals fund and £6,662 contributed in aid of borough rate. Revenue per car-mile was 11·08d., average working expenses were 6·70d., exclusive of power, which cost 1·46d. Passengers carried were 23,933,065, car-miles run 2,787,809 and units used 5,398,258=1·93 per car-mile.

King's Lynn.—The electricity department's accounts for the year ended March 31 show total capital expenditure £56,762 (increase £1,126, of which £22,210 is outstanding.

Income was £9,000, working and general expenses were £4,773, leaving gross profit £4,226 (£4,662). Interest required £853 (£860, and repayment of capital £2,017 (£2,017) and the net profit was £1,350 (£1,776). Works costs were 0·95d. (0·92d.) and total costs (exclusive of public lamp maintenance, capital charges and war allowances) 1·36d. (1·28d.) per unit. Average price obtained was 2·76d. (2·66d.) Units generated were 656,340 (723,214) and sold 615,803 (669,874). Total maximum supply demanded was 515 kw. (450 kw.) and load factor was 14·55 (16·99) per cent. Horse-power of motors connected is 766 (749).

Portsmouth. The [illegible] year ended March 31 show total capital expenditure £730,607 (increase £5,600), of which £22,555 has been paid, while £219,462 has been contributed out of revenue for capital outlay, and the amount in sinking fund is £219,462.

[illegible] working expenses were £56,888 (£57,619). Grants to dependents of employees serving with H.M. Forces absorbed £1,769, interest required £21,643 (£21,592), sinking fund £18,454 (£18,263) and income tax £1,940 (£1,301), and, with interest on credit balance, £779, the balance amounts to £24,074, or £34,777, including £10,703 brought forward from last account. £10,000 (£5,000) has been contributed in aid of rates, £3,000 [illegible] revenue per car-mile was 12·201d. (11·204d.) and working expenses, including power, were 5·599d. Passengers carried were 27,554,194, car-miles run 2,438,621 and units used 3,272,089=1·139 per car-mile.

The [illegible] W. F. Sullivan [illegible] many men having joined H.M. Forces and the difficulty of filling their [illegible]

Councillor Timpson, chairman of the Tramways Committee, in sub-[illegible] of rates had been increased by £5,000, from £5,000 to £10,000. The [illegible] were £1,769. There had been complaints from the public and the Council [illegible]

[illegible] profit transferred [illegible]

COMPANIES' MEETINGS AND REPORTS.

MONTREAL TRAMWAYS CO. (LTD.)—The report for the year ended June 30 states that the gross earnings decreased $117,572, operating expenses $492,118 and net earnings $125,454. The ratio of operating expenses to earnings is 56·92 per cent., compared with 58·89 per cent. $212,732 has been charged to contingent renewal account, $666,430 has been expended on maintenance of plant and equipment, making the total expenditure on upkeep $879,162. The gross earnings were $6,525,232, operating expenses, $3,713,996; net earnings, $2,811,235. After deducting city percentage ($414,149), interest on bonds and loans ($825,415), on debenture stock ($800,000), dividends of 10 per cent. ($278,880), and placing $275,000 to contingent account, the surplus is $124,991.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The managing director (Mr. A. E. Hadley), who presided at the meeting last week, explained that the chairman (the Marquis of Winchester) was on active service at the Front, and Lord Brabourne had succeeded the late Mr. Fricker on the board. Mr. Brakhan resigned his seat on the board last October, and on the outbreak of war the late Mr. Rathenau ceased to be a director. It was not proposed to fill up those two vacancies. Referring to the balance-sheet and profit and loss account for 1914, he said the auditors' certificate was again satisfactory. With regard to the sum of £41,653. 18s. 8d., to which they referred, that sum included £3,500 deposited with the Dresdner Bank on behalf of the debenture trustees and £7,700 on behalf of contractors' retentions, and was at their risk; the balance represents moneys which were remitted to Berlin prior to the war for payment of debenture interest in Berlin, and which had doubtless been paid, but owing to the war it had not been possible for them to receive the discharged coupons. Having explained the figures in the balance-sheet, he said the credit balance for 1914 was £266,446. 16s. 11d. The next item, in connection with power stations, buildings, equipment and land, had been increased during the year by £395,753, mainly on extensions to the Simmerpan station and at Brakpan, and on consumers' sub-station equipments and transmission lines. Their investment in the Rand Mines Power Supply Co. stood at £3,492,494 after writing off reserve for depreciation. The Victoria Falls Company held 500,000 shares of £1 each in the Rand Mines Company, together with a first mortgage bond fully securing the loan. On the year's operations there was an increased gross profit over the preceding year of £87,871. Interest [illegible] had increased from £205,920 to £234,842. The directors had applied £150,083 towards depreciation and certain writings off, carrying forward £161,248. They had paid a dividend at the rate of 6 per cent. per annum for the six months ended June 30, 1913, and a further dividend at the same rate for the 10 months ended April 30, 1914. Those dividends were paid on Jan. 6 and June 21, 1915, respectively, and accounted for £160,000, thus leaving £106,447, against £105,198. 15s. 9d. The increased profit enabled them to distribute an additional £40,000, and showed the continued and growing [illegible] again shown satisfactory increases, and they hoped to pay off the arrears [illegible] dividend payments. The heavy capital expenditure necessitated by the recent large extensions to the plant of this company and the Rand Mines Power Supply Co. had now practically terminated, but from now [illegible] from the provision made for depreciation had hitherto been required for extensions to the plants of both companies, but in future those annual provisions would be available for redemption of debentures. If the [illegible] and every effort was being made in that direction—the board did not anticipate any difficulty in meeting these charges. Since then the meeting the extensions to the air compressing plant at Rosherville has been completed, and now the output of electrical power [illegible] received that the whole of the extensions of 33,500 H.P. of electrical plant at the Brakpan station was in commission. With the plant installed they should be able to meet any normal increase in the business.

NEW COMPANIES, MORTGAGES AND CHARGES.

NEW COMPANIES.

ANDOVER & DISTRICT ELECTRICITY CO. (LTD.) (141,280)—Reg. Aug. 16, capital £10,000 in £1 shares, to take over from Messrs. Crompton & Co. the transfer of and all benefits and rights under the Andover Electric Lighting Order (1915), to carry out and work the undertaking authorised by such order, or to apply directly for and acquire any similar electric lighting order, and to carry on the business of producers and suppliers of electrical energy, &c. First directors are T. Webb, Dr. E. A. Farr and J. A. Houblon. Reg. office : 26, Bridge-street, Andover.

"BALLANTYNE" SUBMARINE CRAFT DETECTOR & TELEGRAPHS (LTD.) (9,452).—Reg. in Edinburgh Aug. 12, capital £500 in 115 preference and 350 ordinary shares of £1 each and 700 deferred shares of 1s. each, to provide for making and testing of an experimental apparatus and acquiring certain inventions relating to "apparatus for the detection and location of submarine craft and submarine telegraphy between ships or ships and shore," and to carry on the business of experimental engineers, &c. Private company. First directors are J. H. Ballantyne, R. Semple, jun., and D. Mactaggart. Reg. office : Glasgow.

ELECTRO ALLOYS (LTD.) (141,329)—Reg. Aug. 20, capital £10,000 in £1 shares, to take over the existing inventions, rights and processes of E. B. Crombie relating to the precipitation of zinc and other metals, minerals and mineral oils, to carry on the business of metal merchants, metallurgists, engineers, electricians, &c. Private company. Secretary (pro tem.) : C. E. Warren. Reg. office : 62 and 63, Queen-street, E.C.

INDUSTRIAL INVENTION (LTD.) (141,222)—Reg. Aug. 8, capital £3,000 in £1 shares, to carry out experiments and research work chiefly on deposition of metals and utilisation of waste products. Private company.

LINDSAY & WILLIAMS (LTD.) (141,305)—Reg. Aug. 18, capital £2,000 in £1 shares, to take over the business of an insulating material manufacturer carried on by H. R. Williams as Lindsay & Williams. Private company. First directors are not named.

RUNBAKEN MAGNETO CO. (LTD.) (141,311)—Reg. Aug. 18, capital £3,000 in £1 shares, to takee over the business of magneto manufacturer carried on by J. H. Runbaken & Co., and so carry on the same and the business of manufacturers of spare parts for magnetos, ignition apparatus, &c. Private company. First directors are J. H. Runbaken (managing director), H. P. Flynne and S. H. Flynne (all permanent).

MORTGAGES AND CHARGES.

BRECKNELL, MUNRO & ROGERS (LTD.)—Particulars of £2,500 debentures, created Aug. 9, 1915, have been filed, whole amount being now issued. Property charged : Company's undertaking and property, present and future. No trustees.

WINSCOMBE ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on July 17 1915, of £870 debentures, part of series of which particulars have been filed.

CITY NOTES.

MEMORANDA (Aug. 25).—Bank rate 5 per cent. (since Aug. 8, 1914 Consols 65. Consols Pay Day Sept. 1. Stocks and Shares Ticket Days Sept. 9 and 28. Pay Days Sept. 10 and 29. Price of silver, 22⅜d.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—The dividend on the 6 per cent. preference shares for the half year ending Aug. 31 will be paid on the 1st prox.

ASCOT DISTRICT GAS & ELECTRICITY CO.—An interim dividend at rate of 5 per cent. per annum has been declared for the past half-year.

CROSSLEY BROS. (LTD.)—Interim dividends at rate of 5 per cent. per annum on the cumulative preference and at rate of 4 per cent. per annum on the ordinary shares have been declared. No ordinary dividend has been paid since 1912.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—The preference dividend of 7 per cent. per annum for half year ending Aug. 31 has been declared.

SUBMARINE CABLE COMPANIES' ACCOUNTS.—The standing of the securities of the submarine telegraph companies in the investment market has been [illegible]

Description.	No. of £1 stock.				Price.			
Anglo-American								
Do. 6% pref. ordinary	£3,289,350	21½	20½	21				
Brazilian								
Do.	300,000	11½		12				
Direct	£752,400	7½		7⅞	7⅝			
Eastern Telegraph, ordinary	£1,000,000	12⅞						
Do.	£2,000,000	12⅞		13	77			
Do.	£2,000,000	12⅞		13	81	4	18	
Cuba Submarine	150,000	3½		3¾	32	33¼		
Direct Spanish	17,000	£7						
Western Telegraph (£10)	207,930	13⅞	13½	13⅝	11	11½		
Do. 4½% pref.	£816,759	7½	6⅞	7⅛	6⅜	6⅝		

shares may fairly be described as gilt-edged. All the more reason, therefore, for shareholders and stockholders to experience some anxiety as to the effect the war is likely to have npon their investments. From time to time the leading financial journals deal with this subject in the light of the suitability of these stocks for safe and sound investment. The "Economist" for Aug. 14 dealt at considerable length with the latest accounts of the following companies : Cuba Submarine, Direct Spanish, Eastern, Eastern Extension, Great Northern, Indo-European and Western ; and, after dealing in tabulated form with the various heads of the accounts, the preceding table, giving particulars of the stock and market prices at end July of several of the securities, is furnished. Investors will at once realise from this table the intrinsic merits of these securities, more especially when it is remembered that there has been practically no variation in the percentage of dividend declared over a very long period, and that the ample reserves provided for in the accounts and the liberal writing down of reserve fund investment depreciation allows for all probable future eventualities. The general situation is summarised as under :—

C[illegible]

to last until December, may very likely show further substantial advances. Nevertheless, it must be kept in mind that profits, by the nature of the business, are subject to very wide fluctuations, and, as we have suggested above, there is every likelihood of depression after the war. The further development and increased competition of wireless is, as it has been for years, a bogey. The further extension of wireless for commercial and Press purposes has been postponed, at any rate, for the duration of war. At the present moment no man can prophesy with any authority how soon after the war, or to what extent, wireless is likely to encroach upon the earnings of submarine cable companies. That is a question which investors must decide according to their own expectations.

We think, in justice to the companies who own submarine cables, it should be pointed out that they have been subject to the threatened competition of wireless telegraphy for many years without their revenue being injuriously affected in any way. It is common knowledge that wireless telegraphy has fed the cable companies in certain ways and in certain areas. There is nothing whatever to show that any material alteration will be experienced in this regard. Wireless telegraphy appears to have a field of its own, and this only in competition with the cable service in that should the commercial field become more freely open to wireless competition than formerly this is likely to beneficially, and not adversely, affect the cable companies, inasmuch as telegraphy will surely be materially extended as the result of the additional facilities which will be so provided.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Aug. 25. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	NAME.	Price, Wed. Aug. 25.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9⅜†	7 2 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9⅛†	4 15 6	Feb, Aug
10	6%	Do. 6% Cum. Pref.	10†	6 0 0	Feb Aug
5	10%	Bromley & Kensington Ord.	5⅛	9 15 2	Mar, Sept
St.	4%	Central Elec. Supp. C. Deb. St.	9½	4 8 5	..
St.	4%	Charing Cross West End & City Debs..	23⅜	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	4⅝†	5 10 10	..
5	5%	Do. Ord.	4†	6 5 0	Aug, Feb
10	9%	City of London Elec. Lt. Ord.	12½	7 4 0	Feb, Aug
10	6%	Do. 6% Pref.	12⅜	4 17 0	Mar, Jly
St.	5%	Do. 5% Deb. St.	110	4 10 11	Jun, Dec
10	8%	County Elec. Supply Ord.	10¼	6 11 10	Mar. Sept
10	6%	Do. 6% Pref.	10½	5 14 4	Feb, Aug
St.	4½	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs...	77	5 16 8	July
5	9%	Kensington and Knightsbridge Ord. ..	7⅛†	6 4 2	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, Jly
5	5%	London Elec. Supp. 6% Pref.	5⅛	5 13 1	..
St.	4%	Do. 4% Mort. Deb.	89¾	4 11 11	Jan, Jly
5	3½	Metropolitan E. Supp. Ord.	2⅜†	6 5 0	Mar, Aug.
St.	4½	Do. 1st Mort. Deb.	99	4 14 ..	Jan, Jly
St.	..	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, Jly
..	..	Newcastle & Dist. E.L. 6% 2nd Dbs ..	98½	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S.5%2dMt.Db.St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1⅛	5 11 ..	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs. ..	95	5 5 3	Jan, Jly.
St.	4½%	Urban Elec. Supp 4½% Db. St.	84	5	Apl, Oct
1	..	Waste Heat & Gas Elec. Gen. Stations..	1	7 2 3	Mar, Aug
..	..	Westminster E.S. Corp. Ord.	7⅛	6 7 5	May, Sept
..	..	[illegible]	5	5 12 6	Jan, Jly
		Electric Railways & Tramways.			
5	5%	British Elec. Traction 5% Debs.....	77½	6 9 0	Apl, Oct
St.	..	[illegible]	71	5 7 11	Feb, Aug
St.	4%	Central London Guar. Assented Ord. ..	7	5 14 3	..
St.	4%	Do. do. Assented Def. Ord. ..	3	5 14 3	..
St.	..	[illegible]	1½	5 12 7	Jan, Jly
St.	4%	[illegible]	71	5 12 7	Jan, Jly
St.	..	[illegible]	6	4 1 3	May, Nov
St.	5%	[illegible]	6	6 7 0	Feb, Aug
10	1	[illegible]	9½	5 17 6	Feb, Aug
1	..	[illegible]	1	6 13 4	Jan, July
St.	4%	[illegible]	7	6 7 3	May, Sept.
St.	..	Do. 4% Debs.	3	5 11 1	Jan, Jly.
St.	1	[illegible]	23½	5 4 5	Feb, Aug
1	1½	[illegible]	2⅛	5 13 6	Feb, Aug
St.	3½	[illegible] Pref.	71½	4 14 3	Feb, Aug
St.	3½	Do. 3½% A Debs.	82½	4 4 6	Jan, July
St.	3½	Do. 3½% B Debs.	84½	4 4 1	Jan, July
St.	4%	Metropolitan Elec. Tram. Ord.	14½	.. ..	Feb, Aug
St.	4%	Do. 4% Pref. Ord.	52	4 7 0	May, Nov

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	NAME.	Price, Wed., Aug. 25.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways—*cont.*		£ s. d.	
St.	4½%	Metropolitan Dist. Ry. 4½% First Pref.	63½	6 9 4	Feb, Aug
Stock	6%	Do. 6% Perp. Debs.	123½	4 12 8	Jan, July
St.	4%	Do. 4% Debs.	72	5 11 1	Jan, July
Stock	4%	Do. 4% Debs. (1903-5)	87½	4 11 7	Jan, July
St.	4%	Do. 4% Guar. Stock	73½	5 6 0	Mar, Sept
10	..	Underground E. Rys. of London Shares	1½	.. ..	..
1/0	..	Do. A Ord.	0	.. ..	..
St.	6%	Do. 6% Inc. Deos.	104	5 15 3	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 15....	74	8 2 2	Mar, Sept
..	4½%	Do. 4½% Bds.	93	4 11 10	Jan, July
5	..	Yorkshire W. Riding Ord.	¾	.. ..	March
5	6%	Do. Pref.	4½	7 1 8	Jan, July
		Electric Manufacturing, &c.			
1	12½	Babcock & Wilcox Ord.	21	6 4 5	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅜	5 6 3	Mar
100	5%	Do. Prior Lien Debs.	93½	5 8 6	Jan, July
1	6%	Do. 6% Pref.	⅝	6 12 5	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	101½	7 0 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 9 1	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅞	6 6 4	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	11⅞	9 12 0	Azrii
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	103½	6 16 4	Jan, July
5	2½	Do. 5% Pref.	4	6 5 0	Feb, Aug
1	15%	Castner Kellner	25½	5 1 6	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	8½	7 13 7	Sept
		Edison & Swan U Eds Lt.A. £3 pd.	¼	.. ..	Feb, Aug
1	6%	Elec. Construction Ord.	8½	9 4 7	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs.	64½	5 15 6	Jan, July
10	6%	General Electric 6% Pref.	9⅜	6 4 5	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13	7 13 10	Feb, Aug
5	2½	Do. 4½% Cum. Pref.	4½	5 0 0	..
St.	44%	Do. 44% Deb.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	8½	6 1 2	Feb, Aug
10	5%	Do. Pref.	8⅜	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	98	4 1 8	Apl, Oct
12	20/0	Telegh. Con. & Main. Co.	30½	7 16 2	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅞	4 16 0	May, Aug
1	6d.	Do. 5% Pref.	⅝	5 14 3	May, Aug
St.	4%	Do. 1st Deos.	79	5 1 6	Jun, Dec
100	44%	Do. 4½% 2nd Debs.	99½	4 10 6	Jan, Dec
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	3½%	Anglo American 6% Pref. Ord.	98½	6 1 10	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21⅛	6 14 11	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	6⅛	6 7 11	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	6⅛	5 13 6	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5%	Direct Spanish 10% Pref.	7⅞	6 13 4	..
10	4%	Direct United States	7⅝	6 16 2	Ja,Ap,Jly,O
St.	7½%	Eastern Tel. Co. Ord.	113½	6 1 3	Ja,My,Jly,O
St.	17%	Do. 3½% Pref.	65	5 2 11	Ja,My,Jly,O
St.	4%	Do. 4% Deos.	79½	5 0 6	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs...	79½	5 1 9	Feb, Aug
10	7½%	Do. Ord.	11½	6 4 5	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. with Coup. 8....	31½	6 13 4	Ja, My, Jly
25	13%	Indo-European Tel. Co.	50	6 10 0	May, Nov
1	1½	Marconi's Wireless Tel. Co.	1⅝	5 3 3	April
1	7%	Do. 7% Pref.	1⅛	4 0 0	July
10	9½	West India & Panama Ord.	14	8 17 9	May, Nov
10	6%	Do. 1st Pref.	6⅞	7 1 2	May, Nov
St.	4%	Western Teleph. Co.	11½	6 1 9	Mr,Jly,O.Dec
St.	4%	Do. 4% Deb. St.	79½	5 0 4	Jun, Dec
..	41%	Western Union 50 yr. Bds.	97⅛	4 12 1	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	12½	6 3 8	Ja,Ap,Jn.O
1	7%	Cuban Telephn. Co. 5% Bds.	7⅝	6 11 7	Jan, Jly
1	7%	Monte Video Telephn. Ord.	8⅛	5 12 5	Nov.
..	44%	New York Telephone 4½% Bds.	99⅛	4 10 3	May, Nov
1	10%	Oriental Telephone Ord.	1⅝	5 1 3	Apl, Oct
St.	4%	Do. Deb. St.	80	5 0 0	Jan, July
St.	44%	Telephn. Co. of Egypt Db. St.	85	5 4 8	Jan, July
5	5%	Western River Plate Ord.	5⅛	7 8 10	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅞	5 3 3	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTeleph. & Trust.	9⅞	6 5 6	Sp.Dc,Mr,Jn
10	6%	Do. 6% Pf.	10⅜	5 12 3	Sp.Dc,Mr,Jn
100	8%	Marconi International Corporation	80	6 5 0	Ja, Ap‖, Jly.O
..	4½	Do. $100 Inst.	67½	5 15 6	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	125½	4 15 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	71⅞	7 0 6	Jun, Dec
St.	44%	Do. 4½% Debs.	89	5 12 6	Jan, July
St.	4%	Do. 4% Debs.	78	5 13 2	Jan, July
5	2½	Do. 5% Pref.	4	6 17 1	Jan, July
5	2½	Do. 5% Pref.	3⅞	7 19 6	Jan, July
100	3½	Brazil Tramways Ord.	43	12 10 0	Fb,M,Aug,N
10	5%	Do. 5% Pref.	8½	7 2 10	Ja,Ap‖,Jly,O
..	..	Buenos Ayres Tramways Consolidated	6⅜	5 16 5	May
..	..	Do. 6% Pref.	9⅜	5 6 7	May, Nov
St.	41%	British Columbia 4½% Con. Debs.	65½	6 12 ..	..
..	..	Do. 5% Pref.	4	5 11 5	Mar, Sep
..	..	Havana Elec. Ry. 5% Bds.	50½	6 13 1	Feb, Aug
..	..	Madras Elec. Trams 6% Cum. Pref.	6	6 0 0	..
100	8%	Manaos Trams 5% Debs.	63	7 4 11	Jan, July
..	..	Metropolitan Electric Tramways	5⅛	.. ..	Fb,M,Aug,N,
..	..	Do. 5% Pref.	3⅞	12 17 6	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)..	87½	4 11 5	Feb, Aug
1	..	Rio de Janeiro Tram. L. & P. 50 yr. Bds	70⅛	7 3 2	Jun, Dec
100	4½	Do. 4½% Debs.	87	4 12 5	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
..	..	Adelaide Elec. Supply 6% Pref.	5⅝	5 14 4	Mar, Sept
..	..	Do. 6% Cum. Pref.	6⅛	.. ..	Jun, Dec
1	..	Bombay E. S. & T 6% Pref.	1⅜	5 17 ..	..
..	..	Calcutta E. S. Corp. Ord.	2⅛	7 11 3	May, Nov
..	..	Do. 6% Pref.	5⅛	6 4 5	..
..	..	Do. 6% Cum. Pref.	5⅛	6 4 5	..
..	..	Mexican Electric Light Co.	11⅞	6 6 4	Ja,Ap,Jly,O
..	..	Do. 5% Pref.	5⅛	7 1 2	June, Dec
..	..	Do. 5% Cum. Pref.	5⅛	6 4 5	Apl, Oct
..	..	Do. 6% Cum. Pref.	6⅛	6 4 5	Jan, July
St.	4½	Toronto Power Co. 4½% Deb. St.	87½	5 2 6	Ja,Ap‖,Jly,O
St.	4½	Do. 4½% Deb. St.	87½	5 1 9	May, Nov
..	..	Victoria Falls & Transvaal Power Co.	6⅝	.. ..	Jan, July
..	5½%	Do. 5½% Mort. Debs.	80	6 7 11	Jan, July

METAL PRICES.

Messrs. J. B. Carnham & Sons, 132, Upper Thames-street, London, E.C., quote under date August 25, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	12½d.	English Lead	£22 10 0
Solid Drawn Copper Tubes	12½d.	Antimony	Nominal.
Brazed Copper Tubes	12½d.		
Brazed Brass Tubes	14½d.	Old Metals.	per ton.
Brass Wire	13½d.	Clean Scrap Copper	£61 0 0
Copper Wire	13½d.	Brazlery Copper Scrap	£55 0 0
Rolled Brass	12½d.	Clean Scrap Brass	£48 0 0
Brass Sheets	13½d.	Old Lead	£18 5 0
		Old Zinc	£35 0 0
	per ton.	Hollow Pewter	£110 0 0
Copper Sheets	£95 0 0	Black Pewter	£80 0 0
Spelter	£64 0 0	Gun Metal	£88 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date August 24, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£75 0 0	Old Lead	£18 10 0
Clean Mixed Brass	£49 0 0	Tea Lead	£17 0 0
Clean Copper	£61 0 0	Hollow Pewter	£105 0 0
Brazlery Copper	£55 0 0	Shaped Black Pewter	£75 0 0
Gun Metal	£80 0 0		

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £70; Commercial Tinman's Solder, £90; Blowpipe Solder, £100.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	No. of weeks.	Aggregate. Amount.	Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 18	1,905	– 161	11	21,323	– 353
Anglo-Argentine	.. 17	50,932	+ 6,241	33	1,684,807	– 135,699
Ashton-under-Lyne	.. 21	824	– 22	21	10,276	+ 245
Ayr Corporation	.. 21	651	– 138	14	7,185	– 64
Bath Electric Trams, Ltd	.. ..	..	.. ..	..	.. ..	..
Birkenhead Corporation	.. 22	1,428	+ 153	21	28,563	+ 1,667
Birmingham Corporation	.. 14	15,304	+ 3,568	20	261,859	+ 14,446
Blackburn Corporation	.. 18	1,295	– 328	21	28,350	– 1,064
Blackpool Corporation	.. 19	4,006	+ 1,333	21	39,515	– 5,660
Blackpool and Fleetwood	.. ..	..	.. ..	..	.. ..	..
Bolton Corporation	.. 22	2,819	– 89	21	56,027	– 3,901
Bournemouth { Trams	.. 18	2,830	+ 609	20	44,146	– 696
Bournemouth { Buses	.. 18	53	+ 8	20	801	– 155
Bradford Corporation	.. 21	7,139	– 311	20	138,459	+ 3,079
Brighton Corporation	.. 22	1,624	+ 348	22‡	24,539	– 1,184
Bristol Trams { Trams	.. 20	4,739	+ 346	35	155,642	– 677
Bristol { Buses,&c.	.. 20	5,540	+ 1,157	33	159,875	+ 26,688
Burmah E. Trams & Ltg	.. 21	R4,290	+ R134	33	R115,891	+ R949
Burnley Corporation	.. 21	1,570	– 46	21	48,056	– 36
Burton Corporation	.. 22	299	– 8	21	6,098	– 388
Bury Corporation	.. ..	..	.. ..	..	.. ..	..
Calcutta Tramways Co.	.. 21	R66,538	R762	..	.. ..	..
Camborne-Redruth	.. 21	115	– 12	33	4,517	– 94
Cardiff Corporation	.. ..	..	.. ..	..	.. ..	..
Cork Electric Trams Co.	.. 14	564	– 2	33	16,474	– 297
Coventry Corporation	.. ..	..	.. ..	..	.. ..	..
Croydon Corporation	.. 13	1,980	+ 318	19	37,131	+ 1,489
Derby Corporation	.. 21	1,092	– 54	20‖	22,063	– 4
Dover Corporation	.. 21	376	+ 106	20	6,703	+ 1,192
Dublin & Lucan Railway	.. 20	167	+ 10	7	1 213	– 103
Dublin United	.. 22	6,349	+ 39	33	201,915	+ 5,758
Dundee Corporation	.. 19	1 372	+ 135	14§	18,750	+ 306
East Ham Council	.. 21	1,395	+ 193	23‖	27,531	+ 4,678
Exeter Corporation	.. ..	..	.. ..	..	.. ..	..
Glasgow Corporation	.. 21	21,763	+ 1,989	12‡	252,625	+ 14,392
Glossop Trams	.. 21	135	– 29	34	4,154	– 151
Gloucester Corpn.	.. 18	368	– 42	20	6,888	– 137
Halifax Corpn. { Trams	.. 12	2,571	+ 613	20	46,532	– 903
Halifax Corpn. { Buses	.. 17	54	– 15	20	1,053	– 23
Hastings Elec. Trams Co.	.. 19	1,556	+ 333	33	31,251	– 1,352
Huddersfield Corpn.	.. 21	2,752	+ 432	20	56,482	+ 6,253
Hull Corporation	.. 21	2,904	+ 118	20	52,252	+ 202
Ilford District Council	.. 21	685	+ 47	20	13,861	+ 2,305
Ilkeston Corporation	.. 18	144	+ 11	20	2,691	– 35
Ipswich Corporation	.. 21	663	+ 188	19	11,775	+ 1,400
Isle of Thanet Co.	.. 21	1 079	– 122	46‖	18,535	– 9,675
Kilmarnock Corporation	.. 21	164	+ 9	14	2,488	– 47
Lanarkshire Trams Co.	.. 14	2,179	+ 234	33	63,252	– 161
Lancaster United	.. 15	1,811	.. ..	33	56,862	+ 2,075
Leeds Corporation	.. ..	9,401	+ 1,125	21	187,297	+ 10,020
Leicester Corporation	.. 21	3,117	+ 464	34	100,274	+ 2,763
Leith Corporation	.. 21	783	– 72	14	11,240	+ 194
Lincoln Corporation	.. ..	..	.. ..	..	.. ..	..
Liverpool Corporation	.. 14	13,542	– 102	33‖	428,383	– 1,192
Llandudno&ColwynBayR	.. 20	706	+ 196	38	12,250	+ 593
London County Council	.. 11	45,178	+ 1,864	19	812,287	– 30,784
Lowestoft Corporation	.. 21	134	– 98	16§	8,215	– 1,752
Maidstone Corporation	.. 12	234	– 18	20	4,606	– 70
Manchester Corporation	.. 21	18,910	+ 989	20	371,059	+ 2,028
Nelson Corporation	.. 21	177	+ 11	20	4,060	– 398
Newcastle-on-Tyne Corpn	.. 21	6,501	+ 1,503	21‖	129,881	+ 19,789
Newport (Mon.) Corpn.	.. 14	881	– 83	20	16,675	– 477
Northampton Corporation	.. 20	711	– 206	20‖	15,751	– 3,361
Nottingham Corporation	.. 14	3,735	+ 421	20	76,729	+ 3 640
Oldham Corporation	.. 22	2,402	– 248	22	50,600	– 134
Portsmouth Corporation	.. ..	..	.. ..	..	.. ..	..
Preston Corporation	.. 18	1,013	– 10	20**	19,492	+ 21
Rawtenstall	.. 21	2,092	– 214	20‖	36,389	+ 1,026
Rotherham Corporation	.. 18	1,236	+ 183	20	23,064	+ 2,288
Salford Corporation	.. ..	..	.. ..	..	.. ..	..
Sheffield Corporation	.. 22	9,326	+ 1,314	21‖	188,512	+ 19,586
Southampton Corpn.	.. 18	1,649	+ 144	20	30,313	+ 1,289
Southend Corporation	.. 18	1,332	+ 180	20	18,455	– 5,946
South Shields	.. 21	872	+ 119	20‖	16,775	– 108
St'lyb'dge,Hyde,&c.,Jt. B.	.. ..	..	.. ..	..	.. ..	..
Sunderland Corporation	.. 20	1,573	+ 50	21	31,524	– 1,365
Sunderland District	.. ..	..	.. ..	..	.. ..	..
Swindon Corporation	.. 18	211	– 11	20	4,071	+ 366
Tynemouth Trams Co.	.. 17	1,203	+ 41	20	4,069	+ 308
Wallasey Corporation	.. 21	1,508	– 64	22‖	27,877	– 790
Walsall Corporation	.. 21	847	– 15	34	24,331	+ 3,048
Wolverhampton Corpn.	.. 21	1,191	– 25	21	20,069	+ 2,213
Warrington Corporation	.. ..	..	.. ..	..	.. ..	..
West Ham Corporation	.. 19	3,470	+ 430	20	64,088	+ 5,400
Wigan Corporation	.. 19	1,523	+ 112	20	30,792	+ 99
Wolverhampton Corpn.	.. 18	1,124	+ 149	20	22,549	+ 205
Yorkshire W.R. Trams	.. 22	1,600	+ 208	34	53,860	+ 3,936

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ‖ Plus 3 days. ¶ Plus 2 days. ** Compared with one week more last year

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NOTES.

A Large Power System.

THE account which we give elsewhere of the electric supply system supplying San Francisco is of interest owing to the extent of the area that is covered. A consolidation of interests has taken place in recent years, with the result that a number of companies are now working together, and are supplying a connected load amounting to something like 500,000 H.P. The extent of the combined networks is seen in the fact that a supply is given to 222 municipalities, including 11 of the largest cities in California. There are at times 19 generating systems operating in parallel, and it might be thought that the paralleling of these stations at considerable distances apart would present some difficulties. Actually, however, it has been found that the paralleling of the various stations has presented no difficulty, whatever the length of line, and that this operation is carried out more easily than the paralleling of generators in the same station. Naturally in systems of this magnitude the controlling of the load is a very important operation. The "load dispatcher" is an official who is already known to us, but as far as we are aware we have only one system large enough in this country to render his help necessary. In the case of the San Francisco system the whole load is in the hands of a single dispatcher, who is in direct telephonic communication with the entire system. No operation can be carried out without first obtaining his consent, and in order to facilitate his operations he has before him a working model of the entire system. Every generating station, switching point, transmission line and sub-station is shown, and the switches are made up in dummy form for hand setting. It must, we imagine, take a very special type of engineer to stand this class of work for any length of time, but we suppose the necessity evolves the type. Another interesting point is the governing. Each station, with one exception, takes its allotted portion of the load and makes no attempt to govern unless there is a serious variation in frequency. The governing is simply left to one particular station, and, although all the important power houses are equipped with governors, these are set so as to be sluggish in action, and therefore do not operate except with wide variations of speed.

State Aid for Research.

AT a time when a good deal of thought is being given to the encouragement of research in this country, we have considered it desirable to reproduce at some length a report by Prof. R. A. GREGORY which appeared as an appendix to the recent annual report of the British Science Guild. Prof. GREGORY's figures put the position so clearly that they deserve wide publicity; and they also give an account of the subject which is not readily obtainable from other publications. The outstanding feature of the position is the paucity of the funds provided in this country, as compared with those in other countries, for scientific work. Perhaps this is emphasised most strikingly by the statement that the annual grants to the various scientific research departments of the Carnegie Institution of Washington amounted to £50,000 more than the total grant for purposes of scientific investigation included in our Civil Service estimates of the year under review. In making this comparison it must be borne in mind that the Carnegie Institution is the work of a single individual, who thought it desirable to make endowments amounting to £4,400,000 to "encourage, in the broadest and most liberal manner, investigation, research and discovery, and the application of knowledge to the improvement of mankind." Grants made by the trustees amount to nearly £250,000 annually.

By way of contrast, the annual grants made by Parliament for scientific investigation and similar services amount to about £100,000, but this sum includes an amount of £40,000 for the National Physical Laboratory and the Meteorological Office, whose services are rather national

than the prosecution of scientific research. The Parliamentary grants to universities and university colleges in England and Wales amount to about £267,000. The Scottish universities have the advantage of receiving £100,000 per annum from the Carnegie Trust, and the expenditure of this sum has been followed by marked results; a large number of original communications to scientific journals coming from those who have benefited by this particular trust. In Germany, on the other hand, the annual expenditure by the State on universities amounts in round figures to £1,800,000. In 1913 the expenditure of the University of Berlin alone was £242,000, and of this amount £200,000 was derived from State funds. Generally speaking the equipment of our universities is very poor compared with the equipment of the universities in Germany. We doubt, for example, if any German university would put such poor equipment as that in the Cavendish Laboratory at the disposal of a physicist like Sir J. J. Thomson. Our physicists and our chemists have done a marvellous work in maintaining the scientific standard of this country in the past, but this work has generally been carried out at a great disadvantage. It may possibly be a good thing to work under a certain amount of difficulty, but unless the Government sees the advantage of providing more ample funds we cannot expect the scientific men of this country to maintain their position against those of other countries which think it worth while to provide special facilities.

Contour Maps of Load Curves.

It is pointed out by Mr. Max du Bois that useful information is obtained by constructing load curves in three dimensions instead of two dimensions. The idea can be carried out, though not very conveniently, by cutting out the ordinary load curves so as to leave the area of the curve, and to stand these records on edge one against the other in order of date; thus a sort of relief map is obtained in which the hills denote periods of high load and valleys periods of low load, the height, say, from left to right giving variation with the time of day, and the variation at right angles to this giving that from day to day. Actually, this form of construction would, no doubt, not be necessary; a contour map would be made similar to that of which we give a small illustration in another column. The map which we reproduce is of some interest, as it shows the rapid falling off of power supplied in this particular undertaking in France after the declaration of war. It is also interesting, as showing in this instance a very satisfactory form of load in normal times, the night load being only about half the day load. Such maps would, no doubt, be rather troublesome in their preparation, but they might prove useful in cases where it is desired to see readily the number of units that are required above a certain power, or the amount of water that must be provided to supply the power during certain times of the year and so kindred problems.

"The Field Leakage of Turbo-Alternators."—Erratum. We are asked by Mr. E. G. Anderson to note the following errors in his article bearing the above title in our last issue: The word "inside" should read "outside" on page 765, second column, lines 16 and 22, and on page 767, first column, last line.

Royal Engineers (Wireless Section).—There are several commissions available in the Wireless Section of the Royal Engineers for general service during the period of the war. Applications are invited from candidates with good technical knowledge of wireless telegraphy and used to the control of men. Applications should be addressed to Major Handley, M.I.E.E., O.C., Wireless Training, Oxford Cottage, Sandown, I.W.

Electric Railways in Canada.—The annual report of the Ottawa Department of Railways and Canals for the year ended June 30 states that there are now 60 electric railways (including street railways) in Canada, aggregating 2,052·44 miles of single track.

There are four railway systems having over 100 miles of single track—viz., the British Columbia (345 miles), Montreal tramways (234 miles), Toronto railway (133 miles) and the Winnipeg railway (101 miles). The passengers carried during the year numbered 794,059,593 and the car-miles run were 98,917,808. The total capital expenditure is returned at $147,595,342, and the year's net earnings were $7,867,546, and after various deductions for reserve, &c., the surplus was $1,873,955. On one-third of the lines there was a deficit on the year's working.

Increasing the Life of A.C. Commutators.—Commutator life on the lines of the Indianapolis and Cincinnati Traction Company has been materially increased by applying an insulating paste filler in the commutator slots of the single-phase motors used by the Company. The commutator segments made by the slotting machine are filled with a mixture of dental plaster of Paris and hard-cooked starch in parts equal by weight made into a paste by adding gum shellac and stirring to a uniform consistency. This prevents carbon and copper dust from collecting in the slots. The paste is a fair insulator, and eliminates the destruction of the edges of the commutator bars by arcing, so often caused by the collection of copper dust in the slots.

Power and Pumping Plant at Medicine Hat.—According to the "Electrical News," of Canada, the city of Medicine Hat in Alberta, is now provided with a new electric pumping and power plant. The central station contains three 750 k.v.a condensing turbo-generators drawing steam from four 400 H.P water-tube gas-fired boilers. The units run at 3,600 revs per min. and deliver three-phase current at 2,200 volts and 60 cycles to three 3,000,000 gallon-a-day low-lift pumps and three high-lift pumps of the same capacity for operating the mechanical gravity filter plant. A Koerting ejector condenser is provided for each turbine, the injection water being taken from the discharge header of the low-lift pumps through a small centrifugal booster pump.

New Electric Car Sheds of the L. & N.W. Railway.—The work on the new electric lines of the London & North-Western Railway in the north of London is proceeding as fast as war conditions will allow. One of the largest undertakings involved is the construction of a huge shed for the new rolling stock at Willesden Junction. This when completed will house 17 coaches, the area covered approaching 18,000 sq. yds. There will be 21 running roads under cover, each having a pit through out its length. Electricity, taken from the mains of the Earl's Court line alongside, has been used in several ways to overcome the difficulties presented by the shortage of labour. An electric hoist is used to raise bricks to the top of the scaffold and an electric crane unloads material from barges on the Grand Junction Canal into trucks which are taken to the site by an electric locomotive. The contractors are Messrs. Scott Middleton.

"Constructional Data of Small Telescopic Objectives."—We have received a memoir giving data for the construction of achromatic object glasses for small telescopes, which has been prepared at the National Physical Laboratory. The work has been carried out by desire of the Director-General of Munitions Supply, and is intended for the assistance of opticians who may be engaged in the manufacture of optical instruments. The crown and flint glasses for which the calculations have been carried out are those contained in a recent list of optical glasses issued by Messrs. Chance Bros. The memoir is by Messrs. T. Smith and R. W. Cheshire, and is obtainable from

the publishers, Messrs. Harrison & Sons, 45, St. Martin's-lane, London, W.C., price 2s. 6d., excluding postage. The tables are copyright. It is hoped later to supplement the present publication by a further Paper dealing with the corrections which may be necessary in relation to object glasses of somewhat larger size, or when special conditions have to be met.

Interconnection of Large Stations in the United States.—The transmission network of the Montana Power Company, U.S.A., now covers a large area in Montana and Idaho and connects the following stations :—

	KW.
Madison River	11,000
Canyon Ferry	7,500
Hauser Lake	14,000
Big Hole	3,000
Butte	5,000
Rainbow Falls	21,000
Small plants aggregating	7,390
Total power developed	68,890

The following generating stations are under construction or in contemplation :—

	KW.
Great Falls	85,000
Holter	30,000
Thompson Falls	30,000
Snake River	20,000
Missoula River	10,000
Total power undeveloped	175,000

The total power capacity of the finished scheme will, therefore, be 244,000 kw. The earlier interconnecting transmission lines work at 50,000 volts and the later at 100,000 volts. 418,000 acre-feet of water can be stored in the Hebgen reservoir and the auxiliary reservoirs at the different power sites, but as some of this passes in turn through several installations on the Madison and Missouri Rivers the virtual storage capacity is far greater.

Street Lighting in Chicago.—The City of Chicago has the largest municipally-owned electric street lighting system in the world, having in operation at the present time 7,200, 100-c.p. series Tungsten lamps, 10,000 series flame arcs of the latest type, 8,000 600-c.p. type "C" Tungsten lamps, and 3,000 6-ampere enclosed arcs. The latter lamps are being rapidly displaced by the 600-c.p. type "C" units, and it is estimated that by the end of 1915 a total of 15,000 of these units will be installed. The following interesting comparison of operating costs under Chicago conditions was given recently by Mr. R. Palmer, of the Department of Gas and Electricity, Chicago.

Comparative Operating Costs under Chicago Conditions.

Items of Cost.	465 watt Flaming Arc.	325 watt Nitrogen Tungsten.
Power (@ $15 per H.P. per year)	$10·25	$7·16
Sub-station operation	1·00	0·70
Carbons or renewals	4·00	8·00
Repairs to lamps and fixtures	1·75	0·50
Globes	0·70	0·40
Trimming	3·80	...
Installing	2·70	1·99
Cleaning globes	(inc. in trimming)	1·73
Repairs to circuits and poles	5·40	5·20
Miscellaneous expense	0·23	0·23
Office expense and superintendence	0·30	0·45
	$31·12	$26·36
Fixed charges on aerial construction	19·19	14·30
Total annual cost per lamp	$50·31 (£10·1)	$40·66 (£8·1)

Fixed charges include interest at 4 per cent., taxes at 1·5 per cent., and depreciation at an average rate of 5·5 per cent. on lamps, posts, line construction, sub-station buildings and equipment, transformers, &c.

Metropolitan Munitions Committee. We [illegible] at the organisation of the Metropolitan Munitions Committee now practically complete and that most [illegible] being done. A central office has been established at Mandeville Place, Kingsway, with Mr. Cecil Partridge as [illegible] and Mr. Ireland as chief engineer, with a competent staff and commodious premises. The jurisdiction of the Committee extends over the whole of the Metropolitan Police area, which has been divided into 10 districts, each under a district manager associated with an assistant and a munitions engineer; and the following gentlemen have been appointed as district managers :—

District.	Name.	Address.
Northern	A. Hugh Seabrook (acting)	62, Finsbury pavement, E.C. (temporary address)
North-Western	E. T. Ruthven Murray	346, High-road, Kilburn, N.W.
Southern	A. C. Cramb	Town Hall, Croydon.
South-Eastern	W. G. Head	Borough Hall, Royal Hill, Greenwich, S.E.
South-Western	C. O. Grimshaw	6, Eccleston-place, S.W.
Eastern	C. Newton Russell	215/217, Bishopsgate, E.C.
East Central & part South-Eastern	E. Harlow	64, Bankside, S.E.
Western	R. S. Downe	Carnegie Library, Hammersmith, W.
Poplar & Stepney	G. M. Gill (temporary address)	East London College, Mile End, E.
Outer Eastern	S. H. Wood	Gas Works, Becton.

Any information likely to be of use in connection with the production of munitions, and all inquiries, offers of premises, of tools, plant or services, &c., should be directed to the General Manager, Metropolitan Munitions Committee, Alexandra House, Kingsway, or to one or other of the district managers, according to the district.

Static Electricity on Running Belts.—That the unavoidable slight slip of all running belts on their pulleys produces static charges of electricity in these two bodies has often been remarked, and it has sometimes been suggested that this has been the cause of mysterious explosions in powder works. Interest, therefore, attaches to a simple device for removing this charge, described by Mr. W. T. Estlick in the "Electrical Review and Western Electrician." This was used in a textile mill where cotton looms were running with rubber work, so that it was necessary to keep the room perfectly dry. These conditions caused the accumulation of large charges of electricity in the belts of the motors driving the looms, with the result that the belts attracted all the particles of lint floating about, eventually shaking them on to the yarn and making the work dirty. The bits of lint would also gather in the motor, and when this was blown out would settle on the work. On two occasions, also, a squirrel-cage motor burnt out, apparently from no other cause than that of the charge in the rotor discharging to earth by sparking across on to the stator winding and puncturing the insulation. Copper strips connected to earth were then placed above and below the belt, brushing lightly against it; after this no more burning out occurred, and the collection of the particles of lint was also prevented.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

Prof. E. Leconte contributes an article on "The Measurement of the Temperature of Solid Bodies" (p. 813).

We publish a further instalment of Dr. C. C. Garrard's article on "Apparatus for Protecting Electrical Machinery against Abnormal Electrical Conditions" (p. 805).

A description is given of the "Interconnected Systems Serving San Francisco" (p. 801).

We reproduce in abstract a Paper by Mr. N. W. Storer on "Economies in Power Consumption in Electric Railways" (p. 797). This is discussed in our Leading Article (p. 812).

A report by Prof. R. A. Gregory on "State Aid and Private Benefaction for Scientific Research and University Education" is reproduced at some length on page 810.

An abstract is given of a Paper by Mr. V. Stobie on "The Manufacture of Electric Steel in the Stobie Furnace" (p. 807).

We reproduce in digest abbreviated form an article on "The Operation and Rating of the Electric Locomotive," by Mr. A. H. Armstrong (p. 817).

A description of a method of representing "Load Curves" in Relief," by Mr. M. Du Bois, is given on page 811.

OBITUARY.

J. A. Seager.—We regret to record the death recently of Mr. J. A. Seager, B.Sc., who for on a number of occasions contributed to our columns and those of our contemporaries. Mr. Seager was an old Merchant Venturer, and his first journalistic work was done when he was a shift engineer at the Bow station of the Charing Cross and City Company, some 10 years ago. He subsequently produced the "Tyneside Electrical Pioneer" for the Newcastle-on-Tyne Electric Supply Co., and organised and conducted their business-getting and publicity department. During the later years of his life he was a free lance journalist, and in this capacity had made many friends. His loss is to be greatly regretted, because he was a promising figure in the field of technical journalism.

Henry Crookes.—We regret to record the death of Mr. Henry Crookes, in his 57th year, the eldest son of Sir William Crookes, P.R.S.

Killed in Action.—We regret to announce the death of Lieut. L. L. Rees-Mogg, R.E. At Sidney Sussex College, Cambridge, he took a first class in the Mechanical Science Tripos and graduated B.A. in 1911, and was elected to a B.A. scholarship of his college. He was a member of the University O.T.C. He afterwards went to Messrs. Willans & Robinson's engineering works at Rugby. He was gazetted Second Lieutenant, R.E. (Reserve of Officers), in February, 1913, and Lieutenant in June last. He was in his 26th year.

The death is also reported of Capt. Lionel G. O. Townsend, South Staffordshire Regiment, 7th Battalion, the only son of Mr. Oliver C. Townsend and Mrs. Townsend, Lawnside, Hagley, Worcestershire. Not very long ago he was on the engineering staff of the Dundee Corporation electric supply system.

The country loses a brilliant young physicist in Second Lieutenant Henry Gwyn-Jeffreys Moseley, M.A., Trinity College, Oxford, Royal Engineers, who was killed at the Dardanelles on August 10th. He was the only son of the late Prof. H. N. Moseley, and was educated at Eton and at Trinity College, Oxford, where he held a Millard scholarship. He was at one time Lecturer and Demonstrator in Physics, under Sir E. Rutherford at Manchester, where, after two years, he was awarded the John Harling Fellowship for Research. He then returned to Oxford where he continued his work in Prof. Townsend's laboratory. His publications were chiefly on radio-activity and X-rays.

It is also announced that Capt. John Miller, 6th Royal Welsh Fusiliers, was killed in action on Aug. 16, at the Dardanelles. Capt. Miller was on the permanent engineering staff of Messrs. Guinness & Co., and was a prominent member of the Engineering and Scientific Association, Ireland, of which he was president when war was declared.

PERSONAL.

Senor Ricardo Lopez has been appointed Chief of Constructions of the Argentina National Telegraph Department.

Royal Engineers (T.F.)—The following promotions have been made:—

London Electrical Engineers.—Lieuts. H. C. C. Tufnell, H. M. Edmunds, W. P. Digby to be temporary Captains. Second-Lieuts. T. W. G. Acland, S. Matthews, R. C. Milliken to be temporary Lieutenants. Capt. H. E. Webb-Bowen to be temporary Major.

APPOINTMENTS VACANT AND FILLED.

An instructor in mechanical and electrical engineering is wanted for the Wandsworth Technical Institute. Salary £150 per annum. Applications to the Principal, Gladstone-road, Wimbledon. *See advertisement.*

Armature and stator winders are required for railway work in the London district. *See advertisement.*

The University of London is about to appoint a principal officer at a salary of £2,000 a year. Names of those desirous that their names should be considered should reach the Secretary to the Senate, University of London, South Kensington, S.W., by Sept. 15.

The Municipal Council of Sydney (N.S.W.) invite applications for the position of deputy general manager of the electricity supply department. Salary £650, rising to £700 per annum. Applications to be received by Mr. [illegible], by Sept. 13.

Mr. [illegible] has been appointed lecturer in mechanical engineering at the University of Perth, W. Australia. Mr. [illegible] has been an assistant electrical engineering examiner to the Victorian Mines Department.

Mr. S. H. E. Barraclough, lecturer in mechanical engineering at Sydney (N.S.W.) University, has been appointed to the chair of mechanical engineering at the university.

INSTITUTIONS AND SOCIETIES.

Iron and Steel Institute.—The autumn meeting of the Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, Sept. 23 and 24, commencing at 10:30 a.m. on the 23rd and at 10 a.m. on the 24th. In the absence of Mr. Greiner, Mr. Arthur Cooper, LL.D. (immediate Past President), will preside at the meeting. On Thursday a selection of Papers will be read in abstract and discussed; and the Council will give notice of amendment of bye-laws for the removal from the Institute during war time of members who are subjects of enemy countries. On Friday a further selection of Papers will be read in abstract and discussed. Among the Papers that will be read we notice one on the "Influence of Heat-treatment on the Specific Resistance and Chemical Constitution of Carbon Steels," by Prof. E. D. Campbell, and one on "The Magnetic Transformation of Cementite," by R. H. Smith.

Institute of Chemistry.—In the "Proceedings of the Council" of the Institute of Chemistry it is stated that in March the Royal Society submitted a memorial to the Prime Minister directing attention to the position of certain chemical industries in this country as revealed by the effects of the war, and recommending more co-operation between manufacturers and scientific workers, and an increase of research work. Afterwards the President of the Board of Trade received a joint deputation from the Royal Society and the Chemical Society, with representatives from the Councils of the Institute of Chemistry, the Society of Chemical Industry and the Society of Public Analysts. Prof. Raphael Meldola was first appointed as the representative of the Institute, but because of his illness Mr. E. W. Voelcker, vice-president and Prof. Herbert Jackson were appointed. Later Mr. Pease announced in the House of Commons that the Government would appoint an Advisory Council on Industrial Research, and that from £25,000 to £30,000 was likely to be devoted to research purposes this year. After Mr. Henderson had succeeded Mr. Pease as President of the Board of Education, the particulars of the "Scheme for the Organisation and Development of Scientific and Industrial Research," were published. The Council of the Institute have greatly assisted the Government in obtaining the help of professional chemists for work connected with the war, lists of Fellows and Associates available for appointments being prepared, as well as a larger list of many graduates and students not on the Register of the Institute. A number of the Fellows of the Institute have been granted commissions in the R.A.M.C., and others are engaged on analytical work. A special committee has been appointed jointly by the Institute and the Chemical Society to consider glass manufacture, and the chemistry of hygiene, on which are serving Prof. R. Meldola, Prof. H. Jackson and Mr. T. R. Merton, of the Institute's Glass Research Committee. This last committee carried out work of direct value to manufacturers, some of the most interesting researches dealing with the cause of the phosphorescent glow in X ray bulbs. In January last Prof. Meldola, then President, addressed a letter to the Government drawing attention to the importance of cotton in the manufacture of explosives, in answer to which an assurance was received that the Council would be consulted if necessary. The new premises of the Institute are nearing completion.

ARRANGEMENTS FOR THE WEEK.

BRITISH ASSOCIATION.

September 7th.

8 p.m. Presidential Address by Prof. A. Schuster, F.R.S., at the Free Trade Hall, Manchester.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week ending Sept. 11, 1915:—

Monday.—Drills 6.30 to 7.30 and 7.30 to 8.30. Section III., Technical Instruction. Section I., Musketry at the Miniature Ranges. Sections II. and IV., Squad Drill.

Friday.—Drills 6.30 to 7.30 and 7.30 to 8.30. Section IV., Technical Instruction. Section II., Musketry at the Miniature Ranges. Sections I. and III., Squad Drill.

Signalling.—It is proposed to form a signalling class and the names of those wishing to join should be given at once to the section commanders.

ECONOMIES IN POWER CONSUMPTION IN ELECTRIC RAILWAYS.*

BY N. W. STORER.

In April, 1912, in a Paper before the A.I.E.E. at its New York meeting, Samuel Insull presented a very strong and convincing argument in favour of large central power stations as against a number of isolated plants. One of his strongest arguments was the enormous saving in fuel that would result on account of the higher efficiency and better load factor with the larger plant. Taken in the aggregate, the figures given were startling and have shown not merely an immense saving in dollars and cents, but a large step towards the conservation of our nation's fuel supply. He estimated that if this system of power generation were adopted for the entire country it would result in a saving of over 200,000,000 tons of coal per annum—a most stupendous amount. Mr. Insull pointed out that the electric railways in any community would not require more than 15 to 20 per cent. of the total power used, but where figures such as that are involved, it is well worth to try to save a small part of that percentage; for instance, it is probable that not far from 1,000,000 tons of coal will be burned in Chicago this year to furnish power for the electric railways. Chicago has good reason to be proud of her electric railways, yet I do not doubt that if an entirely new equipment of cars were to be installed with all of the economies that can be introduced with our present knowledge, not less than 40 per cent. and possibly 50 per cent. of that 1,000,000 tons of coal could be saved

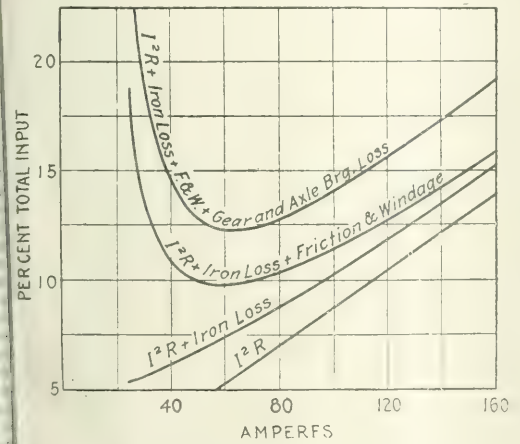


FIG. 1.—LOSSES IN 500-VOLT 50 H.P. MOTOR.

very year. Since some of the cars that have been installed on the Chicago surface lines in the last two years have cut the power consumption per car-mile by reduction in weight, field control, &c., to less than 67 per cent. of that of older cars of the same capacity, it can be seen at once that the above statement is not [illegible] as it looks. It is the purpose of this Paper to show how some of the savings have been effected and to explain in some detail the possibilities of further economies, especially from the standpoint of the electrical equipment.

A large part of the energy now consumed, considered in the light of the present knowledge and the best modern practice, is wasted, but on account of the large amount of money invested it will continue to be wasted until the older cars and equipments are worn out. In fact, a great deal of power is still wasted, even in the most modern equipments, if the possibilities are considered.

In taking up the question, there are two things to consider:

1st—The weight to be handled.

2nd—The efficiency of the equipment for handling it.

There is one idea that has been drilled into [illegible] in this country, in the last few years to such a [illegible] I should like to record a protest to many of them [illegible] every pound of weight on a street car costs the company [illegible] per annum. I base on the whole produced goodwill [illegible] a great deal has been done in this respect in Chicago, where the weight of the cars on the surface lines [illegible] and [illegible] of these cars on the surface lines [illegible] was cut about 25 per cent. A part of this reduction lies in the use of two motor equipments with maximum traction instead of four motor equipments. This change would, of course, save a great deal of weight if the same total motor capacity were necessary. A reduction in weight of the entire equipment, however, made it possible to use two 50 H.P. motors where four 40's had been used on the older cars. Moreover, the modern 50 H.P. motor weighs no more than the old 40, so that the two motors on the new cars weigh only half as much as the four motors on the old cars. It is beyond my province to tell how the trucks and car bodies were lightened except to say that it was done by a design that made every pound of material in them perform some necessary function.

Coming to efficiency, the energy consumed by an electric car or locomotive is practically all dissipated in the following ways: (1) In overcoming train resistance; (2) in ascending grades; (3) in motor losses; (4) in gears and motor axle bearings; (5) in rheostats; (6) in auxiliaries; (7) in brakes.

The importance of train resistance may be judged from the simple formula for power consumption necessary to overcome it. Twice the train resistance in pounds per ton divided by the motor efficiency equals watt-hours per ton-mile. The train resistance of a street car probably varies on account of local conditions between the limits of 10 lb. and 20 lb. per ton, so that, assuming 80 per cent. average efficiency for the motor, the energy required to overcome train resistance varies from 25 to 50 watt-hours per ton-mile. The total power consumption for street cars usually varies from 120 to 180 watt-hours per ton-mile, so that probably not more than 25 per cent. is used in overcoming train resistance.

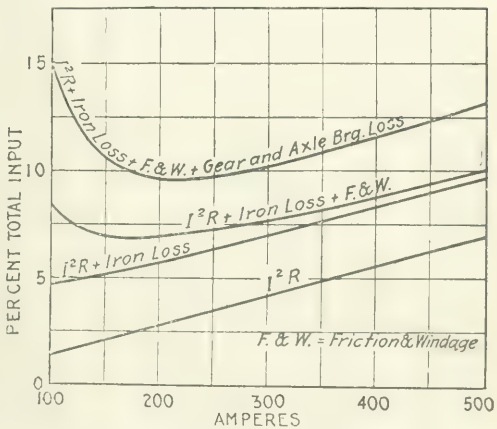


FIG. 2.—LOSSES IN 550-VOLT 210 H.P. MOTOR.

Journal friction is one element that can be greatly reduced. This amounts to probably not more than 6 lb. per ton in average service, but can be practically eliminated by the use of ball or roller bearings. This may save from 6 to 15 watt-hours per ton-mile, and possibly more. In high-speed railroading, the question of air resistance becomes one of considerable magnitude. The resistance offered by the air is due not only to the pressure at the front end but to friction on the sides. The head resistance of an ordinary car at a speed of 60 miles per hour amounts to 800 lb. to 1,000 lb. and requires from 110 kw. to 150 kw. to overcome it. Every projection on the car that creates an eddy in the atmosphere increases this amount.

Motor Losses.

The efficiency of a railway motor varies from 80 to 90 per cent., small motors ordinarily used in city service having a maximum efficiency, including gears and axle bearings, of 85 to 86 per cent., while large motors run 2 to 3 per cent. higher. The motor losses consist of the I^2R losses in the armature, field windings and brushes; the [illegible] losses in armature iron and pole faces, eddy current losses in bands and armature windings due to rotation in the magnetic field; and friction losses in bearings, brushes and windage. Figs. 1 and 2 show the loss curves for two typical railway motors that are used in large numbers. The [illegible] commutating pole type motor.

In other types of railway motors [illegible] the use of the art [illegible] such [illegible] control [illegible] for an increase [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] iron [illegible]

* Abstract of a Paper read before the Western Society of Engineers (U.S.A.).

sive motor. A full discussion of efficiency is, therefore, unnecessary, but it is desirable to consider briefly the losses due to friction and windage. To show their relative importance I have translated them from watts to train resistance. A motor of 40 H.P. to 50 H.P. with ordinary speed characteristics will have approximately 400 watts friction loss at a car speed of 10 miles per hour; this power translated into train resistance is equivalent to 20 lb. A two-motor equipment would then add 40 lb. to the total train resistance. With a car weighing 20 tons loaded, the armature friction and windage then amounts to 2 lb. per ton.

Rheostatic Losses.

The rheostatic loss for straight parallel control may be illustrated in the following formula where A is the current for one motor, T the time to reach the motor curve, and E the line voltage; rheostatic loss $=2A\times0{\cdot}45E\times T=0{\cdot}90AET$. The total power taken from the line during this acceleration is 2AET, and 45 per cent. is therefore lost in the rheostat. This is on the basis of 10 per cent. drop of voltage in the motor at starting; *i.e.*, a loss of 90 per cent. in rheostat at starting, or an average of 45 per cent. which the rheostat is in circuit. In series parallel the total time will be divided between series and parallel in the ratios of the counter E.M.F.'s after the resistance is cut out. In this case it will be in the ratio of 40 to 90 or 44·4 per cent. of the time will be spent in series and 55·6 per cent. in parallel up to the time the motor curve is reached.

Thus the rheostatic loss $=A\times0{\cdot}40E\times0{\cdot}444T+2A\times0{\cdot}25E\times0{\cdot}556T$ $=0{\cdot}456AET$. The total power from the line in this case is $AE\times0{\cdot}444T+2AE\times0{\cdot}556T=1{\cdot}556AET$.

The rheostatic loss is thus cut almost in half by using series parallel instead of parallel control, and the total power during acceleration on resistance was reduced by this means over 22 per cent. The use of four motor equipments makes it possible to go still further and use full series, series parallel and parallel control. But since the rheostatic loss in ordinary city service is only 12 to 20 per cent. of the total power used, the saving resulting from starting with four motors

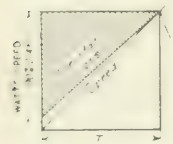


Fig. 3.

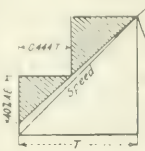


Fig. 4.

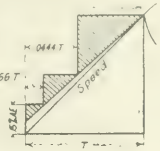


Fig. 5.

Saving of Energy by Series-Parallel Control.

in series will scarcely exceed 2·5 per cent. of the total power used, unless there is a great deal of operation at extremely low speeds. Figs. 3, 4 and 5 show the losses in the three cases as shaded areas.

The rheostatic loss (other things being equal) varies as the square of the speed at which the motor curve is reached in acceleration. This being true, the characteristics of the motors themselves, and also the rate of acceleration must have a great deal to do with the rheostatic loss. For example, a motor with a steep speed characteristic, geared for a certain schedule speed, will reach the motor curve at a lower speed than one with a flat speed curve geared to the same speed, and will, therefore, have less rheostatic loss. A higher rate of acceleration will also reach the motor curve at a lower speed, especially with an unsaturated motor. This reduces the rheostatic loss in the same way.

The shape of the speed curve has been too often left out of consideration because the unsaturated motor (the one with the steep speed curve) is usually slightly heavier than the saturated motor of the same rated [illegible] speed, and stress has been laid on the [illegible] of the motor at the expense of efficient operation. It, of course, saves power to lighten the car equipment, but if it is followed to the extreme of efficiency the net result may be worse than with a heavier equipment.

[illegible] control in rheostatic losses is one which was [illegible] the old type of the street railway motor and used [illegible] to be the accepted practice to use additional [illegible] which were all of the straight parallel type. After the series parallel controller and the single reduction motor were introduced, this control of the field as a means [illegible] speed [illegible] reduction of rheostatic [illegible] the [illegible] of the series field construction [illegible] the [illegible] motor [illegible] field control [illegible] to 90 per cent. and sometimes as much as 20 per cent. in the power consumption. To get the best results the motor should be geared to give the highest speed desired with the short or permanent field. The full field speed curve should be 20 to 25 per cent. or more if possible, lower than the short field speed curve at the accelerating tractive effort. Referring to Fig. 4 and assuming that the full speed of the motor at the accelerating tractive effort is 20 per cent. below that of the short field, and that the same rate of acceleration is maintained, a field control equipment would perform

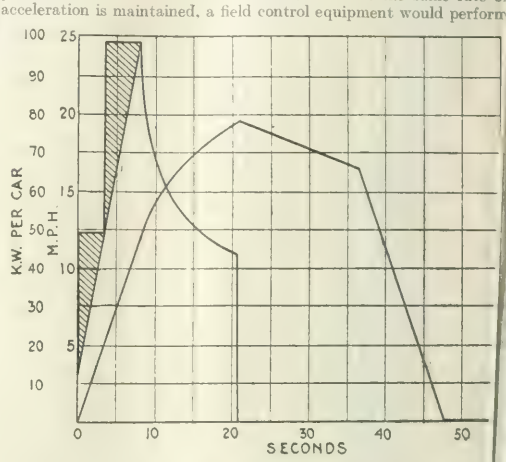


Fig. 6.—Speed-time Curve showing Rheostatic Losses (Shade with Simple Series-Parallel Control.

Data: Weight of loaded [illegible] two 50-h.p. 500-volt motors; rate of acceleration and braking, 1½ m.p.h.p.s.; 33 in. wheels; gear ratio 16:68; watt-hrs. per ton mile, 11[illegible]

the service indicated in Fig. 4, with approximately one-half the rheostatic loss. Where the balancing speed on short field is higher than that of the non-field control equipment, a still further saving in power consumption will result on account of the more rapid acceleration on the motor curve permitting a longer coasting period and consequently a lower speed at the time the brakes are applied and less loss in them. Where stops are frequent the use of field control thus effects a very substantial saving in power consumption. Figs. 6 and 7 show speed time curves of typical conditions of service on street railways. Fig. 6 shows the typical run with stand

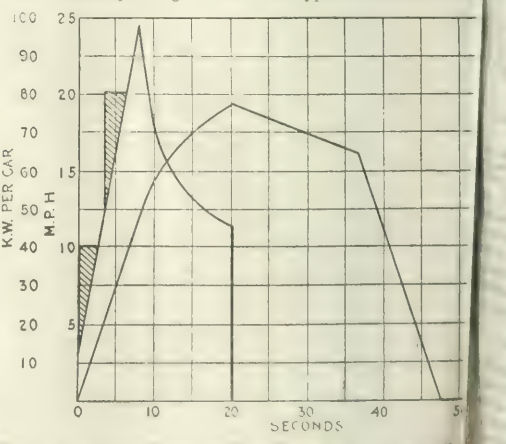


Fig. 7. Speed-time Curve for Same Car as in Fig. 6, with Field Control.

[illegible] p. [illegible] e 1038.

motor without field control, and Fig. 7 shows the same run under identical conditions of load and speed, but with field control. The difference in rheostatic losses is clearly shown.

Fig. 8 shows a set of general curves that may be applied to almost any condition of acceleration on electric railways with reasonable accuracy. The curves are intended primarily to show the theoretical losses entailed in accelerating 1 ton under certain conditions of rate, efficiency, train resistance and rate of acceleration with and wit[illegible]

field control. With these curves are included others showing watt-hours input and output or energy used in overcoming train resistance, all plotted in terms of speed at which the motor curve is reached.

For instance, take the speed time curve in Fig. 6. The energy stored in the train at the time brakes are applied is all lost, either in brakes or in overcoming train resistance during braking. The brakes were applied at 16·3 miles per hour. Reference to stored energy curve in Fig. 8 shows that at this speed 7·5 watt-hours per ton are stored. Part of this (4 watt-hours) was stored while accelerating on resistance at an efficiency of 56 per cent. (approximate); the remainder (3·5 watt-hours) with motors accelerating on motor curve at an efficiency of about 83 per cent. The first portion, 4 watt-hours at 56 per cent. efficiency takes 7·15 from line. The second portion, 3·5 at 83 per cent. efficiency, takes 4·22 from line, or a total of 11·37 for each stop, or 68·22 watt-hours per ton-mile. The train resistance of 20 lb. per ton would normally require with average efficiency of 80 per cent., 50 watt-hours per ton-mile, but since we have already included the braking period, that distance, or 13·5 per cent., must be deducted, leaving 43·25. The total per ton-mile then is 68·22 + 43·25 = 111·47 as compared to 112·8, given by Fig. 6.

The ratio between the sum of the curves of stored energy and friction to the curve of input is the efficiency of the equipment during acceleration to the motor curve. With the conditions of motor efficiency, train resistance, &c., assumed here, this efficiency is found to be approximately 56 per cent. It will hold approximately constant regardless of the time of acceleration, or whether on level or

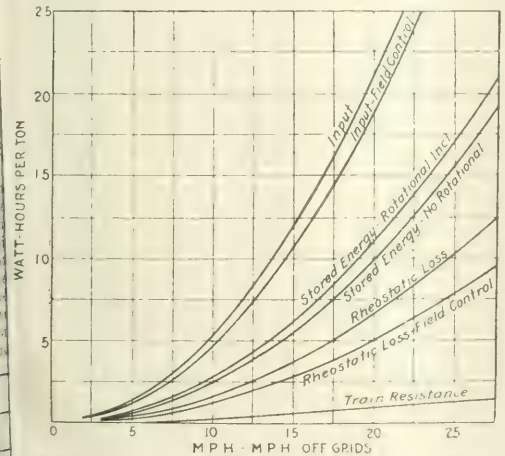


Fig. 8.—Analysis of Power Consumption in Straight Line Acceleration.

Data: Weight, 1 ton; acceleration, 1·7 m.p.h.p.s.; acceleration force, 183 lb.; trol, series-parallel, with and without field control; motor efficiency at full voltage, per cent.

ele. The rheostatic loss with a given tractive effort is directly oportional to the rate of acceleration; in other words, if the car re starting on a grade that would cut out the rate of acceleration half, the time on the rheostat would be doubled and the rheostatic s double that shown on the curve. This is a very convenient ve to have, since everything is plotted in terms of watt-hours per t. It is a good check on speed time curves.

Losses in Brakes and Regenerative Control.

his portion of the energy used by electric railways is usually e part of the total, and is in most cases entirely wasted. How to vent this waste of energy, which not infrequently amounts to 30 per cent of the total used by the car, has been a regular will o' the wisp to a great many engineers. The accomplishment of this would be that of far greater moment than any other single portion of the total energy used, and is worthy of the most careful attention.

me of the schemes for saving this energy is that of elevating the ion tracks above those between stations, thus changing the tic energy of the moving train to the potential energy of the on an elevation. This is theoretically the most efficient method can be devised, but a little consideration of it will show why it not been more often used. In order to conform to the usual kly an idea of the requirements for such a system I have shown ing. 9 a curve showing the heights to which station tracks would to be elevated in order to change all of the kinetic to potential

energy for various speeds. The speed time curve in Fig. 6 shows the brakes applied at a speed of 16·3 miles per hour. Assuming that the rotational energy of the train is sufficient to balance the train resistance, it would be necessary to elevate the track at every stopping place 8·9 ft. in order to save the energy that is dissipated in brakes on this typical run. This is, of course, out of the question for a street

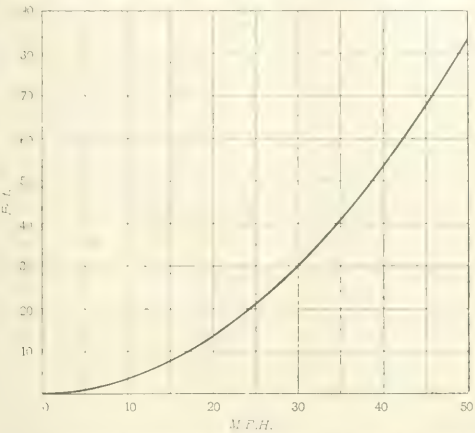


Fig. 9.—Curve showing heights to which Station Tracks must be raised for various speeds to turn kinetic energy of train into potential energy.

railway. A train stopping from a speed of 25 miles per hour, which corresponds to elevated railway service, would require station tracks elevated 21 ft. in order to store the energy lost in stopping. A train running at a speed of 40 miles per hour would climb to an elevation of over 50 ft. before coming to a stop. These figures are sufficient to show the impracticability of this method of saving the kinetic energy in a train for any class of service except subway and elevated

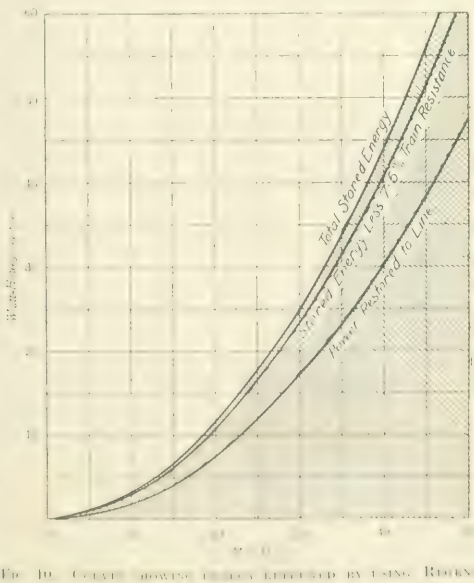


Fig. 10.—Curve showing Energy Returned by Using Rheostatic Braking for Stopping.

railways where the number and location of stops are quite definite. Even in such service the scheme is open to the following objections, which make it impracticable:—

1. It would greatly increase the cost of any construction.
2. Elevated railway stations would be so high as to require elevators to take passengers to and from the streets.

3. It is possible to, [illegible] stations. With [illegible] cars [illegible] the average [illegible] would be decreased, due to the fact that only a part of the train is on the grade at one time. About all that can be done with such trains is to mount a long, low grade before braking actually begins and ending so that the entire train can be on level track at the station. This grade would have to be mounted during the coasting period, which would slow down the schedule unless the motors were geared for higher speed.

The use of the electric driving motors as generators returning energy to the line during braking periods was one of the earliest arguments in favour of electric traction. It has been realised only to a very limited extent in actual service. The three-phase railways in Italy and Switzerland were the first to use this plan in extensive commercial service. It is well known that an induction motor driven above synchronous speed will act as a generator and will supply power to the system from which it derives its magnetising current. A locomotive driven by induction motors will, when connected to the line, therefore maintain a practically constant speed regardless of whether it is going up hill or down. In the former case it takes power from the line; in the latter, feeds power into the line. This system is now used with marked success on the Italian State Railways and is also used on the split-phase locomotives that will shortly be put in service on the Norfolk and Western Railway. The operation of the latter locomotives is exactly the same as that of three-phase locomotives, both in running and in regenerating. The advantage of being able to hold a heavy train without the use of brakes when descending a mountain grade is of far greater importance than the mere saving of power would indicate. The wear and tear on brakes on these heavy grades is enormous, and there is a continual danger from accidents, all of which are overcome by the use of regenerative control. The locomotives have been a perfect revelation to the operating men on the Norfolk and Western in this respect.

Induction motors can be used to some extent for stopping trains that are running above the minimum synchronous speed, by changing the motors from the high speed to the lower speed combination and gradually reducing the speed by means of the resistance in the secondaries of the motor. They are, however, not particularly efficient for such work on account of the rheostatic loss and the fact that the minimum speed that can be reached in braking is the lowest synchronous speed.

With direct current on the line, regeneration has been accomplished by the use of shunt motors, but these have been used only to a very limited extent and chiefly in Europe. Shunt motors are similar to induction motors in being inherently constant speed machines. The shunt motor, however, has the advantage of a wide range of speeds which are secured by changes in the field strength. For this reason, it is much more efficient for stopping trains than the induction motor. It has the disadvantage of not being suitable for railway operation on account of its liability to flash under sudden changes of voltage which are bound to occur on any railway line.

The shunt motor is also necessarily larger and more expensive than the ordinary series motor, is less fool-proof and requires a more complicated control system. These reasons appear to have been ample thus far to prevent its extensive use.

In order to show the possibility of regenerative braking for stopping trains Fig. 10 is given. This shows the stored energy in terms of watt-hours per ton and speed in miles per hour, the portion of this that would be required for overcoming train resistance assumed to be 15 lb. per ton with a braking rate of 2 miles per hour per second, and the portion that could be regenerated, assuming that the train could be brought to rest by regeneration with an average efficiency of 75 per cent. This is as much as can reasonably be hoped for in the present stage of the art, but shows plainly the great stake for which to work. The speed time curve shown in Fig. 6 shows the braking applied at a speed of 16·3 miles per hour. Even with the high train resistance of 20 lb. per ton and the low braking rate of 1·5 miles per hour per second assumed for this typical run, 27·5 watt-hours per ton-mile, or approximately 25 per cent. of the total power used [illegible] to the fact that it was possible to regenerate at 75 per cent. efficiency, could be brought [illegible]. Even with an efficiency of only 50 per cent., 18 watt-hours per ton-mile, or over 16 per cent. of the energy would be saved.

In the [illegible] the essentials of an equipment for regenerative braking with direct-current motors are the use of the standard series-wound motors and a control equipment that would add but little weight and complication to that used without regenerative [illegible] and [illegible] would [illegible] additional [illegible] cost of maintenance and additional [illegible] would be [illegible]. The point would [illegible] be reached where [illegible] would [illegible] the saving.

ON THE CALCULATION OF ELECTRIC WINDINGS.*

BY G. MEYER.

The method of calculation here suggested has for its main feature the use of a magnitude q/F, which is obtained as follows: Ohm's law may be stated

$$I = \frac{EI}{L} = \frac{l_m \cdot cQF}{E \cdot 1{,}000 \cdot \rho},$$

where l is the mean length of one turn of the winding in millimetres, n the number of turns, q the cross-section of the conductor in square millimetres, and s a specific resistance of the metal forming the conductor corresponding to a length of 1 metre and a cross-section of 1 sq. millimetre, c is the loading—*i.e.*, maximum current in amperes per square millimetre, Q the cross-section of the coil (cross-section of the winding space) in square millimetres (the area of the section of one side only of the ring being taken), and F is a fraction which gives the amount of copper in unit cross-section of the coil.

From the above it will be seen that

$$\frac{q}{F} = \frac{cl}{1{,}000 \cdot E}$$

The following table gives values of q/F for enamelled, double silk-covered and double cotton-covered wire, viz:—

d. Diameter of bare wire in mm.	q. Copper cross-section in sq. mm.	q F. Enamel.	D.S.C.	D.C.C.
0·07	0·003885	0·00671	0·0170	...
0·08	0·005503	0·00832	0·0195	...
0·10	0·007854	0·01245	0·0250	...
0·12	0·01131	0·01695	0·0312	...
0·15	0·01767	0·0250	0·0419	0·106
0·18	0·02545	0·0346	0·0540	0·139
0·20	0·03514	0·0418	0·0632	0·175
0·22	0·03801	0·04498	0·0727	0·191
0·25	0·04901	0·06630	0·0886	0·216
0·30	0·07067	0·08886	0·1183	0·262
0·35	0·09962	0·1195	0·1525	0·311
0·40	0·1426	0·154	0·191	0·425
0·45	0·1590	0·192	0·234	0·486
0·50	0·1906	0·236	0·282	0·555
0·55	0·2378	0·283	0·333	0·624
0·60	0·2827	0·334	0·389	0·700
0·65	0·3332	0·393	0·448	0·781
0·70	0·3805	0·453	0·513	0·900
0·80	0·5026	0·588	0·671	1·085
0·90	0·6362	0·741	0·831	1·285
1·00	0·7854	0·913	1·010	1·699
1·10	0·9503	1·098	1·245	1·95
1·20	1·131	1·301	1·461	2·21
1·30	1·327	1·528	1·695	2·50
1·40	1·539	1·77	1·945	2·80
1·50	1·767	2·03	2·22	3·125
1·60	2·011	2·30	2·50	3·46
1·70	2·270	2·60	2·80	3·82
1·80	2·545	...	3·13	4·18
1·90	2·835	...	3·46	4·58
2·0	3·142	...	3·82	4·99
2·1	3·464	...	4·18	5·41
2·2	3·801	...	4·58	5·84
2·3	4·155	...	4·98	6·30
2·4	4·524	...	5·40	6·78
2·5	4·909	...	5·85	7·28
2·6	5·31	...	6·30	7·78
2·7	5·73	...	6·78	8·31
2·8	6·16	...	7·27	8·86
2·9	6·61	...	7·78	9·42
3·0	7·07	...	8·32	10·02
3·1	7·55	...	...	11·20
3·2	8·04	...	...	11·85
3·3	8·55	...	...	12·50
3·4	9·08	...	...	13·15
3·5	9·62	...	...	13·83
3·6	10·18	...	...	14·52
3·7	10·75	...	...	15·25
3·8	11·34	...	...	16·00
3·9	11·95	...	...	16·75
4·0	12·57	...	...	17·50
4·5	15·90	...	...	21·6
5·0	19·64	...	...	26·1
5·5	23·76	...	...	31·1
6·0	28·27	...	...	36·5

* Abstract of an article in the "Elektrotechnische Zeitschrift," Vol. XXXVI., pp. 2-4.

In using the above table, for wires of circular section, Q should be taken as equal to $(\sqrt{3}/2)nD^2$ (where D = the overall diameter of the insulated conductor), on the assumption that the turns of each layer of the winding lie in the channels formed between the turns of the layer beneath. This gives

$$F = \frac{\frac{d^2\pi n}{4}}{\frac{\sqrt{3}}{2} nD^2} = \frac{\pi}{2\sqrt{3}} \cdot \frac{d^2}{D^2}$$

If, however, the conductors in successive layers are to be taken as lying directly over each other, $Q = nD^2$. This, however, may cause errors amounting in some cases to 12 per cent.

The method of calculation is as follows :—

(a) To Determine the Cross-section of Conductor.—If the dimensions of the coil and the pressure are given the formula

$$\frac{q}{F} = \frac{cs}{1{,}000} \cdot \frac{Ql}{E}$$

is employed. Here the product of the length and breadth of the cross-section of the coil is used for Q, and the mean length of a turn for l (all in millimetres). The product cs generally remains the same with coils used for similar purposes. When the value of q/F has been determined, the value of d or q can be obtained at once from the table.

(b) To Determine the Current.—The procedure given under *(a)* is followed and the value given in Column 2 of the table for q is multiplied by c, since $I = qc$.

(c) To Determine the Pressure.—Assuming the cross-section q to be known, or to be calculated from the current according to the equation given sub *(b)*, the corresponding value of q/F is obtained from the table. E can then be calculated from the equation :—

$$E = \frac{cs}{1{,}000} \cdot \frac{Ql}{\frac{q}{F}}$$

(d) To Determine the Dimensions of the Coil, the Current and the Pressure being Known.—First the cross-section of the conductor is calculated from the formula $q = I/c$.

Then the corresponding value of q/F is obtained from the table. This is introduced into the equation,

$$Ql = \frac{q}{F} \cdot \frac{1{,}000\,E}{cs},$$

where Ql is the product of the desired dimensions of the coil—viz., length of cross-section of coil × width of cross-section of coil × mean length of one turn. In selecting values for these three factors, it must be remembered that l/π must be greater than the width of the cross-section of the coil.

(e) To Determine the Cross-section of Coil, the Thickness of the Wire, the Number of Turns and the Current, the Strength of Field (H) *being Given.*—Starting from Ohm's law,

$$I = \frac{RI}{E} = \frac{lcsI}{1{,}000\,qE},$$

and since the number of ampere-turns N required is proportional to the strength of the field multiplied by the length of the lines of force in centimetres and $N = nI$, the cross-section q can be calculated from the equation

$$q = \frac{lN}{1{,}000\,E}$$

The corresponding value of q/F can then be obtained from the table, and Q calculated from the equation,

$$Q = \frac{q}{F} \cdot \frac{N}{cq}$$

The current $I = cq$ and the number of turns $n = N/cq$, it will be seen from the equation for Q_1 have already been determined.

The following example is given of the use of the method : An apparatus is to be provided with 100 equal electromagnet coils, of which each has a field strength H of 25 ampere-turns per centimetre length of the lines of force. The length of the lines of force corresponding to each coil is 15·4 cm., so that each coil must have $25 \times 15{\cdot}4 = 385$ ampere-turns. The 100 coils are to be connected in series on to a direct-current network, the true pressure of which is 109·4 volts. Each coil will thus have an available pressure of 1·094 volts. The space available for the coil permits a mean length of turn $l = 250$ mm. Silk-covered copper wire with $s = 0{\cdot}0175$ ohm per metre of 1 sq. mm. cross-section is to be used. The loading $c = 2{\cdot}5$ A/mm². Then the copper cross-section

$$q = \frac{lN}{1{,}000E} = \frac{0{\cdot}0175 \cdot 385 \cdot 250}{1{,}000 \cdot 1{\cdot}094} = 1{\cdot}539 \text{ mm}^2.$$

From the table it is found that the corresponding value of q/F is 1·945, and the diameter of the bare wire 1·4 mm. The cross-section of the winding space

$$Q = \frac{q}{F} \cdot \frac{N}{cq} = 1{\cdot}945 \cdot \frac{385}{2{\cdot}5 \cdot 1{\cdot}539} = 194{\cdot}5 \text{ mm}^2,$$

and the current $I = cq = 2{\cdot}5 \times 1{\cdot}539 = 3{\cdot}85$ amperes, and the number of turns

$$n = \frac{N}{I} = \frac{385}{3{\cdot}85} = 100.$$

The section of the coil Q = 194·5 mm² can be thrown into factors —*e.g.*, 13 mm. × 15 mm. The specification of the coils is thus complete.

INTERCONNECTED SYSTEMS SERVING SAN FRANCISCO.

More and more are power companies coming to realise the advantages of linking up with other systems so as to ensure continuity of service in the event of breakdown and the possibility of the transfer of energy at times of heavy peak load on any of the interconnected systems. This is carried out nowhere perhaps on so vast a scale as among the large supply companies feeding the City of San Francisco and the surrounding territory. Our contemporary, the "Electrical World," has recently given an interesting description of these systems with exhaustive tabulated information of their equipment, and it is on this description that the present article is based.

Fig. 1 is a map showing the long-distance transmission lines

Table I.—*Financial and Physical Data of Central California Central-station Companies as at Dec. 31, 1914.*

	Pacific Gas & Electric Co.	Great Western Power Co.	Sierra & San Francisco Power Co.	Northern California Power Co., Consolidated.	Ohio Electric Corp.
Par value of bonded debt outstanding in hands of public	£15,011,260	£1,340,800	£3,111,200	£1,407,640	£142,600
Stock issue outstanding in hands of public	£10,182,120*	£2,500,000	None	£2,000,000	£1,950,000
Taxes paid in 1914	£118,000	£27,200	£11,033	£7,668	£2,148
Annual interest paid on bonds, 1914	£738,968	£199,600	£151,629	£78,786	£14,796
Dividends paid in 1914	£122,997	None	None	None	None
Gross revenue in 1914	£3,444,101	£536,200	£232,448	£154,237	£53,670
No. of employees, all classes	1,048	1,000	196	186	60
No. of hydro-electric plants and aggregate rating	10 plants; 121,000 h.p.	1 plant, 75,000 h.p.	3 plants, 60,000 h.p.	7 plant 30,067 h.p.	2 plants, 3,000 k.w.
No. of steam stations and aggregate rating	4 stations, 61,417 h.p.	2 plants, 43,000 h.p.	2 plants, 28,118 h.p.	None	1 plant, 1,000 k.w.
Annual load factor, per cent.	60·6	68	61·2	66·8	81
No. of consumers served	378,706	17,000	3,717	7,931	2,063
Installed lighting load in horse-power	211,720	17,000	2,548	7,663	1,375
Installed motor load in horse-power	200,878		65,340	37,196	975
No. of municipalities served	177	17	19	8	1

* Includes £1,500,200 7 per cent. preferred stock subscribed for but not fully paid and issued.

entering San Francisco. These are all connected in the city, while some of the companies also receive energy from still other companies at various points on the line.

The system of the Pacific Gas & Electric Co. is the largest in the West, and possesses the most generating stations. However, in years gone by the company was unable to generate sufficient energy to meet the demands and found it expedient to contract for energy in bulk from some of the other hydro-electric systems not so situated. The Northern Californian Power Co. has a contract, expiring in December, 1925, to deliver 10,667 H.P. to the Pacific Gas & Electric Co. at Chico, where connection is made with the latter company's Natomas and Richmond. It also delivers 3,375 kw. to the Oro Electric Corporation at Stockton, Oroville, and at some of the dredges of the Oro Corporation. The Sierra & San Francisco Power Co. delivers energy also to the Coast Valleys Gas & Electric Co. at Salinas, and to the Western States Gas & Electric Co. at Manteca, and purchases energy from the City Electric Co. a subsidiary of the Great Western Power Co. in San Francisco. It is connected with the Tuolumne Transmission Co. at Tuolumne, and also with the West Side Lumber Co., both of these companies doing a general public utility business. Certain financial and statistical data of the principal interconnected companies are given in Table I.



Fig. 1.—Map showing the Interconnected Transmission Systems Leading into San Francisco (Double Lines Indicate Two Lines Running South).

Pacific Gas & Electric Co.

The system of the Pacific Gas & Electric Co. represents the consolidation of a number of smaller companies, each with a system peculiar to itself and none of them originally designed with a view of being tied in with any other system. The company at present operates 10 hydro-electric stations and four steam stations. The location and rating of these are given in Table II., which also gives other details of the

Table II.—*Main Generators of the Pacific Gas & Electric Co.*

Station.	No.	Voltage.	K.v.a. (each).	K.v.a. (total).
Alta (hydraulic)	1	500	1,000	1,000
De Sabla (hydraulic)	2	2,300	2,000	13,000
	1	2,300	5,000	
	1	2,300	4,000	
Centreville (hydraulic)	1	2,300	5,500	6,400
	1	2,300	900	
Colgate (hydraulic)	1	2,400	5,500	14,200
	3	2,400	2,000	
	3	2,400	900	
Deer Creek (hydraulic)	1	2,300	5,500	5,500
Electra (hydraulic)	5	2,300	2,000	20,000
	2	2,300	5,000	
Folsom (hydraulic)	5	800	750	3,750
Newcastle (hydraulic)	2	500	400	800
Drum (hydraulic)	2	6,600	12,500	25,000
Yuba (hydraulic)	2	2,400	300	600
	1	500	500	
Station A, San Francisco (steam)	3	500	1,500	54,000
	1	11,000	12,000	
	2	11,000	15,000	
	2	11,000	3,500	
Station C, Oakland (steam)	1	4,150	9,000	21,000
	1	4,150	12,000	
Station B, Sacramento (steam)	1	4,150	5,000	5,000
San José (steam)	1	2,300	400	2,200
	1	2,300	1,500	
	1	2,300	300	

machines. All of the stations operate at a common frequency of 60 cycles and run in parallel on a 60,000 volt network, which is also supplied with additional energy from various other interconnected systems. Fig. 2 is a view of the latest and largest station of the company, known as the drum station from which energy is transmitted at 110,000 volts to a sub station at Cordelia, where the load centre of the Pacific Co.'s system is. From this point electricity is distributed radially at 60,000 volts to the cities and valleys surrounding the bay. Fig. 3 shows the huge Spaulding dam built for the Drum station, and Figs. 4 and 5 show the interiors of the Electra hydro electric and Sacramento steam stations respectively, while Figs. 6 and 8 show respectively the transformers of one of the sub-stations and the wooden pole construction of the Northern California Power Co. at Chico, where a junction is made with that system.

The area served by the Pacific Gas & Electric Co. is 37,775 sq. miles. The circuits extend into 30 of the 58 counties of the State of California containing within their borders the most thickly populated sections of the State centering between San Francisco and San Francisco Bay, the fertile Sacramento, Santa Clara, Sonoma and Napa Valleys and a large portion of the San Joaquin Valley. These counties have an

area of approximately 37,000 sq. miles, and according to the 1910 census had a population of 1,325,000. Electricity is supplied directly or indirectly through other companies to 214 cities and towns, the cities served being the 11 largest in the State.

There are at times 19 generating systems operating in parallel. Not only is the entire system of the Pacific Gas & Electric Co. welded together in a single operating unit, but through its interconnections with the other large generating systems around San Francisco there can be a very wide interchange of load between these systems and the



Fig. 2.—Drum Power House.

system of the Pacific Gas & Electric Co. in case of accident to any one of them. This ensures continuity of service throughout the entire field of operations. The paralleling of the various stations regardless of the length of line between them or the loads carried has not developed any difficulties, but, on the contrary, it has been found that paralleling can be done much more readily in such cases than when the generators are paralleled in the same station. The systems may be paralleled at the generating stations or on the low-voltage side of sub-stations. As a matter of fact, the paralleling is done almost entirely on the 60,000 volt side, trans-

dispatcher. In his office is a board upon which is a working model of the entire system. Every generating station, switching point, transmission line, sub-station, &c., is shown, and the switches are made up in dummy form for hand setting to correspond with the conditions in the field. Whether the switch is an oil switch or an air-brake switch is indicated by the form of the dummy, and the lines of interconnected companies are shown in different colours, as are also lines operating at various voltages.

The system of switching in use enables different power stations to be separated, leaving one or more running together upon such lines and loads as can be conveniently carried. Continuity of service is guaranteed in the more important districts by the steam stations, and since these are all turbine-driven they are operated readily in

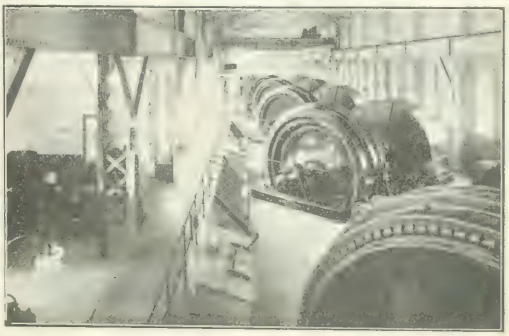


Fig. 4.—Interior of Electra Station.

parallel with the transmission line and under normal conditions carry a good portion of the wattless current. At the same time they serve as a standby, and in case of trouble pick up the load on very short notice. As a rule, the hydro-electric station generators are connected directly to line without automatic circuit-breaking equipment of any kind, and energy is never shut off the lines entirely unless it is absolutely necessary to do so.

The governing of the division of load between the different stations is not so great a problem as might appear. Each station, excepting one, takes its allotted portion of the load and makes no attempt



predetermined limits, the speed control being left entirely to a single

It might be thought that with the large steam turbine station in San Francisco the water-power plant would be operated at constant load and that the fluctuations would be taken by the steam plant. While this would undoubtedly be the best arrangement for operation, the fact is that there is not at present enough transformer equipment between the hydro-electric system and the steam system to make it possible for the steam system to govern the whole without overloading the transformers. No attempt, therefore, is made to feed

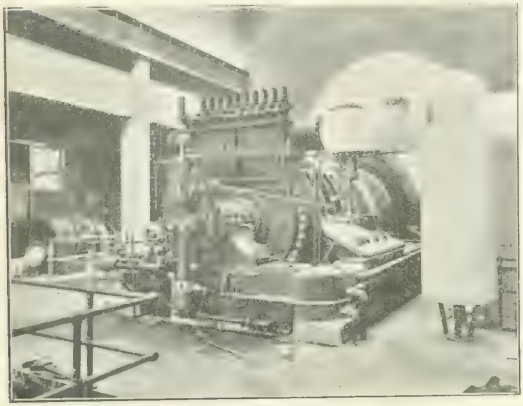


Fig. 5.—Steam Turbine Set in River Station, Sacramento.

the whole of the San Francisco load with transmitted energy. The units in the new Drum station can be adjusted for speed from no-load to full-load by the governors. With one unit governing (and one of the Drum units is large enough to govern alone) the governor is set to give the unit the same speed at full load as it does at normal load. The parallel operation of the system as a whole is very satisfactory indeed, there being no reciprocating units whatsoever. The greater number of the lines feeding into the system are supplied from transformers delta-connected on the low-tension side and star-connected on the high-tension side with the neutral grounded.

normal. Broadly speaking, there are two seasons on the Pacific Coast—one wet and one dry—and insulator troubles are usually encountered during dry seasons or just when the first rains start in. The troubles are due chiefly to leakage from the surface of the insulators on account of the dirt and the salt which are deposited by the winds. As soon as the heavy rains come this accumulation is washed off and the number of insulator troubles is materially reduced. Insulators which operate without trouble on the 60,000 volt lines in the

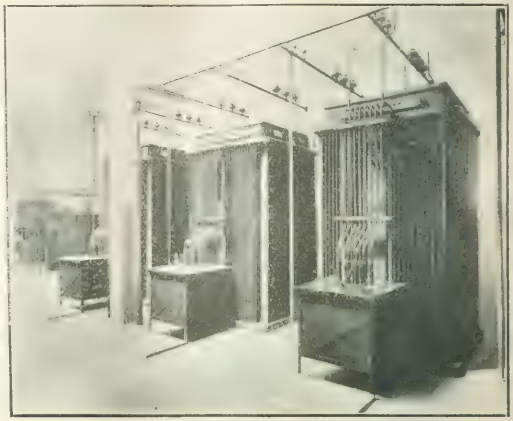


Fig. 6.—Transformers in San Mateo Sub-station.

mountain districts outside of the fog belt give a great deal of trouble on the 11,000 volt lines in the bay district, where they are exposed to more severe conditions of dust, fog and smoke. All of the companies find it necessary to wash the insulators on the lines along the ocean front once or twice a year.

The curves herewith (Fig. 9) show the proportion of energy generated by water-power and steam power, and the proportion which is purchased by the Pacific Gas & Electric Co. Prior to the operation of the Drum plant about half of the total output of the Pacific Gas & Electric Co.'s system was generated by steam and half

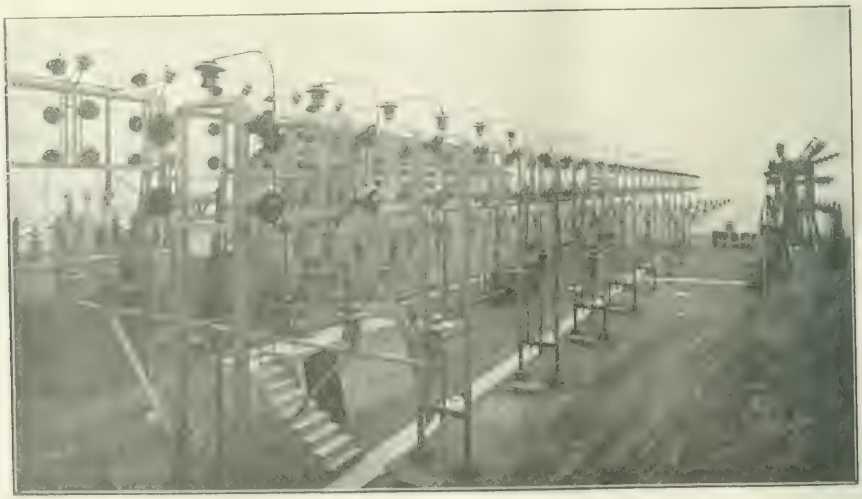


Fig. 7.—Switch at South Tower of Carquinez Strait Crossing.

Because the rainfall on the Pacific Coast is comparatively [illegible] so that the engineers were able to attempt to provide against [illegible] by [illegible] about four days' supply of coal [illegible] by 25 per cent. above

by water power. Since the operation of the new Drum station however, this ratio has been changed. California crude oil is used for boiler fuel in all of the steam stations of the Pacific Gas & Electric Co., and in the largest station of the company an average of 217·68 kw

hours was generated per barrel of fuel oil used throughout the year 1913. The Cordelia sub-station, which is situated at the load centre of the system, was erected for the purpose of stepping-down the potential of the Drum-Cordelia tower line from 110,000 volts to 60,000 volts. It is built in Spanish Renaissance style, as are also many of the other sub-stations and the steam station at Sacramento. The main transformers are of the auto-transformer type.



FIG. 8.—THE LINES OUTSIDE CHICO SUB-STATION.

The celebrated crossing of the 60,000 volt lines over Carquinez Strait, in the San Pablo arm of San Francisco Bay, has been increased in carrying capacity recently and new anchors provided. Two more cables have now been added to the original four, thus providing two

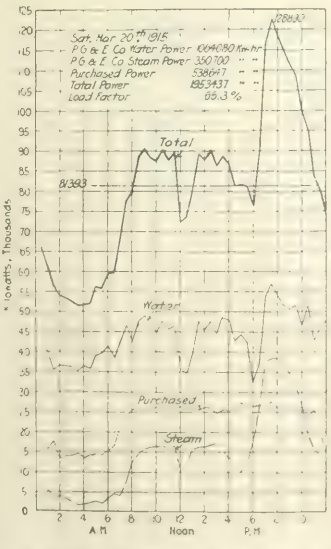


FIG. 9.—LOAD CURVES SHOWING THE PROPORTION OF ENERGY GENERATED AT THE PACIFIC COMPANY'S STEAM AND WATER POWER PLANTS AND THAT PURCHASED FROM OTHER SYSTEMS FOR A DAY IN MARCH.

independent three phase lines across the strait, the saddle span over which is 4,427 ft. long. Fig. 7 shows the outdoor switches at the south tower. The Ridge sub-station in Berkeley is where the 60,000 volt lines terminate.

(To be concluded.)

APPARATUS FOR PROTECTING ELECTRICAL MACHINERY AGAINST ABNORMAL ELECTRICAL CONDITIONS.*

BY C. C. GARRARD.

(Continued from p. 737.)

Summary.—The author deals first with the conditions which give rise to abnormal electrical conditions of a transient type, such as those due to switching, arcs and sparks. Methods of suppressing arcs to earth are described. The author then passes on to pressure rises between the turns of electrical windings, and those due to causes exterior to the system, such as lightning. Various protective devices are described, such as water jet earthing resistances, the Moscicki and other condensers, Giles' valve and the more ordinary lightning arresters. In conclusion the question of earth plates is considered.

LOW EQUIVALENT CYLINDER TYPE LIGHTNING ARRESTERS.

It was found when constructing multigap arresters for high voltages and for circuits having high short-circuit capacities, that in order to render them non-arcing (*i.e.*, capable of suppressing the dynamic arc which follows the discharge) that a very large number of gaps were required. As an alternative to using such a large number of gaps a series resistance can be used. Both expedients had the effect of increasing the equivalent spark gap. As a result of the experiments of Thomas, however, it was found possible to construct a cylinder type of arrester which, while having a low equivalent spark-gap, was yet non-arcing on high voltages, and with any amount of power behind the discharge. Such an arrester was designated the "Low Equivalent Arrester," and the principle of its construction is shown in Fig. 26 (*see* P. H. Thomas, "Function of Shunt and Series Resistance in Lightning Arresters," "Trans." Am.I.E.E., Vol. XIX., 1902, p. 1021). It will be seen that approximately double as many gaps are used as are necessary to withstand the normal voltage. About half of these are shunted by a non-inductive resistance, and a comparatively small series resistance is used. Under normal conditions, therefore, the middle gap is at about earth potential, and a relatively small rise only is required to jump across the unshunted gaps and discharge through the shunt and series resistances. The current passing through the shunt resistance, however, causes a difference of potential to appear across the shunted gaps, and if this be high enough these break down also. The arc across these gaps being shunted, however, is unstable and quickly goes out, so that the unshunted gaps have then both resistances in series, and the dimensions of these are so chosen that the arrester is non-arcing at the normal voltage. It will thus be seen that the equivalent spark gap of this arrester is fixed by the few number of unshunted gaps. A heavy discharge passes, however, over all the gaps. Thus the non-arcing characteristic corresponds to twice the number of gaps as does the equivalent spark-gap.

Multigap arresters have also been made successfully without any series resistance at all. Two types of these as made by the General Electric Co. are illustrated in Fig. 27 and Fig. 29. The principle is exactly the same as the low equivalent arrester just described except that the series resistance is done away with. This is rendered possible by a suitable dimensioning of the parts. It will be noticed that there are considerably more shunted gaps than unshunted. Should the shunted gaps not spark across then the shunt resistance, being in series with the other gaps, is sufficient to suppress the arcing. If, however, the shunted gaps do break down then there are sufficient of them to render the arrangement non-arcing. The makers of this type claim that the shunted gaps constitute a selective path for high-frequency discharges (compare British Patent 5,575/06 now void). The cause of this is that the cylinders really constitute a series of small condensers in parallel with the shunting resistance. Now the resistance will have an increasing impedance with increasing periodicity, whereas the impedance of a condenser goes down with increase of frequency.

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Thus high periodicity discharges will prefer to go straight across all the gaps, and thus secure themselves an easy and unrestricted passage to earth. At the normal frequency, however, the reverse is the case and the current is diverted from the gaps to the shunting resistance. Naturally this selective action will depend largely upon the dimensions of the apparatus. It was found that cylinders about $\frac{7}{8}$ in. in diameter and 1 in. long with a $\frac{1}{32}$ in. gap gave the best results.

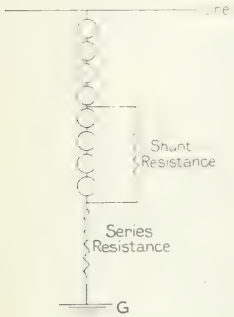


FIG. 26.—PRINCIPLE OF CONSTRUCTION OF LOW EQUIVALENT LIGHTNING ARRESTER.

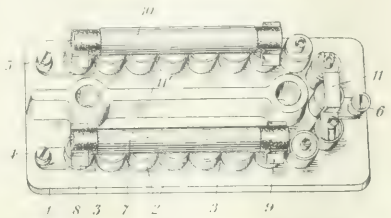


FIG. 27.—LIGHTNING ARRESTER, MADE WITHOUT SERIES RESISTANCE, FOR PROTECTING BOTH LINES OF 2,000-VOLT SINGLE-PHASE CIRCUIT. (General Electric Co.).

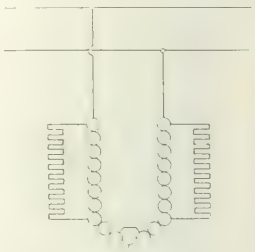
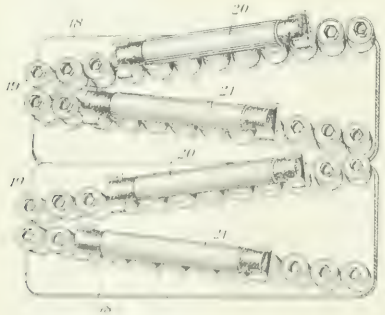


FIG. 28.—CIRCUIT CONNECTIONS FOR ARRESTER SHOWN IN FIG. 27.

Fig. 27 represents a unit which has been found suitable for protecting both lines of a 2,000-volt single-phase circuit. For higher voltages the General Electric Co. used the units shown in Fig. 29 which can be combined to form arresters even for 60,000 volts. A valuable property which has been experimentally discovered with this arrester is that the alternating dynamic current which flows after a discharge is interrupted at the zero point as with an oil switch. Thus the current is stopped without setting up surges or potential rises.

Fig. 30 illustrates a complete arrester made upon this principle for a 12,500-volt three-phase system with earthed neutral. In this case the shunt resistances 35 are arranged on separate bases to the gaps. It will be noticed that two-thirds of the gaps in each leg are shunted. The three legs are brought



[illegible] power 25, between which and earth another set of gaps 26 are connected. The adjustable gaps 27, 28 and [illegible]

[illegible] are doubt that the arrester constructed on these principles [illegible] protective value. During severe [illegible] charge to earth, as [illegible] arrester as to [illegible] discharge capacity [illegible] are already somewhat out of date for important [illegible] and that more modern [illegible] the Multiple Condenser Electrolytic Arrester, [illegible] are [illegible]

Distribution of Potential Across the Gaps of Roller Type Lightning Arresters.—A multiple-gap roller arrester really consists of a number of small electrostatic condensers in series, the rollers forming the plates of the condensers and the air gaps the dielectric. If all the rollers and the air gaps are of the same dimensions, and if the whole arrester is far removed from any other objects, then the distribution of the total voltage across the arrester will follow a straight line law and the voltage across each gap will be equal. It is not possible, however, to remove the arrester entirely away from the influence of surrounding objects, and, as a matter of fact, each successive roller has a certain electrostatic capacity as regards earth besides that as regards its neighbouring rollers. This

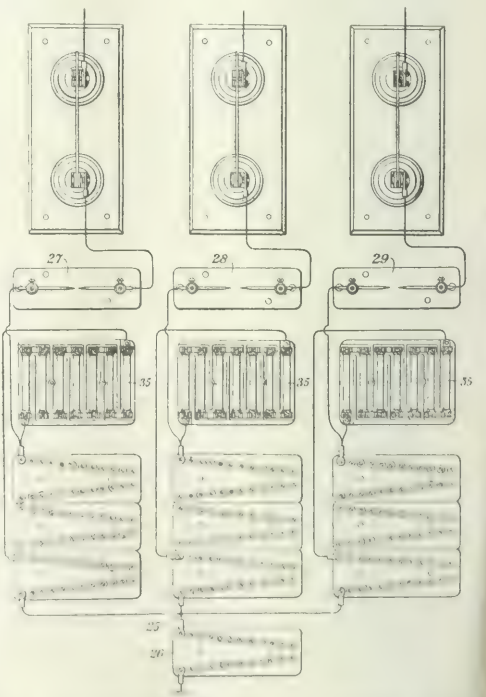


FIG. 30.—THREE PHASE LOW EQUIVALENT ARRESTER FOR 12,500 VOLT THREE PHASE SYSTEM WITH EARTHED NEUTRAL, AND WITHOUT SERIES RESISTANCE. (General Electric Co.)

can be represented diagrammatically as in Fig. 31. The successive rollers are represented as *a*, *b*, *c*, *d* and *e*. Between *a* and *b*, &c., small condensers are shown, as are also the con-

densers between each roller and earth. Across each condenser a charging current will flow, and it is quite evident that the current across *a*, *b* is higher than that across *b*, *c* by the amount of the charging current of the condenser formed between *b* and earth. Similarly, the current across *b*, *c* will be higher than that across *c*, *d* and so on. Now, the capacity of condenser *a*, *b* is the same as that of *b*, *c*, the rollers and gaps being equal. As more current flows across *a*, *b* than across *b*, *c*, it follows that the potential across *a*, *b* will be higher than

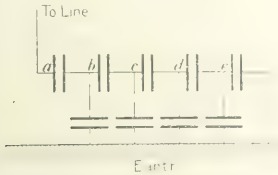


Fig. 31. Condenser Action of Roller-type Lightning Arrester.

that across *b*, *c* and so on. In other words, the total voltage does not divide itself equally across the gaps, but is concentrated more across the gaps nearest the line. The result of this is that more gaps are required than would otherwise be necessary to hold back the voltage and render the arrester non-arcing, and it is difficult to avoid continuous crackling and sparking across of those gaps near the line.

In order to overcome this difficulty the earth shield has been introduced (*see* Fig. 32). This consists of a piece of metal



Fig. 32. Roller-type Lightning Arrester with ground shield.

connected to the line and placed near the gaps which are farthest from earth. It is found in practice that the use of the shield often permits a great reduction in the number of gaps to be made (compare Peck, "Proc." I.E.E., Vol. XL., 1908, page 510).

The action of the earth shield may be understood from the following: It was seen above that the reason of the higher voltage existing across the gaps nearest the line (without

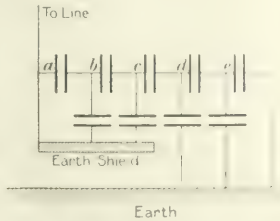


Fig. 33. Condenser Action of Roller-type Lightning Arrester with earth shield.

shield) was that the charging currents of all the succeeding earth condensers had to pass through these gaps. The earth shield, however acts as a shunt path for the charging current, and in effect increases the capacity of the gaps under its influence. This will be seen by reference to Fig. 33.

(*To be continued.*)

THE MANUFACTURE OF ELECTRIC STEEL IN THE STOBIE FURNACE.*

BY VICTOR STOBIE.

There are two distinct types of electric furnaces—the arc furnace and the induction furnace, but, for the purpose of this Paper, I would subdivide the former again, according to size, into large ones and small ones, taking the small class to include those up to 6 tons and the large class from 7 tons upwards. My reason for the subdivision of the furnaces is because the relation between the weight of the furnace structure and the weight of the charge in small furnaces is often six to one, whereas in the case of large furnaces it is down at times to a proportion of three to one. This means that a very large portion of the heat in the small furnace must be devoted to keeping the fabric hot, and it is often found a distinct advantage to heat separately the hearth of the furnace at the same time as the steel charge is being heated, in order that the large abstraction of heat from the molten bath by the hearth, usually experienced in small furnaces, will not chill the bottom layers of the steel. The importance of this will be realised when considering high percentage alloy steel making, as unless an equable temperature is obtained throughout the mass of the charge, any of the alloys at the bottom of the furnace will tend to remain there on account of their greater specific gravity when cold than when hot. This reaches a maximum of importance in such steel as high-speed steel, where the heaviest material of the charges weigh more than three times that of the main mass of the bath. In this case the disadvantage of a cold hearth is aggravated by the melting point of tungsten, the heavy material in question which sinks to the coldest part of the bath, being much higher than that of steel.

Some electric furnace designers had considered the point, but, on trying to overcome it, they did so without regard to other disadvantages which they were substituting for the original one. One attempt was as follows: To overcome the effect of the cold hearth the sending of the current through a central bottom portion of the hearth was tried so that the passage of the current through the dolomite should heat the latter; but furnaces so designed have been found to suffer from an over-heating of that single central portion of the bath. In such a case the hearth becomes extremely soft, through the heating-up caused by the passage of the current, and it will not then resist the ordinary processes of the furnace. The result is that one is never sure of having the ladle ready when the steel decides to tap itself out through the hearth of the furnace. I have overcome this excessive hearth heating by devising an electric system which automatically compels the current to divide itself up over the whole mass of the hearth. This gives just the amount of auxiliary hearth heating required in a small furnace.

In the 5-ton Stobie two-phase furnace two-phase currents are made to take a long journey through the metal and give quick heating effect, as follows: The electrode attached to the outer cable of one circuit is placed at one end of the bath above the slag, and the electrode connected to the outer wire of the other phase is placed at the opposite end of the bath, also above the slag. The electrode on the inner or neutral wire of each phase is placed in the hearth of the furnace at the opposite end to the other electrode of its circuit. This arrangement of electrodes causes each circuit to be connected through the longest distance in the charge, and is characterised by the crossing in direction of flow of the currents of electricity. To both types of Stobie furnaces a unique attachment is usually made, permitting of the additional heating of the furnaces by means of town gas or oil.

The above combination of oil or gas heating, with electric heating in an ordinary electric steel melting furnace, offers three considerable advantages, the first being in the cheaper melting of the raw materials and the confining of the use of electricity to those portions of the process which are more efficiently accomplished by its use; the second is in the increase in the neutral properties of the atmosphere in the furnace during the use of electricity as the heating medium. This is accomplished by cutting off the gas supply whilst maintaining a small supply of gas or oil. The third advantage being in the diffused heat from the gas or oil for preparing the sides of the chamber after each end or other stoppage used for burning in the original hearth. The furnace is tilted on rockers by motor-driven gearing acting on wire ropes. The furnace is tilted towards the furnace platform when slag is to be removed from the bath, an opening in the platform permitting the discharged slag to fall to the shop floor level into a bogie for removal. The same mechanism tilts the furnace in the reverse direction for tapping. At each end of the furnace are placed the motors for regulating the position of the electrodes, which is the

* Abstract of a Paper read before the Cleveland Institute of Engineers.

means adopted for regulating the current, and, therefore, the temperature of the furnace.

The majority of early large arc furnaces are three-phase furnaces. One type was mesh-connected, and the other star-connected with one phase reversed. The effect of reversing one phase in the latter type of furnace has not been published. The large Stobie furnace has no such complication, but is an ordinary star-connected one. The three phases are each connected to an electrode above the bath, and the central point of the star connection is carried to another electrode also above the bath. The object of this device is to avoid to the greatest extent any overloading of the conductors; to avoid fluctuations in the electrical conditions, and to give a better distribution of heat over the surface of the metal. This is accomplished by the fourth electrode above the bath taking the unbalanced currents in the furnace, instead of each phase-electrode being burdened continually with the unbalanced currents in the two phase-electrodes

The overloading of cables and electrodes in most types of large furnaces will be realised when it is remembered that any phase electrode in those furnaces may be seriously overloaded itself, when it is called upon to additionally carry its share—50 per cent.—of an overload taking place simultaneously on one of the other phases. Such overloading may easily cause a breakdown of some part of the electric system. This cannot possibly happen in the Stobie three-phase furnace, because the fourth electrode is obliged to take all unbalanced current, and its chance of being overloaded is practically nil. The detailed electrical principal of this furnace is as follows: Three electrodes above the bath are connected to the three phases of a four-wire star-connected supply, whilst a fourth electrode, also above the bath, is connected to the middle or neutral point of the supply system. The electrode are gaps above the metal are adjusted according to the phase and interlinked pressures. Any reduction in the resistance of the arc gaps under one of the three-phase electrodes will reduce the resistance of the phase circuit by a greater percentage than it will reduce the resistance of the interlinked circuit; therefore, the resulting excess of current would be taken by the fourth or neutral electrode.

When a three-phase electric furnace is working the phases are never balanced on account of the constant movement and fluctuation in the resistance of the material which is being melted, and the waviness of the surface of the bath when molten; the fourth or neutral electrode will, therefore, constantly carry current and do its share of the heating or melting of the charge. By this arrangement of four top electrodes a much better distribution of heat is obtained in large furnaces than by the use of only three electrodes. A characteristic feature of the casting of electric steel is that hardly a spark can be seen when the steel is flowing, this being due to the extreme deadness of the material before it leaves the furnace. It is a visible sign of that essential property of freedom from gases which should always obtain in the best steels.

The method of manufacture in the electric furnace when using a solid charge, is as follows: The whole of the material should, if possible, be charged into the furnace previous to the switching on of the current along with some lime. The electrodes are brought into contact with the charge, and the circuits through the furnace are adjusted by separating the electrodes from the charge and establishing arcs between them. When the steel has commenced to melt, white flames appear at the door of the furnace. These flames are remarkable inasmuch as, although sometimes highly illuminating, they are comparatively cool. These flames are a sign of the charge being ready to receive the iron oxide, which is relied upon to rid the charge of its impurities. On adding the iron oxide in the shape of ore or millscale the incandescent flames turn to thin yellow ones, this state continuing until the slag is removed. When the steel is melted, the charge hand, from experience, will see whether the slag requires thinning or thickening, this being done normally by additions of sand or lime. The boil, which is obtained ordinarily in the electric [illegible] as used on open hearth practice, the raw materials containing very little carbon, silicon and phosphorus. [illegible] furnace, would, of course, give much anxiety to the melter. In the [illegible] furnace [illegible] the [illegible] to be distributed [illegible] charge. [illegible] of the heat imparted [illegible] [illegible] is the slag [illegible] of the [illegible] process. The [illegible] is rotated [illegible] [illegible] [illegible]

castings, the following will be the costs, assuming a furnace of 1 ton capacity is installed :—

Steel scrap per ton	£2	10	0
Current, 800 units at 0·3d.	1	0	0
Electrodes	0	6	0
Slags	0	2	0
Repairs	0	6	0
Labour	0	6	0
	£4	10	0
Melting loss, 2½ per cent.	0	2	3
Total per ton	£4	12	3

Should a high quality of steel, say, as at least for alloy steels be required, the costs in a 5-ton furnace would be as given in the following table :—

Steel scrap at 50s. per ton by 5	£12	10	0
Current, 800 units at 0·3d. by 5	5	0	0
Electrodes, 7s. 6d. by 5	1	17	6
Slags	0	5	0
Repairs	1	5	0
Labour	1	0	0
Ordinary additions	0	0	0
	£22	3	6
Melting loss	0	11	6
	£22	15	0
Per ton	£4	11	0

Plus, in both cases, interest and depreciation.

The reason the current consumption is as high in the 5-ton furnace as in the 1-ton is because the process followed for steel for castings is a simpler and cheaper one than for ingot steel.

RECENT PROGRESS IN PYROMETRY.*

BY CHAS. R. DARLING.

During the past five years, which is the period intended to be covered by the present Paper, considerable advances have been made in the production of instruments for the measurement of high temperatures. Much valuable work in this direction has been carried out at the National Physical Laboratory in this country and at the United States Bureau of Standards.

Various investigations of fixed points have confirmed, or at the most slightly modified, previously accepted figures. Up to the highest reading obtainable on the gas scale (1,550°C.), the standards now in use appear to be well established ; and beyond this the melting point of platinum, as deduced by several different methods, is now accepted as 1,755°C. This is a useful fixed point for the calibration of high-reading pyrometers.

One of the chief features of recent years has been the extension of the use of base-metal junctions in place of platinum and platinum alloys. Suitable base-metal couples develop a relatively high E.M.F., and enable a strong and cheap indicator to be used in place of the sensitive instrument required for couples of the platinum series. Most makers now furnish iron-constantan pyrometers, which may be used up to 900°C. For temperatures below 700°C., copper-constantan junctions are much used, as, for example, in pyrometers for superheated steam. C. C. Bidwell ("Physical Review," June, 1914) has shown that a junction of carbon and graphite may be used to read temperatures as high as 2,000°C.

Materials for protecting junctions from the corrosive action of furnace gases have been added to by the introduction of alundum (oxide of aluminium), which melts at 2,050°C. ; a material known as "silit," which has a carborundum base, and [illegible] a substance resembling carborundum. All these materials are brittle, and therefore will not stand rough usage. As a protection for junctions used to read the temperature of molten [illegible], a tube of molybdenum has proved successful, as this metal is a good conductor of heat and is not acted on by the molten alloy.

A new departure in commercial instruments has been made by the Leeds & Northrup Co., of Philadelphia, who have adopted the potentiometer principle, formerly used only for [illegible] work. The advantages of this arrangement are greater sensitiveness and independence of the resistance of the pyrometer and leads. As drawbacks, there is more intricacy in the [illegible] and more time is required for adjustments, but the indicator gives no deflection. Several methods for adapting an indicator for special ranges have been devised. In one form, due to the Cambridge Scientific Instrument Co., the potentiometer principle is used to alter the zero of the indicator. The same firm has also introduced a mechanical device for achieving the same object. In this a suspended coil indicator is used, and by turning a torsion head a twist is imparted to the suspension, so that the pointer does not move over the scale until the temperature of the junction has reached an assigned figure. In the multi-range instrument made by R. W. Paul the indicator takes the place of the galvanometer in a Wheatstone bridge circuit, the pyrometer being in series with the indicator. By throwing the bridge slightly out of balance, a current may be made to pass through the indicator in an opposite direction to that produced by the heated junction, and only when this opposing current is overcome will the pointer begin to move over the scale.

The regulation of the temperature of superheated steam on locomotives has given rise to the problem of producing an indicator practically unaffected by vibrations. This has been solved in various ways by different makers, and satisfactory instruments are now procurable for this purpose.

No special change is to be recorded in resistance pyrometers. The recent work of Sir William Crookes has shown that platinum is distinctly volatile above 1,000°C., and this explains satisfactorily why resistance pyrometers were found to change their calibration when used above this temperature. For work at low or moderate temperatures the resistance pyrometer is much used on account of its superior accuracy, which, however, is only operative when the temperature to be measured is subject to precise control. It is now customary to employ thermo-electric pyrometers for the general run of metallurgical work, and to use a resistance pyrometer for very exact work, and for a workshop standard within its upper limit—1,000°C.

The researches of Northrup on the resistance of molten metals ("Journal" of the Franklin Institute, January and March, 1914) suggest a possible extension of the range of resistance pyrometers by the use of a liquid element. Melted copper, for example, shows a uniform increase in resistance up to 1,400°C., and this fact might be utilised in measuring temperatures if a suitable appliance were forthcoming. The decrease in the resistance of pyro-conductors with rise in temperature may possibly be utilised for resistance pyrometers. Alundum, for example, has a resistance of 6,100 ohms per centimetre cube at 1,100°C., which falls to 190 ohms at 1,600°C., an average decrease of nearly 12 ohms per degree, which could easily be detected on a coarse instrument.

A distinct improvement in radiation pyrometers has been the introduction of pivoted indicators in place of the suspended-coil type formerly in use. This has been made possible by the use of more sensitive junctions to receive the radiations. The Féry pyrometer has been modified by Whipple for determining the temperature of molten metals by mounting the pyrometer at the open end of a fire-clay tube, so as to be permanently focussed on the closed end which is immersed in the metal. Foster uses a similar plan in connection with his fixed-focus pyrometer, the end being closed by a salamander tube which is dipped into the metal. Mr. R. W. Paul has introduced a radiation pyrometer in which the rays are received in a tube containing a polished cone, a junction at the apex receiving the radiations. This type of instrument, originally due to Thwing, gives the same reading at all distances within a given limit, and therefore requires no focussing.

The standard forms of optical pyrometers due to Féry, Wanner and Holborn and Kurlbaum are now well established, and have been improved in details with a view to industrial use. A new type of optical pyrometer, based on the principle of colour extinction, has been introduced. In the form devised by Heathcote in the research laboratory of the Rudge-Whitworth Company, cells containing a liquid of the correct colour and density are used, so that the luminous [illegible] The instrument consists of an eye-shade in which four cells are mounted, two of which are capable of extinguishing the light at the working temperature, whilst the other two correspond to a slightly higher temperature. Either pair may be brought before the eyes by moving a slide, and when the heated object is just visible in the lower pair, but invisible in the higher, the correct temperature has been attained. In another form a single cell is used, in which the depth of liquid may be adjusted until extinction occurs, and the temperature read off on a scale graduated in temperatures according [illegible]

Another form of extinction pyrometer has been designed by Alder [illegible] (No. 27,033, 1914). This consists of a small telescope, the rays through which are intercepted by a wedge of dark-coloured glass, which is moved until the sighted object just ceases to be visible. Temperatures are read from a scale which moves with the prism.

* Abstract of a Paper read before the Royal Society of Arts.

[illegible] Physical Society in March, 1915. It was shown that the temperature of many metallic substances could be measured by matching the colour against that of a black body until identical. A Lummer-Brodhun photometer was used, and the temperature of the black body varied until equality of hue was obtained. Filament lamps, with an ammeter and rheostat in the circuit, were thus matched, and became secondary standards, a given current corresponding to a known temperature.

Lovibond has suggested an optical pyrometer in which a standard source of light is brought to equality of tint with the heated object by interposing tintometer glasses.

The value of temperature records is now so much recognised in the industries that all makers of pyrometers have given special attention to recorders, and have devised arrangements for registering the readings of several pyrometers simultaneously.

The thread recorder of the Cambridge Scientific Instrument Co. has been improved in many details. In one of the latest forms two indicators are made to record on a single chart wound on a long drum rotated by clockwork. At intervals a presser-bar pushes the pointer on to an inked thread, which touches and leaves an ink-dot on the graduated chart. By having two threads, coloured with different inks, and a mechanism which brings each thread in turn beneath the pointer, four simultaneous records may be taken, the pyrometers concerned being automatically switched on to the indicators in correct sequence.

Paul has adopted a motor drive in his new recorder which also embodies other novel features. The chart is made in the form of a continuous roll. The pointer is pressed periodically on to an inked ribbon, which touches the chart at a place where the latter is passing over a knife-edge, and hence a dot is produced.

A somewhat similar arrangement of pointer and inked ribbon is used in the latest form of Siemens' recorder, but clockwork is used for the motion.

All the places at which pyrometers are made in Britain are under the direction of skilled scientific men, who are constantly devising new instruments and finding wider fields for their application. All are in close touch with the National Physical Laboratory. The result is a thriving and extending industry, not threatened by foreign competition and not requiring artificial props to ensure its success.

STATE AID AND PRIVATE BENEFACTIONS FOR SCIENTIFIC RESEARCH AND UNIVERSITY EDUCATION.*

BY PROF. R. A. GREGORY.

1. Scientific Research.

Towards the end of last year a statement [illegible] was remarked that the annual grants of the various scientific research departments of the Carnegie Institution of Washington amounted to £50,000 more than the total [illegible] sum for purposes of scientific investigation included in the Civil Service Estimates. [illegible] to note to promote scientific research than the richest State in the world merits needs more than a passing mention, as the subject and some particulars may be of interest.

The Carnegie Institution of Washington was founded by Mr Carnegie in 1902 with an endowment of £2,000,000, to which he added £400,000 in 1907, and a further £2,000,000 in 1911. The articles of incorporation of the Institution declare that the objects of the corporation shall be to encourage, in the broadest and most liberal manner, investigation, research, and discovery, and the application of knowledge to the improvement of mankind. The income for the year 1915 amounts to nearly £400,000, of which £300,000 is a permanent endowment fund, £12,000 for publications and £10,000 for administration. The chief grants voted for scientific work in the financial year 1913-14 are as follows:—

Department of Botanical Research	£8,430
Department of Economics and Sociology	1,000
Department of Experimental Evolution	12,500
Geophysical Laboratory	17,100
Department of Historical Research	6,220
Department of Marine Biology	3,830
Department of Meridian Astrometry	5,040
Nutrition Laboratory	9,160
[illegible]	2,000
Solar Observatory	44,180
[illegible]	31,480
[illegible]	380
	22,000
[illegible]	£163,520

* [illegible] paper read before the Section of Economic Science and Statistics of the British Association [illegible]

We see, therefore, that the Institution provides about £168,000 annually for research in various departments of science, and £120,000 for publications.

The annual grants made by Parliament specifically for scientific investigations and related services amount to about £100,000, and the details of the estimates for 1915-16 are shown in the subjoined table :—

Grants in Aid of Scientific Investigation, &c.
(*Civil Service Estimates for* 1915-16.)

Royal Society :—	
(i) (*a*) Scientific Investigations	£4,000
(*b*) Scientific Publications	1,000
(ii) Magnetic Observatory at Eskdalemuir	1,000
(iii) National Physical Laboratory	7,000
(iv) Aeronautical Section of the National Physical Laboratory	9,425
Meteorological Office	22,500
Royal Geographical Society	1,250
Royal Academy of Music	500
Royal College of Music	500
Marine Biological Association of the United Kingdom	500
Royal Society of Edinburgh	600
Scottish Meteorological Society	100
Royal Irish Academy	1,600
Royal Irish Academy of Music	300
Royal Zoological Society of Ireland	500
Royal Hibernian Academy	300
British School at Athens	500
British School at Rome	500
Royal Scottish Geographical Society	200
National Library of Wales	8,200
National Museum of Wales	17,300
Solar Physics Observatory	3,000
British Academy	400
School of Oriental Studies	1,500
North Sea Fisheries Investigation	1,250
Imperial Transantarctic Expedition, 1914-15	5,000
Edinburgh Observatory	1,657
	£90,582

The grants to the National Physical Laboratory and the Meteorological Office, amounting altogether to nearly £40,000, are for national services rather than scientific investigation; and when these amounts are deducted the actual sums voted by the State to scientific institutions, or for purposes of research, are seen to bear little relationship to those which the trustees of the Carnegie Institution of Washington are able to give. Even the minor grants made by the Institution amount to more than five times the sum with which the Royal Society is entrusted by the State annually for allocation as grants in aid of scientific investigation.

In addition to the specific grants under the head of scientific investigation, much larger funds are at the disposal of the National Health Insurance Joint Committee and the Development Commissioners.

The author then gives particulars of the grants available from the Development Fund.

2. State Aid to University Education.

The Universities and University Colleges in Great Britain which are in receipt of grants from the Board of Education are as follows: The Universities of Birmingham, Bristol, Durham (Armstrong College), Leeds, Liverpool, Manchester, Sheffield, London (including University College, King's College, Bedford College, School of Economics, and East London College), the University Colleges of Nottingham, Reading and Southampton; the University of Wales (University Colleges of Aberystwyth, Bangor, and Cardiff).

The subjoined table shows the sources of income of these institutions :—

Incomes of Universities and University Colleges.

	1. England. Amount.	P.c. of total.	2. Wales. Amount.	P.c. of total.
Fees	£183,880	27·8	£17,456	27·7
Endowments	95,045	14·4	4,448	7·1
Donations and subscriptions	22,381	3·4	2,330	3·7
Annual grants from local authorities	103,650	15·7	3,441	5·5
Parliamentary grants (*see* below)	233,000	35·2	34,220	54·3
Contributions from hospitals, &c., for services rendered	2,338	0·4	—	—
Other income	20,486	3·1	1,432	1·7
	£660,780		£63,027	

Grand total, £723,807.

The income from endowments of universities and university colleges in England and Wales in receipt of State grants is about £100,000, which equals the amount of the annual income of the Carnegie Trust for the Universities of Scotland. About half this amount is devoted annually to the payment of students' fees and the other moiety is voted as grants for (1) the better equipment of the Scottish universities and colleges by the foundation of additional chairs and lectureships and by the provision of new laboratories and permanent equipment, and (2) the encouragement of research. A writer in "Nature," of May 14, 1914, in an article

upon the twelfth annual report of the Trust [illegible] The impetus to research, which has been produced by the war [illegible] can be gauged from an examination of the sections [illegible] In the eight years 1903-11, the trust appointed in this department 45 scholars, 25 fellows and 31 grantees. The work of these has resulted in the publication of more than 130 original communications to scientific journals. Now, in 1912, the contributions of the whole British chemical world to the "Transactions" of the Chemical Society amounted to only double this number. 266, so that it is evident that the [illegible] encouragement of research, has indirectly in the course of [illegible] years produced a series of results equal to half the annual output of the whole Empire at the present time. This, it must be remembered, represents only a single department of the Trust's activities; for, in addition to chemistry, work is being carried out in physics, biology, medicine, economics, history and languages."

The Parliamentary grants to universities and university colleges (1912-13) included in the foregoing table are made up of contributions under various heads as shown below :—

	England.	Wales.
Exchequer	£170,000	£25,500
Board of Education: Technological and other professional work	22,600	430
Board of Education: Training of teachers	22,400	4,990
Board of Education: Other grants	8,500	230
Other Government departments	9,500	3,070
Total	£233,000	£34,220

The grants for technological and other professional work, amounting to about £23,000, are part of a total sum of nearly £45,000 allocated under this head in 1913-14. Twenty-four institutions in all receive State aid in this way; 10 of them being also in receipt of the Exchequer grants to universities and colleges.

In Germany, State subsidies provide the main part of the incomes of the universities. The annual expenditure for the universities from State funds amounts in round figures to £1,800,000. In 1913 the expenditure of the University of Berlin alone was £242,000; and of this amount £200,000, or about 83 per cent., was derived from State funds.

The estimates for the year ending March 31, 1916, show the following grants for universities and colleges in the United Kingdom :—

Great Britain.

University of London	£8,000
Victoria University of Manchester	2,000
University of Birmingham	2,000
University of Wales	4,000
University of Liverpool	2,000
Leeds University	2,000
Sheffield University	2,000
Bristol University	2,000
Durham University	2,000
Scottish Universities	81,000
Colleges, Great Britain	150,000
University Colleges, Wales	12,000
Welsh University and Colleges: Additional grant	15,000
Total	£287,000

Ireland.

A. Grants for the general purposes of the	
Queen's University of Belfast	£18,000
University College, Dublin	32,000
University College, Cork	20,000
University College, Galway	12,000
B. Grants in respect of the cost of purchasing land and providing or improving the necessary buildings and equipment for the	
National University of Ireland and Dunsink College, Dublin	40,000
University College, Galway (£1,850 revote)	—
C. Additional grant in augmentation of sums amounting to £1,500 or more contributed from local sources in 1914-15 towards increasing the remuneration of University College, Galway	2,000
Total	£124,000
Imperial College of Science and Technology	30,000
Royal College of Science, Dublin	17,000
University Institutions in respect of technological work	46,000
Grand total	£317,000

Figures are given in regard to the number of [illegible] There are 70,000 students of collegiate grade in the United States, 51,000 students of technical subjects in Germany, and [illegible] and 23,000 [illegible] students in universities and technical institutions in the United Kingdom.

[illegible] for Higher Education and Scientific Research

The report of the United States Bureau of Education for the year ending June 30, 1913, shows that during the year [illegible] and donations, in gifts and bequests by universities and other institutions of higher education, excluding grants by the United States, different States and municipalities, was £4,930,390. Of this amount £895,320 was for increase of plant, £825,980 for current expenses, and £3,209,100 for endowment. Forty-five institutions reported gifts above £20,000. Among the institutions most generously treated, the following may be mentioned :—

Harvard University	£419,090
Columbia University	284,360
Yale University	283,790
University of Chicago	261,590
University of California	249,190
Trinity College, North Carolina	240,640
Massachusetts Institute of Technology	214,320

The income of the 596 institutions of higher education from which the Bureau receives reports was during the year, from State and municipal grants, £3,809,960; from invested funds, £3,313,960; and from fees for tuition and other educational services, £4,183,830.

The benefactions to higher education in the United States during the 40 years from 1873 to 1913 amounted to nearly £100,000,000, and are still increasing at the rate of about £5,000,000 annually.

The author concludes by giving a list of gifts to institutions in the United States, United Kingdom and the Colonies.

VARIATION OF SPARKING DISTANCE WITH HEIGHT ABOVE SEA LEVEL.*

BY A. KLEINSTÜCK.

The author gives the following formula for determining the variation of sparking distance with height above sea level, viz. :—

$$e' = e_m 10^{-h/k},$$

where e_m = the sparking distance at sea level (760 mm. barometric pressure); e' = the sparking distance at a height h (in metres) above sea level; k = a constant whose approximate value is 18,400.

The following table gives the values of $10^{-h/k}$ for a number of heights, viz. :—

h.	$10^{-h/k}$	h.	$10^{-h/k}$
200	0·975	2,200	0·759
400	0·951	2,400	0·741
600	0·928	2,600	0·722
800	0·905	2,800	0·704
1,000	0·882	3,000	0·687
1,200	0·861	3,500	0·645
1,400	0·839	4,000	0·607
1,600	0·819	4,500	0·570
1,800	0·798	5,000	0·534
2,000	0·779		

The dielectric strength of air also varies directly as the absolute temperature, so that the value x obtained from the above formula is subject to a correction as follows: e' (true) $= e' \frac{273+t'}{273+t}$, where t is the temperature at sea level and t' the temperature at the height h.

It will be seen that this variation of sparking distance with height has a very practical bearing, since an insulator which allows sparks to pass at 90 kv. at sea level, allows sparks to pass at 77·3 kv. at a height of 1,189 metres above sea level.

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"Science Abstracts." The Institution of Electrical Engineers. (London: E. & F. N. Spon). Section A.—Physics. Section B.—Electrical Engineering. Vol. 18, Part 8, No. 212. 1s. 6d.

[illegible] of the Western Society of Engineers. Chicago: The Western Society. Vol. XX., No. 6. 50 cents.

* Abstract of an article in the "Elektrotechnische Zeitschrift."

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ECONOMIES IN ELECTRIC TRACTION.

The work of the electrical engineer is largely concerned with the improvement of efficiency. It is his duty to reduce to a minimum those many small losses which, although they may be somewhat insignificant individually, tend collectively to give a bad result. The importance of these losses is often not appreciated until their effect is shown in the aggregate, and as an example of this statement, we may refer to some figures given by Mr. N. W. STORER in a Paper which we reproduce in abstract in another column. Every engineer is acquainted with the fact that in electric traction there are losses in various directions, but it will probably come as a surprise to him that it should be possible to reduce these losses on the whole by 40 or 50 per cent. The importance of doing so is emphasised in the case of Chicago, where the annual coal bill on account of electric traction is in the neighbourhood of 1,000,000 tons. Mr. STORER is of opinion that not less than 10 per cent., and possibly 50 per cent., of this enormous amount might be saved, and in support of this contention he states that the power consumption on some of the newer cars now being used in Chicago has been reduced to less than 67 per cent. of the older figure.

One direction in which there is considerable waste of power is in the provision of cars that are unduly heavy. This is a subject which is difficult, because reduced weight may lead to reduced life, and, therefore, a balance must be struck between the advantages and disadvantages. It is not unlikely, however, that the subject has not been sufficiently studied from the point of view of economy in running because the necessity of such economy has not been forced upon the attention of the designer. An illustration of this is seen in recent developments in accumulator traction. Here weight is all important, and consequently the weight

of the accumulator car has been reduced to a minimum in what is known as the Beach car in America, and very economical running results have been thus obtained. It must be remembered that the heavier the car the heavier also must be the equipment, and consequently the result is doubly inefficient. Mr. STORER mentions that in Chicago the weight of the trolley cars on the surface lines has been cut down about 25 per cent.; this reduction has been partly due to the use of two-motor equipments instead of four-motor equipments. In this way it has been possible to use two 50 H.P. motors instead of four motors of 40 H.P. Thus the power is less and the motors, owing to their larger size, are more efficient. This is a good example of the cumulative effect often found in practice: more weight entails more power, and more power again entails more weight.

Much of the energy in traction is used in overcoming rail resistance; yet this is by no means the largest part of the energy that is necessary, nor can we expect much reduction in this item. But there are many other sources of loss. For example, journal friction still accounts for a great deal, notwithstanding the possibilities of roller bearings. It is to be hoped that before so very long a considerable saving may be made in this direction.

In regard to motors, we cannot expect any great improvement. Higher efficiency might no doubt be obtained, but that would be gained at the expense of considerable increase in weight, and thus the desired object would be defeated. We must, therefore, expect the losses in this direction to remain as at present.

On the other hand, there is no reason why rheostatic losses should not be considerably reduced. Series parallel control does a great deal in this direction, but the losses can now be still further cut down by field control, owing to the improvements produced by commutating poles.

A problem which is particularly attractive is the complete elimination of braking losses. With this object in view, it has been proposed to build railway lines on the switchback principle, so that the acceleration is largely provided by gravity, and braking is equally rendered more or less unnecessary. This method is actually used to a small extent on the Central London Railway, and we remember a scheme, not so very long ago, in which it was proposed to utilise this system on a projected electric railway running to the Crystal Palace. It is one thing, however, to use a system of this kind for a single car and quite another to use it on a train of cars. The idea is one which is likely to crop up from time to time, but which is not likely to be very fruitful in actual practice. A more practical method is to use some form of regenerative control. Unfortunately, the series motor does not lend itself easily to this kind of work, and consequently, where the gradients are heavy and where regenerative working becomes really important, the three-phase system has found favour, as is seen on the Italian State railways. Possibly the split-phase locomotive, which is being used on the Norfolk and Western Railway in the United States, will show fresh possibilities in this direction.

In any case it must be admitted that there is still plenty of scope for investigation in obtaining economy in the field of electric traction.

ON THE MEASUREMENT OF THE TEMPERATURE OF SOLID BODIES.

BY PROF. FELIX LECONTE (BRUSSELS).

Undoubtedly the most exact method of determining surface temperature is by the thermocouple, but there are many cases in which it is not possible to use this method. This problem presents itself above all in electrical machinery, the power of which is limited by the temperature rise. The temperature of the windings of the machines and the adjoining iron parts requires accurate measurement. The variation of resistance gives a fairly exact and easy means of measuring the variation of temperature in a coil, but it may often be useful to have a more rapid and direct method. The thermometer by contact is then employed; it should also be used for the commutators and rings as well as for the iron.

For this purpose I have had special thermometers made, and have investigated them carefully. Many engineers whose business it is to carry out contract tests do not know the conditions to which such a thermometer ought to respond, and they employ ordinary thermometers. They purchase at great expense thermometers giving the fourth part of a degree, and I generally find a difference between the indications of these instruments and ours of 5 deg. and more in carrying out tests.

Here is a very simple way of comparing the accuracy of two or more thermometers for use against solid bodies. Pour some hot water into an enamelled iron jug, and place the thermometers therein. They generally agree. The two instruments are then applied to the outer part of the jug, at the same height. The same temperature should be read, and this can be verified further by interchanging the positions of the thermometers. In such a test we always find that our instruments are higher than chemical precision thermometers. They are then more exact. The differences vary from 5 deg. to 10 deg., it being understood that temperatures here given are expressed in Centigrade.

We attribute this sensibility to the following features which we have tried to embody in a practical thermometer:—

1. The glass is reduced to a minimum thickness. This seems to us to be necessary because the glass is a bad heat conductor. Our instruments are, however, sufficiently robust for ordinary use.

2. The mass of mercury is reduced to a minimum—a condition obviously essential.

3. The bulb is as voluminous as possible, contrary to the foregoing, in order to present a large contact surface to the body it is desired to observe.

4. The length of the graduated tube is reduced. We have 150 mm. for 100 deg., *i.e.*, 1·5 mm. for each degree. This allows a quarter of a degree to be read without error, although it is really superfluous.

5. The diameter of the tube does not exceed 5 mm. to 6 mm. which allows of its insertion everywhere into the windings of three-phase and continuous-current machines, rotors and stators.

6. It is not more expensive, being of ordinary manufacture.

The Germans have had attributed to them a deeper knowledge than other people of the details of the electrical industry. Let us examine the statement a little.

According to the Rules of the Verband Deutscher Elektrotechniker for the testing of electric machinery ("E.T.Z.," of June 3, 1915, No. 23; Rule 14):—

"In order to measure the temperature of the parts of a machine by the aid of a thermometer a good heat conducting body, such as tin-foil, should be placed between the thermometer and the part of the machine of which it is desired to know the temperature. In order to prevent loss of heat during the measurement, the bulb of the thermometer should be covered with a bad conductor of heat, such as dry cotton waste, &c."

In the foregoing there are several errors in physics.

1. If tin-foil leaves are placed between the warm object and the thermometer, the metal conducts the heat and diffuses it into the air by radiation and by conduction. The thermo-

under which lead would flow if there were no tin-foil. To reveal this fact delicate instruments such as ours are needed. The experiment is easily made.

2. If the bulb of the thermometer is covered with dry cotton waste, the result is falsified from the start. Indeed, cotton is hygroscopic; that is to say, it is saturated with a maximum of 7 per cent. of water which it is impossible to reduce in practice. It is essentially an absorbent of moisture. An element which contains water is thus brought into contact with the bulb of the thermometer. This water becomes vapourised, absorbs heat and brings the thermometer down to the temperature of the cotton, and not until the saturation of the vapour has been established does the thermometer begin to rise.

This is all just ordinary physics, but it must be granted that most engineers have forgotten the course of physics which lies at the base of all the details of their craft.

Here is an easy experiment. The temperature of the atmosphere being at 15·2 deg. C. a jug is filled with hot water. The thermometer on being plunged into the water gives 37 deg. C.; applied directly to the outside surface it yields 33 deg. C. If you apply a handful of cotton waste it falls to 30 deg. and takes six minutes to rise slowly to 32 deg. If the cotton waste is now withdrawn it falls a little, down to 31·5 deg. We now replace the cotton which has become dry. The thermometer falls to 30 deg., then rises to 31·2 deg. We again withdraw the cotton and it falls to 30·5 deg. It must be borne in mind that the temperature of the water during this experiment is slowly falling.

Another series of experiments performed at Charleroi upon the iron of an alternator is as follows: A thermometer from the electrical works, with a large bulb, covered with cotton waste, indicated 74·8 deg.—one of our thermometers, slid under the same cotton, yielded 75·5 deg.; on withdrawing the latter and placing it against the iron at the side where the temperature was certainly the same, it descended in three minutes to 73·3 deg. The dry cotton was added, and it rose in 10 seconds to 74 deg. and remained there. The figure 75·5 deg., which was certainly the true one, was no more to be found. It is advisable to distrust cotton. A small fibre can come between the object and the thermometer. The temperature is then communicated by rays emitted at very slight distances and not by contact.

In the last experiment the bulb was placed upon the iron at 75·5 deg. with cotton to cover it, and the thermometer went down to 71·2 deg. The lowering of the temperature was caused by the absorption of heat by the fingers through the cotton. Heat was withdrawn by the circulation of the blood, so that the absorption continued. The thermometer only rose if the temperature of the iron increased.

Now let us come to another experiment: the thermometer on one of the poles of an electric starter marks 58 deg. when covered with a rag; the latter is taken away and the thermometer falls to 56·5 deg. and stops there. It has been cooled by the current of air which runs along the piece of metal.

The employment of cotton must be made with care. Observations can be brought to within 0·5 deg. of accuracy by the use of our thermometers.

The difference may be greater with large bulb thermometers, for the radiating surface of the thermometer itself is greater and the contact with the solid is not so good.

There are cases in which cotton cannot be employed—for instance, when the solid one wishes to know the temperature of is in motion, such as a dynamo commutator or a motor ring.

[illegible] made upon the commutator of a [illegible] running at 960 revolutions [illegible] furnished with four rows of [illegible] The thermometer was slung the commutator, which, however, constitutes a compact metallic mass [illegible] copper, no [illegible] connecting metal. It would seem, then, that the temperature should be the same over the whole mass. But it is not, and that is easily experimented. One [illegible] because the armature, which is the [illegible] is generally [illegible] cooler than the middle of the commutator, because [illegible] the armature [illegible] the commutator [illegible] the [illegible] If the greater part of the heat developed in the commutator comes from the friction of the brushes, and sparking under the brushes, the outer end of the commutator will have a higher temperature than the other end, submitted to a more energetic ventilation. Thus by observation, the causes of abnormal heating may be ascertained.

The following are the temperatures of the commutator described above, while in motion:—

Armature end	47·5 deg. C.
Middle	50·0 deg. C.
Outer end	52·5 deg. C.

We published in 1908 in "La Lumière Electrique," of Paris, a technical study connected with this subject, and entitled "Thermomètres sur Collecteurs." Since then we have made a number of observations which confirm our theory.



METHOD OF USING THERMOMETER ON ROTATING COMMUTATOR.

The fixing of the thermometer needs a certain amount of care. It is advisable to support it lightly upon the commutator by means of a combination of thin strings, so that it does not jump on unavoidable roughnesses, and so that it stays in contact with the moving metal (*see* Figure). A reading of 52 deg., for example, has been corrected to 66 deg. by lightly pressing the thermometer upon the commutator for three minutes by means of a cotton wad.

It is well, for the first readings, to place a cotton wad, heated for a few seconds on the commutator, on the bulb of the thermometer; if a great change is noticed, it will be because the thermometer is badly placed and this should be remedied.

It should be borne in mind that, according to the rules, it is the highest temperature shown during the experiment which is taken into consideration. During the 7 years that our method has been used we have been forced to reject no small number of machines which passed the less severe tests of the older methods

LOAD CURVES "IN RELIEF."*

BY MAX DU BOIS.

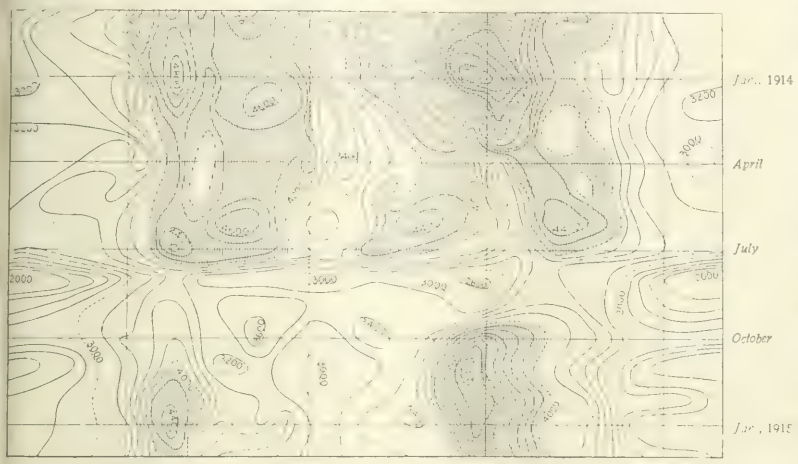
If the daily load curves of a central station were cut out of paper according to their contour, and the strips of paper were put together in their chronological order, the curves would combine together to produce a rugged surface, like a range of hills. In other words, the axes of co-ordinates in a load-curve are those showing the hours of the day and the output of power. To these we should add a third showing the daily sequence, and thus we obtain the load curves in relief. If the result is to be shown graphically on paper, one constructs a sort of contour map, in which the altitude curves correspond to the instantaneous output of the station at any moment. These relief curves are very useful, as they tell at a glance how the station is working, and they also give hints as to how the gaps may be stopped and the direction in which it may seem hopeful to look for new customers.

Let us take the annexed diagram as a basis. It shows the output of one of the French stations, the contour lines being spaced at centuries corresponding to 200 kw. It represents a provincial station serving the south of France, and has fairly steady load curves. All the peaks in the morning and evening are less marked than in the whole station. The depression, which corresponds to the declaration of war, is also interesting. The level is immediately depressed at the whole of the line, and this was followed in November by a marked improvement, but only in respect of the lighting load. With regard to the improvement, due to new customers, the contour map shows that the improvement made between 1912 and 1914. In 1912 the [illegible] seem to have had very steep sides, but they have been exceeded by plateaux of considerable bulk, which shows an improved utilisation of the output of the station. In order to improve matters still further it is necessary to look for a type of customer who takes more energy in the daytime in summer than in winter. All this seems to point directly to the farmer. If the slight sinuosities are carefully examined, the peculiarities of the different agricultural occupations can be distinguished. As for the night output, the

* Abstract of an article in "La Lumière Electrique."

actually in the present case reached 3,000 kw., which is half the maximum output.

This plan has the advantage of showing on one surface the entire annual or monthly output of a station, and there is no need to think about the gradual changes that have taken place during the period. It has the advantage that it almost seems to indicate of itself the remedies to be applied in case of any abnormal gap. The method of economising the means of production may also be indicated. In the present case the distributing company buys all its power below a certain level of output from one of the hydro-electric companies, which has a large output and a low head of water. Above this level and for the peaks it falls back on another station, utilising a high fall and having certain machinery in reserve. From this contour map it is easy to calculate how much water must be dammed up in a reservoir in order to deal with the peak throughout the year. Suppose it were a question of making a lake to hold the water which was to be utilised for all times when the output was above 4,000 kw.



Contour Map showing the Variation of the Output during the Year 1914.

With the planimeter one would evaluate the areas of the curves above this level, taking account of their distance apart, and in this way it would be possible to get a fair estimate of the kilowatt-hours which the reservoir would have to furnish. The uses of these "relief" load curves do not seem at present to be generally known.

CORRESPONDENCE.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Among the amusing elements in this discussion, which has now spread over a period of over seven years, are the many attempts, wise and otherwise, to try to circumvent what these new experiments have taught us. Among the most amusing are some of those made in the early part of the discussion, in which one opponent argued that all physically open circuits must be considered as being theoretically closed, while another opponent maintained that all physically closed circuits must be considered always as being theoretically open. My reply was an expression of sympathy for the students whom they teach.

In your issue of July 30th, p. 634, Mr. Humphry MacCallum replies to my letter to you, published in your issue of July 16th, p. 559, and advances a suggestion (which, by the way, is not new) of an explanation as to why we should accept drawing the conclusions which I did—namely, that the conductor itself, physically, must cut the flux to produce induction, and that a shunting by the circuit alone, the conductor being at rest, will not produce induction. I note that this is a mere suggestion and not the results of an experimental research. I would predict, however, that the experiment which he suggests, involving the use of a telephone as an indicator of currents, would probably give him the results that he desires, but that in my opinion it would by no means be final, as the telephone is so extremely sensitive that it is difficult not to get a current due to entirely extraneous conditions, as, for instance, the stray fields in this case. The results would, therefore, muddle the issue rather than clarify it, and they would, therefore, interest only those who are more anxious to overthrow these new conclusions, and not those who, like myself, are anxious only to find out what the true facts are, whether they are in accordance with our prior ideas or not. If I am wrong, there is no one more anxious than myself to know it.

It seems to me that a much more conclusive form of experiment, which I regret I have no facilities at hand for trying out at present, would be to make the stationary block of thin insulated laminæ, extending from brush to brush (therefore breaking up his supposed eddy currents), and making each brush touch one before leaving the other, being careful to move both brushes exactly alike so as never to break the circuit.

These laminæ could furthermore be made of relatively high resistance, so that his supposed shunting effect would not be great enough to nullify the detecting power of the galvanometer. To assure one that the galvanometer was sufficiently sensitive, the two brushes might be placed in the middle of the block, and the whole block with its brushes be then moved bodily together through the same field and at the same speed as before.

Mr. MacCallum, I note, ignores Prof. Blondel's experiment in which there is no such large block for the circulation of eddy currents, yet Prof. Blondel's experiments lead to exactly the same conclusion that mine did many years before.

It is now seven years ago since my experiments and conclusions were published, and, judging from the number of replies, they were extensively read. Considering the apparently desperate attempts made by some to refute them, it is probably safe to assume that if my conclusions had been incorrect, it would have come out before this time.

After writing the above, your issue of August 6th reached me, and I note with pleasure that Prof. Blondel and Prof. Gheysens both express virtual agreement in the main features. I was pleased that Prof. Blondel called attention to the fact that his experiment shows that the seat of the E.M.F. is in that part of the conductor that cuts the flux, that is, it is not equally distributed over the whole circuit as a loop, which would be inferred from the usual statement of Maxwell's law. I desire to correct him, however, in his statement that this had never been done before, as I have maintained this for many years, and have no doubt mentioned it in some of my Papers.

I agree with him that for many practical purposes the old statement of the law is very convenient, and gives correct results; my claim has been that it is not universal, and the law which Dr. Steinmetz has worded (with some co-operation with me) was intended to be the universal statement.

I think the suggestion above to make the block of insulated laminæ will answer some of the statements of Prof. Gheysens. His Fig. 3, it seems to me, is only unessentially different from what is done in the ordinary direct-current generator by the commutator. I am, &c.,

Philadelphia, Aug. 17. Carl Hering.

STATE AID FOR INDUSTRIAL RESEARCH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your letter, it is not necessary to say anything with regard to the need for research; we are all agreed that discovery is to an industry what the birth-rate is to the life of a nation. If the rate of discovery falls below the rate of obsolescence, the industry is doomed. And we are pretty well agreed that the State should give substantial grants in aid of research. This outlay would not be an expenditure, it would be an investment, giving a very much higher return than most investments. The large amount of money spent in the development of the metallic filament lamp through its various stages, was not one-tenth of the profit made from sales; and it was not one-hundredth of the value of the lamp to the myriads of users of electric light.

The main points for discussion are: How can State aid be made most effectual? What persons should carry on the research, and how should they be remunerated?

Some researches are best carried out by a manufacturer, and others best by universities and public institutions.

Manufacturers have many things in their favour. They know the improvements that are wanted. Their experts are familiar with the conditions that have to be met, and with the difficulties of the problem. They often have available heavy machinery and expensive apparatus which is necessary for the research. They can at comparatively small expense carry out improvements on apparatus commercially manufactured in quantity; they are thus able to put an invention upon the market immediately, watch its effect on a large scale, and introduce necessary improvements. The manufacturer makes improvements for profit, and the best test of the value of an invention is the fact that it is commercially profitable.

On the other hand, there are certain drawbacks to research carried out by the manufacturer. As a rule, the experts in the works are so busy with routine work that they have very little time for experiments. They are often men who have not the highest training in science and mathematics, however competent they may be in their particular work. There is usually a tendency on the part of the management to cut down all expenditure which is not absolutely necessary for turning out standard manufactures. Any change in a design causes increased cost in the factory, so that the expert who suggests a change meets with a good deal of opposition. Radical departures are almost out of the question. In fact, one may say that as a rule a manufacturer only makes investigations in those cases where the profit to be derived is in sight. When a manufacturer does make an improvement he generally covers it by a patent, and this obstructs in a measure the flow of ideas which otherwise would spring from it.

The State could do a good deal to minimise these drawbacks. By consulting with a manufacturer or a group of manufacturers, arrangements could be made for certain investigations to be carried out, partly at the expense of the State. The question of who is to derive the pecuniary advantage of improvements made, would be dependent upon the circumstances of each particular case.

Highly trained investigators in various departments of engineering, physics and chemistry, mathematicians and others could be retained by the State, and their services given free of charge to manufacturers when required. It has often been suggested that manufacturers should keep "tame mathematicians" to help them in difficult problems; but very few are able to afford the luxury.

There are many investigations which are much better carried out by universities and public institutions. In addition to [illegible] and fellowships awarded by these bodies, there should be considerable sums granted in aid of specific researches. It should be open to any person to apply for a grant in aid of some research outlined by him, and if his qualifications to carry out the work were proved, and the proposed research seemed of sufficient importance a grant should be made, the amount of which should be fixed having regard to the probable cost, the chances of success, and the importance of the work to be undertaken. Persons receiving grants might work either in a factory or under the auspices of a public institution.

We might have more men at our universities to act as directors of research, who would originate investigations and advise students and research scholars in their experiments. The salaries paid to such directors of research should be sufficient to attract men of high theoretical training and wide practical experience. At present many of the chief lecturers and demonstrators upon whom this work devolves are extremely poorly paid, and their time is very much occupied by teaching duties.

Another very important matter for discussion in connection with research is the provision of competent researchers. It is not true that these are born and not made; they must be born and made. The engineering and scientific professions at present do not afford sufficient promise of reward to induce all the men who have good natural qualifications to enter them. We ought to raise the monetary reward and the honourable status of the scientific investigator to such a point as to secure all the suitable men. The method of training these men should be arranged so that it not only supplies the tools for investigation, but develops and practices the inquiring habit of mind. This is such a large subject in itself that it would be impossible to deal adequately with it in a short letter.—I am, &c.,

Manchester, Aug. 31. MILES WALKER.

WIRELESS TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Replying to the letter of Mr. Round in your issue of August 6th my British audion patents were assigned and lapsed through no fault of my own. That fact, however, should scarcely justify the refusal of those who have since appreciated, and appropriated the device bodily in their "own improvements," to acknowledge its true origin.

In September, 1912, the audion amplifier was demonstrated to the engineers of the American Telephone & Telegraph Co. and licenses under all my U.S. audion patents offered to that corporation for use on their long-distance lines. Mr. Armstrong's work on the ultraudion principle was independent of my own. Although his circuits differ from mine he openly admits that he started with the grid audion and has used it exclusively in all his work.—I am, &c.,

New York, Aug. 18. LEE DE FOREST.

[We have taken the liberty of somewhat abbreviating our correspondent's letter.—ED. E.]

THE OPERATION AND RATING OF THE ELECTRIC LOCOMOTIVE.*

BY A. H. ARMSTRONG.

The present article touches upon the subject of electric locomotive operation, what excuse it has for existence, and draws some few comparisons with the steam locomotive as to its selection and rating.

Commencing with the New York Central locomotive, we have a directive type admirably adapted to high-speed passenger service. It is designed to deliver a moderate tractive effort at a high speed. The "T" type of locomotive, weighing approximately 130 tons, has a capacity of 14,000 lb. tractive effort at a speed of 53½ miles per hour, or a continuous motor capacity of approximately 2,000 H.P. For the one-hour period the output is 2,600 H.P. The time element plays a very important part in the determination of the rating of an electric motor. In a steam locomotive the tractive effort or pulling power is determined by the diameter of the piston and the steam pressure behind it, and the locomotive can deliver this tractive effort continuously provided it has sufficient boiler capacity to supply the steam. With the electric locomotive, on the contrary, allowance must be made for the fact that the insulation used deteriorates if heated continuously above a certain amount. It takes a considerable time for the motor to heat up to this dangerous point, thus giving rise to a momentary rating or starting effort, a one hour rating and a continuous rating.

In the early electric locomotive design there was no such thing as continuous rating, as the runs between stops were short and the designing engineers were concerned mostly with the question of starting or accelerating tractive effort and commutation. With the extension of electrified lines and more especially with the

* Abstract of an article in the "General Electric Review."

introduction of the electric locomotive on main steam trunk lines, it was found that the motive power was called upon to deliver a continuous output for long periods at a time, and it became necessary to introduce air blown or ventilated motors as well as fireproof insulation in order to secure the large output required without exceeding the limitations of space and weight. Electric locomotives to-day suitable for the heaviest class of freight and passenger service are entering into competition with the steam locomotive with a full appreciation of the phenomenal growth and possibilities of the latter as developed during the past few years.

In designing such electric locomotives the electrical engineer is fully alive to the fact that a steam locomotive has been built weighing 750,000 lb. on drivers, and having a total weight of 850,000 lb., and that nearly 90 per cent. of the total weight of the locomotive and tender is now rendered available for tractive purposes by the development of the Mallet principle to include cylinders placed upon the tender itself. The tractive effort of these locomotives has increased to values as high as 160,000 lb. for the latest type of Mallet. It is also known that the introduction of the steel passenger car, with the need of high sustained speeds of between 60 and 70 miles per hour, calls for the hauling of passenger trains weighing over 1,000 tons, and that provision is made in the latest New York Central electric locomotive to take care of 1,200 tons at 60 miles an hour. Due appreciation is also paid to the results secured with the combination of superheating and simple engine which has so largely replaced the compound. Also mechanical pushers and fire door openings with hand firing, have increased the efficiency of the fireman. The modern steam locomotive has been so improved as to fuel economy. Some locomotives using mechanical stokers or oil-fired boilers are in operation, giving 3,000 or more indicated horse-power.

Fully appreciating the above facts and the magnitude of the problem confronting him, the electric railway engineer, nevertheless, offers in the modern electric locomotive a type of motive power which can accomplish results in transportation which are not possible to obtain with the steam locomotive as regards tonnage handled, speed on mountain grades and general flexibility and economy in operation. The first large locomotive built was placed in operation on the Baltimore & Ohio Railway in 1895, and it is worthy of note that this was a gearless locomotive and a forerunner of the highly efficient gearless locomotives now in operation upon the New York Central road to-day. The New York Central locomotive, as developed in the later "T" type, is capable of hauling the heaviest passenger trains over any length of track at a cost for upkeep not exceeding 1¾d. per mile run.

The first railroad in the U.S.A. to adopt electric freight locomotives having large sustained output capacity is the Butte, Anaconda & Pacific Railway. The one motive inspiring this installation was economy in operation, and preliminary reports indicated that the savings in electric over steam operation should be sufficient to pay something like 18½ per cent. upon the capital required to electrify. The saving, as indicated by the first six months' operation, was about 20 per cent. gross return upon the capital required for electrification. This makes no allowance for the scrap value of more than 20 steam locomotives discarded.

On this road the heaviest class of freight trains are operated electrically, regular operation calling for the movement of from 3,500 to 4,000 tons behind the locomotives from the Butte yards to Anaconda, and record has been made of train weights as high as 4,500 tons trailing against a gradient of 0·3 per cent. Each locomotive weighs 80 tons, all on drivers, and two such units coupled together comprise a complete engine. At the Butte end there is a gradient of 2 per cent. against the returning empty cars, and at Anaconda a 1·1 per cent. grade, against which one of the above locomotives hauls 25 cars, or approximately 2,000 tons.

This leads up to the subject of the rating of an electric locomotive. The Butte locomotive, weighing 80 tons, all on drivers, will give a continuous tractive effort of 26,000 lb. at a speed of approximately 16½ miles per hour at full sub-station line voltage. This corresponds to 16" per cent. of the weight upon the drivers. From 18 to 19 per cent. coefficient of adhesion between steel rail is now considered good steam practice, and the electric locomotive rating is clearly below the steam practice. The electric motor, of course, gives a perfectly uniform rotation to the driving wheels, and should thus give something like 10 per cent. more tractive effort than the steam locomotive with its reciprocating parts. Continued operation has shown whether this coefficient of 10 per cent. may be safely applied or not. In the meantime the steam practice is being followed in the loading of electric locomotives.

Locomotive boilers have shown a coefficient of adhesion as high as 35 per cent., or even more under special circumstances, but it is fair to assume a maximum of 30 per cent. as a figure in operation, and even 25 per cent. must be termed the average. There is, therefore, not much difference between the tractive effort required on ruling grades and that required for starting, and in order to be "fool proof" and capable of meeting the exacting demands of the heaviest kind of service, the electric locomotive should be capable of delivering continuously a tractive effort equal to from 16 to 18 per cent. coefficient of adhesion of the weight upon its drivers. The Butte locomotive is, therefore, rated at 26,000 lb., or 16·25 coefficient of adhesion, as its continuous output, and this capacity is sufficient to meet all demands of operation on the Butte, Anaconda & Pacific Railway.

Coming now to the latest type of trunk line electric locomotive, the one designed by the General Electric Co. for the Chicago, Milwaukee & St. Paul Railway,* this is a direct development of the Butte, Anaconda & Pacific both as to type of locomotive and general system of electrification installed. The weight of the locomotive is 260 tons, of which 400,000 lb. are on the drivers. Each of the eight driving motors has a continuous rating of approximately 400 H.P., making the sustained continuous output of the complete locomotive 3,200 H.P. at the rim of the drivers. This locomotive, however, has a capacity of 3,600 H.P. for one hour, and even greater than this for short periods. The sustained tractive effort is 72,000 lb. at a speed of 15¾ miles per hour at full sub-station line potential. Compare this with the Mallet engine of approximately the same weight now in operation on the St. Paul road, and we find that the Mallet has 76,200 lb. tractive effort, corresponding to 23·5 per cent. coefficient of adhesion; but it toils painfully at speeds seldom exceeding 7 to 10 miles per hour when operating at its full hauling capacity. It is in this matter of higher speed for the same tractive power that the electric locomotive excels. In fact, the question of speed is simply one of cost and expediency, as the horse-power output of the electric locomotive can be raised to any value desired without exceeding the limits of track loading.

The St. Paul locomotive, weighing 70 tons, has a capacity to haul a 2,500-ton trailing load behind the locomotive on a 1 per cent. grade at nearly 16 miles per hour without any assisting locomotive. Between Piedmont and Donald, a distance of 22 miles to the summit of the Rocky Mountains, there exists a 2 per cent. grade, against which two locomotives will haul 2,500 tons trailing, the second locomotive being used at the rear of the train as a pusher.

The general design of the St. Paul locomotive comprises a locomotive divided in halves for facility in shop repairs, each half being identical and equipped with four driving axles and two guiding axles. The design is identical with the Butte locomotive, except for the addition of the four-wheel guiding truck at each end of the locomotive, one of the reasons for its introduction being that the same locomotive is thus made available for both passenger and freight service. All parts of the locomotive are identical, whether used for freight or passenger service, with the single exception of the gearing between motors and driving axles, which has a ratio of 4·56 for freight service and 2·45 for passenger service. This should result in effecting a great reduction in the cost of maintaining the locomotives.

A second type of light locomotive for shifting service may be introduced later, although in this connection arrangements are being made to operate independently, one-half of the locomotive being equipped with draft gear in place of the articulated joint joining the two halves.

The installation on the St. Paul road will use for the first time on such a large scale a principle which should be of the greatest advantage in the operation of mountain grade divisions; that is, the utilisation of the motors on the locomotives to brake the train on down grades and return the energy of the descending train back into the trolley. The efficiency of the locomotive, both electrical and mechanical, is nearly 90 per cent. It is probable, however, that a power saving of less than 10 per cent. will result from the regenerative braking feature of the electric locomotives, and the principal advantage resulting from the introduction of the electric brakes will be to relieve brake shoes and wheels from the dangers attending over-heating.

In conclusion, it is well to comment on the suitability of the New York Central gearless type of locomotive for passenger service. There are no bearings on the motor of any kind, as the armature is mounted directly upon the driving axle and the field structure is part of the frame which is carried upon the journals. The electrical efficiency of the motor and the frictional losses on the commutator, due to the brushes, are therefore the only losses to be considered, and the efficiency of the locomotive in operation is, therefore, between 93 and 94 per cent. This is rendered more important when it is explained that the maximum efficiency occurs at approximately the free running speed between 50 and 60 miles per hour. In other words, the motor has a drooping efficiency curve, being highest at free running and lowest at overloads or during acceleration, and in

* A description of these locomotives, by Mr. Armstrong, appeared in THE ELECTRICIAN, Vol. LXXV, p. 743, August 20, 1915.—ED. E.

this respect being just the reverse of the efficiency curve of geared motors, which reach their highest point at practically the one-hour load capacity of the motors. The gearless locomotive is, therefore, particularly adapted to operate on fairly level profiles, and could not be utilised to such great advantage on roads like the St. Paul, which contains many heavy grades sustained over a long distance. It is very difficult to combine in one structure motors capable of hauling 800 tons trailing over heavy sustained grades, and also have the characteristics required for good operation on level track at 60 miles per hour, and in the St. Paul locomotives recourse to gearing between motor and driving axle appears necessary to secure the greatest all-round advantages at the lowest first cost.

THE MEASUREMENT OF CURRENT IN NETWORKS.*

BY L. LEWIN.

It is often very necessary in view of extensions or for other reasons to know the current that is passing through some particular conductor in a network. This is often the case in the middle of the network, where the cables were laid at the earliest stage of the undertaking, and at a time when the extensions that have since grown up were thought most improbable. Even if new cables are laid in the more crowded districts to take a portion of the load, the older cables still continue their work, and are only partially relieved. If measurements are made, it is at best an awkward and cumbrous business; if an ammeter is to be put in place of a fuse, it has to be done at times of light load, and removed much later in the day when the load has passed the peak. This proceeding makes a whole day necessary for finding the current carried by the cable at the time of its heaviest load. Moreover it is very plain that this is at best an uncertain method owing to the methods of effecting the connections and various other causes. There is on the market an apparatus that has been designed for this purpose, *i.e.*, of finding the current carried by any particular portion of the network. In this apparatus, a magnetic field, due to the current carried by the conductor, is neutralised by an artificially created counter-field; the amount of this artificial field serves as a measure of the current carried by the network. But this is a very uncertain method, and it is quite useless in the case of conductors of the armoured type carrying direct current. It might be useful on alternate-current networks, and mainly on overhead cables. It consists essentially of a transformer without a primary coil, or rather the primary coil is constituted by the conductor in the network, either directly or indirectly. Even, however, in the case of alternate current, the method is not without its difficulties and uncertainties.

The author has for some time employed a plan which requires no special apparatus and enables one to determine in a few minutes all that is required. The only thing that is wanted is a millivoltmeter, that is an ammeter without shunt, and possibly a small series resistance. The shunt is the fuse in the network itself. In large networks there is, comparatively speaking, a limited number of types of fuse. In a town network, for instance, most of the distributing cables carry fuses which blow at 200 amperes, while some blow at 300 amperes. Fuses are either of silver or lead wire; there may therefore be 8 or 10 different types of fuse with which to deal. In order to use these fuses as shunts, they must be calibrated with the millivoltmeter. For each of these fuses, there must be a calibrating curve or table. One must first find out whether all the fuses of the same type are similar in resistance and material. For this resistance determines the deviation of the needle of the instrument; the temperature-coefficient affects the character of the calibration curve, in so far as this depends on temperature. The uniformity of the fuses is therefore a very important point in the application of this method, and preliminary tests have to be carried out.

For the purpose, a number of fuses of any given type are connected in series, and loaded with a constant current. The current ought not to be too high in order to do away with the disturbing effect of temperature. It is sufficient to pass 20 or 30 per cent. of the total carrying capacity of the fuse, according to the sensitiveness of the voltmeter. As soon as the temperature of the fuses has become constant, *i.e.*, after 5 or 10 minutes, the millivoltmeter is firmly connected to each of the fuses in succession and readings are taken. In this way readings are obtained, similar to those in Tables I. and II. Table I. is for Britannia fuses, blowing at 100 amperes, of the small type with 10 strips; for the test, they carry 25 amperes. Table II. is for silver wire fuses, blowing at 200 amperes, and carrying for purpose of test 50 amperes. Out of these fuses, we choose those which gave results most nearly agreeing with the mean readings.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft, 49, 1914.

Table I.—*Showing the Readings obtained on the Millivoltmeter with seven different Fuses of the Britannia Type.*

Number of the fuse.	Reading on millivoltmeter.	Mean reading.	Percentage deviation from the mean.
1	62·8		+0·48
2	63·0		+0·8
3	60·0		−4·0
4	66·0	62·5	+5·6
5	62·0		−0·8
6	61·0		−2·4
7	63·0		+0·8

Table II.—*Showing the Readings obtained on the Millivoltmeter with seven different types of Silver Wire Fuse.*

Number of the fuse.	Reading on millivoltmeter.	Mean reading.	Percentage deviation from the mean.
1	45·8		−2·14
2	47·0		+0·43
3	47·0		+0·43
4	47·2	46·8	+0·48
5	46·8		0·0
6	47·1		+0·64
7	46·5		−0·64

Table III.—*Giving Readings with Increasing and Decreasing Loads on 100-ampere Britannia Fuses with Series Resistance of 1·6 ohms.*

Amperes.	Reading on millivoltmeter with increasing load.	Reading with decreasing load.	Mean of the two readings.
25	15·5	15·9	15·7
50	31·5	32·1	31·8
75	48·0	49·5	48·7
100	64·9	67·1	66·0
125	82·0	85·0	83·5
150	101·5	104·9	103·2
175	123·3	126·0	124·7
200	147·0	...	147·0

Table IV.—*Giving Readings with Increasing and Decreasing Loads on 200-ampere Silver Wire Fuses; Series Resistance, 1·5 ohms.*

Amperes.	Reading on millivoltmeter with increasing load.	Reading with decreasing load.	Mean of the two readings.
20	20·5	20·6	20·5
40	41·8	42·0	41·9
60	63·8	64·3	64·0
80	87·6	88·8	88·2
100	103·7	...	103·7

Thus of the Britannia strips, we take No. 1, and of the silver wires, either No. 2 or 3. With these we now make our calibrating curve or table. The readings are taken 10 minutes after the current has been applied, in order to conform as nearly as possible to the conditions in practice, where the current is likely to rise and fall slowly. Thus we get Tables III. and IV.

Tables III. and IV. show that the readings differ according as the load happens to be rising or falling. These differences amount to 0·7 per cent. with the Britannia fuse, and 1·7 per cent. for the silver wire type. But these differences only become marked at heavy loads, when the heating of the fuse is very noticeable. If we take Tables I. and II., we find that the greatest deviation of the Britannia fuse from the mean is 5·6 per cent., and of the silver wire 2·14 per cent. But these maximum deviations seldom occur; and it is fair to assume that with this method, the accuracy of the results can be depended on to within 5 per cent. If in certain cases it is thought to be necessary to get very accurate results, the following method can be adopted. At the time of maximum load, the distributing box is opened, the millivoltmeter is connected to the fuse, and the reading is taken. Next day at a time of low load, the fuse is taken out and another is put in its place. The fuse, which is removed, is taken to the test room and loaded with current until the voltmeter gives the same reading as was given on the network. In this way a very exact result can be obtained, if the heating effect is properly allowed for. Exactly the same can be done on networks where there are many different types of fuse; in such a case there might be a difficulty in using calibrating curves. The plan might also be useful with fuses of an unusual type, for which no calibrating curves were available. The method can also be applied to trace the effects of faults on the networks or leakage currents, or to test the uniformity of distribution under various conditions, *e.g.*, with three-core and three-phase cables.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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THE OPPORTUNITY FOR BUYING ENGINEERS.

The protracted nature of the present European war, and the prospect of the continuance of the struggle perhaps for another 12 months or longer, should provide encouragement for those who are organising ways and means to capture German trade. The hue and cry raised on this account 12 months ago could not be justified in view of the idea that the war would be short; with a prolonged war the case is different. Obviously the transfer of a vast amount of trade with all the principal countries of the world from German hands to those of the Allies could not be effected within a few months. Subsequent events have occasioned the transfer of so much industrial effort to the production of munitions that on every hand one hears of the inability of manufacturing concerns to deal with anything but Government work. In the electrical industry there are signs of a movement having for its object a co-operative effort whereby trade in British electrical machinery, appliances and apparatus can be secured in the principal allied countries. Attention is especially directed to the case of Russia.

A movement of this character must necessarily bring into bold relief the work which has been done, and which now can be done even more effectively, by that class of professional men who have appropriately styled themselves "Buying Engineers." A number of these firms have been in business for many years, and have succeeded in conclusively proving the value of their services to purchasers of plant and machinery in the Colonies and foreign countries. They have made it their business to act on behalf of their clients in the selection of any plant, machinery or apparatus of which they may be in need. The buying engineer is essentially the result of a baneful system that was at one time all too common, and which we fear is still in operation, under which the home manufacturer regarded the foreign buyer as an individual upon whom could be foisted any class of material. The fact that thousands of miles separated the maker and his client, and the further fact that the latter paid, perhaps, through an exporting house, against bills of lading, seems to have aggravated this evil. It is easy enough to argue that the colonial buyer once bitten is twice shy, but one has to put oneself in the position of the overseas purchaser, with his limited choice of markets and his infinitely long wait for delivery. We believe that those of our Imperial customers who have traded through buying engineers in this country have nothing but satisfaction to express for the services which have been rendered them and the promptitude with which their requirements have been carried out.

The war, by encouraging trade among such European countries as Russia and the Balkans, is thrusting a new responsibility upon the buying engineer. It should also tend to increase his numbers, for at the moment there are regrettably few of him. The time may not yet be ripe for the formation of a group of such men, but it cannot be far distant when some measure of co-operation will help to improve not only their inter-relations, but also the trade of the country generally overseas. Where the problem of language is introduced, as it is undoubtedly being, the buying engineer will find himself again in an advantageous position in giving service both to the manufacturer and the prospective purchaser. He can act as an intermediary probably more effectively, and certainly on a more extensive scale, than the manufacturer, particularly that type of manufacturer who has done little or nothing to perfect his sales organisation, and prefers to trade through independent parties. We certainly think the work of organising British trade abroad should take account of the buying engineer, and in every possible way make use of his experience.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Aug. 23, 1915. to Aug. 28, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible] U.S.A. Elec. machinery, £6,570; elec. [illegible] £3,053; telegraph materials, £136; lamp parts, £224; elec. wire and cable, £384; trolley parts, 70 cases; unenumerated, £2,226—1,220 pkgs. *Switzerland:* Unenumerated, £72. *Holland:* Elec. lamps, £1,542—11 pkgs.; elec. machinery, £65. *Norway:* Elec. lamps, £250; unenumerated, £290. *France:* Carbon candles, £569; elec. lamps, £80; lamp parts, £1,159; elec instruments, 24 pkgs.; wire and cable, £320; unenumerated, £160. *Denmark:* Elec machinery, £160. *Italy:* Wire and cable, £493; elec. machinery, £444. *Sweden:* Elec lamps, £276; lamp parts, £36; unenumerated, £110. *Canada:* Wire and cable, £106. *Spain:* Carbons, 31 pkgs.

EXPORTS.

To Australasia.—*Auckland:* Elec. machinery, £68; unenumerated, £306. *Melbourne:* Elec. machinery, £93; wire and cable, £680; unenumerated, £719. *Sydney:* Elec. machinery, £826; wire and cable, £2,525; unenumerated, £2,638. *Wellington:* Elec. machinery, £47; wire and cable, £39; unenumerated, £980. *Brisbane:* Elec. machinery, £147; unenumerated, £243. *Christchurch:* Elec. machinery, £55; unenumerated, £38. *Perth:* Unenumerated, £185. *Dunedin:* Unenumerated, £225. *Hobart:* Elec. machinery, £114. *Rockhampton:* Wire and cable, £40. *Townsville:* Elec. machinery, £345; wire and cable, £191. *Lyttleton:* Unenumerated, £316. *Wanganui:* Elec machinery, £704.

Africa.—*Durban:* Elec. machinery, £471; wire and cable, £3,129; unenumerated, £586. *Port Elizabeth:* Unenumerated, £125. *Cape Town:* Elec. machinery, £244; unenumerated, £499. *Beira:* Elec. machinery, £73; unenumerated, £135. *Delagoa Bay:* Unenumerated, £225. *Mossel Bay:* Unenumerated, £42.

Egypt.—*Port Said:* Unenumerated, £29. *Alexandria:* Wire and cable, £16.

South and Central America.—*Buenos Ayres:* Wire and cable, £6,149; elec. machinery, £1,207; unenumerated, £2,389. *Callao:* Unenumerated, £34. *Iquique:* Unenumerated, £68. *Rio de Janeiro:* Unenumerated, £40. *Punta Arenas:* Unenumerated, £32.

Japan.—*Kobe:* Unenumerated, £451.

U.S.A.—*New York:* Unenumerated, £81.

China.—*Shanghai:* Elec. wire and cable, £53; old telegraph wire, 252 t.; unenumerated, £70.

India, Ceylon and China and Straits Settlements.—*Bombay:* Wire and cable, £36; unenumerated, £290. *Calcutta:* Wire and cable, £245; elec. machinery, £43; unenumerated, £178. *Madras:* Wire and cable, £55; unenumerated, £89. *Karachi:* Unenumerated, £105. *Ceylon:* Elec. machinery, £49; wire and cable, £20; unenumerated, £24. *Singapore:* Unenumerated, £17. *Penang:* Unenumerated, £108.

Canada.—*Montreal:* Unenumerated, £673. *Halifax:* Telegraph material, £171; wire and cable, £12,010; unenumerated, £63.

West Indies.—*Trinidad:* Wire and cable, £22; unenumerated, £16.

France.—*Dieppe:* Unenumerated, £135. *Calais:* Wire and cable, £5,300. *Marseilles:* Elec. machinery, £217. *Gravelines:* Telegraph material, £576.

Malta.—Elec. machinery, £33; unenumerated, £179.

Spain.—*Barcelona:* Wire and cable, £32.

Portugal.—*Lisbon:* Unenumerated, £33.

Norway.—*Christiana:* Wire and cable, £1,290.

Holland.—*Amsterdam:* Wire and cable, £1,559.

Gibraltar.—Wire and cable, £14; unenumerated, £76.

St. Lucia.—Unenumerated, £27.

Mediterranean Ports: [illegible] £16

FOREIGN GOODS (duty paid and free).

Sydney: Unenumerated, £15. *Bombay:* Unenumerated, £29. *Adelaide:* Unenumerated, £15. *Madras:* Unenumerated, £98. *Wellington:* Unenumerated, £12. *Hong Kong:* Unenumerated, £19. *Dieppe:* Unenumerated, £53. *Paris:* Unenumerated, £61. *Genoa:* Unenumerated, £30. *Durban:* Elec. machinery, £135. *New York:* Unenumerated, £1,339. *Perth:* Unenumerated, £18. *Port Elizabeth:* Unenumerated, £10. *Singapore:* Unenumerated, £581.

Note.—**The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."**

EDUCATIONAL NOTES.

University of London, University College.—The new session in the faculty of engineering begins on Monday, October 4th. There are degree and diploma courses, and students desirous of taking a full degree or diploma course must have passed the matriculation examination or some examination accepted in its stead.

There are special courses of less than three years for students who have already undergone a partial training elsewhere, and who have attained a sufficient standard. There are good facilities for post-graduate work and research. A Goldsmith entrance scholarship, tenable in the faculty of engineering, value £90, will be competed for the month, and applications for entry forms must be made by 10th inst. Intending students should communicate with the Provost as soon as possible, and in any case not later than Sept. 15. Full particulars of courses, &c., may be obtained from the secretary, Mr. Walter W. Seton, M.A., D.Litt., Gower-street, W.C.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and medicine. Prospectus from the secretary, Mr. F. H. Priest, M.A.

University of Edinburgh.—The University provides courses in [illegible] engineering, qualifying for the degree of B.Sc. in engineering and extending over three years. The next session opens on Oct. 15. A preliminary or entrance examination is held this month. Full particulars from the Matriculation Office.

University College of North Wales. In the electrical engineering department a systematic course of instruction in electrical measurement and practical electricity will be commenced in October for students proposing to enter the profession of electrical engineer. The laboratory is well equipped, and good opportunities are given for practical work. Prospectuses may be obtained from the Registrar and Secretary, Mr. J. E. Lloyd, M.A.

Heriot Watt College, Edinburgh.—This college provides theoretical and practical training for mechanical, electrical and mining engineers, chemists, &c. There are complete courses of instruction, extending over four years, for those who are studying for the fellowship of the Institute of Chemistry. An entrance bursary of £25 per annum is offered for competition on Sept. 20. Particulars of courses, fees, &c., from the Clerk (Mr. R. Macnaughton, S.S.C.), Heriot Trust Office, Edinburgh.

Imperial College of Science and Technology, South Kensington, London.—The City & Guilds (Engineering) College, the engineering section of the Imperial College, provides complete courses of instruction leading up to and including the highest specialised instruction for students, with the object of fitting them for leading positions as civil, mechanical or electrical engineers, scientific advisers, &c. The departments are: Mechanical engineering and motive power (under the direction of Prof. Dalby); civil engineering and surveying (Prof. Dixon); electrical engineering (Prof. Mather); mechanics and mathematics (Prof. Forsyth). Applications must be made by the first Monday in September for admission to the courses qualifying for the diploma of Associate of the City & Guilds of London Institute, and candidates must pass the entrance or matriculation examination of the College held in September or have passed the matriculation of the University of London in certain subjects. The diploma of the Imperial College is granted for advanced specialised or fourth year work. Prospectuses, &c., from the Registrar.

Royal Technical College, Glasgow.—The day courses commence on 28th inst. and the evening classes on 23rd inst.

The diploma of the College is granted in civil, mechanical and electrical engineering, mining, naval, architecture, chemistry, metallurgy, &c. The diploma course extends over three or four sessions and the College is affiliated to the University of Glasgow, the degrees of the University in engineering and applied chemistry being open to its students. There are also full courses of instruction in the schools of navigation and wireless telegraphy. The calendar price 1s. (post free 1s. 4d.), and prospectus (free) may be obtained from the Director.

Northampton Polytechnic Institute.—The session 1915-16 will commence on October 4 next. In the engineering day college there are full-day courses in the theory and practice of civil, mechanical and electrical engineering.

The courses in civil and mechanical engineering include specialisation in automobile and aeronautical engineering, and those in electrical engineering include specialisation in radio-telegraphy. (These courses include periods spent in commercial workshops and extend over four years. They also prepare for the degree of B.Sc. in engineering at the University of London.) The entrance examination will take place on Sept. 28 and 29. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examination which will be held this month.

In technical optics there are full and part-time courses in all branches, and instruction is given in specially equipped laboratories and lecture rooms. An Aitchison scholarship (value £30) will be offered in this department at the entrance examination. Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to the principal, Dr. R. Mullineux Walmsley, St. John-street, London, E.C.

South-Western Polytechnic (London).—This Polytechnic will reopen on Sept. 27 for day and evening classes. The engineering courses include lectures in electrical and mechanical engineering, physics, chemistry and mathematics and practical instruction in the fully-equipped laboratories of the Institute. There is a three years' day course, leading to a diploma or university degree, in electrical engineering; also a four years' evening course suitable for electrical engineering and wiremen's examinations of the City and Guilds Institute.

Students are prepared by recognised teachers of the University of London for the B.Sc. degree in engineering of the university, for the examination for admission to the various engineering societies and the examination of the City and Guilds of London Institute. The evening courses include, in addition to the engineering courses as above, classes in electrical wiring, building construction, and other trade subjects. In the electric wiring department an advanced course has been arranged for the preparation of candidates for the final wiremen's examination of the City and Guilds of London Institute. The laboratories and workshops of the institute may be inspected by intending students. Arrangements have been made for placing students who have passed satisfactorily through the three years' course day in positions with large engineering firms, and hitherto such firms have offered more vacancies than the Institute has been able to fill with its students. Prospectus may be obtained from the secretary, Manresa-road, Chelsea, S.W.

City and Guilds of London Institute.—The programme for the Session 1915-16 which contains the regulations for the registration,

conduct and inspection of classes and examination of candidates in technological subjects, and for the award of teacher's certificates in manual training and domestic subjects, has recently been published.

Among the chief alterations for 1915-16 we notice the following: Candidates in Grade II., Electrical Engineering, may take either the continuous current or the alternate current section alone or both sections in the same year. The syllabuses in electro-metallurgy and coal tar distillation have been revised, and the revised syllabus in mechanical engineering, which was issued separately last year, is also included. The programme is published by Mr. John Murray, Albemarle-street, W., at ninepence net.

LEGAL INTELLIGENCE.

Enemy Alien's Shares.

At Bow-street (London) Police Court on Tuesday the Concordia Electric Wire Co. (Ltd.), and its two directors, Messrs. Robert Fifer and Leopold Aron (otherwise Frank), were summoned for not communicating to the Public Trustee full particulars of 13,993 shares in the company held for the benefit of an enemy alien.

Mr. Travers Humphreys (for the Director of Public Prosecutions) said that defendants were each liable to a penalty of £100 and a further £50 for every day from Dec. 27 until June 9 last, during which the default had continued. Four days had been selected for the purpose of the prosecution, so that the maximum penalties amounted in each case to £250. Defendant company was registered in 1902 for the purpose of trading as a branch of a firm of electrical wire makers at Adlershof, near Berlin. The nominal capital originally was £2,000 in £1 shares, all but seven of which were held by the defendant Aron as nominee in trust for the parent company in Germany. In November, 1913, a further 12,000 £1 shares were issued, and were also held in trust for the German company by Aron and Fifer, who each had 6,000. In May last Aron was expecting to be interned—as had since happened— and he transferred the whole of his shares to two of the company's employés, to Mr. Leonard Thornton (the secretary), and Mr. Belcher (a traveller), under an arrangement by which he would receive all the profits without his name appearing in the register of shareholders. Fifer, who was born in Berlin of Russian parents, had become naturalised in this country, and still held his shares. No notice of those enemy share holdings was sent to the Public Trustee. The company's books showed that the profits for the last three years had amounted, respectively, to £3,294, £2,292 and £2,655, and the shares were valued at par.

For the defence, Mr. George Elliott, K.C., said that the omission to make the returns was entirely due to ignorance. Since the war the company had executed contracts for the British Government. No part of the profits had been transmitted to Germany since the war began.

The Magistrate remarked that for reasons of their own defendants had set themselves out to defeat the Trading with the Enemy Act, and in each of the three cases he imposed a penalty of £250 and he also ordered the company to pay 25 guineas costs.

BUSINESS NOTICES.

Roger H. Wills and Wm. H. Bow, Hall, electric engineers, &c., 211, Corn Exchange Buildings, Manchester, have dissolved partnership.

Representative Wanted. A Swedish firm of lift manufacturers [illegible] for England.

LIQUIDATIONS.

The adjourned meeting of creditors of Venner's Electrical Cooking & Heating Appliances (Ltd.) will be held on Thursday next, Sept. 9, at Blomfield House, 85, London-wall, London, E.C., at 12.30 p.m.

G. Stroud & Co., Ltd., is being wound up voluntarily, and Mr. W. J. Colquhoun, 211, Upper Thames-street, London, E.C., has been appointed liquidator. A meeting of creditors will be held at the offices of Messrs. Vaughan & Williams, 13, George Inn-square, London, W.C., on Sept. 6.

ELECTRICITY SUPPLY.

EXTENSIONS.

Coventry.—On Tuesday the Corporation decided to apply to the L.G. Board for sanction to borrow £80,088 for extensions of the electricity supply undertaking.

The Electric Lighting Committee reported that they had had before them the question of the proposed extensions at the electricity undertaking, the estimate for which was sanctioned by the Council on July 27, and they recommended that application be made to the Local Government Board for sanction to borrow the amount required. A letter had been received from the Ministry of Munitions in reference to the assurance which the Committee have asked from the Government. They were particulars of certain arrangements which the Ministry of Munitions were prepared to sanction. It was resolved that, in accordance with the authority given to the Committee, the town clerk be instructed to make formal application to the L.G. Board for sanction to the necessary loan, and that the manager be authorised to dismantle and dispose of the two 600 kw. sets which it will be necessary to displace in order to make room for the new plant. At a subsequent meeting the chairman reported as to further interviews with the Ministry of Munitions in reference to the proposed extensions, and the town clerk submitted a letter of Aug. 14 from the Ministry of Munitions, approving of the placing on order of a 6,000 kw. turbo-generator, with the necessary boilers and accessories, and of proceeding with extensions to the engine house so as to accommodate that machine and provide temporary room for a 3,000 kw. turbine set. The letter also stated that the financial questions put forward by the Corporation would be placed before the Treasury. The Committee decided that, in accordance with the authority given to the Committee, application be made to the L.G. Board for sanction to a loan of £80,088. 10s.; that provisional contracts be entered into with the British Thomson-Houston Co. for a 6,000 kw. set, and with Messrs. Babcock & Wilcox for four boilers; that the resolution passed at the last meeting with regard to the dismantling and disposal of the two 600 kw. sets be rescinded, and that the sets be retained until the new plant is installed. It was also resolved that it be referred to the chairman and vice-chairman to consider the suggestion of certain estate owners to advance capital money for laying cables to new buildings, with power to agree terms and conclude arrangements.

Erith.—The Council have decided to extend the electricity station buildings, and tenders are being invited for the work.

St. Helens.—An unopposed inquiry was held last week by Mr. A. W. Brightmore into the application of the Corporation for sanction to borrow £15,000 for extensions of the electricity works.

It was explained that the application was rendered necessary by the increased demand for energy by various firms in the town who were engaged on war work. The original estimate was £14,000, but owing to the increase in the price of materials they had to ask for £15,000.

The borough electrical engineer (Mr. E. M. Hollingsworth) said they hoped that some of the works in the district would benefit after the war by capturing German trade, and that they might have many successful years before them.

GENERAL

Belfast.—As stated in our last issue, a rather serious fire broke out at the electricity works on the morning of the 22nd ult., involving the part of the building immediately over the bunkers.

We learn that this portion of the building was designed to avoid coal dust causing a nuisance in the adjoining street, and was in consequence poorly ventilated, but was constructed largely of wood. Heating in one of the bunkers liberated sufficient gas to fill this structure; the gas became ignited and fired all the woodwork simultaneously. The damage was chiefly confined to this structure and the coal conveyor, which has been partly destroyed. There was no interruption to the electricity supply whatever, the Fire Brigade effecting a splendid save of the adjoining buildings. The whole is covered by insurance, and the work of restoration will easily be completed before the winter's load.

Burnley.—The charges for the supply of electrical energy have been revised as follows:

For private lighting, 3½d. per unit; heating, 1½d. per unit; power, an increase of 5 per cent. In Reedley Hallows, lighting will be 4½d. and heating 2½d. per unit, with 5 per cent. increase for power.

Cardiff.—The Electric Lighting and Tramways Committee has revised its estimates, and has effected economies amounting to £3,826 for the current year.

The sum of £9,850 in the yearly estimates for electric street lighting is to be reduced by £2,264 to £7,586. This is to be effected by extinguishing altogether those lamps now extinguished at midnight, which will leave the city with approximately half of its present electric lighting.

The engineer and tramways manager (Mr. Arthur Ellis), reporting upon the question, said there was a possibility of carrying economies in street lighting too far, and there were certain areas in the city where for specific reasons it was not desirable that the present lighting should be reduced. He was unable to hold out any hope of economising in the tramcar service, nor would he approve of refusing new customers for the supply of electricity.

The decreased lighting comes into force on the 1st inst., and the Town Clerk was instructed to give a week's notice to the gas company of the Corporation's intention to discontinue about one-half of their present street lamps.

Manchester.—At the meeting of the City Council on Wednesday Councillor Ross Clegg moved the following resolution:

That a special committee of members of the Council (other than members of the Electricity Committee) be forthwith appointed for the purpose of making inquiry into the working and control of the Corporation electrical department, and that an independent expert in electricity who is not connected with the undertaking be appointed to report as to how the undertaking can be run on business lines, be engaged by such special committee to advise. That they be empowered to hear the views of citizens who may be either favourable or unfavourable to the present and/or prospective policy of the Electricity Committee, and that they shall report to the Council as to the necessity or otherwise on their judgment of certain proposals being forthwith proceeded with or postponed until after the present period of national financial strain.

The resolution was, however, rejected by a large majority.

Surbiton. The Council have approved the agreement for the complete transfer of the electricity undertaking to C. Handley Cable & Construction Co.

Hitherto the company has been working and maintaining the works for the Council, but it is now proposed to transfer the entire undertaking to the company, and steps have been taken to obtain the sanction of the Board of Trade to the transfer.

Thornton Lanes.—At the last meeting of Bispham Urban Council the chairman stated that as they had now got the electric supply cable up to the Thornton boundary it would be beneficial if Thornton Council could be got to take a supply of current in bulk from Bispham rather then have a generating station of their own.

West London Linking-up Scheme.—A special meeting of Fulham Borough Council was held last week in order to further consider the scheme for the linking-up of the Fulham, Battersea and Hammersmith electricity supply undertakings.

The Electricity and Lighting Committee reported that at the meeting of the Council on July 28 an expenditure of £4,550 was authorised for linking up the Battersea and Fulham generating stations, subject to the completion of the principal and supplemental agreements between the Battersea, Fulham and Hammersmith Borough Councils and to the consents of the Treasury, the London County Council and the Board of Trade being obtained. The London County Council and the Board of Trade had approved the agreement incorporating the scheme subject to the testing of meters being carried out by the London County Council's electrical inspectors, instead of as proposed by an inspector appointed by the Board of Trade, and the Committee saw no objection to the alteration. Hammersmith Borough Council had not notified its approval of the supplemental agreement, but had suggested that a clause should be inserted in the principal agreement, providing that, in the event of Hammersmith Council not receiving sanction to incur the necessary expenditure to enable it to join in the scheme within the next three or four months, such agreement should not be binding upon Hammersmith Council, and it would thereupon drop out of the scheme. The Fulham Committee thought this suggestion might lead to unforseen complications, and they were not prepared to recommend its adoption. Battersea Council was anxious that the work of linking-up with Fulham should be put in hand at the earliest possible moment, and the Committee were of opinion that unless the Hammersmith Council was prepared to execute the two agreements, the scheme, at any rate for the present, should be limited to linking up the Battersea and Fulham stations, and they recommended accordingly. And that the Council should approve the scheme for the linking-up of the generating stations of Battersea and Fulham Councils only, on the lines previously agreed with regard to the three boroughs, subject to the necessary modifications. The Committee also recommended that the contracts with W. T. Henley's Telegraph Works Co. and the British Electric Transformer Co., whose tenders were accepted by the Council in July be proceeded with as soon as the amended agreement between Battersea and Fulham Borough Councils had been executed.

The report was unanimously agreed to.

LIGHTING & POWER NOTES.

Asylum Lighting. Hampshire County Council have recently received 21 tenders for electric lighting and power plant for the new asylum at Park Prewett, Basingstoke. The amounts varied from £22,855 to £15,489. The Council have decided to accept the lowest, that of Messrs. Hill, Upton & Co., of Oxford, subject to the sanction of the L.G. Board.

Electricity in Mining. The chairman of the Sussex Coal Mining Co. (Sir A. B. D. Pearson, Bart.) stated at the meeting on Friday last that when the war broke out the Sussex Mining District Co. had placed an order with the British electrical company for a turbo-generator to give them additional power, part of which was to be used in the converter plant.

Owing to the war the electrical company were unable to fulfil their contract, and last November the necessary machinery was ordered in England. After delays occasioned by the congestion of factories in this country, the machinery was at the point of shipment last month, when it was requisitioned by the British Government, and now had to be obtained elsewhere. It was thought that the end of difficulties that had to be got over. Difficulties of transport were also affecting deliveries from the [illegible] Co. [illegible] Pearson was elected a member of the Council.

Electricity in Motor Tyre Works.—The Dunlop Company recently [illegible] from Fort Dunlop, situated about 72 acres in Erdington, Birmingham.

It is stated that over 10,000 hands will ultimately be employed, but [illegible] have just been erected for the immediate [illegible] Power [illegible] Electricity will be used throughout. The work of erecting [illegible] is being proceeded with as expeditiously as possible. When completed there will be 2 miles of railway sidings in connection with the works. Steel embedded in concrete forms the floors of the new shops and are built in bays of about 600 ft. in length and 150 ft. in width. The electric drive is employed and 1,400 H.P. is taken from the Birmingham Corporation electric mains for the first shops erected. At a later stage, however, this power will be supplemented by the installation in the factory of steam turbines aggregating 2,800 H.P.

Electricity in Oil Fields.—At the recent meeting of the Russian Petroleum Co. the chairman (Mr. Herbert Allen) stated that they had installed electric motors in place of oil-fed steam boilers, from which they were only just beginning to feel any material benefit.

The report just to hand from Baku stated that the fuel consumed on their main plot was now reduced to 1,300 poods per day, whereas last year they were using 3,800 poods per day. That saving of 2,500 poods per day, at 40 copecks per pood, meant £3,000 per month, and after setting that against the cost of the electric current consumed the saving should run into a good many thousands of pounds per annum. But as further wells were changed over to the electric drive the quantity of oil used as fuel should be still further reduced. They had spent on the electric motors something like £15,000, all of which had been provided out of local resources.

Electricity in Tea Plantations.—At the recent meeting of the Anglo-Dutch Plantations of Java, Ltd., the chairman (the Hon. C. H. Strutt) said their factory had had to be extended and the machinery in it was driven by electric motors. Electric current was obtained from their electric power station at Soeroepan.

It was one of the advantages of their property that they had large falls of water which could be utilised for generating electricity. To his mind there was something eminently satisfactory in wind and water power, especially the latter. One was thus using perpetually recurring power which otherwise would be wasted, not, as in the case of oil and coal, using the world's wealth which could not be replaced. It was like living on one's income instead of on one's capital. Their electric power was installed not in view of the needs of Kassomalang alone. They instituted sufficient power to supply all the wants of their hill estates and of Soebang, too, if necessary. They had thought it wise to postpone laying on that power until they had had a little further experience of the results at their Kassomalang estate, so that when they extend their operations they could do it with full efficiency and economy.

Glasgow.—The lighting of the streets is to be reduced by one-half after midnight in order to effect economies and to comply with the restricted lighting regulations. The electric lights on one side of each street are to be extinguished at 12 o'clock where the new system is adopted.

Miners' Electric Lamps.—In a portion of the South Wales coalfield it has been agreed to use electric lamps instead of Davy lamps, to minimise risk, and colliers who use them are offered a penny per ton extra.

Oxford. Incandescent electric lamps have been substituted for the arc lights in the main streets of the city.

Workhouse Lighting.—The Callan Co-operative Electric Light Society has submitted a tender for the lighting of the workhouse at Callan (co. Kilkenny).

It is estimated that the annual cost of lighting will be £45, with electric current at 6d. per unit for lighting and 2d. for power and heating. The matter is at present under the consideration of the Guardians.

TRACTION NOTES.

Dover. Two of the six electric lorries which were recently ordered by the Corporation for house refuse collection have been delivered and are reported to be working very satisfactorily.

L. & S.W. Railway.—The inauguration of the electric service on the section from Waterloo to Wimbledon has been postponed.

Light Railways. The Dearne Valley Light Railways Order has been submitted to the Board of Trade for confirmation.

Maidstone. Last week the Council considered a report by the Joint Highways and Light Railways Committee as to the maintenance of the light railway track.

The Committee recommended that the maintenance of the whole of the roads covered by the tramway system in the borough and that portion of the road outside the borough for which the Light Railways Committee are liable be in future carried out by the Highways Committee, such maintenance to include the tramways track (other than the rails and plate laying), and that the Light Railways Committee do reimburse the Highways Committee 50 per cent. of the actual cost of maintenance.

Exception was taken to the recommendation on the ground that the Highways Committee had no power to spend money on the upkeep of the road outside the borough, and to meet this point the words "and that portion of the road outside the borough for which the Light Railways Committee are liable" were struck out.

With this amendment the report was adopted.

TELEGRAPH NOTES.

Radiotelegraph Notes.—The "Electrical World" states that the U.S. Navy Department has nearly completed the enlargement of the New Orleans naval radio station to one of 30 kw. power, and that the station will be used principally as a relay station for messages between Atlantic and Pacific Coast stations, and between Darien, on the Panama Canal Zone, and Arlington, near Washington.

The construction of the transatlantic radiotelegraphic station at Stavanger, which had been delayed by the war, is now being proceeded with. Extensive reconstruction is said to be taking place the cost of which amounts to £40,000.

American Wireless Patent Litigation.—It is announced in the "Electrical Review and Western Electrician" that a suit has been brought by Mr. Nikola Tesla against the Marconi Wireless Telegraph Co. of America for the annulment of one of the chief Marconi patents, and simultaneously a suit against the company for infringement of his (Mr. Tesla's) patents.

The dispute began in Aug., 1914, when the Marconi Co. sued Herr Fritz Lowenstein, a German engineer, alleging that certain wireless apparatus sold by him to the United States Navy was made in violation of Marconi Co.'s American patent 763,772. It was announced then that Mr. Tesla would testify for Mr. Lowenstein and allege that the Lowenstein devices were developed from Tesla patents 645,576 and 649,621, which were granted prior to the Marconi patent. In the present suit Mr. Tesla bases his action on the allegation that his two patents were granted in 1900, and that the Marconi patent was not granted until 1904. The company claims that its patent was granted to Signor Guglielmo Marconi on the proof of independnet invention by Marconi, and was not due to or based on any invention of Tesla. A preliminary hearing took place before Judge A. N. Hand, in the federal district Court in New York City on Aug. 5.

Wireless News.—It is announced that a newspaper tariff for news by wireless is now available for morning, evening and weekly newspapers at a tariff of three guineas, two guineas and one guinea per week respectively.

Particulars of the different services can be obtained from the Wireless Press (Ltd.), Marconi House, Strand, London, W.C. From these particulars it is shown that the services available are: (1) German service, including German official and semi-official, and Austrian and Turkish official communiques, (2) French official communiques, (3) Belgian official communiques. The method of distribution of the news (which is undertaken on behalf of the Wireless Press) is (*a*) through the tapes machines of the Exchange Telegraph Co, (*b*) in the London district by a service of messengers, (*c*) in the provinces by means of telegrams at press rates (these rates are, of course, in excess of the subscription rate).

EMPIRE NOTES.

Australasia. It is stated that the Town Board of Pay Town, a suburb of Dunedin, N.Z., is about to spend about £6,000 on electric lighting, water supply and drainage extensions.

The "Commonwealth Engineer" states that: Following on the recent purchase by the Commonwealth Defence Dept. of the engineering works of the N.S.W. Government, at Cockatoo Island, arrangements have been concluded for the installation of new power station plant and the supply of about 180 machine tools. Tenders have been invited for the supply of the plant, &c. The scheme was drawn up by Mr. King Salter, director of the dockyard, and Mr. G. A. Julius. The power plant will include three 1,000 kw. 250 volt d.c. geared turbine generators, one 225 kw. d.c. generator, two rotary balancers (1,200 amperes, 250-125 volt sets) and one of 250 amperes, switchboards, &c.; reciprocating sets and exhaust turbines, including three 500 kw. 250 volt d.c. generators, two 750 k.v.a. a.c. turbo-generators, two 600 amperes rotary balancers (250-125 volt sets) and one of 250 amperes; two 750 kw. mixed pressure turbo (250 volt) d.c. generators; five Diesel engines for direct coupling to d.c. generators and capable of a continuous full load output of 600 kw. at 250 volts, and one Diesel set of 225 kw. at 250 volts. The water tube boilers specified are to work at 200 lb. per sq. in. and to evaporate 20,000 lb. of water per hour at 70°F., with mechanical stokers, economisers, two motor-driven turbine centrifugal feed pumps, three superheaters, and there will be one forcing plant, with motor driven air pumps capable of dealing with the exhaust steam from one 1,000 kw. steam turbine set.

Balmain (Queensland) Council is considering the question of making its own electricity.

Castlemaine (Victoria) Council has accepted the tender of Mr. G. W. Stewart on behalf of a syndicate to form a 10 years' concession for the supply of electric light and power. There is to be a minimum of 120 street lamps, including 100 of 100 c.p. and 20 of 200 c.p., the syndicate to supply lamps and fittings and keep them in order, for £4 per lamp per annum. The syndicate is given the right to supply private consumers at 7d. per unit for lighting and 3½d. for power.

Cottesloe (W. Australia).—During the first half of 1915 consumers connected to the electric supply mains increased from 770 to 926. 105,129 units were sold compared with 83,100 in the corresponding period in 1914. The revenue from the sale of current and street lighting in the year 1914 was £3,490. 16s. 1d., and for the past half-year £2,827. 17s. 3d.

Current from the Lake Coleridge (N.Z.) electric power plant being available, farmers in the Lincoln district, 14 miles from Christchurch, have undertaken the erection of a flour mill to deal with the large quantities of grain that are grown in the district.

Mr. J. J. C. Bradfield, of the Public Works Department, Sydney (N.S.W.), has drawn up a scheme for the construction of underground electric railways in Sydney:—

City Lines.—Mr. Bradfield proposes that six lines shall leave the existing railway system north of Redfern station, and pass underground on a gradient of 1 in 40. A d.c. high-tension system of traction is contemplated. The permanent way of the line, which will have to accommodate the ordinary rolling stock of the State, will consist of 100 lb. steel rails on hard wood sleepers, bedded on ballast. The total length of single track is rather more than 16 miles.

Eastern Suburban Lines will start from the city railway between Circular Quay and St. James stations by means of two junctions, forming an outer and an inner circle. The outer circle line will have a total length of about 10¾ miles of double track, while the inner circle line will extend to nearly 7¼ miles of double track.

West and North Suburban Lines.—The Western railway will be 5¼ miles in length of double track.

The Premier, in introducing the Greater Melbourne Bill in the Legislative Assembly recently, said it aimed at the unification of the public utilities of 25 municipalities. The functions for which the Bill provided included the supply of water, tramways, electric light and power, gas, &c. It was proposed to constitute a metropolitan council of 30 members elected by the ratepayers. The estimated population of the metropolis was 639,000. The municipal districts had been grouped in such a way as to preserve, as far as possible, community and identity of interest. The area comprised the Cities of Melbourne, Brunswick, Camberwell, Caulfield, Collingwood, Essendon, Fitzroy, Footscray, Hawthorn, Malvern, Northcote, Prahran, Richmond, South Melbourne, St. Kilda, the towns of Brighton, Coburg, Kew, Port Melbourne, Williamstown, the shire of Preston, portions of the borough of Oakleigh, and the shires of Heidelberg, Moorabbin and Nunawading.

In 1925 the undertaking of the Melbourne Electric Supply Co. would become available for purchase by the municipalities. The electrification of the whole of the tram service was but a matter of time and that would necessitate the supply of a large quantity of current. At present the city supplied current to its boundaries and it was then retailed by the suburban municipalities. To make sufficient provision for Melbourne's electrical needs it was necessary that there should be a single power-house of sufficient dimensions to meet all requirements for some years ahead. The electric lighting undertakings of the metropolis were at present practically confined to the City Council, the Melbourne Electric Supply Co. and the North Melbourne Electric Tram & Lighting Co. The Council was eventually to be the sole electrical supplier within the metropolis, and as a means towards this end was to have power to take over all the concerns now operating. If the amount of compensation was not agreed upon it would be determined by arbitration.

Burma. "Indian Industries & Power" says outside of Rangoon and Mandalay there are no electric plants in Burma, except a small lighting set in the oil fields at Yenangyoung. It is thought that Burma will be slow to adopt electricity.

Canada.—A zinc ore-smelting plant is being erected at Welland for the Weedon Mining Co., of Sherbrooke, Quebec.

A new company, to be entitled the Canadain Zinc Co., which will have a capital of $500,000, will be incorporated for working the plant. The Weedon Mining Co. owns large zinc deposits on the north shore of the St. Lawrence. The ore will be smelted by an electrical process, for which 4,000 H.P. will be required, and the company is negotiating with the Hydro-electric Commission for the supply of power.

Egypt. A recent report of the British Chamber of Commerce of Egypt on openings for British trade in that country says:—

The bulk of the machinery imported is for agricultural purposes, the greater proportion being supplied by the United Kingdom, but in recent years Germany increased her imports. Electric motors are imported principally from the United Kingdom, but British manufacturers have neglected the market in electrical appliances, the bulk of which, especially metal filament lamps, came from Germany and Austria. Artesian well boring has recently created a large demand for pumping machinery and pipes. Unreasonably long credits have been allowed in recent years, especially by German manufacturers who compete with inferior machinery at lower prices. Of the imports of iron and steel the United Kingdom supplies a considerable share, but Belgium was predominant in iron and steel plates, bars and angle iron and girders, and imports from Germany showed annual increases. Girders were principally supplied by Belgium. Wrought and cast iron pipes and galvanised wrought iron pipes are largely imported for Government work and artesian wells.

The report states that sufficient care has not been exercised in the appointment of responsible and competent agents, and, in many cases, plausible representatives of alien nationality and of no standing have been appointed with disastrous results. British manufacturers are often reluctant to appoint agents abroad, the reason being that they do not wish to compete in any way with the home export and commission firms. They should, however, note that business with the Egyptian market in

manufactured goods is largely done through local commission agents. Terms should be given short shrift to the discretion of the local agents. When prospects of business make it justify the expense, a visit by the agent or a director to pay visits to the agency. Travellers should be sent periodically when the magnitude of the business to be done warrants the cost of such visits.

India.—"Indian Industries & Power" says the Bombay Electric Supply & Transways Co. proposes an extension of their tramways from Parel terminus along Kingsway to a point 450 yds. north of Naigaum Cross-road.

In connection with the scheme for general street lighting in Madras, discussed at a conference at Ootacamund recently, an agreement between the Madras Corporation and the local electric supply Co. was approved. Sub-stations are to be built at the Adyar and Kilpauk.

At a recent meeting of the Bhiwpuri Electrical Co. Sir D. Tata said investigation of additional areas had recently been made, under the direction of the general manager (Mr. H. P. Gibbs), with a view to the future expansion of the hydro-electric works. The surveys had been completed and a general scheme drawn up. The first section of the new undertaking would include a lake of 9,000,000,000 cubic ft. capacity in the Andra Valley about 9 miles north-west of Walwhan Dam, and a power house near Bhivpuri, about 12 miles north of the present Khapoli power house. It is calculated that by this means 60,000 E.H.P. for 12 hours daily can be supplied in Bombay at a cost much lower than the present cost. The Bhama Valley, to the north, has also been surveyed with a view to a further extension, and it is anticipated that a further 40,000 E.H.P. can be got from that source.

Jamaica.—The terrific hurricane which occurred in Jamaica on Aug. 12 interrupted the transmission plant of the West India Electric Co., but the company's engineer (Mr. Campbell), and his staff set promptly to work and adjusted matters by the early morning. At daylight the tramway service started as usual, and but for a little interruption here and there worked smoothly throughout the day. The falling of trees considerably affected the telephone and electric lighting services in Kingston, but matters were speedily put right by the activities of the company's officials.

FOREIGN NOTES.

Argentina.—The Revista de los Rios says Deputy Tomas de Vedia has presented a pension project to the Chamber of Deputies, providing for the creation of a pension, superannuation and [illegible] fund for permanent employés of tramways, telephones, [illegible] companies.

Under the scheme, the contributions to the fund would be exacted from employés and the public, the companies not being called upon to contribute. The following are the proposed sources of revenue: (1) 2 per cent. deduction from employés' salaries; (2) one month's salary of each employé to be paid in 24 monthly instalments; (3) the half of the first month's salary of every new employé taken on, also payable in 24 monthly instalments; (4) the difference of one month's salary in cases of promotion or increase of salary; (5) a "supplement" of 5 cents to be charged by tramway companies from passengers travelling on Sundays and [illegible] a monthly supplement of 30 cents to be charged for each telephone apparatus, and each gas or electric meter; (7) interest on investments; and (8) donations and legacies.

The local press of San Pedro has instituted a propaganda in favour of the [illegible] of a local co-operative society to undertake the electric lighting of the town.

The Cordoba Provincial Government has issued a decree authorising a company to establish a telephone service connecting Marcos Juarez with the towns of Cruz Alta, Los Surgentes, Inriville and Camilo Aldao.

The Otis Elevator Co. has been authorised by decree of the National Government to establish a branch or agency in Argentina.

Brazil.—[illegible] the Hon. H. [illegible] Commercial Attaché at Rio de Janeiro on the trade of Brazil for 1912 [illegible] the total value of the imports for the year 1912 [illegible] £91,162,000, [illegible] £1,000,000 in excess of the figures for 1911. The total value of the exports for 1912 [illegible] £91,499,000, [illegible] £1,000,000 in excess of the figures for 1911. [illegible] £2,000,000 in excess of the figures for 1910.

[illegible] increasing the assumed value and the duty by one-third.

Nearly every kind of electrical apparatus is on sale by local firms in [illegible]

Enemy Patents in Japan.—H.M. Commercial Attaché at Yokohama (Mr. H. P. [illegible], C.M.G.) reports that the Japanese Supreme Court has laid down that as a result of the war, rights in industrial property (patent rights, trade marks, &c.) held in Japan by enemy subjects are suspended during the war in cases where such enemy subjects have not a domicile or place of business within the Japanese Empire. This judgment reverses a ruling of the Japanese Patent Office that as a result of the war between Japan and Germany, the International Convention for the protection of industrial property is suspended for the time being.

Italy.—It is reported that electric is being substituted for gas lighting in the streets of many Italian towns, because it can be extinguished more quickly in the event of visits of hostile aircraft, and also in consequence of the increased cost of coal.

Japan.—A consular report states that the construction of tramways in Nagasaki and the surrounding district is contemplated.

Norway.—It is proposed to erect hydro-electric works at the Björlva waterfalls, in the vicinity of which a new factory for the manufacture of sulphate of ammonia and cyanamide will be established.

Portugal.—A concession has been granted to the Companhia Carris de Ferro do Porto for the construction and working for 75 years an electric railway from Botica da Maia to Ermezinde station.

Russia.—In a report by H.M. Consul at Helsingfors (Mr. V. Kestell Cornish) it is stated that Germany, Sweden and Switzerland have hitherto held the market in electrical machinery and there should now be an opening for British enterprise in Finland.

In other branches of industry chemicals have hitherto come from Germany, turbines from Germany and Switzerland, steam engines, lathes and tools from the United Kingdom, Germany, Sweden, &c., and boilers from Germany.

A consular report from Batoum (Caucasus) says the trade in electrical machinery has almost entirely fallen into German hands, but certain activity exhibited by manufacturers at home should succeed in gaining a part of the trade for British made goods. There are not many countries in the world with so many rivers adaptable for furnishing the energy required for working hydro-electric installations as in the Caucasus, but up to now only about a dozen or so power stations exist. In the Northern Caucasus there is a 1,000 H.P. power plant at Beli Ugol railway station on the river Podkumok. At Gagri, on the Black Sea coast, Prince Oldenburg's climatic station possesses an electrical power plant, the water for which is taken from the river Jockvar. At the monastery of New Athos the monks have erected a small electric plant. The Sakhalinum Electric Co. have built a power station on the river Besletk. At Batoum M. Fefelov owns a water-power plant for furnishing electricity to private consumers. Messrs. Ananov Brothers have a small water-driven installation in the Kutais district for working their saw mills. V. G. Shah-Paronian possesses a small station for driving machinery at Akhalkalaki. There is also a comparatively small water-power installation at Borjom, on the estates of the Grand Duke. At Sanain there is a hydro-electric station of 700 H.P. belonging to the Caucasus Metallurgical Co. At Gori a small electric plant is owned by Prince I.H. Amilahvari. The town of Erivan has two water-power stations, and similar stations exist at the copper mines of Katar in the district of Zangezur and on the property of the Caucasus Copper Co. at Dzmsoul. The latter develops over 1,000 H.P.

A concession was granted by the Russian Government in November, 1912, to a British firm for the erection and equipment of water turbine-driven plants for furnishing electrical energy to towns and industrial centres of the Northern and Trans-Caucasus. The concessionnaires obtained permission to use the waters of the River Terek at Kazbek and of Lake Goktscha. Some progress was made with the scheme during the first half of 1914, but the financial side of the question has still to be solved, and it is not expected that this can be done before the close of the war.

A report from Baku says firms interested locally are making inquiries in reference to certain public works about to be undertaken by the town of Tashkent in Transcaspia. The works will include a large electric power station for lighting the town, supplying power for tramways and other commercial purposes. None of the schemes are, however, to be entered upon until the European situation improves.

Spain.—The Marquis de Lozoya has purchased Don Jose Echevarrieta, and others in the province of Santander, the concession granted to the Count of Penalver for the generation of 25,000 horse-power by means of the waters of the River Pas, and for the transmission of the power to Santander, Torrelavega and other towns.

MISCELLANEOUS NOTES.

Bolton.—The Electricity Committee have decided to [illegible] a balance of £10 towards the funds of the Engineering Standing Committee.

Bridlington.—On Saturday the county borough electrical engineer (Mr. J. Irons) was fined £3 for having failed to observe the rules in force at the electricity supply works. Defendant stated that the roof was [illegible] by a cornice, which had slipped out of position.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade have issued lists Nos. 35 and 36 of articles in respect of which inquiries have been received for names of manufacturers or producers, and copies may be obtained by United Kingdom manufacturers and exporters of British goods from 73, Basinghall-street, London, E.C.

Customs Decisions.—The Governor of the Uganda Protectorate has issued an Ordinance (No. 15 of 1915), dated June 5, providing for the free importation of electric cable or wire, posts for carrying same and all other material required for generating, storing or distributing electric energy.

Proof must be given to the Director of Customs that such articles and materials have been imported solely for such purposes, such exemption not to include lamps or their fittings or material, other than industrial machinery, required for using electric energy. This item has been substituted in lieu of "Apparatus and appliances used in connection with the generating and storing of electricity, but not including lamp posts or lamps or their fittings."

Electricity Supply Undertaking Profits.—The clause set out below has been inserted in the Tunbridge Wells Electric Lighting Extension) Provisional Order of 1915:

9. Notwithstanding anything contained in sec. 7 of the schedule to the Electric Lighting (Clauses) Act, 1899, incorporated with this Order, the undertakers may, if they think fit, instead of carrying the net surplus remaining in any year of the revenue received by them in respect of their undertaking and the annual proceeds of the reserve fund when amounting to the prescribed limit to the credit of the local rate, apply the whole or any portion thereof to the purchase of electric mains or lines, machinery, apparatus, appliances and fittings for the supply of electricity, to defraying the cost of laying such mains or lines and the fixing of such machinery, apparatus, appliances and fittings and to the formation of a fund for working capital:

Provided that the fund so formed shall not at any time exceed a sum equivalent to one-half of the gross annual revenue of the undertaking for the time being.

Fire.—On the 27th ult. a fire broke out on Messrs. M'Whirter & Son's premises at Holm-street, Glasgow. A number of electric motors, as well as the buildings, were damaged by fire and water. The damage is estimated at £1,500.

London Wiremen's Wages.—In regard to the award of Sir David Harrel (set out in our issue of Aug. 20th) as to the wages of wiremen in the London area, we have received a communication from Mr. W. Ellard-Styles, of the Automobile & Electrical Equipment Co., stating that, although the award is binding only as to the members of the Union in the London area, the London Electrical Masters' Association have decided to give the increased wages to all their employés (union and non-unions).

Military Hospital Fans.—Miss Olga Nethersole, of Heathland Lodge, East Heath, Hampstead, London, N.W., is appealing to the public to send her 1500 electric fans for the military hospitals at Malta.

TENDERS INVITED.

Electric Lamps.

The Guardians of the Poor of the Parish of KENSINGTON (London) invite tenders for the supply of Electric Light Lamps to their Infirmary, Marloes-road, W., for six months from Oct. 1, 1915. Forms of tender, &c., from the Clerk (Mr. W. R. Stephens), Guardians' Offices, Marloes-road, Kensington, W. Tenders by 3 p.m. of Thursday, Sept. 23. *See an advertisement.*

Switchgear, Transformers and Cables.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. British port of e.h.t. Switchgear suitable for 22,000 volts working pressure; e.h.t. Static Transformers (22,000 to 6,600 volts) of 4,200 k.v.a. and 2,000 k.v.a. single phase and 3,000 k.v.a. and 1,250 k.v.a. three phase; and Armoured Three-core Cable for 22,000 volts, with Boxes. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders are to be delivered by noon, Sept. 29.

Turbo-Generators, Boilers, Condensing Plant, &c.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. British port of (*a*) one Turbo-generator of not less than 5,000 kw. capacity, with Condensing Plant, &c.; (*b*) one or two Turbo-generators of about 10,000 kw. capacity, with Condensing Plant, &c. Copies of specifications and forms of tender from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, Westminster, S.W., to whom tenders (in duplicate) should be delivered by noon, Sept. 24.

JOHANNESBURG Municipal Council invite tenders by Sept. 25 for supply and erection of two 3,000 kw. Turbo-Generators, Condensing Plant, Switchgear, &c. Specifications from the Controller of Stores, and tenders to the Town Clerk.

JOHANNESBURG Council also require tenders by noon Sept. 30 for Two (or, alternatively, One) Water-tube Boilers, with Superheaters, Mechanical Stokers and Draught Plant. Specifications from the Controller of Stores, Municipal Offices, Johannesburg.

Generating Plant.

The AUSTRALIAN COMMONWEALTH Department of the Navy require tenders by noon Oct. 25 for Power-station Plant and Equipment for the Naval Dockyard Cockatoo Island, Sydney, N.S.W.; also by noon Oct. 27 for Motor [illegible] from Director of Naval Contracts, Navy Office, Melbourne.

Electrical and Tramway Stores.

The directors of the POWELL DUFFRYN Steam Coal Co. invite tenders for the supply of Electrical Goods [illegible] pany, 101, Leadenhall-street, E.C., by 10 a.m. Sept. 8.

ISLINGTON (London) Guardians' Workhouse invite tenders by Sept. 7 for six months' supply of Electrical Fittings and Sundries, Ironmongery, &c. Forms of tender from the Clerk, St. John's-road, Upper Holloway, N.

Condensing Water Tunnel, &c.

EDINBURGH Corporation requires tenders by 10 a.m. Oct. 1 for the construction of Shaft and Tunnel for obtaining sea water for condensing at the new Portobello electricity works. Specification, &c., from the Engineer, Dewar-place station, Edinburgh.

Wiring and Fittings.

KIRKCALDY Town Council require tenders by first post Sept. 6 for Electric Light Installation at new sanatorium and other buildings at the Fever Hospital. Specification, &c., from the Burgh Electrical Engineer.

Transformers, Relays, Fuse Blocks, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Sept. 8 for Transformers and Relays for Point Indication for Automatic Signalling (contract 28,918); and Electric Point and Lock Detectors (28,951) during five years; and by 10 a.m. Sept. 29 for 5,000 Fuse Blocks, 5,000 Spare Porcelain Bases and 10,000 Spare Fuse Clips (29,080). Specifications from the Commissioners' Offices, Spencer-street, Melbourne, Australia.

Telegraph and Telephone Material, Wire, Instruments, &c.

The Postmaster-General's department of the Commonwealth of Australia invites tenders (until Sept. 23) for the supply of Condensers, Galvanometers, Relays and Sundries, and for Incandescent Electric Lamps, and (until Oct. 6) for the supply of Poles (iron or steel) and Fittings.

The Deputy Postmaster-General, Brisbane (Queensland), invites tenders until Oct. 6 for supply of Tinned Copper Wire (schedule 357) and Porcelain Pothead Insulators (schedule 360) for the COMMONWEALTH, Postmaster-General's Department.

The Deputy Postmaster-General, Melbourne, invites tenders by 3 p.m. Sept. 14 for Telephone Switchboard Parts (schedule 1,220) and (until 3 p.m. Sept. 21) for Telephone Parts (schedule 1,225) and [illegible] for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Brisbane (Queensland), requires tenders by Oct. 6 for 2,850 yds. Silk and Cotton Insulated [illegible] for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Perth (W. Australia), requires tenders by Sept. 29 for Telephone Switchboards, &c. Tender forms and [illegible] from the Commonwealth offices, 72, Victoria-street, S.W.

Engine and Dynamo, &c.

The Deputy Postmaster-General, Adelaide (South Australia), requires tenders by 2 p.m. Oct. 6 for Petrol Electric Generating Plant, direct-coupled to Dynamo, and for Engine-driven Generator for Charging Batteries at Central Telephone Exchange, Adelaide, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications from the Deputy Postmaster-General.

Meters and Time Switches.

JOHANNESBURG. Transvaal Council require tenders by Sept. 25 for supply of 1,595 Electricity Meters and 50 Time Switches. Specification from the Controller of Stores, Pleinsquare, Johannesburg.

Tram Rails, Poles, &c.

Tenders are invited by the PRAHRAN AND MALVERN (Victoria) Tramways Trust for the supply of 1,350 tons of Steel Rails and 200 Pairs of Fishplates, including Bolts (contract 67), and 400 Steel Spare Poles and 20 Steel Anchor Poles (contract 68). Specifications from the office of the Trust, 59, William-street, Melbourne, where tenders are to be sent to the chairman of the Trust by noon Sept. 14. Local representation is necessary.

Electric Capstans.

SYDNEY Harbour Trust Commissioners invite tenders by 2 p.m. Oct. 25 for the supply of 6 Electrically-operated Wharf Capstans. Specification, &c., from the office of the Commissioners, Circular Quay, Sydney, N.S.W.

TENDERS RECEIVED AND ACCEPTED.

SHEFFIELD.—The Electric Supply Committee recently accepted the following tenders :—

A. Reyrolle & Co., switchgear, £240 ; Sharpe & Co., water pipes, £200 ; Lea Recorder Co., water-recording apparatus, £115 ; and Stewarts & Lloyds, steam pipes, £60.

SALFORD.—The Electricity Committee has accepted the tender of J. Gerrard & Sons (at £1,341) for alterations to buildings and construction of foundations at the Frederick-road electricity station for the additional 5,000 kw. turbo-alternator.

GLOSSOP.—The Council have accepted the tender of Urban Electric Supply Co. for the supply of electricity to the 45 electric street lamps and maintenance thereof for two years at £2. 16s. per lamp per annum.

BRISTOL.—The tender of Buchanan & Curwen has been accepted by the Bristol Docks Committee for wiring the new sheds at the Royal Edward Dock.

COLCHESTER.—The tender of Joslins (Ltd.) has been accepted for telephonic communication works, &c., at hospital, and for wiring certain wards, &c.

SALFORD.—The Tramways Committee has accepted the tender of the Tudor Accumulator Co. for welding about 550 tramway rail joints at 27s. 6d. per join.

POPLAR (London) Borough Council has accepted the tender of Economisers (Ltd.) at £360 for renewing the tubes of the economiser at the refuse destructor.

STIRLING.—The tender of Lockhart & Meanie has been accepted for wiring the municipal buildings and that of W. and T. Marshall for telephone and bell fitting.

BRISBANE.—The Brisbane Water and Sewerage Board have accepted the tender of the Engineering Supply Co. of Australia for one 5 B.H.P. and one 2 B.H.P. motors.

ECCLES.—The Council has accepted the tender of Joseph Chapman & Sons for the construction of a coal bunker at the electricity works.

COATBRIDGE.—Messrs. Chamberlain & Hookham have secured the contract from Coatbridge for meters for the ensuing 12 months.

ARGENTINA.—The Director of Posts and Telegraph Dept. has been authorised to purchase 1,350 metric tons of bolts from Messrs. Colson, Bradshaw & Pyne, at $8,080 m/n each (total about £94) and 5,150 from the India Rubber, Gutta Percha & Telegraph Works Co., at $9,676 m/n each (total about £540).

COONAMBLE (N.S.W.).—In connection with the electric lighting scheme for Coonamble, the following contracts have been let :—

Fullarton Electric Co., Edinburgh, gas engine ; Electric Construction Co., 40-kw. generator ; Siemens Bros. Dynamo Works, booster ; Tudor Accumulator Co., 435-ampere-hour storage battery ; Amalgamated Gas Producers, Cambridge, gas producer.

Messrs. N. S. W. [illegible] have been received by the Coonamble Council.

British Insulated & Helsby Cables (*rec. for acceptance*), bare copper [illegible] 7/16 cable 9.8d. per lb., 7/16 cable 9.8d., 7/14 cable 9.8d., 19/16 cable 9.8d., 19/14 cable 9.8d. ; Australian General Electric Co., 1s. 3½d., 1s. 3d., 1s. 2½d., 1s. 3d., 1s. 2½d.

Australian General Electric Co., 5 cm. by ½ in. copper bus bar (rate 100) £22. 12s., 4 in. by ½ in. (rate per 100) £26. 2s., 3 in. by ½ in. (per bus bar) £9. 11s., 2 in. by ½ in. copper bus bar (per bus bar) £13. 1s. ; British Insulated & Helsby Cables (*rec. for acceptance*), ditto £18. 10s., £14. 16s., £11. 2s., and £7. 8s.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :—

Postmaster-General's Dept., Melbourne.—Commonwealth Art Pottery & Insulator Co. Ppy., £3,540. 8s. 4d. ; Lawrence & Hanson, cable, £356.

Postmaster-General's Dept., Adelaide.—Western Electric Co., cable, £7,024. 3s. 1½d., jointing sleeves, £86. 12s. 11d. ; A. J. Todd & Co. (agent for F. B. Cook), jointing sleeves, £75. 7s. 9d. ; Colton, Palmer & Preston (agents for British General Electric Co.), telephone sets, £35. 6s. 3d. ; Noyes Bros., accumulator cells, £291 ; Newton, McLaren (Ltd.), power board, &c., £478.

Postmaster-General's Dept., Hobart.—British Insulated & Helsby Cables, copper wire, £363 ; Siemens Bros. Dynamo Works, cable, 1,259 yds. at £1,080 per mile, 1,902 yds. at £810 per mile, 1,736 yds., £675 per mile, 900 yds., £475 per mile, 4,630 yds., £320 per mile, 264 yds., £286 per mile, 9,080 yds., £210 per mile, 6,754 yds., £125 per mile.

Victorian Railways.—Siemens Bros. Dynamo Works, fuse boxes and fuses in connection with electrical equipment of Ballarat and Bendigo workshops, and switchgear and accessories at rates ; Australian-General Electric Co., d.c. generator, &c., for Spencer-street goods sheds, £147. 10s., and rheostat, £7. 5s., static transformers, £68. 10s. each, and incandescent lamps for year to June, 1916, ; British Insulated & Helsby Cables, overhead equipment for St. Kilda, Brighton street railway, at rates ; R. W. Cameron & Co., tram rails, at rates ; Western Electric Co., cable, £62 per mile, at rates ; Crompton & Co., motors and spare parts for Ballarat and Bendigo workshops, at rates.

Department of Home Affairs, Melbourne.—Ramsay, Sharp & Co., electric lighting of drill hall, Young, £114. 17s. 6d.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date at which the latter differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS

3,902 SIEMENS BROS. & CO. (LIMEHOUSE & GRINSTEAD). Circuits for telephone exchanges.

10,110 RALTH. Gas detectors, especially for portable electric head lamps. (14/9/14.)

11,940 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Electric signalling in stallations.

11,993 NORMA CLOCK WORKS. Magnetic chucks and like holding devices. (17/5/13.)

12,210 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke.) Enclosed electri fuses or safety cartridges.

12,372 DREW. Means for [illegible] high-frequency currents.

An arrangement for producing alternating currents of high frequency having triple coil and a vacuum tube provided with electrodes connected in the secondar circuit, and electrodes connected in the primary circuit in parallel with a switc device, the primary circuit including a source of current so provided that, on operatio of the switch, make and break currents in the primary circuit induce currents in th secondary circuit and through the vaccuum tube, whereby the path through th electrodes of the primary circuit is rendered conductive, and mutual action betwee the circuits continued, whereby high frequency alternating currents are produce in the tertiary coil.

12,443 LIBANO. Insulator for the overhead conductors of electric lines. (31/5/13.)

12,479 ALLGEMEINE ELEKTRICITÄTS-GES. Electric welding. (20/5/13. Addition t 595/14.)

12,682 MELLERSH-JACKSON. (Geb. Jaeger.) Electric switch for incandescent lam fittings.

12,814 SIEMENS-SCHUCKERTWERKE. Slip-rings for dynamo-electrical machinery. (31/5/1

13,136 SIEMENS-SCHUCKERTWERKE. Regenerative braking of electric polyphase cor mutator machines. (21/6/13.)

13,210 SIEMENS-SCHUCKERTWERKE. Tautening device for overhead electric co ductors. (29/5/13.)

13,520 SIGNAL-GES. Radiating system for signalling by electric waves for aeroplan (Addition to 736/13 and 23,728/13.)

13,541 GLADITZ. Manufacture of incandescent electric lamps.

13,553 GES. FÜR ELEKTRISCHE ZUGEBEUCHTUNG. Vehicle lighting plants working wi dynamo and storage battery. (11/7/13.)

13,554 GES. FÜR ELEKTRISCHE ZUGBELEUCHTUNG. Vehicle lighting plant working w [illegible] (11/7/13.) Addition to 13,553/14.

13,920 SIEMENS-SCHUCKERTWERKE. Searchlights or projectors. (21/6/13.)

14,278 SIEMENS BROS. DYNAMO WORKS & KITSON. Rotary dynamo-elect machinery.

14,375 SIEMENS BROS. DYNAMO WORKS & KITSON. Process for starting electrica connected rotary converters and asynchronous generators.

14,434 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckertwerke.) Switching arrar ments for rotary converters.

14,483 MIROSCHY & CO. & FISCHER. Electric transformers and other high-tens electric apparatus.

14,493 SIEMENS-SCHUCKERTWERKE. Terminal arrangements for overhead elec conductors. (21/6/13.)

15,471 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Circuit arrangements telephone systems.

15,546 SIEMENS BROS. & CO. Frischen & Quintian. Partly Siemens & Halske A ges.) Selecting devices for telephone or other circuits. (Addition to 818/13

15,871 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges.) Interrupting devices high-tension electric currents.

A device for intermittently energising Rontgen ray tubes or other high-tens appliances in succession, in which the primary circuit of an induction coil or tr [illegible] conductors arranged parallel to the axis about which they rotate, in synchron with the low-tension interrupter, between fixed contact segments, to the upper lower of which segments the secondary winding of the said induction coil or tr former and the tubes, or other appliances, are respectively connected.

15,881 DEUTSCHE TELEPHONWERKE. Detector for electromagnetic waves. (24/11/14

15,[illegible] SIEMENS BROS. DYNAMO WORKS & KITSON. Windings of dynamo-ele machinery.

[illegible] & CO. Process for the manufacture of electrolytic electr (21/7/13. Addition to 17,759/13.)

16,945 Szilard. Electrometers. (15/12/12. Divided from 29,908/13.)
17,949 Siemens-Schuckertwerke. Starting switches or controllers for dynamo-electric machinery. (24/7/13.)
18,033 Blessing. Telephone systems. (31/7/13.)
18,123 Siemens-Schuckertwerke. Signalling arrangements for use with projectors or searchlights. (31/7/13.)
18,290 Bronsart. (Telegraphentrafik-Ges.) Writing or printing telegraph system.
18,302 Colley. Electric hoisting apparatus.
18,466 Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke.) Control of searchlights, guns or other objects from a distance and means therefor.
18,494 Wilson. Measuring electrical energy. (14/8/13.)
18,496 Gill. (Cutler-Hammer Mfg. Co.) Electric heater units for fluid meters.
18,497 B.T.-H. Co., Young & Watson. Relays for electric regulators.
A relay for an electric regulator having a circular coil divided into two sections adapted to be differentially excited and a rectangular bi-polar core almost completely surrounding said coil.
18,502 Siemens-Schuckertwerke. Electrical switches. (22/11/13.)
18,565 Siemens Bros. & Co. & Pettigrew. Circuit arrangements for operating the selecting devices of telephone installations by number impulses.
18,566 Allgemeine Elektricitäts-Ges. Incandescent electric lamps. (18/8/13.)
18,685 B.T.-H. Co. (G.E. Co., U.S.) Electric resistance.
19,882 Beaver & Claremont. Electric cable.
20,603 Maddick. Attachment to prevent theft of electric lamps or globes. (19/2/14.)
21,785 B.T.-H. Co. (G.E. Co., U.S.) Electric circuit-breakers.
22,897 Anderson & Atchley. System of control for maintaining the relative speeds of a number of electric motors. (Cognate application, 6,086/15.)
23,121 B.T.-H. Co. (G.E. Co., U.S.) Vibrating rectifiers for electric currents.
A current rectifying device comprising a transformer having a closed main path for the magnetic flux and a shunt path for the magnetic flux provided with an air-gap in which the free end of a movable armature is located so as to be actuated by the flux set up in the shunt path.
23,366 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Control system for electric motors.
24,039 Mellersh-Jackson. (Soc. Anon. Movo) Maximum current or overload circuit-breakers.
24,429 Adickes. Binding posts for electric conductors.

1915 Specifications.

1,928 Garlitz. Magnetic skelp-charging machines. (7/2/14.)
5,089 Sterling Telephone & Electric Co. & Wass-Miller. Telephone key.
6,117 W. T. Henley's Telegraph Works Co. & Jones. Electrical distribution apparatus.
6,221 Marks. Combined electric switches and plug couplings.

APPLICATIONS FOR PATENTS

*Note.—The undermentioned Applications (except those marked †) are not open to public inspection until after complete Specifications become Open. Those marked * are accompanied by Provisional Specifications. Those marked † are proceeded with on the Applicants' request (accompanied by a remittance) previously to the ordinary publication. Numbers in brackets refer to communications of inventions. When complete Specification accompanies application an asterisk is affixed.*

July 26, 1915.

10,785 Lane & Honeyman. Rumblers and the like for electrolytic purposes.*
10,803 Haefely & Co., Akt.-Ges. Vacuum drying and impregnating device. (24/7/14 Switzerland.)*
10,816 Holt. Aerial illuminating devices.
10,821 Sutton. Railway signalling and control apparatus.
10,837 Downes. Flexible electric conductors.

July 27, 1915.

10,845 Kavanagh. Electric ignition devices.
10,851 Coates & Jones. Joint or intersection boxes and means for connecting electric cables thereto.
10,894 Gardner. Apparatus or devices for use in submarine signalling.
10,901 Segre. Electric apparatus.*

July 28, 1915.

10,938 House. Electrical switch controlling devices.
10,942 Fairweather. (Singer Mfg. Co., U.S.) Power-transmitting connections.
10,957 & 10,958 Samuel, Slingo, Cointon & Douglas. Electric railway systems. (Addition to 14,984/14 and 15,539/14.)*

July 29, 1915.

10,983 Rainey. Isochronising and synchronising systems in multiplex telegraphy. (18/8/14, U.S.)*
10,996 Fairweather. (Singer Mfg. Co., U.S.) Power-transmitting mechanism.
11,011 Marino. Electrolytically depositing a strongly adherent and malleable layer of tin on iron and other metallic surfaces.*
11,013 Rule & Feld Bros. & Co. Electric switch plugs.
11,033 Codd. Magnetos.*

July 30, 1915.

11,050 Gloyne. Perpetual magnetic power wheel.
11,053 Leitner. Ignition devices for internal-combustion engines.
11,072 Kat & Callender's Cable & Construction Co. Identification of electric cables
11,074 B.T.-H. Co. (G.E. Co., U.S.) Electrodes.
11,075 W. R. Sykes' Interlocking Signal Co. & Tarrant. Railway signalling apparatus.
11,088 Müller. Separation of suspended bodies from electrical insulating fluids. (31/7/14, Germany.)*

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Aberdeen.—The Corporation tramway accounts for the year ended May 31 show total capital expenditure £366,332 (increase £10,250), of which £21,335 is outstanding.

Revenue was £88,002 (compared with £85,266 in previous year), and working expenses were £51,525 (£47,036), leaving gross profit £36,477 (£38,230). Interest required £4,788 (£5,598), sinking fund £5,178 (£4,896) and depreciation and renewals £13,626 (£13,459). Special expenditure was £1,626 (£1,286). £7,590 (£12,989) has been placed to reserve, £2,000 contributed to the Common Good, and £1,666 to city improvements. Passengers carried were 24,048,816 (22,218,142), car-miles run 1,909,010 (1,832,588) and units used 2,317,204 (2,170,033).

Mr. R. S. Pilcher (general manager) says in his report the receipts are still showing a regular increase. The year's profit was £11,000 (compared with £12,989 last year), the decrease being due to increased expenses, mainly due to the war. The reserve account amounts to £36,806, depreciation and renewals account to £152,997, and the sinking fund to £51,980. Total, £241,783. Current consumption was 1·213 (1·184) per car-mile. A war bonus of 2s. per week has been granted to employés earning 28s. per week or less. 24 women car conductors have been engaged, and have proved satisfactory. 122 of the employés (48·03 per cent.) have joined H.M. Forces, and the Corporation is making up their pay to the usual amount, £875 having been paid during the year in such allowances. The increase of the average length of halfpenny stages from 840 yds. to 1,010 yds. has been justified by the results. There has been a great increase in the volume of traffic with a slight increase in receipts. Working expenses were 6·482d. (6·16d.) per car-mile, and total revenue was 11·06d. (11·17d.).

Chester.—The accounts of the tramways department for the year ended March 25 show total capital expenditure £82,934 (no increase), of which 15,403 has been repaid.

Revenue was £13,382 (compared with £13,432 in previous year) and working expenses were £8,590 (£8,128). Interest required £2,748 (£2,754) and sinking fund £1,018 (£1,018), leaving net profit £903 (£1,531), which has been carried to reserve or renewal fund. Average total revenue per car-mile was 9·25d. (9·28d.) and working expenses, including power, were ·94d. (5·62d.) Average fare charged per mile was 0·8d. (as in previous year). Passengers carried were 3,275,944 (3,217,899), car-miles run 347,318 (347,260) and units used 414,118 (378,158)=1·19 (1·08) per car-mile.

Croydon.—The tramway accounts to March 31 last show total capital expenditure £286,764, of which £106,407 has been redeemed.

Total revenue was £88,615 (compared with £87,026 in previous year), working expenses were £70,308 (£69,743), and, after providing £1,974 for tax allowances, and adding £749 (£664) bank interest and tax on stock, the gross profit was £17,082 (£17,947). Interest required £7,889 (£7,943), sinking fund £7,415 (£7,415) and income tax £1,587 (£1,227), the net profit being £191 (£1,3624).

The general manager (Mr. T. B. Goodyer) reports that the passengers carried were 19,847,402 (19,227,878), car-miles run 2,800,672 (2,798,175), and units used 3,000,308=1·071 per car-mile. Route receipts per car-mile were 7·53d. (7·28d.). From April to July, 1914, inclusive, receipts increased £2,382, and but for the war the increase for the year would probably have been about £6,800. At March 31 last 108 of the employés were serving in H.M. Forces. The number of motor-buses operating in the borough in the four quarters of the year were 90, 95, 70 and 60 on week-days, and 155, 146, 100 and 80 on Sundays. In July, 1914, it was announced that the Government hoped that there would be a Joint Committee of both Houses of Parliament to inquire and report on the present law relating to motor omnibuses and trolley vehicles, whether any amendment was necessary, and what contribution (if any) should be payable towards the cost of road maintenance by the proprietors of such vehicles. In view of the national crisis nothing further was done in connection with the matter. It was announced in March last that, in view of the complaints as to damage caused to roads by heavy motors and locomotives, the President of the L.G. Board had appointed a small expert committee to inquire into the sufficiency of the existing requirements with respect to the construction of these vehicles, including weights on wheels, widths of tyres, diameter of wheels, &c., and to report what amendments are desirable.

Glasgow.—The traffic receipts of the Corporation tramways department continue to increase in a satisfactory manner.

From June 1 until Aug. 21 inclusive, the traffic receipts were £252,625. 5s. 10d., compared with £238,232. 18s. 6d. for the corresponding period of 1914, an increase of £14,392. 7s. 4d. The numbers of passengers carried were 77,893,912 against 73,506,340 last year. A large proportion of the engineering and other concerns are running day and night shifts, and it is stated that the workmen's traffic on Sundays is almost as brisk as it is on week days.

Greenock.—The accounts of the electricity supply undertaking for the year ended June 30 were recently approved by the Corporation. The net profit was over £10,000, which constituted a record in the history of the undertaking.

The total capital expenditure is £346,150 (including £34,358 on the extension to Port Glasgow), an increase of £33,180. The total revenue for the year was £62,705, including £17,125 from the sale of current for private lighting, £37,693 for power, £741 from the public lighting and £5,558 from the Greenock & Port Glasgow Tramways Co. The total expenditure was £30,588, leaving £32,117 gross profit. The cost of generation was £22,059, of which coal and other fuel (including £1,557 paid to refuse destructor account) came to £16,153, oil, waste, &c., to £861, station wages to £2,774 and repairs and maintenance to £2,270; the cost of distribution was £1,633, repair and renewal of public lamps

[illegible] general establishment charges, &c., £2,621. After meeting interest (£8,531), instalments of loans repaid (£10,263), income tax (£221), [illegible] the net profit was £10,397. The number of units generated were 16,881,777 (against 13,049,840 in 1913-14) and 14,207,575 units were sold (against 11,457,438), of which 12,993,086 were to private consumers by meter and 1,152,420 to the tramways company. The total maximum supply demanded was 6,042 kw. (against 5,300 kw.). There are only 55 public lamps, as in the previous year, and the charges for electric current were also unchanged.

Halifax. [illegible] March 31 show gross capital expenditure £304,763 (increase £18,047), [illegible] mortgage debt has been redeemed.

Revenue was £61,434 (against £55,654 in previous year), working and general expenses and special charges amounted to £29,896 (£28,707), and, after providing for income tax, interest, sinking fund, &c., the net profit is £776 (£4,109), of which £4,041 (£3,893) is to be devoted to relief of rates. Average price obtained was 1·282d. (1·329d.) per unit. Units generated were 12,373, 230 (10,800,225), and sold 11,075,893 (9,670,008). Total maximum supply demanded was 5,102 kw. (4,480 kw.). There are 2,517 (2,492) consumers, and total connections are equal to 304,703 (282,008) 30-watt lamps.

Liverpool.—A traffic return compiled by Mr. C. W. Mallins, manager of the Corporation tramways, shows that the receipts from Jan. 1 to Aug. 21 were £442,221 (compared with £443,061 in the [illegible] last year), and passengers carried were [illegible].

The chairman of the Tramways Committee (Mr. E. Russell-Taylor) explained to the Council that the decrease in receipts with an increase in passengers was due to 4,483,755 free journeys having been given to soldiers and to nurses.

Salford.—The tramway accounts for the year ended March 31 show gross capital expenditure £725,485, of which £512,605 is outstanding.

Revenue was £262,454 (compared with £277,856 in 1913-14), working expenses were £170,521, allowances to employés serving with H.M. Forces absorbed £6,226, interest (including income tax, &c.) £21,071, sinking fund £668 and rents to outside authorities £29,063, leaving a net balance of £32,264 (£26,450). Average total revenue per car-mile was 10·807d., traffic receipts being 10·577d. (against 10·461d.), and working expenses, including total power cost, were 7·022d. Average ordinary fare charged per mile was 0·46d. Passengers carried were 54,343,908 (53,124,546), car-miles run 5,828,238 (6,235,278) and units used 9,602,534 [illegible] per car-mile.

Mr. G. W. Holford (general manager) says in his report the length of tramways worked by the Corporation is 75¼ miles. The stock of cars is 200, in addition to tower and salt waggons, &c., and 24 bogie truck type cars are on order. 407 employés have left to join H.M. Forces. So far as it has been adopted, the employment of female labour has been attended with considerable success. £22,000 (as in previous year) has been contributed in aid of rates and £10,264 (£4,450) placed to depreciation and renewals account. The Council, having decided that no employé should be at a financial loss consequent upon enlistment, the wages of the men have been made up to the extent of £6,226. 14s. 5d. In regard to a war bonus to the other employés during the war, the Committee decided to grant such special terms to the skilled workmen as were agreed upon between their Trades Unions and Employers' Federations, and to all others the following: Householders, 2s. 6d. per week; other than householders, 1s. 6d.; and youths under 18, 1s. These payments [illegible] per week.

Approximately 14½ miles of line have been relaid since 1908, and in nearly all cases rails of the Sandberg specification (which it is anticipated will give a longer life than the rails previously used) have been adopted, and the joints welded by the Thermit process. The rail-joints of the tramways in Eccles New-road between Weaste-road and the borough [illegible] Broad (people have been electrically welded by the Tudor process. The staff have also during the year been engaged on the work of conversion from single to double line [illegible] Prestwich.

COMPANIES' MEETINGS AND REPORTS.

[illegible] GAS LIGHT & COKE CO.—At the half-yearly meeting on [illegible] (Mr. W. Lucas, J.P.) said [illegible] Owing to the continued [illegible] of both gas and electricity by private consumers, they considered it [illegible] benefits which they hoped to get from it eventually. There would have been a great increase but for the military restrictions placed on lighting, which had resulted in candles being used in many houses in place of other illuminants.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—The report for 1914 states that during the year a few of the outstanding shares of the Rio de Janeiro and the Sao Paulo Tramway, Light & Power Companies were acquired, and a large controlling interest was secured in the Cia Rede Telephonica Bragantina, a telephone company carrying on business throughout the state of Sao Paulo. The company has also acquired an important interest in the Cia Telephonica do Estado de Sao Paulo, whose total issued share capital on Dec. 31, 1914, was $116,217,500, divided into 1,062,175 ordinary and 100,000 6 per cent. cumulative preference shares of $100 each. In January, 1914, the Rio de Janeiro and Sao Paulo Companies created issues of 5 per cent. general mortgage bonds, that of the Rio de Janeiro Co. being for an authorised amount of £2,000,000 and the Sao Paulo Co. for £1,000,000. The bonds were created for use as collateral security for raising moneys for capital requirements when necessary, and during the year a portion of each of these securities was issued for this purpose. The year has been one of general business depression in Brazil on account of the local conditions, both financial and commercial. After war was declared, the conditions became very serious and the monetary stringency was so acute that the Government declared a moratorium which continued until the end of the year. The Government made an issue of currency which helped to relieve the stringency, but caused great fluctuations in exchange, the value of the milreis dropping as low as 10⅛d. during the second week in September. The war had also the effect of stopping the usual method of remittances by means of bills of exchange, and for several months it was practically impossible to remit money from Brazil for payment of coupons and dividends. As the situation did not improve, the Board decided in October to remit its funds in coffee, as they felt that this method of remittance was a sound and safe procedure. As the Rio de Janeiro Co. has under charter a fleet of steamers for carrying coal and other material required by the companies in Rio de Janeiro and Sao Paulo, the board employed such steamers on their return journeys for freighting the coffee purchased in Brazil to the New York and European markets, and as coffee is a staple product in commerce, it offered a safe, and at that time the only practical, means of remitting the companies' funds. Up to the end of the year there had been purchased and shipped from Rio de Janeiro and Santos 278,400 bags of coffee of the value of 11,695 contos of reis, all of which has since been disposed of in New York at prices which have enabled the company to net an average of 13$\frac{5}{8}$d. per milreis, which is materially in excess of the average rate of exchange during the same period, even if it had been possible to buy bills for such a large amount of money. The result of the company's operations for the year have not been as satisfactory as anticipated. The earnings of the tramway systems in Rio de Janeiro and Sao Paulo were seriously affected, but the gross income of the combined companies in Brazilian currency showed an increase over the previous year. The revenue from securities owned and under contracts with subsidiary companies was $7,523,695·85 and interest on advances to subsidiary companies came to $535,117·25, a total of $8,058,813·10. Deducting general and legal expenses, administration charges and interest on loans the surplus available for dividends was $7,666,532·19. After payment of a 6 per cent. dividend on the preference and common shares the net surplus was $809,412·69. All possible expenditure on capital account in connection with the development of the property was suspended, but there was a large amount of work under way which it was necessary for the subsidiary companies to complete, and a considerable amount of construction work had also to be carried out in order to comply with the obligations of the different concessions. The board express their keen regret at the death of Dr. F. S. Pearson, the late president of the company, who was lost by the sinking of the Lusitania. In May Mr. Alex. Mackenzie was elected president of the company as well as of the Rio de Janeiro and Sao Paulo Tramway, Light & Power Companies, and of the Sao Paulo Electric Co.

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—The equivalent number of 33 watt lamps connected at March 31 was 130,132, against 130,357 in 1914 and 107,108 in 1913; and the number of passengers carried was [illegible] against 5,566,170 and 5,707,842 respectively. The year's revenue was £86,799. 12s. 5d. and the expenditure £56,990. 1s. 1d. leaving a gross profit of £29,809. 11s. 4d., against £31,499. 16s. 7d. The decreased profit is accounted for by abnormal conditions during the last nine months of the year. A serious drought, lasting about seven months, was experienced in Victoria, resulting in a serious trade depression, and the [illegible] adversely affected the receipts from the tramways in Ballarat and Bendigo. A considerable number of the male inhabitants of Ballarat and Bendigo have enlisted (including several of the company's employés) and the absence of so large a number of men has also affected the traffic receipts. The balance to credit of profit and loss account, including £3,626 brought forward, and after deducting debenture interest, &c., £17,021. The directors propose to devote £14,658. 15s. to pay arrears of preference dividend to write £8,000 off discount and commission on debenture stock account, and to carry forward £1,999. 15s. 10d.

MANAOS TRAMWAYS & LIGHT CO. (LTD.)—The report for the year to April 30 states that the gross receipts were £110,420, a decrease of £22,147. The expenses were £81,240, a decrease of £12,605, and net earnings £29,180, a decrease of £9,518. The fall in exchange has resulted in a loss of £6,180 on remittances during the year. After providing for interest, London charges, &c., placing £1,725 to debenture sinking fund, the profit balance of £4,002 is to be carried forward.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

COVENTRY ALUMINIUM & REFINING CO. (LTD.) (141,388).—Reg. Aug. 26. capital £1,000 in £1 shares, to carry on the business of engineers, [illegible] and [illegible] merchants, metallurgists and [illegible] manufacturers, smelters, refiners, assayers, metallurgical chemists, [illegible] and general metal workers. Private company. Reg. office: Nelson-street, Coventry.

MILTON ACCUMULATORS (LTD.) (141,409).—Reg. Aug. 27, capital £1,000 in £1 shares, to carry on the business of manufacturers, repairers, constructors, designers, importers and exporters of accumulators, motors, motor and other cycles and all accessories and appliances relating to motoring, conductors of schools of instruction for motoring, electrical and mechanical engineers, &c. Private company. First directors are M. Wolff and A. J. Mardlin (both permanent). Reg. office: 84, Milton-street, E.C.

STAINES MACHINE CO. (LTD.) (141,259).—Reg. Aug. 12, capital £4,500 in £1 shares (750 management), to carry on the business of iron-founders, mechanical and electrical engineers, manufacturers of machinery and parts of machinery for making munitions of war, tool makers, &c. Private company. First directors are H. H. Clark, H. W. Shaw and E. Pullbrook (all permanent). Reg. office: 1, London-road, Staines.

WESTWOOD ELECTRICAL CO. (LTD.) (141,383).—Reg. Aug. 25, capital £4,000 in £1 shares, to carry on the business of manufacturers of and dealers in electrical and general fittings and accessory parts thereof, electrical and general engineers, &c. Private company. First directors are F. Westwood and E. M. Westwood. Reg. office: Lawdon-road, Bordesley, Birmingham.

WHIPP & BOURNE (LTD.) (141,413).—Reg. Aug. 27, capital £35,000 in £1 shares, to take over the business carried on as "Whipp & Bourne," to carry on the business of switchgear makers, electricians, mechanical engineers, &c., and to adopt an agreement with S. Whipp, C. W. D. Bourne and F. Whipp. Private company. First directors are S. Whipp, C. W. D. Bourne and F. Whipp (all permanent managing directors, subject to holding not less than 5,000 of shares allotted to them under purchase agreement).

STATUTORY RETURNS.

BUDE ELECTRIC SUPPLY CO. (LTD.)—Return to May 1, gives capital as £15,000 in £1 shares, 10,000 shares taken up. £10,000 paid. Mortgages and charges: £2,500 mortgage debentures.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—Capital at May 26 was £135,250 in 62,000 preference and 73,250 ordinary shares of £1 each. All shares taken up. £75,738 paid on 48,750 preference and 26,988 ordinary. £59,512 considered as paid on 13,250 preference and 46,262 ordinary. Mortgages and charges: Nil.

DIRECT UNITED STATES CABLE CO. (LTD.)—The capital in return to May 11 is £1,300,000 in £10 shares. 121,420 shares taken up and £1,214,200 paid. Mortgages and charges: Nil.

EVERETT, EDGCUMBE & CO. (LTD.)—Return to July 29 gives capital as £25,000 in 5,000 6 per cent. cumulative preference, 19,997 ordinary and three "A" shares of £1 each. 3,000 preference, 19,011 ordinary and three "A" shares taken up. £11,496 paid on 2,500 preference, 8,995 ordinary and one "A." £10,850 considered as paid on 800 preference, 10,015 ordinary and two "A." Mortgages and charges: £1,000.

LA PLATA ELECTRIC TRAMWAYS CO. (LTD.)—Return to May 11 gives capital as £1,000,000 in 200,000 preference and 200,000 ordinary shares of £1 each. All shares taken up. £170,007 paid on 170,007 preference. £79,993 considered as paid on 29,993 preference and 200,000 ordinary shares. Mortgages and charges: £100,000.

MERTHYR ELECTRIC TRACTION & LIGHTING CO. (LTD.)—In return to [illegible] gives capital as £100,000 in 6,000 preference and 14,000 ordinary shares of £5 each. 6,000 preference and 8,000 ordinary shares taken up. 30,000 paid. Mortgages and charges: £18,000. [illegible] Electric [illegible] Ltd., Merthyr.

MORTGAGES AND CHARGES.

ELECTRO FLEX STEEL CO. (LTD.) Memorandum of satisfaction to [illegible] 30 [illegible] registered [illegible] Dec. 19[illegible] £10,000 [illegible] Aug. 30 [illegible] charge [illegible] £10,000 [illegible] Aug. 30 [illegible] charge [illegible] £5,000. Property [illegible] and property [illegible] Nottingham.

PITTERS VENTILATING & ENGINEERING CO. (LTD.)—Land registry [illegible] dated Aug. 6 [illegible] £1,000 [illegible] Aug. 6 [illegible] Co. to London and Provincial Bank [illegible]

CITY NOTES.

MEMORANDA (Sept. 1).—Bank rate 5 per cent. (since Aug. 8, 1914) Consols 65½. Consols Pay Day Oct. 1. Stocks and Shares Ticket Days Sept. 9 and 28. Pay Days Sept. 10 and 29. Price of silver, 25 3/8d.

COMMERCIAL CABLE CO.—The regular quarterly dividend of 1 per cent. on the preferred shares and the regular quarterly dividend of 1½ per cent. on the common shares in the Mackay Companies will be paid on the 1st prox. The transfer books will not be closed.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following will be struck off the register of Joint Stock Companies unless cause to the contrary is shown before Nov. 17: Collieries Electric Power Development Synd., Dimming Switches, Electric Speller, Engineering Equipment, Homes Earphone Co., Hydro-Electric Lift & Crane Co., London Electric Treatment Co. (1911), Magnet Galvanising & Plating Co., Universal Patents Bureau.

DAVIS & TIMMINS (LTD.)—The directors announce an interim dividend at rate of 6 per cent. per annum (less tax) on the ordinary shares for the past half-year, payable 15th inst.

DUMBARTON BURGH & COUNTY TRAMWAYS CO.—The accounts for the year ended July 31 show a divisible balance of £10,790, after providing for debenture int. test. A dividend of 1½ per cent. is proposed on the ordinary shares, leaving £3,595 to be carried forward.

OXFORD ELECTRIC CO. (LTD.)—The directors announce an interim dividend at rate of 5 per cent. per annum (less tax) on the ordinary shares for the past half-year.

STEWARTS & LLOYDS (LTD.)—An interim dividend at rate of 10 per cent. per annum has been declared on the preferred ordinary shares for the half-year ended June 30.

TYNESIDE ELECTRICAL DEVELOPMENT CO. (LTD.)—The directors have declared an interim dividend at rate of 6 per cent. per annum on the preferred ordinary and 5 per cent. on the deferred ordinary shares for the half-year ended July 31, payable, less income tax, on Aug. 31.

WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS (LTD.)—The directors have declared an interim dividend of 2½ per cent. for the half-year ended July 31.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Sept. 1. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shes.	Last Dividend	Name.	Price, Wed. Sept. 1.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9⅜	7 2 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9⅜	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	10†	6 0 0	Feb Aug
5	10%	Brompton & Kensington Ord.	8⅜	6 0 2	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	9½	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	83½	4 15 10	Jan, July
5	4½	Do. 4½% Pref.	4⅜	5 10 10	..
5	5%	Do. Ord.	4	6 5 0	Aug, Feb
10	9%	City of London Elec. Lt. Ord.	12½	7 4 0	Feb, Aug
10	6%	Do. 6% Pref.	1..	4 17 0	Mar, July
St.	5%	Do. 5% Deb. St.	110	4 10 11	Jun, Dec
10	7%	County of London Ord.	10..	6 16 7	Mar, Sept
10	6%	Do. 6% Pref.	1..	5 14 4	Feb, Aug
St.	4%	Do. 2nd Deb.	97	4 12 0	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	77	5 16 8	July
5	4%	Kensington and Knightsbridge Ord.	7⅛	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	85	4 13 0	Jan, July
5	3%	London Elec. Supp. 6% Pref.	5⅛	5 13 1	..
St.	4%	Do. 4% Mort. Deb.	84	4 11 11	Jan, July
..	3½	Metropolitan E. Supp. Ord.	..	0 0 0	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	97	4 14 0	Jan, July
St.	..	Midland Elec. Corpn. 1st Mort. Deb. St.	..	0 0 0	Jan, July
..	..	Newcastle & Dist. E.L. 6% 2nd Dbs.	15½	6 1 10	Mar, Sept
St.	..	Newcastle-on-Tyne E.S.5%2d Mt. Db. St.	100	0 0 0	Mar, Sept
1	1%	North Metropolitan E. P. Supp. 6% Pref.	1⅛	5 11 7	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs.	96	5 5 3	Jan, July
St.	4%	Urban Elec. Supp. 4½% Db. St.	84	5 7 10	Apl, Oct
1	1%	Waste Heat & Gas Elec. Gen. Stations.	1⅛	0 17 3	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	5⅜	6 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4⅜	5 2 7	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	7⅛	4 4 4	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	11	5 9 11	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	7⅛	5 8 11	..
St.	4%	Do. do. Assented Def. Ord.	7⅛	5 4 4	..
5	4	Do. Ord.	4	4 10 0	Jan, July
St.	5%	Do. 5% Deb. St.	8⅛	4 5 4	Jan, July
St.	4%	Do. 4% Deb. St.	81	4 15 4	May, Nov
St.	6%	Do. 6% Deb. St.	89	6 15 0	Feb, Aug
10	4	Do. Ord.	7⅛	5 12 7	Feb, Aug
1	1	London Electric Ry. Ord.	1⅛	1 4 3	Jan, July
St.	4%	Do. 4% Deb.	76	5 2 3	Mar, Sept.
St.	5%	Do. 5% Deb.	85	4 14 4	Jan, July.
St.	4%	Metropolitan Elec. Tramways Ord.	7⅛	5 5 0	Feb, Aug
St.	6%	Do. 6% Cum. Pref.	7⅛	4 10 0	Feb, Aug
St.	4%	Do. 4% Deb.	74	4 11 3	Feb, Aug
St.	4%	Do. 4% Deb.	8⅛	4 4 4	Jan, July
St.	4½%	Do. 4½% Deb.	8⅛	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	1⅛	..	Feb, Aug
St.	4%	Do. 4% Perp. Deb.	92	4 7 0	May, Nov

† Ex. ...

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price, Wed., Sept. 1.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*	£ s. d.		
St.	4½%	Metropolitan Dist. Rv. 4½% First Pref.	64⅛	6 19 9	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	129⅛	4 12 8	Jan, July
St.	4%	Do. 4% Debs.	72	5 11 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	87½	4 11 7	Jan, July
St.	4%	Do. 4% Guar. Stock	75½	5 6 0	Mar, Sept
10	..	Underground E. Rys. of London Shares	1⅛	.. ..	..
1/0	..	Do. A Ord.	⅛	.. ..	..
St.	6%	Do. 6% Inc. Debs.	101⅛	5 17 4	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 15...	73⅛	8 4 1	Mar, Sept
..	4½%	Do. 4½% Bds.	93	4 11 10	Jan, July
5	..	Yorkshire W. Riding Ord.	⅛	.. ..	March
5	6%	Do. Pref.	4½	7 1 8	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2½	6 4 5	Apl, Oct
1	8%	Brit. Aluminium Ord.	1⅛	5 6 3	Mar
100	5%	Do. Prior Lien Debs.	93½	5 8 6	Jan, July
1	6%	Do. 6% Pref.	⅞	6 12 5	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅛	7 0 4	Aug, Feb
5	3%	Do. 6% Cum. Pref.	5⅛	5 9 1	Jan, July
1	6%	British L.M.Enamelling Mfg. Co. 6% Pref.	⅛	6 6 4	Mar, Sep
2	7½	Brit. Westinghouse Pref.	1⅞	9 12 0	April
100	6%	Do. 6% Prior Lien Debs.	101⅛	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10⅛	6 16 4	Jan, July
5	2/6	Do. 5% Pref.	4	6 5 0	Feb, Aug
1	15%	Castner Kellner	3	5 0 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	7 13 7	Sept
5	..	Edison & Swan U. Elec. Lt. A. £3 pd.	⅛	.. ..	Feb, Aug
1	6%	Elec. Construction Ord.	⅞	9 4 7	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
10	6%	General Electric 6% Pref.	7⅜	6 4 8	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13⅛	7 14 0	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅛	5 0 0	..
St.	4½%	Do. 4½% Deb. St.	91½	4 18 4	Jun, Dec
10	8%	India Rubber, G. P. &c., Ord.	8⅛	6 1 2	Feb, Aug
10	5%	Do. Pref.	8⅛	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	98	4 1 8	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	30⅜	7 16 9	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅜	4 14 1	May, Aug
1	6d.	Do. 5% Pref.	⅝	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	81	4 18 9	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99½	4 10 3	Jan, Dec
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	98⅛	6 1 8	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21⅛	6 19 11	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	85⅛	6 3 11	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	8⅛	5 13 6	May, Nov
10	10%	Do. 10% Pref.	15⅛	6 11 2	..
5	10	Direct Spanish 10% Pref.	7⅞	6 13 4	..
10	4%	Direct United States	5⅛	6 15 5	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	115	6 1 9	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	66	5 6 1	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	79⅛	5 0 6	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	79	5 1 3	Feb, Aug
10	7%	Do. Ord.	11⅛	6 0 0	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. with Coup. 8	33	6 13 4	Ja, May, July
25	13%	Indo-European	50	6 10 0	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 3 3	April
1	7%	Do. 7% Pref.	1⅛	3 15 11	July
10	9d.	West India & Panama Ord.	1⅛	8 17 9	May, Nov
St.	6%	Do. 1st Pref.	8⅛	7 1 2	May, Nov
10	7%	Western Telegh. Co.	11⅛	5 13 6	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	74⅛	5 7 4	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99⅛	4 10 6	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telegh. $100 Cap.	131⅛	6 1 11	Ja, Ap, Jn, O
..	5%	Cuban Telephn. Co. 5% Bds.	76	6 11 7	Jan, Jly
1	7½d.	Monte Video Telephn. Ord.	⅝	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	100⅛	4 9 3	May, Nov
1	10%	Oriental Telephone Ord.	1⅛	5 1 3	Apl, Oct
St.	4%	Do. Db. St.	89	5 0 0	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 5 8	Jan, July
5	8%	United River Plate Ord.	5⅛	7 5 5	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅞	5 3 3	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	9⅞	6 3 1	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10	6 0 0	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	80	6 5 0	Ja, Apl, Jly, O
..	4%	Do $100 Pref	67½	5 18 6	Ja,Ap, Jly,O
100	6%	Submarine Cable Trust Certs.	125⅛	4 15 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	71⅛	7 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	64⅛	5 12 6	Jan, July
St.	4%	Do. 4% Debs.	72⅛	5 10 4	Jan, July
5	2/9	Do. 5% Pref.	4	6 17 6	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3⅞	7 11 6	Jan, July
100	1½	Brazilian Traction Ord.	47	8 13 7	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	84⅛	7 2 7	Ja,Apl,Jly,O
..	8%	Brisbane Trams Ord.	6⅛	5 16 5	May
..	2/6	Do. 6% Cum. Pref.	4⅜	5 2 7	May, Nov
St.	4½%	British Columbia 4½% Cum. Debs.	60	7 7 4	..
5	9½%	Calcutta Elec. Trams Ord.	1	7 16 4	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	85½	5 13 1	Feb, Aug
..	5%	Madras Elec. Trams 6% Cum. Pref.	5	6 0 0	..
100	5%	Metropolitan Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Trams Common St.	31	.. ..	Fb,M,Aug,N,
..	6%	Do. B.	40	12 10 0	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	79	4 13 1	Feb, Aug
1	7%	Rio de Janeiro Tram., L. & P. 50 yr. Bds	70⅛	7 1 3	Jun, Dec
100	4½%	Tramways Havana 4½% Bds.	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	3%	Adelaide Elec. Supply 6% Pref.	4⅛	6 1 6	Mar, Sept
St.	5%	Buenos Ayres Gas 5% Deb. St.	71⅛	6 2 2	Jun, Dec
1	..	Buenos Ayres Tramways Ord.	1⅜	5 14 7	..
..	..	Do. 6% Pref.	⅞	7 11 3	May, Nov
..	..	Do. 6% 2nd Pref.	⅞	5 4 4	Mar, Sept
St.	..	Compañia Hispano Americana 6% Deb. St.	107⅛	5 12 3	Ja,Apl,Jly,O
St.	..	Mexican Light & Power 5% 1st Mtg. Debs.	..	5 1 1	June, Dec
St.	..	Do. 5% 2nd Mtg. Debs.	47⅛	5 1 6	Apl, Oct
1	..	Rio de Janeiro Light & Power 5% Mtg. Debs.	..	5 1 3	Jan, July
..	..	Do. Ord.	1⅛	4 14 4	Ja,Apl,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	97⅛	4 12 1	Jan, July
1	4½%	Do. 4½% Trust Debs.	89⅛	5 1 9	May, Nov
..	..	Victoria Falls & Transvaal P. Co., 6% Pf.	9	.. ..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	..	6 7 7	Jan, July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Sept. 1 the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	13d.	English Lead	£23 5 0
Solid Drawn Copper Tubes	13½d.	Antimony	Nominal.
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	15d.	**Old Metals.**	per ton.
Brass Wire	12½d.	Clean Scrap Copper	£62 10 0
Copper Wire	13d.	Brazlery Copper Scrap	£55 0 0
Rolled Brass	12½d.	Clean Scrap Brass	£48 0 0
Brass Sheets	12½d.	Old Lead	£18 10 0
		Old Zinc	£35 0 0
	per ton.	Hollow Pewter	£110 0 0
Copper Sheets	£98 0 0	Black Pewter	£80 0 0
Spelter	£74 0 0	Gun Metal	£57 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date August 31, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£75 0 0	Old Lead	£19 0 0
Clean Mixed Brass	£54 0 0	Tea Lead	£17 10 0
Clean Copper	£65 0 0	Old Zinc	£40 0 0
Brazlery Copper	£60 0 0	Hollow Pewter	£112 0 0
Gun Metal	£62 0 0	Shaped Black Pewter	£80 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £70; Commercial Tinman's Solder, £90; Blowpipe Solder, £100.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	No. of weeks.	Aggregate Amount.	Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	Aug. 28	1,961	+ 335	12	23,284	— 18
Anglo-Argentine	,, 26	48,885	— 115	34	1,733,692	— 135,81
Ashton-under-Lyne	,, 28	597	+ 165	22	10,873	+ 41
Ayr Corporation	,, 28	523	+ 82	15	7,708	+ 1
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	,, 29	1,462	+ 233	22	30,025	+ 1,90
†Birmingham Corporation	,, 21	15,624	+ 3,582	21	276,569	+ 18,02
Blackburn Corporation	,, 25	1,286	— 9	21	29,637	— 1,11
Blackpool Corporation	,, 26	3,555	+ 1,138	22	43,070	— 4,59
Blackpool and Fleetwood	,, 28	1,899	+ 562	34	26,351	— 2,63
Bolton Corporation	,, 28	2,859	+ 170	22	58,886	— 3,73
Bournemouth { Trams	,, 25	2,925	+ 784	21	47,071	+ 6
Bournemouth { Buses	,, 25	61	+ 18	21	662	+ 13
Bradford Corporation	..	..	..	..	..	..
Brighton Corporation	,, 29	1,601	+ 290	22½	26,141	— 89
Bristol Trams { Trams	,, 27	4,799	+ 301	34	160,441	— 37
Bristol Trams { Buses, &c.	,, 27	5,423	+ 1,283	34	165,298	+ 27,97
Burmah E. Trams & Ltg.	,, 28	R5,174	+ R1,608	34	R121,065	+ R65
Burnley Corporation	,, 28	1,558	+ 253	22	49,614	+ 28
Bury Corporation	,, 29	298	..	22	6,396	+ 38
Bury Corporation	,, 29	1,457	— 83	22½	30,472	— 1,09
Calcutta Tramways Co.	,, 28	R65,282	+ R 35	..	..	..
Camborne-Redruth	..	..	..	..	..	..
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	,, 26	562	+ 55	34	17,035	— 24
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	,, 28	1,125	+ 137	21½	23,189	+ 13
Dover Corporation	,, 28	397	+ 119	21	7,100	+ 1,31
Dublin & Lucan Railway	,, 27	177	+ 23	8	1,390	— 5
Dublin United	,, 27	6,551	+ 474	34	208,466	+ 6,25
Dundee Corporation	,, 25	1,445	+ 161	15½	20,195	+ 42
East Ham Council	,, 28	1,382	+ 103	21½	28,913	+ 4,8
Exeter Corporation	,, 27	462	+ 101	21	8,548	+ 3
Glasgow Corporation	,, 28	21,341	+ 1,537	13½	273,966	+ 16,0
Glossop Trams	,, 28	157	— 32	35	4,311	— 1
Gloucester Corpn.	,, 25	387	— 49	21	7,275	— 3
Halifax Corpn. { Trams	,, 24	2,553	+ 174	21	49,095	— 7
Halifax Corpn. { Buses	,, 24	47	— 4	21	1,101	—
Hastings Elec. Trams Co.	,, 26	1,644	— 404	34	32,895	— 9
Huddersfield Corpn.	,, 25	2,782	+ 597	21	59,264	+ 6,8
Hull Corporation	,, 28	3,092	+ 169	21	65,852	+ 3,0
Ilford District Council	,, 28	709	+ 94	21	14,571	+ 2,4
Ilkeston Corporation	,, 28	148	+ 12	21	2,836	—
Ipswich Corporation	,, 28	713	+ 213	20	12,489	+ 1,6
Isle of Thanet Co.	,, 28	1,063	+ 193	47½	19,598	— 9,8
Kilmarnock Corporation	,, 28	168	+ 18	16	2,656	—
Lanarkshire Trams Co.	,, 28	2,173	+ 325	34	65,425	+ 4
Lancashire United	,, 28	1,943	+ 270	34	58,810	+ 2,3
Leeds Corporation	,, 28	9,625	+ 1,765	22	196,923	+ 11,7
Leicester Corporation	,, 28	3,236	+ 247	35	103,510	+ 3,3
Leith Corporation	,, 28	703	+ 51	15	11,992	+ 2
Lincoln Corporation	,, 28	173	+ 62	22	3 111	+ 1
Liverpool Corporation	,, 28	14,082	+ 1035	34½	456,304	+ 1
Llandudno&ColwynBayR	..	..	..	..	..	..
London County Council	,, 18	46,442	+ 2,739	30	858,379	— 28,0
Longford Corporation	,, 28	149	— 111	17⅜	8,415	— 1,4
Maidstone Corporation	,, 28	242	+ 18	21	4,848	—
Manchester Corporation	..	..	..	..	..	..
Nelson Corporation	,, 28	141	+ 2	21	4,251	—
Newcastle-on-Tyne Corpn	,, 28	6,666	+ 1,284	22½	136,448	+ 20,2
Newport (Mon.) Corpn.	,, 21	859	+ 89	21	17,564	—
Northampton Corporation	,, 27	768	+ 94	21½	16,519	+ 3,4
Nottingham Corporation	,, 27	3,949	+ 603	21	80,679	+ 4,1
Oldham Corporation	,, 27	2,510	+ 206	23	53,110	+
Portsmouth Corporation	..	..	..	..	..	..
Preston Corporation	,, 28	928	+ 95	21**	20,467	+
Reading	..	..	..	..	..	..
Rotherham Corporation	,, 25	1,259	+ 209	22	24,323	+ 2,2
Salford Corporation	,, 30	5,319	+ 624	22½	115,161	+ 1
Sheffield Corporation	,, 27	9,311	+ 2,311	22½	197,823	+ 21,4
Southampton Corpn.	,, 27	1,779	+ 375	21	32,093	+ 1,7
Southend Corporation	,, 27	1,288	— 180	21	19,743	— 6,7
South Shields	..	..	..	..	..	..
Stlybridge,Hyde,&c.,Jt. B.	..	..	..	..	..	..
Sunderland Corporation	,, 27	1,622	+ 148	22	33,147	— 1,1
Sunderland District	,, 28	662	+ 142	43	24,413	—
Swindon Corporation	,, 28	202	+ 31	21	4,293	+
Tynemouth Tram Co.	,, 28	678	+ 144	7	4,747	+
Wallasey Corporation	,, 28	1,536	+ 139	19	29,412	—
Walthamstow Corporation	,, 28	838	+ 240	35	25,168	— 3
Wednesbury Corporation	,, 28	1 186	+ 344	22	21,251	—
Warrington Corporation	,, 28	455	+ 33	21	9 660	+
West Ham Corporation	,, 28	3,737	+ 449	21	67,825	+
Wigan Corporation	,, 26	1,578	+ 142	21	32,371	+
Wolverhampton Corpn.	,, 28	1,155	+ 183	21	23,704	+
Yorkshire W.R. Trams	,, 28	1,736	+ 314	35	59,276	+ 4

(a) These comparisons are with the corresponding period last year. * Partly electric † Includes omnibuses, &c. ‡ Minus 2 days. ‖ Minus 3 days ¶ Plus 3 days ¶ Plus 2 days. ** Compared with one week more last year

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NOTES.

The British Association Meeting.

THE meeting of the British Association this year, notwithstanding the accessibility of Manchester as a centre, is comparatively small, the membership being only 1,350. Moreover, the usual attractions are much curtailed. It is not unnatural that the shadow of the war, the greatest catastrophe within the memory of living man, should be distinctly felt at such a meeting of the British Association. This is noticeable particularly in the address of the President and in the addresses of the Chairmen of the Sections; thus in that stress is laid by the President, Prof. A. SCHUSTER, on the value of organisation and on the view that the effectiveness of organisation is largely a matter of discipline. The same note is struck by Dr. H. S. HELE-SHAW in his address to Section G. The latter points out that our national system is at fault and that we should seek to implant in the minds of young and old those ideas of discipline and service to the State, the lack of which so seriously threatens the organisation of our industrial life. Leaving, however, this national question on one side we find some other interesting topics raised in Prof. SCHUSTER'S address. One of these is the question whether minds are essentially different in different walks of life. Is, for example, the mind of the mathematician essentially different from that of the successful artist or of the successful business man? Although most of us would say that the mathematician must possess particular and uncommon faculties, yet POINCARÉ came to the conclusion that mathematics merely require a special type of memory. Similarly, he expresses the view that invention consists in selecting, and in only taking into account, those combinations which are likely to be useful.

PROBABLY many of us will feel disinclined to put the matter so simply as it appealed to POINCARÉ. Nevertheless there is no doubt much truth in the view that invention consists largely in the selection of suitable combinations for detailed study, and we are in agreement with Prof. SCHUSTER in his statement that when a new fact or generalisation is announced there are always many who claim to have had, and perhaps vaguely expressed, the same idea. They put it down to bad luck that they have not pursued it, but in reality they have failed to perceive its value and thus have shown their incapacity as inventors. Prof. SCHUSTER objects strongly to the way in which artificial barriers are erected between different groups of industries with the idea that special gifts are associated with different occupations. He, therefore, sees little use in clamouring for affairs to be managed by men in one particular line or another, because such clamouring generally arises through contrasting the strongest men in one line with the weakest in another. We think it will be generally agreed that no one particular line is desirable, but that combination is the ideal, particularly between theory and practice. As Prof. SCHUSTER says, the most fatal distinction that can be made is one that brings men of theory into opposition to men of practice, for both theory and practice are essential for the greatest progress.

IN his address to Section G, Dr. HELE-SHAW referred to certain points which cannot receive too much emphasis. One of these is the fact, which we do not think is sufficiently realised at the present time, that when the present war comes to an end it will certainly be followed by a commercial war of the most strenuous kind. This will be as serious to us, as a nation, as the war which is still raging, and we shall be exceedingly foolish if we are not prepared for it. It is only necessary to look at the marvellous progress made by Germany during the last half century in the arts and

manufactures to realise to some extent what we have yet to meet. German industrial and financial methods may be artificial, but they have produced remarkable results, and we can only hope to compete with German products by adopting proper organisation and by all interests combining for the common good. Turning to education, Dr. HELE-SHAW rightly remarks that a professor is very rarely endowed with both the gift of teaching and with that of original research. Not infrequently, however, it happens that a professor who is capable of carrying out valuable researches has to spend the bulk of his time in teaching and in routine work, attending innumerable committees and burdened with the general organisation of his college or university. There should be some discrimination in these matters. If a professor is a bad lecturer, as sometimes happens, and yet is capable of valuable research, he should, as Dr. HELE-SHAW suggests, be relieved of some of the work for which he is least fitted. In other words, let us try to make the most of the men we have.

Factory Lighting.

It will be remembered that in 1913 a Departmental Committee was appointed to inquire and report as to the conditions necessary for the adequate and suitable lighting of factories and workshops. The importance of the subject scarcely needs emphasising, and yet it is quite clear that there are many factories whose owners do not feel that it is worth while to have anything more than an inferior standard of illumination. There is little doubt that insufficient light is bad for the health and leads to defective eyesight, and that the output of a factory is materially diminished by insufficient illumination. In the evidence given before the Committee a case was cited in which the output was diminished 12 to 20 per cent. during the hours of artificial light, and in another factory the earnings of the workers increased 11·4 per cent. after the installation of a better system of lighting. There can really be no question that, from the commercial point of view, good illumination in factories is worth paying for. There is a difficulty, however, in drawing up satisfactory regulations on the subject. It is comparatively easy to state, for example, what is a "reasonable temperature," as vaguely required by the Factory Acts; but, when we come to illumination, what is adequate in one case may be totally inadequate in another.

AN example of this fact is found in experiments carried out at the National Physical Laboratory, in which it was found that seamstresses could work comfortably with white calico under an illumination of 1¼ foot-candles, whereas they required 4 foot-candles in working with black material. That there should be such differences is quite obvious to those who are accustomed to problems of artificial lighting, but they render it impossible to draw up any hard and fast rules of a general character. Consequently, the Committee have contented themselves, and we think quite wisely, with making general recommendations, such, for example, that the illumination on a horizontal plane at floor level in [illegible] should be not less than 0·2 foot-candle. [illegible] quite new enough, but it is pointed out that it is necessary to deal with minima rather than with average practice. No great attention seems to have been given to the question of glare, but presumably this will be considered at a later date when matters of detail can be decided. Nothing is said about rival systems, but probably this part of the subject was not intended for discussion. For the present, the Report marks an advance which should be appreciated by all workers in factories.

Long-Distance Cable Telephony.

THE Post Office has recently laid down a 52 pair loaded telephone cable from London to Birmingham, the special feature of which is that one of the pairs is a 300 lb. wire. The cable in question is, therefore, something of an experiment, for it has been held that loading such a cable would be comparatively useless. Events have proved, however, that the engineers are amply justified in the experiments that they have made. Last Wednesday we were privileged to carry on some conversation on this particular cable, for the purpose of which the pairs were looped together so as to make up various lengths. With a length so obtained of 663 miles, consisting of 220 miles of 300 lb. wire and 44 miles of 200 lb. wire, the speech was excellent, and no cross talk was experienced, although other wires of the cable were in use at the time. Even with a length of 854 miles speech was possible. In due course this cable is to be extended to Liverpool, as mentioned in another column where we give some further particulars. This cable is certainly an excellent advance, and Sir WILLIAM SLINGO and his staff are to be congratulated upon their progressive policy.

Marconi Wireless Telephone.—The wireless telephone that Mr. Marconi has been lately developing has been adopted by the Italian Navy, and tests are said to have been carried out by the British Admiralty.

Munition Works to be Controlled.—The number of controlled establishments under the Munitions of War Act is now 715, as 180 additional works have been brought under the Act as from September 6th by an Order issued on Sept. 4th by the Minister of Munitions.

Discovery of Radium in Colorado.—It is reported that mineral springs have been discovered in Colorado containing radium in such large quantities that a gramme of the metal will in future cost only £7,200 instead of £32,000. This is stated in a note from the French Ministry of Foreign Affairs to the Académie des Sciences.

Germany's Raw Material.—According to "The Times" Dr. Walter Rathenau, the chairman of the Allgemeine Elektricitäts-Gesellschaft, who is also the president of the Raw Materials Department of the German General Staff, has stated that all anxiety about raw materials had vanished. Germany, though shut in by the blockade, could still produce large quantities of war materials. They had escaped economic pressure as they had accustomed themselves to internal trade, while England was striving to raise funds to pay her enormous bills for her imports and foreign orders.

Voltmeters Approved by Board of Trade.—On Sept. 6 the Board of Trade approved the patterns of the Muirhead recording voltmeter, Type MR1 for testing electrical pressure supplied on constant pressure continuous current systems, provided the voltmeter be constructed as described in specification and drawings H.8.814, and in accordance with patent 702,936, deposited by Messrs. Eversheds & Vignoles. On the same date the Board also approved of the Muirhead recording voltmeter Type MR2 (specification, &c., H.8.813 and patent 62,253) for testing electrical pressure when supplied on a constant pressure alternating current system, also deposited by Messrs. Eversheds & Vignoles.

Munitions Inventions Branch.—The Invention Branch of the Ministry of Munitions, the formation of which was announced in our issue of August 13th, has now moved to new quarters at Princes-street, Storey's-gate, S.W. (formerly the premises of the Whitehall Club). The department is now in working order, and suggestions of all kinds are invited, though inventors are reminded that it is undesirable to forward ideas before they are well thought out. It is, therefore, desirable for them to find out as far as possible from the Patent Office records what has been done before in the same line. All communications are confidential, and do not prevent a patent being subsequently taken out should the inventor so desire or should the department think fit. It is stated, to remove misconceptions, that any civil or military servant of the Crown is quite at liberty to send in suggestions.

Electrification on the North-Eastern Railway.—It is stated that experiments have been commenced on the electrified section of the North Eastern Railway from Shildon to Newport, and the Company hope to open the line to traffic by the end of the month. This will constitute the first application in the British Isles of electric locomotives to heavy goods traffic, though, as is well known, this system has worked successfully in the United States and on the Continent, notably in Italy. Two small electric locomotives have, however, been in operation for 10 years from the Quayside, Newcastle, to Trafalgar Sidings, their use being due to a desire for cleaner working in the tunnel. The line now electrified was decided on for the first experiments because there are no steep gradients or any great obstacles to electrification. Also the traffic is almost entirely heavy goods, feeding the blast furnaces at Erimus Sidings, Newport, near Middlesbrough, so that the working results will be easily ascertainable. An overhead system is employed, with two bow collectors on each engine. Altogether there will be 10 locomotives, of which nine are already built at the Company's Darlington works and tested. They are eight-wheeled, with a motor driving each axle, and can each haul a load of 1,000 tons. Power from the Newcastle-on-Tyne Electric Supply Company and the Cleveland & Durham County Company will be supplied at 1,500 volts to the overhead conductors, which will be about 17½ ft. above rail level.

Current Topics.

The subjects of current interest dealt with in this issue include the following :—

Dr. P. R. Coursey contributes an article on "The Calculation and Design of Inductances" (p. 841).

We publish an article on "Technical School Research," by Dr. W. Rankit Burnie (p. 849).

We give abstracts of Prof. A. Schuster's Presidential Address to the British Association (p. 844) and Dr. H. S. Hele-Shaw's Address to Section G of the Association (p. 854).

The Committee appointed to investigate the question of the Lighting of Factories and Workshops have now issued their First Report, which contains various recommendations of a general nature on the subject (p. 850).

Our Leading Article deals with the question of "What is Power Supply ?" (p. 848).

An abstract is given of a Paper by Mr. E. H. Rayner on "Precision Resistance Measurements with Simple Apparatus" (p. 836).

We also give an abstract of a Paper on the "Third Rail and Trolley Systems of the West Jersey and Seashore Railroad," by Mr. J. V. B. Carr (p. 834).

We conclude the description of the interconnected systems serving San Francisco (p. 839).

OBITUARY.

SIDDICK HERBERT WILLIAM HIGGINS.—Another of the few remaining pioneers of telegraphy has been taken from among us. On Sept. 1 the death occurred at the age of 66 years of Mr. H. W. Higgins, M.I.E.E., whose name will ever be associated with the introduction and development of the "ticker," and who pioneered a number of successful and useful telegraphic instruments. The record of accommodating the news of the day has undergone no change since the early seventies. He was connected with the Post Office service, and subsequently went to Mauritius as superintendent of telegraphs. The original tape machine came from America, and was known as the invention of Mr. T. A. Edison. When it was first worked in this country, it printed at the rate of six words a minute. Mr. Higgins perfected the apparatus in various ways, and it can now print legibly in tape form at a speed of from 35 to 45 words a minute. Mr. Higgins' first patent in connection with this instrument, which had two wheels, one printing letters and the other figures, was No. 2,576 of 1873. In 1884 Mr. Higgins brought out his single-wire one-wheel sparkless system (Patent No. 12,215), in which there are no sparks at the relay points, and which is used very extensively in newspaper offices and clubs throughout London and the provinces for the distribution of general news and racing intelligence. Amongst Mr. Higgins' numerous other inventions were the column printer (No. 4,628 of 1880), which prints messages as legible as ordinary typewriting on broad bands of paper; the magneto instrument, with circular keyboard, designed for private use (No. 25,644 of 1896); and a call instrument, which came out before telephones in 1874, and which had four plungers for "fire," "police," "cab" and "messenger," each key giving a distinctive number which was registered on a Morse instrument. An improvement was subsequently brought out for fire alarm purposes, and was used in the streets of London by the Metropolitan Fire Brigade. This was used in the first fire alarm posts in London. Mr. Higgins also invented an apparatus to indicate the presence of fire damp, in which the heating of platinum caused the opening or closing of an electric circuit, and an improved bichromate battery, which provided the heavy current necessary for working tape instruments.

One of Mr. Higgins' most interesting inventions is the annunciator, which is in use in 15 rooms in the House of Commons, and which indicates at intervals the name of the member who is speaking in the House and the subject he is discussing. This is a most ingenious system in which electrical contacts are actuated by large metal letters and the signals are built up on the tape in the receiver in "mosaic" blocks, each one-seventh of the depth of the letters printed on the tape, the letters being about 1⅜ in. in depth.

PERSONAL.

ROYAL ENGINEERS (T.F.).—The following appointments and changes have been made :—

Tyne Electrical Engineers : Second-Lieut. C. D. Danby is seconded. Qmr. and Hon. Lieut. W. A. Souter relinquishes his position as quartermaster and becomes second lieutenant.

N. Mid. Divisional Engineers : Sapper G. L. Bronsdon (from London Electrical Engineers) to be second lieutenant.

Second-Lieutenant Leonard Francis Schuster, the son of Prof. A. Schuster, was wounded in Gallipoli on September 2nd. He was in the O.T.C. at Cambridge and afterwards in the Officers' Reserve. In 1913 he was transferred to the 1/3rd County of London Yeomanry.

APPOINTMENTS VACANT AND FILLED.

An instructor in mechanical and electrical engineering is wanted for the Wimbledon Technical Institute. Salary £150 per annum. Applications to the Principal, Gladstone-road, Wimbledon.

The University of London is about to appoint a principal officer at a salary of £2,000 a year. Names of those desirous that their names should be considered should reach the Secretary to the Senate, University of London, South Kensington, S.W., by Sept. 15.

The Kent Education Committee require a science master at the Sheerness Higher Elementary Boys' School and Technical Institute (to teach mechanical and electrical engineering, &c.). Salary £200, rising to £250. Forms of application from Mr. F. W. Crook, Sessions House, Maidstone. Applications by Sept. 17.

Mr. C. E. Crocker, manager of the Kalgoorlie (W. Australia) Power & Lighting Corpn., has been appointed manager of the Perth (W. Australia) City Council's electric lighting and gas departments.

ARRANGEMENTS FOR THE WEEK.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding : Lieut.-Col. C. B. CLAY, V.D.

The following orders have been issued for the week ending September 18, 1915 :—

Drill : 6.30 to 7.30 ; 7.30 to 8.30.

Monday : Section I., Electrical Instruction ; Section III., Musketry at Range ; Section II. and IV., Squad Drill or Signalling.

Friday : Section III., Technical Instruction ; Section IV., Musketry at Range ; Section I. and III., Squad Drill or Signalling.

THIRD RAIL AND TROLLEY SYSTEM OF THE WEST JERSEY & SEASHORE RAILROAD.*

BY J. V. B. DUER.

Summary.—This Paper recites the details and cost of construction of the contact systems as originally installed and subsequently modified and extended, including third rail, third-rail insulators, protection, joint and cross-bonding, track-bonding and trolley structure. The cost of maintaining the various contact structures for seven consecutive years, expressed per single track-mile per year, is presented.

A detailed description of the route, arrangement of tracks and electrical equipment of the electrified portion of the West Jersey & Seashore Railroad has previously been published,† therefore none of this matter will be presented here.

The original contact system consisted of the following single track mileage :—

Third rail.		*Trolley.*	
Main line	127·12 miles	Main line	18·61 miles
Sidings	4·61 miles	Sidings	00·04 miles
		Overlapping third rail	00·91 miles
Total	131·73 miles	Total	19·56 miles

Sub-stations are located approximately 10 miles apart and no third-rail feeders are used. The sub-station bus voltage is now maintained at 700. Trains of from two to seven cars are operated.

Details of Construction.

Third Rail.—The third rail throughout is of the P. R. R. standard cross-section and composition. The rails are in lengths of 33 ft.,

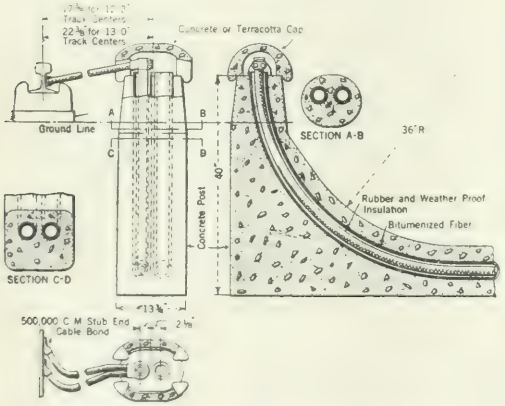


Fig. 1.—Sectional View of Third Rail Jumper.

weigh 100 lb. per yard and have a conductivity about equal to that of a copper rod 1,200,000 cir. mil. Each rail joint is bonded with two copper ribbon bonds of 500,000 cir. mil. area each, concealed under special splice bars, having solid copper terminals compressed into 1 in. holes drilled in the rail.

The third rail end approaches are made of cast-iron. In order that no special insulator need be made to support the end approach, the bottom of which is of different shape than the bottom of the rail, a special clamp and block is designed to fit the regular insulator and to centre and hold the end approach thereto. The side approach, used at cross-overs, consists of a plank mounted at an angle on the side of the rail.

At [illegible] crossing, and other places where the continuity of the third rail is interrupted, each rail is joined electrically by a cable jumper of 1,000,000 cir. mil. area as shown in Fig. 1. The cable is drawn into a black bituminised fibre tube, which is laid in a solid [illegible] the ends of the cable being connected to the rail by [illegible] each of 500,000 cir. mil. area. A [illegible] the cable terminals.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

† "Electrical Operation of the West Jersey & Seashore Railroad," by E. P. Wood. Trans. A.I.E.E., Vol. XXX., 1911, p. 1371.

Insulators.—The third-rail insulators used are of reconstructed granite or porcelain, most of which are of the design shown in Fig. 2. They are held in position by a metal centreing cup which is secured in the tie by means of a lag screw. The rail rests on the insulator and is not fastened in any way, the arrangement preventing strain on the insulators when the ties are depressed due to a passing train. The insulators are placed on ties 9 ft. 4 in. long, spaced approximately 8 ft., or every fourth tie. A new design of insulator has recently been adopted because the method of supporting the top protection boards has been changed. This insulator permits of placing the protection support on the longitudinal centre line of the tie.

Protection.—Originally the third rail was equipped with protection only at stations, 75 ft. on either side of road crossings and in terminal yards, and the construction was as shown in Fig. 3. The bottom

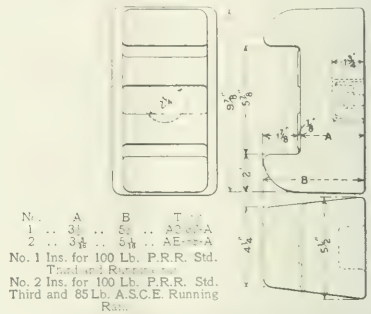


Fig. 2.—Third Rail Insulator—Original Design.

casting is attached to the rail by a hook bolt, which supports the whole protection structure. A maple post, attached to the bottom casting by a bolt, supports the top casting to which are bolted the ends of adjacent top protection boards of 2 in. plank which average 7 ft. in length, this distance, therefore, being the spacing of protection supports at stations. At end approaches the top protection board extends slightly beyond the last support, therefore the top casting here is modified by eliminating a part of the vertical web. The bottom casting is also modified to fit the end approach casting.

Opposite all station platforms, the rail is further protected by a plank fastened to the side of the rail. In most instances the third rail is located on the side of the track farthest from the station pla

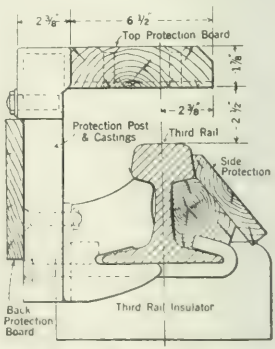


Fig. 3.—Third Rail Protection—Cross-section.

form. To prevent persons on the platform from coming in contact with the contact shoes on the platform side of the car, there is a protection board mounted flush with the platform and supported on castings fastened to the ties.

During the early part of 1912, top protection was added to the unprotected rail. Instead of using the old form of attachment to the rail itself, the board is supported by wrought iron brackets attached to the long ties carrying the insulators, as shown in Fig. 2. Adjacent boards are joined together by means of a wrought iron plate. The wood used in the original protection was not treated in any way but was given several coats of paint after installation; the wood used in this latter installation was given two coats of hot creosote

Trolley Wire.—Originally, a trolley wire of span type construction was used instead of third rail between Newfield and Millville, 10 single track-miles, and between South Gloucester and Haddon-avenue, Camden, 9·56 single track-miles, on account of these districts being thickly settled and the tracks at grade, but in March, 1910, the trolley wire on the Millville branch was replaced by third rail of the same construction as that of the rest of the road. The trolley wire is No. 4/0 grooved section, supported by ¼ in. galvanised steel stranded span wires at a height of 22 ft. above track rails. The supporting poles are mostly of wood and are spaced at a distance of 100 ft. Through Camden, tubular steel poles are used and, wherever practicable, the high-tension transmission poles are used as supports. There are two 750,000 cir. mil. feeders between South Camden sub-station and Haddon-avenue, Camden, and one 500,000 cir. mil. feeder between South Camden sub-station and South Gloucester. The feeder formerly used between Newfield and Millville was 750,000 cir. mil. area. Multi-gap lightning arresters are installed approximately 1,000 ft. apart. All pull-offs, strain ears, feeder ears and splicing sleeves are of bronze and of standard pattern.

Track Bonding.—The track rail joints are bonded similarly to those of the third rail except that two bonds of 400,000 cir. mil. area each are used. Bonds composed of 40 copper ribbons, $\frac{7}{16}$ in. by 0·0225 in. were originally used, but experience showed that the ribbons were too readily broken close to the terminals due to the vibration of the joints, therefore stranded wire bonds of the same total area are now used with greater success. The original bonding was done without interruption to traffic and all holes were drilled by hand, one splice bar being kept in position to provide for the safe passage of trains.

Third Rail Cross-bonding.—Opposite each sub-station a wood insulating block is inserted in the third rail of each track, thus sectionalising the third rail at these points. Originally the third rails of all tracks were electrically connected together midway between sub-stations through fused sectionalising switches, normally kept to obtain the combined conductivity of all rails, so

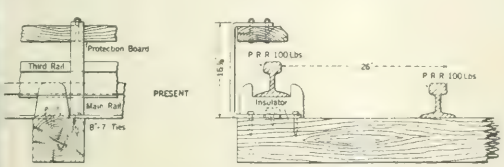


Fig. 4.—General Arrangement of Protection Added in 1912.

arranged that any of the four sections could be disconnected from the rest of the system in the event of trouble or heavy repairs. So little trouble with the third rail has been experienced, however, that there was no advantage attached to the sectionalising feature and the switches were therefore removed and the third rails were permanently bonded together at this point and at two other points between most of the sub-stations to obtain greater conductivity. In terminal yards where there is more likelihood of third rail trouble, the rails of the various tracks are fed through fuses and sectionalising switches, so that if trouble develops on one track, that section of the third can be isolated from the rest.

Cost of Construction.—The original cost of construction is shown in Table I.

Table I.

	Miles.	Total cost.	Per mile.
Third rail, including rail, bonding, insulators, protection, &c.	131·73	$557,636·00	$4,235·00
All the copper bonding, track jumpers, and material, lightning arresters, &c.	19·56	80,500·00	4,120·00
Track bonding	151·29	102,659·00	678·50

Operation and Maintenance Experience.

Shortly after the third rail was placed in service it began to creep in the direction of traffic, with attendant tightening and straining of the copper jumpers around bonds and bonding of insulators. The insulators were broken off on curves by the buckling of the rail and on tangent track by the strain imposed upon them when the creeping rail stopped. The bonds attached to the rail were brought against the trunk or rail creepage occurred. To overcome the difficulty the third rail was bonded to the ties at intervals of from 1,000 ft. to 1,500 ft. and the practice of periodically loosening the splice bars and oiling the joints was established. This eliminated the creepage but the anchors frequently gave trouble by breaking down in insulation, causing delays to traffic, when it was found that the loosening and oiling of the joints in itself gave satisfactory results and all the anchors were removed. The joints are now oiled by the patrolmen every spring and fall. The protection added in 1912 was held by supports attached to the ties, as previously explained, thus holding it stationary and independent of the movement of the rail.

Although sleet-cutting shoes were used on the cars during all seasons when sleet was likely to form, with the provision of an extra-tension device for applying a tension on the shoe of from 90 lb. to 100 lb., considerable trouble was occasioned by sleet, resulting in numerous delays to traffic. Cars specially fitted with calcium chloride tanks, with means for heating same and distributing on the rail while hot, are hauled over the road by steam locomotives when sleet begins to form and this minimises trouble as much as practicable. The addition of the top protection to the rail overcomes sleet formation in a great many cases but is of little use in this respect when a driving wind accompanies sleet-forming weather, in which event the chloride cars are used as formerly.

The trolley wire is given rigid and frequent inspection to locate defects before failures occur. The maintenance cost is about six times that of the third rail, as may be seen by reference to the Table under the heading "Maintenance costs."

Third-rail bonds require practically no attention as tests indicate little change in their resistance. Road crossing jumpers gradually deteriorate and occasionally develop defective insulation and burn out. Due to the vibration of the track rails at joints, the track bonds require testing and partial renewal every six months. Any joint showing a resistance equivalent to 8 ft. of rail or over is marked for rebonding. The following Table shows the results of a number of track bond tests :—

Date.	Joints tested.	Joints defective.	Per cent. defective.
October, 1909.....	46,633	716	1·53
May, 1910.....	46,633	378	0·81
October, 1910.....	46,633	381	0·82

The testing is done by three men working together, and between 5,000 and 6,000 joints can be tested in 10 hours.

Maintenance Costs.—The cost of maintaining trolley, third rail and track bonding systems for the past seven years is given in Table II. The maintenance cost of each system includes the amounts directly chargeable to that system and a pro rata charge for general expenses as follows: Superintendence; maintenance, labour and material; tools and supplies; proportion of expense of purchasing department; telephone operation; stationery and printing; tower car service for trolley; operation of chloride cars for third rail; and bond testing for track bonding. Credit is applied for all scrap

Table II.—*Maintenance Cost per Single Track-mile per Year.*

Year.	Trolley.	Third rail.	Track bonding.
1908.....	$424·25	$53·52	$15·74
1909.....	391·81	71·23	21·18
1910.....	510·44	76·65	15·28
1911.....	376·05	111·99	17·46
1912.....	642·44	99·10	21·47
1913.....	636·10	86·16	14·95
1914.....	450·67	73·54	44·82
Average.....	$490·25	$81·74	$25·84
Percent of investment per mile	14·90	1·93	3·77

Table III.—*Train Detentions Chargeable to Contact Systems.*

Year 1909.

Single-track miles of third rail, 131·73; single track-miles of trolley, 19·56.

	Number detentions.	
	Total	Percent of total for all causes.
Third-rail feed cut out	3	0·032
Third-rail out of place	1	0·011
Third-rail protection out of place	1	0·011
Third-rail protection out of place.....	1	0·011
Sleet on third rail	47	0·510
Trolley wire trouble	253	2·742

Year 1912.

Single track miles of third rail, 141·73; single track miles of trolley, 9·56.

Third-rail short-circuits	14	0·189
Third-rail out of place	1	0·014
Third-rail protection out of place	1	0·014
Sleet on third rail	43	0·581
Trolley wire trouble	48	0·649

material of value. The average maintenance cost per mile per year is also expressed in per cent. of the construction cost per mile.

Train Detentions Chargeable to Contact Systems. Summary reports showing train detentions for all causes are not regularly prepared; such reports for the years 1909 and 1912, however, are available. Some of the figures are given in Table III. Sleet troubles vary considerably during different years, and all detentions due to this cause may occur on one day. The detentions chargeable to the trolley wire are frequent and more or less regular. Figures are given of track resistance.

PRECISION RESISTANCE MEASUREMENTS WITH SIMPLE APPARATUS.*

BY E. H. RAYNER.

Summary. The object of this Paper is to give hints as to the comparison of resistances to a higher degree of accuracy than is usually attempted. Among other points that are raised, it is suggested that the accurate determination of the temperature coefficient of alloys might form a sensitive test and one quickly carried out, of the chemical and physical similarity of such alloys. In the present Paper the use of bridge methods only is discussed, as potentiometer tests require great steadiness of current.

Many electrical indicating instruments can be read to a 1 part in 1,000, and this indirectly fixes the lower limit of accuracy of resistances which can be of any practical use. A resistance box with errors of 1 part in 1,000 would, in fact, be a continual trouble, and a few parts in 10,000 may be regarded as a reasonable limit for Wheatstone bridge and similar resistances, and 1 or 2 parts in 10,000 for standard resistances. Precision measurements may be conveniently defined as those in which an accuracy of 1 part in 10,000 or more is attained.

The measurements described in this Paper attain the accuracy of 1 in 10,000 for practically every case, and in favourable conditions 1 in 1,000,000, or more. The ordinary Wheatstone bridge with plug contacts is not suitable for measurements of this nature, as it does not allow of a sufficiently continuous variation in resistance. If further accuracy is attempted in the usual manner by increasing the ratio between the bridge arms the arrangement becomes insensitive. As an adjunct to a number of other resistances, it, or some similar resistance variable by 0·1 ohm up to 10,000 ohms, will be essential.

In measurements of this nature it is much easier to follow the methods adopted and accuracy attainable if numerical examples are given, and the results of experimental measurements are reproduced for this purpose. These have all been made with a Broca galvanometer of 10 ohms resistance. One of 100 ohms would have been more suitable for practically every experiment quoted, and for many one of 1,000 ohms, so that considerable advantage can be obtained in this respect by choice of one of a more suitable resistance. Still, the Paper shows what can be done when somewhat handicapped in this way. Nature has kindly allowed, when using a galvanometer of resistance R on a Wheatstone bridge instead of one of the most suitable resistance nR, that the sensitivity obtained is only reduced to $1/\sqrt{n}$. It might have been unkindly reduced to $1/n^2$.

For satisfactory work a voltmeter or ammeter to measure the main current is essential. In all measurements the galvanometer circuit should be kept closed, and the current to the bridge reversed, and, for quick working, resistances should be non-inductively wound. If reversing gives a large kick due to inductivity, the galvanometer circuit may be opened momentarily to reduce the effect. It is necessary that the galvanometer should not be affected electrostatically, and arrangements may be necessary to prevent this trouble. If the galvanometer is of the moving coil type it may be [illegible] of the instrument, and if necessary to insulate the whole instrument separately if it has not insulating feet.

If the galvanometer is of the moving magnet type it is desirable [illegible] similar manner. This necessitates silvering the suspension if of [illegible] separately if it has not insulating feet.

* A Paper read before the Physical Society.

altered, and unless the moving part can also attain the new potential at the same instant, or be screened from it, electrostatic forces will come into play, causing a false deflection of the instrument.

It is seldom that resistance measurements of precision are required, except between resistances of simple numerical ratio, and such measurements may be divided into the comparison of nominally equal resistances, and of resistances whose ratio is represented by some simple numerical fraction.

Case I.—Comparison of Nearly Equal Resistances.

This measurement shares with the comparison of nearly equal weights and lengths the position of being capable of being carried out with the highest accuracy attainable in any physical measurement. Differences of 1 part in a million may generally be easily detected between resistances if not less than 1 ohm. It is essential for satisfactory work that they should be capable of carrying a reasonable current.

Comparison by Interchanging in Two Adjacent Arms of a Wheatstone Bridge.

The two resistances are made part of a Wheatstone bridge, A, B the other two sides, P, Q, being nearly equal resistances, which may or may not be of the same nominal value as A and B. In the latter case A and B should be in series as regards the supply current, as this allows of the largest current passing through the bridge, and is therefore, the most sensitive arrangement, and it is also the most convenient. Balance is obtained by shunting one of the resistances with a relatively high resistance. If the bridge is nearly balanced without a shunt, a very high shunting resistance, perhaps a hundred thousand or a million ohms, will be required which is very seldom obtainable. This difficulty can be got over by shunting one of the other arms, say, Q, by any convenient resistance Q′, whose value is not required to be accurately known, so that the required shunt on

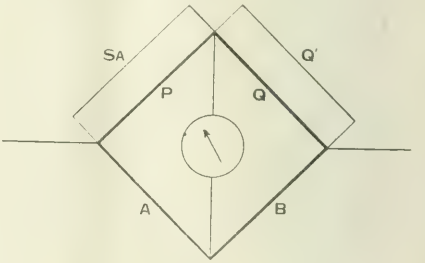


Fig. 1.

P is of convenient dimensions. It has the advantage that the variable resistance is always connected to the same part of the bridge which conduces to the ease and quickness of working. Thus, suppose that S_A is the shunting resistance required in parallel with A when A is connected to P, and S_B the shunting resistance when B is next to P.

If P/S_B and P/S_A are small compared with unity, the author shows that $A/B = 1 + \frac{1}{2}P(1/S_B - 1/S_A)$. An example will make the accuracy obtainable more easily appreciated. Thus P=Q=50 ohms, Q being shunted by a fixed resistance Q′ of about 9,000 ohms.

A = B = 20 ohms. S_A = 8,572 ohms. S_B = 8,493 ohms.

$A/B = 1 + 25 \cdot 0{\cdot}000{,}001{,}08 = 1 \cdot 0{\cdot}000{,}027$.

Thus it will be seen that a difference of 80 ohms in the value of the two shunting resistances corresponds to a difference of 27 parts in a million in the ratio A/B, and as this difference may often be observable to 0·2 or 0·3 of an ohm, the ratio of A to B may be determined to a few parts in ten millions when A and B are nearly equal. It will be noted that absolute accuracy in P or in S_A and S_B is not required, only that the difference between S_A and S_B should not be seriously in error.

The author then deals with the effect of the connecting leads.

The author has used resistances of 50 ohms for such measurements, each wound on open frames. Each resistance was composed of two circuits of 100 ohms each of No. 24 constantan wire, forming a non-inductive arrangement when the two are used in parallel. They are made so that 100 volts can be put on the frame to give 2 amperes, and are regularly used in connection with an accurate electrostatic voltmeter for measuring small alternating currents, a number of frames being put in series or parallel as required. The design is due to Mr. Campbell, and affords the most accurate method of measuring alternating currents of the order 0·001 ampere to 20 amperes.

It is not necessary to shunt the whole of one of the arms of the bridge by the variable resistance. It is often more convenient and accurate with the resistances available to shunt only a fraction.

The change of resistance with increasing current of one of the (50 ohms) frames capable of carrying 2 amperes, was determined in this manner. The wire for these resistances was specially selected for having a very small temperature coefficient. A bridge was made up of one of these frames as one arm and nine others (three in series, three in parallel), so as to be equal in resistance in the adjacent arm, it being assumed that the heating in these being so much less would be negligible. The single resistance and the combination of nine were connected in series to a source of supply, so that somewhat over 200 volts could be applied. The other two arms were each of 10 resistances of 1,000 ohms (usable up to 1,000 volts). These resistances, high compared with the galvanometer resistance (10 ohms), rendered the arrangement insensitive at small currents, but the resistance of zero current can be calculated with good accuracy, as will be shown. One-tenth of the resistance Q (1,000 ohms) was shunted by a fixed resistance of about 5,000 ohms, and balance obtained by shunting a similar section of P by a variable resistance of about the same value. The value of this resistance and the calculation of the relative resistance of P, and, therefore, of A at different currents, is shown in the following table :—

Current.	R.	P.	δP.	Current$^{2\cdot6}$.	δP ÷ C$^{2\cdot6}$.
Ampere.					
0·98	5049·0	9834·68	...	0·95	...
1·41	5033·6	9834·26	−0·42	2·44	0·292
1·74	5016·0	9833·78	−0·90	4·22	0·281
1·98	4997·2	9833·26	−1·42	5·93	0·289
2·19	4978·0	9832·78	−1·90	7·68	0·285

The resistance P is the nominal value of the arm P as shunted,

$$P = 9{,}000 + 1 \div \left(\frac{1}{1{,}000} + \frac{1}{R}\right).$$

P is the change in P from its value at 0·98 ampere, and is practically equivalent to parts in 10,000. From these values (assuming

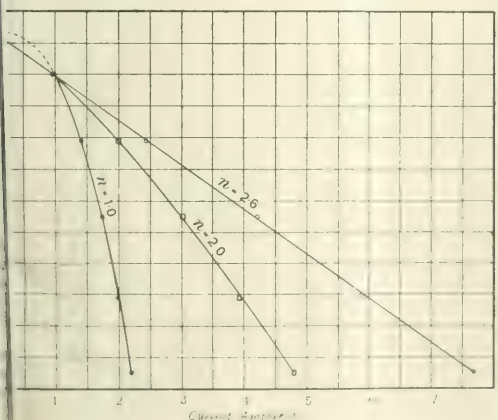


FIG. 2.

bridge to be too insensitive for accurate results below 1 ampere) it is impossible to determine accurately what would be the value of δP at zero current by plotting δP against current ($n = 1$) Fig. 2. It is much better to plot δP against the square of the current, which is nearly proportional to the temperature rise ($n = 2$). This gives a line with some curvature in it. By trial it will be found that plotting δP against current$^{2\cdot6}$ ($n = 2{\cdot}6$), a curve indistinguishable from a straight line results, leading to a value for δP at zero current of −0·28. For 2 amperes δP = −1·47, so that the total diminution in resistance = 1·75 in 9,800, or practically 1·8 parts in 10,000 between the readings measured at 2 amperes (100 volts) and that at a very small current.

Measurement of Equal Resistances by Substitution.—A very convenient method for the rapid comparison of a number of nearly equal resistances is to make up a Wheatstone bridge with one of them in each of the arms, and so adjust the remaining resistance [illegible] Plugs. The unbalancing of the bridge by changing one of the arms by a high resistance. The other three resistances may be specially wound ones, and be roughly proportional to a board with all joints soldered as far as possible. When adjusting a number of resistances to equality using this method, it is convenient to make up the bridge out of lengths of the same wire, which will avoid temperature changes. The choice of dimensions of the resistances will depend on that of the resistances to be measured and the galvanometer resistance, enabling the conditions of maximum sensitivity to be obtained when desired. For work of the highest precision with standard resistances with heavy copper terminals, mercury cups, &c., the method is inferior in accuracy to the comparison of two resistances by interchanging, but for many practical purposes it is more convenient, as the resistance of the connecting leads is eliminated, and there is more latitude in the choice of the resistances of the other three arms of the bridge.

CASE II.—THE COMPARISON OF RESISTANCES OF DIFFERENT MAGNITUDES.

Comparisons of this nature vary much, and only general principles can be suggested. To obtain a ratio of, say, 1 to 10, 10 resistances of the smaller value are put in series, each being capable of direct comparison with the standard. In this way a 10-ohm may be "built up" and compared directly with a 1-ohm resistance, and 100 ohms from 10 resistances of 10 ohms and so on. Or 100 ohms may be verified by making up a bridge with ratios of 10 to 1, consisting of 1 and 10 ohms on one side, against 10 and 100. In cases of build-up arrangements the resistance of end connections is the most likely source of error, and thick copper should be used for resistances of less than 1,000 ohms.

Verification of a Potential Divider.—An instructive example in the measurement of comparatively high resistances is that of a potential divider commonly used in conjunction with a potentiometer to measure 100 or 200 volts. A high resistance is connected across the supply voltage to be measured, and exactly 1 per cent. (or 0·5 per cent.) is tapped off and applied to the potentiometer. A voltage of

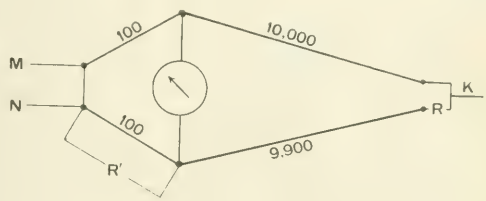


FIG. 3.

1·0 or 1·5 per 100 ohms is commonly used, so that for 100 or 150 volts the whole resistance will be 10,000 ohms, with a tapping at 100 ohms for the potentiometer. If standard resistances of 10,000 ohms and 100 ohms are available, the potential divider may be easily verified, provided the resistance of the internal connections can be neglected; but for precision work this is not sufficient. After being on the circuit for a short time it will be found that the effect of the heating is appreciable. If the whole box changed in resistance homogeneously on this account it would not matter, but the 100-ohm section is often made of thicker wire for ease of adjustment, and even if this is not the case it may remain cooler than the rest, as it is practically always near one end of the resistance box. It is, therefore, desirable that the ratio of the two parts of the resistance, nominally 1 : 99, should be determined at the working voltage. To do this we may take advantage of the useful theorem that the value of n nearly equal resistances connected in series is n^2 times their resistance in parallel to a very high order of accuracy. For instance, suppose half of them are as much as 1 in 1,000 high, and the other half 1 in 1,000 low, the n^2 law holds to one part in a million.

Suppose, then, we have 10 resistances of 1,000 ohms, which can be put in series or parallel, and also a resistance of 100 ohms, the 10 of 1,000 ohms in parallel can be compared with the 100-ohm resistance by inversion with very high accuracy. By putting the 1,000-ohm resistances in series, we now have two resistances of a nominal ratio of 100 : 10,000. It is assumed that these resistances are sufficiently liberally designed so as to be unaffected when 100 volts or more is applied to them in series. The volt box ratio to be proved is nominally 100 : 9,900, which may be converted for the purposes of measurement into 100 : 10,000 by two methods. The [illegible] to add a variable resistance of about 100 ohms to the 9,900, or [illegible] up to 10,000 and the other across the 100-ohm section of the volt box with a variable resistance of about 10,000. The [illegible] the more delicate method as 100 ohms change in the resistance comparable to 1 ohm in the first method. In the second method 10,000 ohms [illegible] the 100 ohm section of the volt box reduce the current

in it by 1 per cent. The effect of this is neglected. Instead of resistances of 100 and 10×1,000 ohms, other convenient resistances of the same ratio can be used. It is possible that the actual resistances of the volt box sections will differ from their nominal value, and correction must be made for this if necessary, when using extraneous resistances in series or parallel with parts of it.

The author gives a comparison of the methods from actual measurements.

Owing to the difficulty in obtaining high continuous-current voltages it is suggested that continuous current should be superimposed on alternating currents so as to obtain tests under working conditions.

Kelvin Double Bridge.—For the comparison of unequal resistances, especially when one or both is less than 1 ohm, the Kelvin double bridge cannot be surpassed.

In the comparison of equal resistances of the order of 50 ohms it has been seen that the short piece of wire connecting A and B affects as much as the last three significant figures attainable in the ratio A : B. If it were practicable to connect the galvanometer exactly

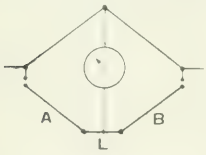


Fig. 4.

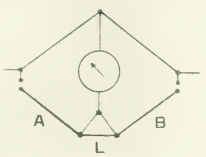


Fig. 5.

to the resistance centre of this wire, allowing for the uncertain contact resistances at the ends, then it would be unnecessary to double the number of observations which are required to eliminate its resistance (Fig. 4). The elegant method of surmounting this difficulty adopted in the Kelvin bridge is to connect the galvanometer, not to the middle point of the wire, but to the middle point of a resistance in parallel with it which is high in comparison with that of the joining wire, Fig. 5. The ends of this resistance should not be joined to the terminals through which the main current passes, but to a separate pair (the potential points of the resistance when these are provided). The resistance may be from 2 to 200 ohms, according to circumstances. In the general case where the two main resistances to be compared are not equal, this connecting resistance must be divided in the ratio of the main resistances. The resistances P, Q, are connected to the other potential points of the two resistances.

In commercial forms of the apparatus P is commonly made equal to R and Q equal to S, Fig. 6. Taking A to be a standard resistance, P and R may be of some simple value of about 20 to 100 ohms, and Q and S can be varied together from 0·1 to 1,000 ohms, and the ratio

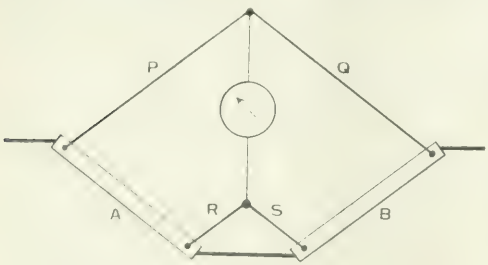


Fig. 6.

of B to A is read off at once to four figures. The sensitivity of the arrangement increases if low resistances, rather than high ones, are

in sensitivity without appreciable loss of accuracy. When measur-

remain balanced. Practically the whole voltage of the source of

As in the case of resistances of an ohm or more, precision measurements are only required as a rule between resistances having a simple nominal ratio, which enables the apparatus to be considerably simplified.

Special Form of Kelvin Bridge.—The necessity for apparatus of this nature for verifying the resistances used in precision alternating electrical measurements has led to the construction of a special Kelvin bridge for the purpose. The resistances to be verified vary from a few ohms to 0·001 ohm, and all have a simple numerical value. They are used in the current circuit when making alternating power and current measurements, and give a 2-volt drop of potential at their rated current.

The apparatus consists of two rows of resistances of 20 ohms each there being 25 in each row. One row forms the part P, Q, and the other R, S, as many of the resistances being used as required and connections are taken off the galvanometer circuit.

As the resistances of the leads connecting the apparatus to the resistances to be compared cannot be made negligibly small compared with 20 ohms, the end coils of the two rows have been adjusted to be 1 part in 1,000 low (0·05 ohm), and the leads used are adjusted to be 0·05 ohm. These end coils must, therefore, always be used and the bridge is adjusted to the correct simple ratio by short circuiting as many of the other coils as may be necessary. For convenience the two rows of 25 resistances are put in concentric circles and copper straps are used for short-circuiting the necessary coils these straps being also used for the galvanometer connections which are arranged concentrically at the centre of the circle. The arrangement has the great merit that all the resistances have th

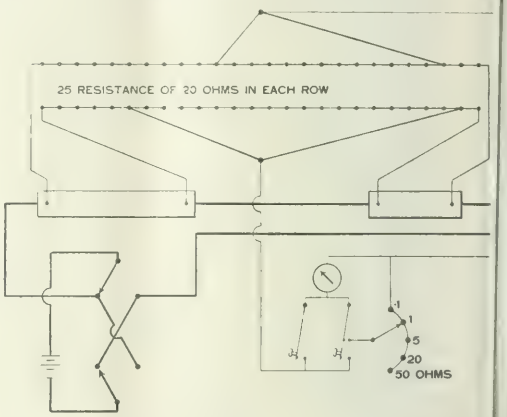


Fig. 7.

same value, and so can be adjusted to equality with high accurac The absolute accuracy is quite immaterial. Balance is obtained shunting A or B, whichever is relatively the higher.

The apparatus is capable of comparing any resistances of the rat m/n, where m and n are any integers whose sum does not exceed 2 Though it is possible to measure ratios of 24 : 1, lower ones such 10 : 1 and 5 : 1 can be somewhat more accurately measured, as th at least two coils can be used in each of P and Q, and the sum uncertainties of the resistances of the temporary connections, & become of less importance.

The arrangement shown for the galvanometer keys has been fou very satisfactory. When one key is depressed the galvanometer first of all shunted by a resistance which can be varied from 0·1 50 ohms, and further depression makes a second contact connecti the galvanometer to the circuit. When approximate balance been obtained the other key is depressed instead, which conne the galvanometer to the circuit without any shunt. It has be found much more satisfactory than the usual arrangement of a k with a resistance in circuit when half depressed which is cut out applying more pressure. A mercury cup reversing key for the ma current is provided.

In order to compare a resistance of, say, 0·001 ohm with one 1 ohm it is necessary to do so in a series of steps, using intermedi resistances of, say, 0·1 and 0·01 ohm with a ratio of 10 : 1 in bridge resistances every time. Any inequalities in the bridge re tances will cause a cumulative error in the final result, so that th should be very accurately adjusted to equality. These differen have been kept down to 2 or 3 parts in 100,000, so that in a "s down" of 3 steps the accumulated error does not exceed 1 in 10,0

INTERCONNECTED SYSTEMS SERVING SAN FRANCISCO.

(*Concluded from p.* 805.)

Great Western Power Co.

The completion of the hydro-electric station of the Great Western Power Co. on the Feather River at Big Bend above Oroville, Cal., marked the beginning of a new era in electric generation and transmission on the Pacific Coast. Prior to that time the typical Western plant received its water through a long wooden flume, and the apparatus was invariably installed in a corrugated-iron house down the canyon. The station of the Great Western Power Co. was the first in which the generating equipment was housed in a substantial structure, and from its erection to the present the station has had the distinction of being the largest single power-house on the coast. The present rating of the station is 50,000 kw. The waterwheels are of the I. P. Morris-Francis type rated at 18,500 H.P. and operating under an effective head of 435 ft. The company has a 15,000 H.P. auxiliary steam station at Oakland and a 28,000 H.P. steam station in San Francisco, so that it has generating equipment aggregating 105,000 H.P.

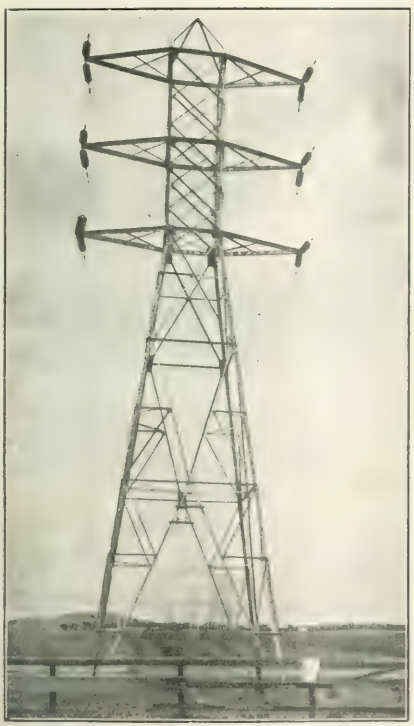


Fig. 10.—Angle Construction on 100,000 Volt Line.

The company has now completed its Big Meadows reservoir, known as Lake Almanor. This lake contains 250,000 acre ft. of water, or sufficient to assure a continuous output of 70,000 H.P. from the present station at Big Bend, even through years of most severe drought. The same stored water can be utilized at power sites known as Nos. 4 and 5 under a combined head of 2,250 ft., where it will generate 150,000 H.P. in the driest season. Power sites Nos. 2 and 3 on the same watercourse will afford 90,000 additional horse-power. It is the intention to increase the height of the present Big Meadows dam so that it will ultimately impound 1,250,000 acre ft. of water. The company has 13 sub-stations, and the transmission system consists of 154 miles of steel-tower line on which are two three-phase circuits operating at 100,000 volts and extending from the Big Bend station to Oakland by way of the Sacramento Valley. A view of an angle tower on this line is given in Fig. 10. There are 21 miles of submarine cable operating at 11,000 volts, connecting the San Francisco steam station with the hydro-electric station and the Oakland steam station. The Oakland steam station is seldom operated. Views of various parts of the system are reproduced herewith.

Sierra & San Francisco Power Co.

The Sierra & San Francisco Power Co. has its principal hydro-electric generating station at Stanislaus, where there is an installation of 34,000 kw., which, with forced ventilation, is capable of developing 50,000 kw., although the full development will necessitate an additional penstock. The company owns also generating plants at Phœnix, near Sonora, and at Oakdale. In addition the company possesses a steam plant at North Beach, San Francisco, containing turbo-generators with an aggregate rating of 18,000 kw. Table III. gives further details of these stations.

Table III.—*Main Generators of the Sierra & San Francisco Power Co.*

Station.	No.	Voltage	K.v.a. (each)	Method of ventilating.	K.v.a. (total)
Stanislaus (hydraulic)	4	4,000	8,500	2 separate fans rated at 60,000 cubic ft. each	34,000
Phœnix (hydraulic)	1	2,400	750	.....	1,875
	3	2,400	375		
Knights Ferry (hydraulic)	2	500	750	.....	1,500
North Beach (steam)	2	12,000	9,000	Suction system	18,000

Water for the Stanislaus hydro-electric plant is taken from the middle fork of the Stanislaus River at a point called Sandbar and carried through approximately 78,000 ft. of wooden flume to the forebay, whence it is dropped through steel penstocks approximately 1,500 ft. to the station. Under its water rights the company collects

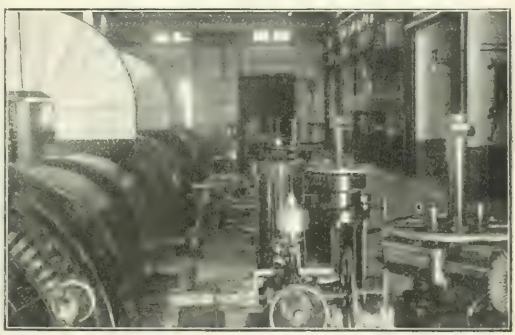


Fig. 11.—Stanislaus Hydro-electric Plant.

in storage reservoirs the rainfall and melting snows from watersheds on the western slope of the Sierra Nevada mountains. These watersheds have an area of 405 sq. miles, and the storage reservoirs now constructed will hold 851,000,000 cubic ft. of water. In addition, the company has under construction a storage reservoir at Strawberry, which, when completed, will impound 762,000,000 cubic ft.

The main transmission line of the company consists of two 110,000 volt circuits carried on steel towers from the Stanislaus plant to the Bay Shore sub-station near the San Francisco city limits, a distance of 136 miles. A branch transmission line at 57,000 volts extends from Port Marion, at the south end of San Francisco Bay, to Salinas, a distance of 73 miles. The main line transmission sub-stations of the company, with ratings, are as follows: Bay Shore, 30,000 kw.; Port Marion, 6,000 kw.; Salinas, 4,000 kw.; Manteca, 4,500 kw.; Stanislaus, 2,000 kw.

At the Stanislaus power-house there are eight Pelton waterwheels, two to a generator, overhung on the same shaft, one wheel on each side of the generator. When delivering 20,000 kw. actual test showed the loss to be a little less than 5 per cent. The maximum capacity of the penstocks by test is 33,000 kw. Each of the eight supply pipes is equipped with a 20 in. Pelton gate valve, gear and worm wheel for hand operation and reversible Pelton motor for automatic operation. Each of the Pelton impulse wheels is rated at 6,000 H.P. maximum overload and was tested to 12,000 H.P. output. Oil-pressure governors actuate the nozzle deflection, and the movement of the needle for regulating the area of the opening is controlled by a hand wheel. The governors are of the Pelton type and have individual oil pumps and separate pressure and discharge tanks.

Synchronising motors and connections permit speed control from the switchboard. Fig. 11 shows some of this regulating machinery.

The electrical equipment consists of four 8,500 kw. generators (which can be raised to 10,000 kw. each by forced ventilation.) Twelve transformers step up the potential from 4,000 to 104,000 volts for delivery to two main transmission lines to Bay Shore sub-station. The transformers are connected "Y," with grounded neutral.

The 104,000 volt transmission line is 138 miles long. It extends from the power-house on the Stanislaus River in the Sierra Nevada mountains straight across the San Joaquin Valley, around San Francisco Bay and up the peninsular to Bay Shore sub-station, passing over mountains, plains, valleys and marsh lands. The line consists of a series of long tangents and is supported on towers throughout, except the 57,000 volt branch line from Port Marion to Salinas, which consists of towers, A-frames and poles. The towers spans average 850 ft., the maximum span approximating 1,925 ft. The towers are of galvanised iron, four columns, square and diagonally braced. In height they vary from 35 ft. to 50 ft. from ground to the lower cross-arm. The wire is of No. 00 copper cable, six-strand, hemp-core, and is completely transposed every 10 miles. The minimum distance between wires is 96 in. Five-element suspension insulators are used. Across the marshes at the lower end of San Francisco Bay the towers were placed on piles with concrete-cap foundations, and the spans approximate 800 ft. in length.

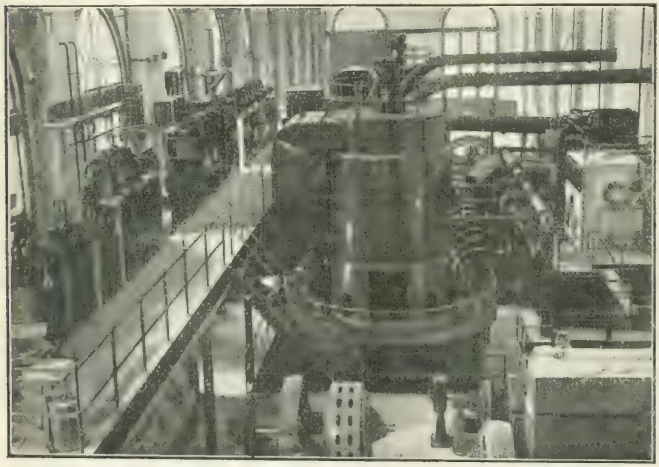


Fig. 12.—North Beach Steam Plant.

The Bay Shore sub-station contains seven 3,750 kw. standard oil filled, water-cooled, 104,000 volt, 60 cycle transformers connected grounded star on the high-tension side and delta on the low-tension side. The North Beach steam station (shown in Fig. 12) is situated on the northern side of San Francisco, and formerly contained reciprocating steam engines. The present generating equipment comprises two 9,000 kw. 12,000 volt Curtis vertical steam turbo-generators. Steam is supplied by 18 B. & W. boilers aggregating 10,300 boiler horse-power and fitted with complete oil-fuel-burning apparatus. A Worthington and a Wheeler condenser are used, water being taken from the bay. At one end of the building is a sub-station of the Pacific Gas & Electric Co., from which energy is delivered to the Panama-Pacific International Exposition, for the electrical supply of which this company has exclusive rights.

The four distributing systems are as follows: Tuolumne division, San Joaquin division, San Francisco division and Santa Clara division.

The Tuolumne division operates in the Sierra Nevada mountains, obtaining energy from three 500 kw. transformers installed in one [illegible] power house. Energy is delivered to the towns of Tuolumne, Sonora and Jamestown, and for operating all the mines of that district. The company also supplies water for mining, irrigation, domestic use, &c., in the above section.

The San Joaquin division, with headquarters at Modesto, comprises [illegible] in the fertile San Joaquin Valley between Stockton and Modesto. The division is fed by four 17,000 volt lines and two 4,000 volt lines from Modesto sub-station. One of the 17,000 volt lines is connected at Knights Ferry with the Tuolumne division, so that an exchange of energy may be made if necessary. Interchange of energy can also be made at Modesto sub-station with the Yosemite Power Co.

The San Francisco division is fed by six 12,000 volt lines going from the Bay Shore sub-station, supplying energy in conjunction with the North Beach auxiliary steam plant to four sub-stations for conversion to direct current for operating the United Railways of San Francisco and supplying a small industrial load.

The Santa Clara division is fed by the 57,000 volt line running from Port Marion southward 73·5 miles to Salinas, where the energy is delivered to the Coast Valleys Gas & Electric Co. at its Salinas sub-station. From there a 57,000 volt line (now operated at 30,000 volts) continues through the towns of Chuler, Gonzales, Soledad, Los Coches and King City. Another line of 22,000 volts goes from Salinas through Hilltown to Monterey. The load comprises domestic, railway and municipal service and a heavy irrigation load.

Northern California Power Co.

The hydro-electric developments of the Northern California Power Co. are situated on Battle Creek and Old Cow Creek. The principal source of water supply is the western slope of Mount Lassen, for many years a snow-capped peak but at present an active volcano, belching forth lava and gases. The company operates seven hydro-electric plants with a combined rating of 50,000 H.P. and also some waterworks and gas works. It supplies light to all important towns in Shasta, Tehama and Glenn Counties, Cal., and has a contract expiring December, 1925, to deliver 10,667 H.P. to the Pacific Gas & Electric Co. at Chico, Cal., where connection is made with that company's lines. The location of six of the stations, as well as the power of the generators and other data, are given in Table IV. The seventh at Snow Creek is a small one of 1,500 H.P.

Energy is transmitted at 22,000 volts and at 66,000 volts. The first type of transmission line follows closely the practice of 15 years ago, solid copper wire being run on 30 ft. wooden poles and insulated by triple petticoat glass insulators. The higher voltage lines are mounted on wooden poles with porcelain insulators. Except for a few places near towns, roads are not followed by the transmission lines.

The sub-stations on the company's system are situated chiefly in the upper Sacramento Valley. At Chico the system of the Northern California Power Co. is tied in with the system of the Pacific Gas & Electric Co., the sub-station containing merely the necessary line switches and instruments for measuring the energy. The company also sells a block of power to the Oro Electric Corporation. Recently the action of the Government in shutting down a number of copper smelters because the fumes destroyed vegetation has deprived the Northern California Co. of a considerable portion of its mining load. This loss was further accentuated when the European war broke out and copper producers curtailed production. Some of the companies connected with the Northern California Power Co.'s circuits suspended operations entirely.

Other Interconnected Systems.

The Western States Gas & Electric Co. furnishes gas and electric service in the city of Stockton, and electric service in Richmond and Placerville, Cal. Electric service is furnished to Stockton and the towns of Gault, Lodi, Floran and Placerville, together with the contiguous territory, by means of duplicate 60,000 volt transmission lines from the company's hydro-electric station on the south fork of the American river near Placerville, supplemented by a steam station situated in Stockton. In the territory around Stockton gold dredging operations are carried on, and the rich agricultural district are irrigated by motor-driven pumps. The company also purchase

Table IV. *Main Generators of the Northern California Power Co.*

Station.	No.	Voltage	K.v.a. (each)	Method of ventilating.	K.v.a. (total)
South	1	6,600	4,000	.....	4,000
Volta	3	500	750	Vacuum from tailrace draws heated air from generators	6,250
	1	2,200	2,000		
	1	2,200	2,000		
Kilare	2	2,200	1,500	.....	3,000
South Cow Creek	2	2,300	750	.....	1,500
Inskip	1	6,600	4,000	7,000 c. ft. belt drvn. exhaust fan in 20 m. draft tube	6,000
	1	6,600	2,000		
Coleman	3	6,600	5,000	Fans each end of rotors	15,000

electrical energy from the Pacific Gas & Electric Co., the Great Western Power Co. and the Sierra & San Francisco Power Co. The hydro-electric station on the American river contains two 1,500 kw. units driven by two 3,000 H.P. impulse wheels. The Stockton steam plant contains a 1,500 kw. vertical turbo-generator and three oil-burning water-tube boilers.

The Snow Mountain Water & Power Co. operates a high-head electrical plant in Potter Valley, 17 miles from Ukiah. The station contains three 2,300 volt three-phase, 60 cycle generators with an aggregate rating of 6,000 kw. The voltage is stepped up to 50,000 volts for transmission. The company sells most of its energy in

lk to the Pacific Gas & Electric Co. at Santa Rosa, 75 miles from generating station, and to other utilities in that section of the te.

The Oro Electric Corporation owns undeveloped power properties Deer Creek and Mill Creek, in Tehama County, and on Yellow ek and adjacent streams in Plumas County, Cal., from which eams approximately 130,000 H.P. may be developed. It also owns o hydro-electric generating plants on the west branch of the ther River and the transmission system and sub-stations for the of Oroville and vicinity. It started suspended work on a 000 H.P. hydro-electric plant on Yellow Creek, Plumas County, year and erected a steam relay plant at Stockton.

THE CALCULATION AND DESIGN OF INDUCTANCES.

BY PHILIP R. COURSEY, B.SC.

Summary.—The author gives curves for facilitating the calculation of coils such as are required in radio-telegraphy, thus avoiding lengthy calculations.

Many formulæ have been given from time to time for calculating the inductance of coils of various shapes, but the majority of them suffer from the serious disadvantage of being

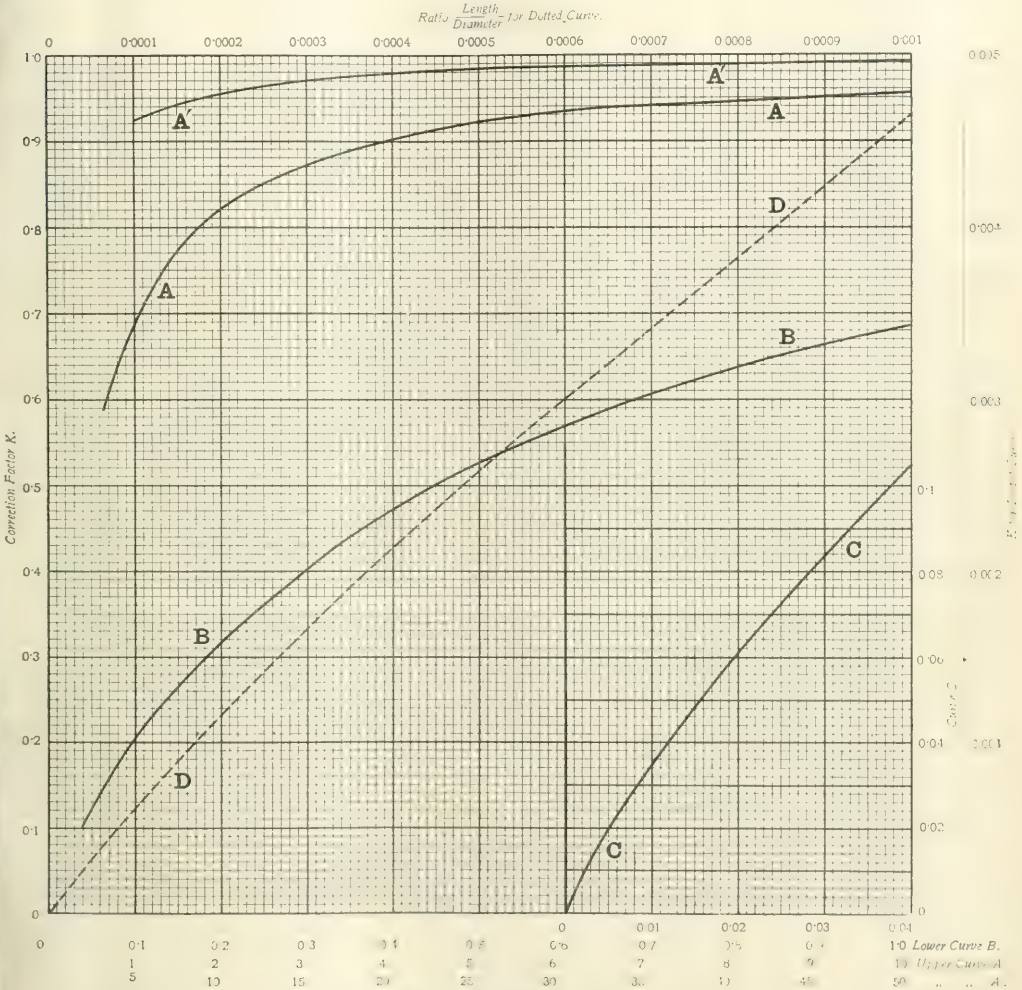


FIG. 1.—CURVES FOR USE WITH FORMULÆ 1 AND 2.

rather complicated and of requiring an amount of calculation that puts them outside the sphere of practical everyday use. Further, the multiplicity of formulæ—each applicable to a different type of coil—renders extremely difficult the selection of the best one to use for any particular case.

Hence it is thought that the following curves may be of value, as by their use the inductance of practically *any* shape of coil may be quickly obtained with an accuracy which is generally sufficient for most practical purposes. They are based on a formula first given by Nagaoka,* but have been extended

* "Journ." Coll. Science, Tokyo, Vol. XXVII. (1909).

by calculation to embrace coils which are not included in the original tables:—

$$L = \pi^2 D^2 n^2 l \kappa, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where L = inductance of coil in centimetres (10^8 cm. = 1 henry),

D = mean diameter of coil in centimetres,

$n = N/l$ = number of turns per centimetre length of coil,

N = total number of turns on coil,

l = axial length of coil,

κ = a correction factor which is a function of the dimension ratio l/D of the coil.

formulæ, from which the inductance of the coil may be quickly obtained. The curves A, A′ and B enable κ to be found for any value of l/D between 0·04 and 50·0, and will meet practically all ordinary cases; if, however, the inductance of coils longer than 50 diameters has to be calculated, a value for κ can easily be obtained by extrapolation from the curve, although the error will be less than 1 per cent. if κ is taken as unity.

Single-turn Coils and Straight Wires.—When the inductance of a single turn of wire is required, or of a very short coil, lower values of the dimension ratio are necessary, so that the small inset curve C (Fig. 1) will be found convenient. For extreme values of this ratio, the dotted curve D may be em-

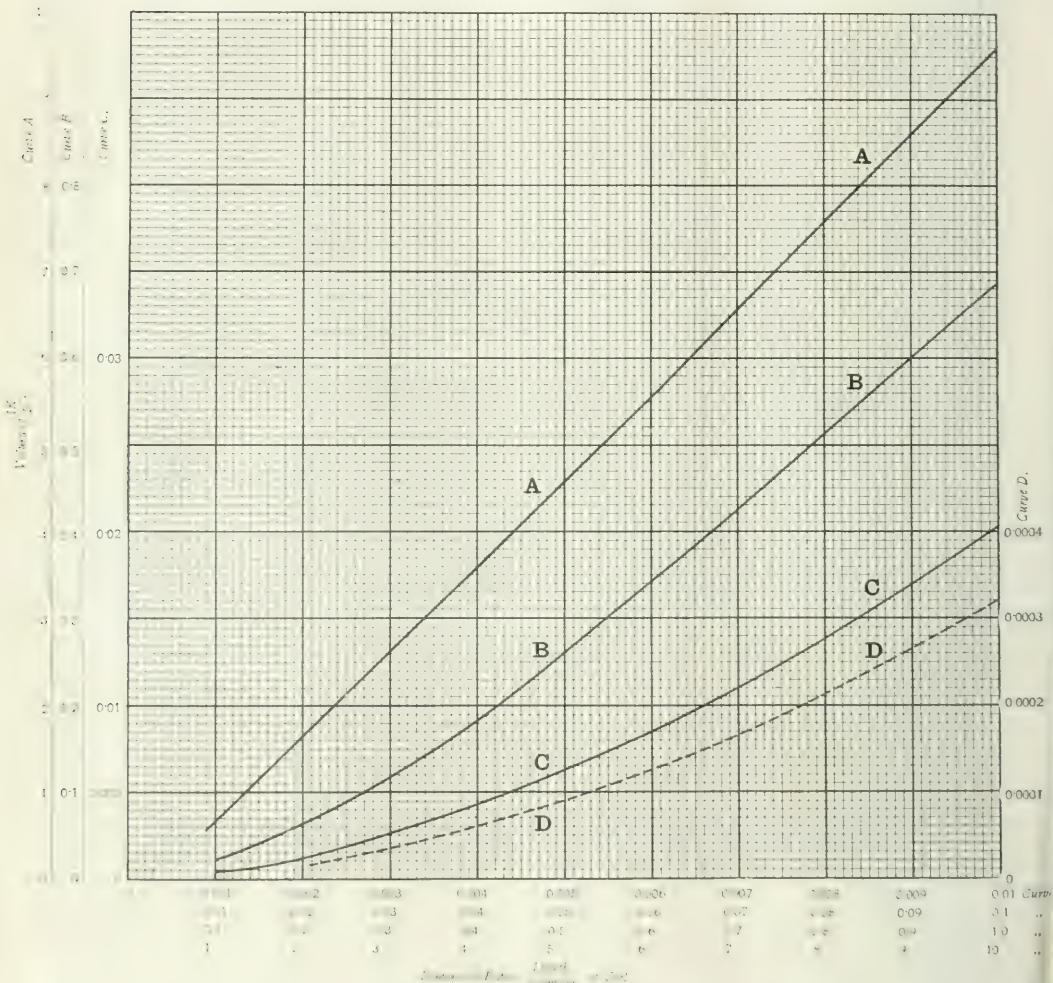


Fig. 2.—Curves for Designing Coil to have a given Inductance.

The [illegible] may also be [illegible]

$$L = \frac{\mathbb{L}^2}{l} \kappa, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and this form is often the most convenient for calculation, $\mathbb{L}$ = the total length of wire on the coil.

The Calculation of Inductance.

Ordinary Solenoid Coils.—By the help of the curves in Fig. 1, the value of the correction factor κ for any given dimension ratio l/D may be read off and inserted in either of the above

ployed, and in this connection it should be noted that the inductance of a straight wire may also be obtained from the curve if the abscissæ are taken to represent the ratio

$$\frac{\text{Diameter of wire}}{\text{Length of wire}} \text{ (instead of } \frac{\text{Length of coil}}{\text{Diameter of coil}}\text{)}$$

as is the case for solenoids, &c.), and the resulting value of κ multiplied by π, *i.e.*, inductance of straight wire

$$L = \pi \frac{\mathbb{L}^2}{d} \kappa, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where d = diameter of wire. (*See* example 2, below.)

In the case of coils of a single turn of wire, the length l to be taken for use in the formulæ and curves is necessarily the diameter of the conductor, as in the case of the straight wires (*see* Fig. 3A).

Flat Coils.—It should be noted that the inductance of a flat spiral coil of mean diameter D, and winding depth $=l$, is practically the same as that of a cylindrical, or solenoidal coil of axial length $=l$, and the same diameter and number of turns (*see* Fig. 3B). Hence the curves may also be employed for coils of this type, thus avoiding the use of the extremely cumbersome Stefan formula.*

The Design of Coils.—The curves in Fig. 2 are intended to facilitate the design of a coil to have any given inductance. Referring to equation (1), a value of n (the turns per centimetre length of the coil) may be provisionally determined, depending upon the insulated diameter of the wire with which the coil is to be wound, if the turns are to touch one another, or from the winding pitch which it is proposed to employ. Then, with the given value of the inductance L, a suitable diameter may be decided upon, and the value of $l\kappa$ obtained from formula (1). Dividing this by the diameter D, we obtain a value for $l\kappa/D$ from which, by the help of the curves in Fig. 2, the corresponding value of l/D may be read off, and hence, as D is known, the true corrected value of the coil length l may be easily calculated.

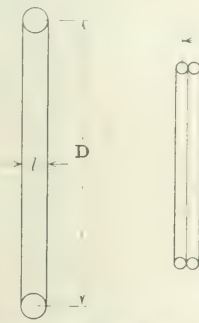


Fig. 3A.—Single Turn Coil. Length of Coil l = Diameter of Wire d.

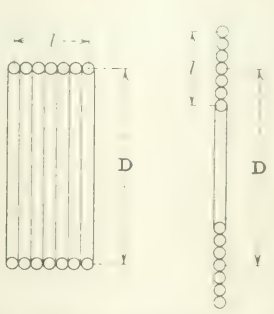


Fig. 3B.—Solenoid and Flat Coil having the same Inductance.

Examples Illustrating the Use of the Curves.—1. Find the inductance of a solenoid coil of diameter D=12 cm. and axial length l=25 cm., wound with 10 turns per centimetre length. We have $l/D=25/12=2{\cdot}083$, therefore, from curve A, Fig. 1, $\kappa=0{\cdot}825$ and substituting in (1) we have

$$\text{Inductance of coil } L = \pi^2 \cdot 12^2 \cdot 10^2 \cdot 25 \cdot 0{\cdot}825.$$
$$= 2{\cdot}94 \times 10^6 \text{ cm.}$$
$$= 0{\cdot}00294 \text{ henry.}$$

2. Find the inductance of 20 ft. of No. 16 S.W.G. copper wire (=0·1626 cm.), (*a*) bent up into a coil of 1 turn; (*b*) stretched out straight.

(*a*) Diameter of turn $= \frac{20 - 3{\cdot}0 \times 0{\cdot}15}{\pi} = 1{\cdot}94$ cm.

$$\therefore \frac{l}{D} = \frac{0{\cdot}1626}{1{\cdot}94} = 0{\cdot}000839.$$

∴ by curve D, Fig. 1, $\kappa = 0{\cdot}00398$, ∴ from (2) the inductance

$$L = \frac{20^2 \cdot 1{\cdot}94^2 \cdot \pi^2 \cdot 0{\cdot}00398}{0{\cdot}1626} = 0{\cdot}00267,$$

(*b*) $\frac{l}{D} = \frac{0{\cdot}1626}{20 - 3{\cdot}0 \times 0{\cdot}15} = 0{\cdot}000267,$

∴ $\kappa = 0{\cdot}00148$ (curve D, Fig. 1).

$$L = \frac{20^2 \cdot 3{\cdot}0^2 \cdot \pi^2 \cdot 0{\cdot}00148 \cdot 10^2 \cdot 20 \cdot 0{\cdot}15}{0{\cdot}1626} = 0{\cdot}00993 \text{ henry.}$$

3. Find suitable dimensions for a coil to have an inductance of 2,000,000 cm., to be wound in No. 22 S.W.G., enamelled copper wire, if the diameter is not to exceed 20 cm.

A suitable winding pitch for No. 22 enamelled wire is 12 turns per centimetre, hence we have

$$\frac{l\kappa}{D} = \frac{L}{\pi^2 D^2 n^2} = \frac{2 \cdot 10^6}{\pi^2 \cdot 20^2 \cdot 12^2} = 0{\cdot}175.$$

∴ From curve B, Fig. 2, we have $l/D=0{\cdot}39$,

whence $l = 7{\cdot}8$ cm.,

= axial length of coil.

In conclusion, it should be stated that the curves here given are not intended for use in cases where extreme accuracy is desired, such as in calculating standard coils, &c., as then one or more of the usual formulæ must of necessity be employed; but when the values are required to an accuracy of a few per cent. only—as is frequently the case—a very considerable amount of arithmetical work may be saved by their employment, while the use of only one method of calculation for all types of coils is a distinct advantage over a multitude of formulæ.

LONG RANGE RECEPTION WITH COMBINED CRYSTAL DETECTOR AND AUDION AMPLIFIER.*

BY HARADEN PRATT.

Summary. The author finds that if an audion bulb is used as an ordinary receiver across the "tapping" condenser in series with a galena detector an amplification of signals of about 10 times is attained. The audion bulb, to be effective for this purpose, must have certain definite voltage-current characteristics which are described.

The measurements described were made at the University of California. The first antenna used in these experiments consisted of a wire 750 ft. (230 metres) long, supported at one end on a 300 ft. (92 metres) steel tower, and by an 80 ft. (24·5 metres) stack at the end nearer the receiving apparatus. The results obtained were so encouraging that two extra wires, spaced about 3 ft. (92 cm.) apart were subsequently added. The strength of the signals was practically doubled by their presence. The fundamental or natural wave-length of the antenna system was about 1,170 metres. The receiving apparatus differed from the usual type only in that a galena-audion amplifying combination was used. The latter arrangement was based on the following principles.

A very good galena crystal and an audion bulb of fair sensitiveness were available in these experiments. When the two were used in combination, the audibility of received signals was enormously increased. It is interesting to note that there are many possible combinations of these detectors, and that a large number were tried before a successful one was found. Five changeable features exist which affect the sensitiveness of the combination. They are:—

1. Polarity of the filament battery;
2. Polarity of the secondary ("B") battery;
3. Interchanging of the galena detector terminals;
4. Interchanging of the grid and plate; and
5. Interchanging of the terminals of the secondary of the receiving transformer.

Each of these features was found to affect the strength of the signals received in the telephone. There was, indeed, one good combination out of 120 possibilities. The proper arrangement under conditions 1, 2 and 4 could be quickly found; however, because of the extreme effect produced when the adjustment was incorrect. The reason for making condition 5 is that the capacity between the primary and the secondary of the receiving transformer and the capacity of the audion apparatus to ground were different for the two modes of connection.

The use of the [illegible] were very satisfactory, previously inaudible signals becoming perfectly audible. To determine the [illegible] a number of measurements of the [illegible] were made. The results [illegible] are only [illegible] and can be [illegible] but also [illegible] calibrating [illegible] the [illegible] adjustment [illegible]

* Paper read before the Institute of Radio Engineers, New York, slightly abbreviated.

was employed. The sensitivity of the galena detector adjustment was controlled from day to day by noting the audibility of a buzzer signal kept constant in intensity throughout the experiments.

The values tabulated below give the mean of more than 200 independent values taken over a period of 30 days. The stations ranged in distance from close at hand to over 5,000 miles (8,000 km.) away. They lay in all directions from the receiving station, their wave-lengths were between 600 and 3,200 metres, and their spark frequencies between 100 and 1,000 per second.

In column 1 are given the audibility using galena alone, in column 2 the audibility using galena and the audion. Column 3 gives the ratio of these audibilities—that is, the amplification ratio.

1. Audibility with galena.	2. Audibility with combination.	3. Ratio.	4. Audibility with galena.	5. Audibility with combination.	6. Ratio.
507·0	3,541·0	7·0	5·0	60·0	12·0
3·5	50·4	14·3	18·3	273·0	15·1
4·5	54·0	11·4	26·2	254·0	9·7
2·7	30·5	11·3	6·0	51·8	8·6
1·5	18·7	12·5	90·5	895·0	9·9
9·8	118·6	12·0	13·0	102·0	7·8
4·5	60·0	13·2	26·0	355·0	13·6
8·0	72·0	9·0	13·0	119·0	9·1
28·0	253·0	9·0	51·0	505·0	9·9

Average amplification = 10·6.

The average value of the amplification is, therefore, about 10. In order to note the effect of changing the "B" battery potential

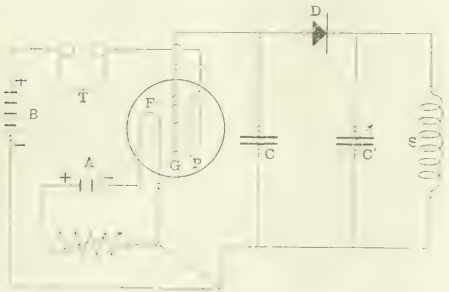


FIG. 1.—ARRANGEMENT OF RECEIVING CIRCUITS.

across the audion when using the adjusting telephone shunt, another pair of telephones was kept in series with the measuring pair and shunt. By listening in this extra pair of receivers it was found that adjusting the shunt for audibility measurements did not disturb the signals. No single set of observations on one signal was averaged for more than one half-hour's readings.

In carrying on these experiments it was noticed that audion bulbs which served excellently as detectors when used alone were not necessarily of value when used in combination with the galena as an amplifier. To determine the proper characteristics of an audion bulb for use in connection with the galena some further experiments were made.

It was noted first that, with certain values of the "B" battery potential of the audion, the clicks in the telephone while adjusting the galena crystal became weak, and the ease of manipulation was greatly increased. On the other hand, at other values of the "B" battery voltage, the clicks were loud and the crystal adjustment could be made only with considerable trouble.

A microvoltmeter was placed across the galena crystal, and it was found that for a certain value of the "B" battery voltage of the audion no P.D. existed across the crystal. It was with this adjustment that the crystal could be adjusted and used most easily. Using one of the crystals the relation between the "B" battery voltage and the potential across the crystal was determined. A curve showing this relation is shown in Fig. 2. (Fig. 1 shows the circuit arrangement of the apparatus.) It is interesting to note that for best results across the crystal the "B" battery voltage for the particular audion used was exactly the critical value for that potential. The point of best potential across the crystal could be obtained in connection with the critical "B" battery value of the voltage by slightly varying the filament or "A" battery voltage.

With poor audion bulbs, unsuited for use as amplifiers in conjunction with galena crystals, these conditions were not found to exist. The "B" battery potential could be varied, but the crystal potential never fell to a very low value. When the "B" battery potential was increased, the crystal P.D. diminished, but the blue light would appear in the bulb, showing that the critical potential value had been passed and saturation reached. No variation in the value of filament current could alter this condition.

It appears that unless the "B" battery potential can be brought to a critical value and at the same time the crystal P.D. is zero satisfactory operation of this device cannot be secured.

One night signals were heard from two Telefunken stations, one in the Marshall Islands and the other on Yap Island in the Caroline group. The distances of these stations from San Francisco are respectively 5,100 miles (8,200 km.) and 6,100 miles (9,800 km.). These signals were heard every night for three months thereafter with a nearly steady audibility of 25. The strength of signals varied but slightly from night to night. Nevertheless, these stations experienced great difficulty in working with each other, although they were but 2,100 miles (3,400 km.) apart. The more distant station of the two could with difficulty be heard using either the audion or galena alone, but with the combination signals were always

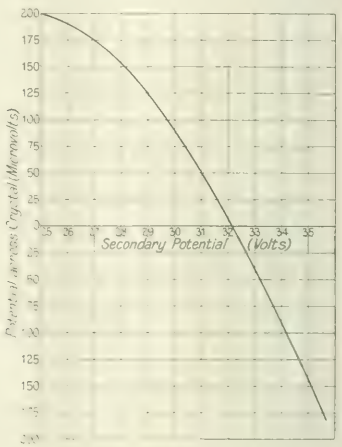


FIG. 2.

readable up to the month of May, when the summer atmospheric began to interfere. Local signals caused no interference, as the wave-length of these stations was above 3,000 metres.

PROF. SCHUSTER'S PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION.*

THE COMMON AIMS OF SCIENCE AND HUMANITY.

Under the influence of the diversity of pursuits imposed upon by the conditions of modern life, different groups of the community, men of business, men of science, philosophers, or artists—have acquired detached and sometimes opposing interests. Each group impressed by the importance of its own domain in the life of the nation, and focussing its vision on small differences and temporary rivalries, was in danger of losing the sense of mutual dependence. But in the shadow of a great catastrophe it has been brought home to us that the clash of interests is superficial, and the slender threads union which remained has grown into a solid bond. What is the fibre from which the bond is twined? Patriotism may express itself outward manifestation, but its staple is the mental relationship which remains continuous and dominant even in normal times, when each of us may peacefully go to earn his living and enjoy the course of his intellectual life.

Were it otherwise, the British Association could not perform one of its most important functions. The success of its scientific work alone is sufficient to show that we are not merely a body promoting social intercourse between men of science and the rest of the community.

* Abstract of an address delivered at Manchester last Tuesday by Prof. A. Schuster, D.Sc., F.R.S.

Nevertheless, it may be admitted that our efforts have been spasmodic, and the time has arrived to consider whether it may be possible to secure not only a greater continuity in our work, but also its better co-ordination with that of other scientific organisations. The present juncture affords the opportunity, and the changed conditions, which in the near future will affect all our institutions, render it indeed incumbent upon us once more to adapt ourselves to the needs of the times. Proposals for a move in that direction have already been made, and will no doubt be carefully considered by the Council. In the meantime, I may draw your attention to the important discussions arranged for by our Economic Section, which alone will justify the decision of the Council not to suspend the meeting this year.

While Babbage laid stress on the benefit which would accrue to pure science by being brought into contact with practical life, scientific men of the present day have more and more insisted on the services they, on their part, are able to render to the industries. The idealistic motive has thus given way to the materialistic purpose. Both aspects are perhaps equally important, but it is necessary to insist, at the present time, that the utilitarian drum can be beaten too loudly.

When we glance at the various occupations of the working parts of a nation, comprising the student who accumulates or extends knowledge, the engineer who applies that knowledge, the geologist or agriculturist who discloses the store of wealth hidden in the soil, the commercial man who distributes that wealth, it seems as if we ought to be able to name the qualities of intellect and temperament which in each pursuit are most needed to carry out the work successfully. But on trying to define these qualities we soon discover the formidable nature of the task.

Among all subjects mathematics is perhaps the one that appears most definitely to require a special and uncommon faculty. Poincaré, starting from the incontrovertible proposition that there is only one kind of correct reasoning, which is logical reasoning, raises the question why it is that everybody who is capable of reasoning correctly is not also a mathematician, and he is led to the conclusion that the characterising feature is a peculiar type of memory. It is not a better memory, but a memory which fixes the order in which the successive steps of reasoning follow each other without necessarily retaining the details of the individual steps.

Poincaré next discusses the nature of the intellectual gift distinguishing those who can enrich knowledge with new and fertile ideas of discovery. Inventing, in his opinion, consists in excluding useless combinations, and therefore: "To invent is to select—to choose." All those who have attempted to add something to knowledge must recognise that there is a profound truth in Poincaré's views. New ideas may float across our consciousness, but, selecting the wrong ones for more detailed study, we waste our time fruitlessly. Do we not all remember how, after the announcement of a new fact or generalisation, there are always many who claim to have had, and perhaps vaguely expressed, the same idea? They put it down to bad luck that they have not pursued it, but they have failed precisely in that, according to Poincaré, is the essence of inventive power. It may be bad luck not to have had a good idea, but to have had it and failed to appreciate its importance is downright incapacity.

An objection may be raised that before a selection can be made the ideas themselves must appear, and that, even should they arrive in sufficient numbers, the right one may not be among them. But new ideas seldom are born out of nothing. They most frequently are based on analogies, or the recollection of a sequence of thoughts suggested by a different branch of the subject, or perhaps by a different subject altogether. It is here that the memory comes in which is not a memory of detail, but a memory of premises with their conclusions, detached from the particular case to which they were originally applied. Applying the same reasoning to other occupations, the same conclusion is inevitable. The commercial man, the politician, and the artist must all possess the type of memory best suited to concentrate in the field of mental vision their own experiences as well as what they have learned from the experience of others; and, further, they must have the power of selecting out of a multiple of possible lines of action the one that leads to success; it is this power which Poincaré calls the inventive faculty.

The argument must not be pushed too far. What is essential, to the mind, is to treat the question seriously, and to dismiss the vague generalities which, by drawing an artificial barrier between different groups of professions, try to cure real or imaginary defects through plausible though quite illusory remedies. All these recommendations are based on the fallacy that special gifts are associated with different occupations. Sometimes we are recommended to bend our the affairs of the nation to men of business; sometimes we are told that salvation can only be found in scientific methods. Every method that leads to a correct result must be called a scientific method, and what requires substantiation is the essential superiority of better than other training for discovering the correct method. This proof, I think, cannot be given. When, therefore, one man calls for the conduct of affairs "on business lines" and the other clamours for scientific methods, they either want the same thing or they talk nonsense. The weak point of these assertions contrasting different classes of human efforts is that each class selects its own strongest men for comparison with the weakest on the other side.

The most fatal distinction that can be made is the one which brings men of theory into opposition to men of practice, without regard to the obvious truth that nothing of value is ever done which does not involve both theory and practice; while theory is sometimes overbearing and irritating, there are among those who jeer at it some to whom Disraeli's definition applies: the practical man is the man who practises the errors of his forefathers.

Why does a theory ever fail, though it may be sound in reasoning? It can only do so because every problem involves a much larger number of conditions than those which the investigator can take into account. He therefore rejects those which he believes to be unessential, and if his judgment is at fault he goes wrong. But the practical man will often fail for the same reason. When not supported by theoretical knowledge he generalises the result of an observation or experiment, applying it to cases where the result is determined by an altogether different set of conditions. To be infallible the theorist would have to take account of an infinite number of circumstances, and his calculations would become unmanageable, while the experimenter would have to perform an infinite number of experiments, and both would only be able to draw correct conclusions after an infinite lapse of time. They have to trust their intuition in selecting what can be omitted with impunity, and if they fail it is mainly due to the same defect of judgment. And so it is in all professions: failure results from the omission of essential considerations which change the venue of the problem.

If we must avoid assuming special intellectual qualities when we speak of groups of men within one country, we ought to be doubly careful not to do so without good reason in comparing different nations. So-called national characteristics are in many cases matters of education and training; and if I select one as an example it is because it figures so largely in public discussions at the present moment. I refer to that expedient for combining individual efforts which goes by the name of organisation. An efficient organisation requires a head that directs and a body that obeys; it works mainly through discipline, which is its most essential attribute. Every institution, every factory, every business establishment is a complicated organism, and no country ever came to prominence in any walk of life unless it possessed the ability to provide for the efficient working of such organisms. To say that a nation which has acquired and maintained an empire, and which conducts a large trade in every part of the world, is deficient in organising power is therefore an absurdity. Much of the current self-depreciation in this respect is due to the confusion of what constitutes a true organisation with that modification of it which to a great extent casts aside discipline and substitutes co-operation. Though much may be accomplished by co-operation, it is full of danger in an emergency, for it can only work if it be loyally adhered to; otherwise it resembles a six-cylinder motor in which every sparking-plug is allowed to fix its own time of firing. Things go well so long as the plugs agree; but there is nearly always one among them that persists in taking an independent course and, when the machine stops, complains that the driver is inefficient. The cry for organisation, justifiable as it no doubt often is, resolves itself, therefore, into a cry for increased discipline, by which I do not mean the discipline enforced at the point of the bayonet, but that accepted by the individual who voluntarily subordinates his personal convictions to the will of a properly constituted authority. This discipline is not an inborn quality which belongs more to one nation than to another; it is acquired by education and training. In an emergency it is essential to success, but if it be made the guiding principle of a nation's activity, it carries dangers with it which are greater than the benefits conferred by the increased facility for advance in some directions.

Why does a scientific man find satisfaction in studying Nature? In the words of Poincaré: "The student does not study Nature because that study is useful, but because it gives him pleasure, and it gives him pleasure because Nature is beautiful; if it were not beautiful it would not be worth knowing and life would not be worth living. . . . The cult of the beautiful guides us to the same goal as the study of the useful." Though Poincaré was, I believe, the first to lay stress on the connection between the search for the beautiful and the achievement of the useful, the æsthetic value of the study of science had previously been pointed out, and well illustrated by Karl Pearson in his "Grammar of Science." As expressed by

him: "It is this continual gratification of the æsthetic judgment which is one of the chief delights of pure science."

In order to trace in detail the part played by purely emotional instincts in directing the course of our lives, we should have to study the causes which influence a child, free to select his future profession. If every man who has reached a certain recognised position in his own subject—it need not be pre-eminence—would write down his own recollections of what led him to make the choice of his profession, we might hope to obtain facts on which a useful psychological study might be based. The only example that I know of such an autobiographical sketch is that of Darwin, which is contained in his "Life and Letters," published by his son, Sir Francis Darwin.

If we look for distinctions between different individuals, we may find one in their leanings either towards the larger aspects of a question or the microscopic study of detail. The power of focussing simultaneously the wider view and the minute observation is perhaps the most characteristic attribute of those who reach the highest eminence in any profession, but the great majority of men have a notable predilection for the one or other side.

There is only one feature in the operation of the intelligence by means of which a sharp division may possibly be drawn between brain-workers showing special capabilities in different subjects. In some persons thought attaches itself mainly to language, in others to visualised images, and herein lies perhaps the distinction between the literary and scientific gift. Those who, owing to external circumstances, have resided in different countries are sometimes asked in what language they think. Speaking for myself, I have always been obliged to answer that, so far as I can tell, thought is not connected with any language at all. The planning of an experiment or even the critical examination of a theory is to me entirely a matter of mental imagery, and hence the experience, which I think many scientific men must have shared, that the conversion of thought into language, which is necessary when we wish to communicate its results to others, presents not only the ordinary difficulties of translation but reveals faults in the perfection or sequence of the images. Only when the logic of words finally coincides with the logic of images do we attain that feeling of confidence which makes us certain that our results are correct.

Latterly men of science, and in particularly physicists, have given increased attention to the intrinsic meaning of the concepts by means of which we express the facts of Nature. Everything—who can deny it?—is ultimately reduced to sense impressions, and it has therefore been asserted that science is the study of the mind rather than of the outside world, the very existence of which may be denied. The physicist has thus invaded the realm of philosophy and metaphysics, and even claims that kingdom as his own. Two effects of these efforts, a paralysing pessimism and an obscure vagueness of expression, if not of thought, seriously threatened a few years ago to retard the healthy progress of the study of Nature. If the outside world were only a dream, if we never could know what really lies behind it, the incentive which has moved those whose names stand out as landmarks in science is destroyed, and it is replaced by what? By a formula which only appeals to a few spirits entirely detached from the world in which they live. Metaphysicians and physicists will continue to look upon science from different points of view, and need not resent mutual criticisms of each other's methods or conclusions. For we must remember that most of the good that is done in this world is done by meddling with other people's affairs, and though the interference is always irritating and frequently futile, it proves, after all, that our interests converge towards a common centre.

I have warned you at the beginning of this discourse not to beat the utilitarian drum too loudly, and I have laid stress throughout on the idealistic side. But I must guard myself, therefore, against one criticism which the trend of my remarks may invite. At times, when the [illegible] when accidental surroundings drive the weak into misery, should I not have found a surer ground for the claims of science in its daily [illegible]?

I [illegible] on this important function of science, which finds its noblest task in surrendering the richness of its achievements to the use of humanity. But I must ask you to reflect whether the achievement of wealth and [illegible] nation, and plunged Europe into war? Is this contempt for all idealistic purposes not responsible for the mischievous doctrine that [illegible]

I must therefore insist that if we delight in enlisting the wealth accumulated in the earth, and all the power stored in the orbs of heaven, or in the orbits of atomic structure, it should not be because we place material wealth above intellectual enjoyment, but rather because we experience a double pleasure if the efforts of the mind contribute to the welfare of the nation.

Happy were the times when it could be said with truth that the strife of politics counted as nothing before the silent display of the heavens. Mightier issues are at stake to-day; in the struggle which convulses the world all intellectual pursuits are vitally affected, and science gladly gives all the power she wields to the service of the State. Sorrowfully she covers her face because that power, accumulated through the peaceful efforts of the sons of all nations, was never meant for death and destruction; gladly she helps, because a war wantonly provoked threatens civilisation, and only through victory shall we achieve a peace in which once more science can hold up her head, proud of her strength to preserve the intellectual freedom which is worth more than material prosperity, to defeat the spirit of evil that destroyed the sense of brotherhood among nations, and to spread the love of truth.

THE "PIEPER" PETROL-ELECTRIC REGENERATIVE SYSTEM OF TRACTION.

In a recent issue of "La Lumière Électrique" there appears an interesting article by Mr. L. Pahin describing the petrol-electric system of traction invented by Mr. Henri Pieper as applied to tramways and railways. The principle is the same as that of the "Pieper" automobile, which we described in 1906,* but it was not until 1908 that this system made its appearance on trams. In that year it was adopted on a tramway of the Société Nationale des Chemins de Fer Vicinaux, in Belgium. In France the Grande Banlieue Railway Company (of Seine and Seine-et-Oise) also ran one of their lines in this way. Since that time Mr. Pieper has developed his "total recuperation" system for use on the lines of the Belgian State Railways.

The original system employs an internal combustion engine of sufficient power to keep a car running over the greater part of its journey, directly coupled to a dynamo, the terminals of which are connected to those of an accumulator. This acts as a "buffer-battery," receiving energy during periods of light load, and giving it out so as to assist the engine when required. The engine-generator set is coupled through a magnetic clutch and suitable gearing to the wheels. When the car reaches an ascending gradient its speed naturally decreases and, as a consequence, the voltage of the dynamo falls. This causes a flow of current from the battery, so that the dynamo, acting as a motor, assists the petrol engine. When running down hill, on the contrary, the car accelerates by gravity, the dynamo voltage rises and the battery receives a charge, absorbing energy from the engine, and from the descent of the vehicle. Thus a braking effect is produced, making the system regenerative.

In order that the engine may at all times give the correct power needed to drive the vehicle or charge the battery, there is a regulator consisting of a solenoid with two windings, one of which is a fine wire coil connected across the battery, and the other of thick wire through which the main dynamo current passes. The movement of the core controls the throttle of the engine. By this means the throttle is fully opened when the car is climbing a gradient, but when descending it is closed to such an extent that only sufficient power is developed to overcome the frictional resistances of the engine.

The engine is arranged to run in either direction. The excitation of the dynamo can be varied so as to suit different average running speeds. Control of the "Pieper" autocar is effected by means of a controller similar to those used on trams. In starting the car the driver first sets the engine going in the correct direction of rotation by taking current from the battery to work the dynamo as a motor. Then by admitting current gradually to the coils of the magnetic clutch the vehicle itself commences to move. The field current is then decreased until the normal running speed is obtained. For slowing down, the excitation is increased, and the battery is thus made to absorb the kinetic energy of the vehicle, then the clutch is released and the air-brakes applied. When the car is at a standstill the engine may be [illegible] the battery.

The car is heated by the [illegible] the [illegible] be switched on the roof. In [illegible] the engine and the trailer [illegible] In the "Pieper" system the [illegible] by the speed of the engine [illegible]

* THE ELECTRICIAN, Vol. LVI., p. 867, March 2, 1906.

required to drive the train. On this account [illegible] small enough to be placed under the floor of the car. In case of emergency, however, the battery would [illegible] the train to the nearest station or depot. It operates under the best conditions, never being completely discharged.

Small four-wheeled cars working on this principle were put into operation in Belgium in 1908 on [illegible] Rhode and Waterloo, and were still running at the commencement of the war. Each autocar weighed from 9 to 10 tons and drew a trailer of about the same weight. A 40-50 H.P. engine was carried transversely in the centre, driving both axles by chain transmission. So successful were these trams that the company ordered eight more of a larger size carried on bogies. A four-cylinder reversible engine, developing 90 H.P. at 950 revs. per min., drove one axle on each bogie through cardon shafts and bevel gearing. The battery (of 60 cells) could give 20 kw. for a discharge of half-an-hour's duration or 90 kw. for one minute. Such a car on a route with comparatively light gradients can average a speed of 37 miles an hour running alone or 16 to 18 miles an hour when drawing two trailers. Under these conditions the petrol or benzol consumption is about 1 litre per train kilometre, *i.e.*, 0·36 gallon per train-mile. This type of car was employed on several light railways in Belgium, and three of a very similar pattern were also put into service in France by the Grande Banlieue Company on the line between Poissy and Saint Germain-en-Laye.

In the cars above described the engine and dynamo are permanently coupled together. This involves a certain loss when regenerating on a down grade, as the engine is turning idly. To avoid this Mr. Pieper has designed two new types of "total recuperation" autocars, in which there is a magnetic clutch between the motor and the dynamo, so that the former may be stopped during a descent. In these cars the engine will be placed on an extension of the frame of the vehicle beyond the end of the car, and will be covered by a bonnet like that of a motor car. A similar extension and bonnet the other end houses the battery. This disposition provides easy access for inspection or overhauling, besides which a chassis with the complete electro-mechanical equipment may be built independently and the body fitted afterwards as with automobiles. Though such a position for the engine necessitates double-gear reduction, this gearing enables an engine of higher speed to be used with the consequent economy in size and weight. Two designs for these cars have been worked out, one for a small vehicle, 31 ft. long on two radial pairs of wheels, and the other a bogie coach 43 ft. long. The first can carry 18 passengers seated and 20 standing on the platforms, and the latter 32 seated and 28 standing.

The Belgian State Railways intend, when circumstances permit, to employ some "Pieper" autocars on lines where the speed is limited to about 37 miles per hour. These will carry a 150 H.P. six-cylinder engine, two dynamos and a "buffer battery" of 120 cells. They will be able to draw one or two large cars as trailers.

Mr. Pieper has also designed another type for speeds up to 75 miles per hour, equipped with an engine of 250 H.P. He proposes to use two such autocars, one at each end of a set of three or four trailers, and operated on the multiple-unit system by a special patented arrangement. Such trains would carry 500 or 600 passengers and run 500 or 600 miles without replenishing.

In a Paper read before the Belgian Society of Electricians just before the war, Mr. L. Saint-Martin put forward some points in favour of petrol-electric traction. It had, he urged, the advantages of electric traction such as cleanliness and speed without the disadvantages of requiring a central station and the installation of conductors along the track. The petrol-electric car had a greater efficiency than the steam engine or electric train; in fact, the net overall efficiency of the three systems was 2 per cent. to 3 per cent. and 5 per cent. to 6 per cent. respectively, but the petrol-electric drive gave 16 per cent., so that it was likely to be adopted in the future even if the price of fuel was high. Besides petrol or benzol, other fuels might be used such as alcohol, naphtha, heavy oils or compressed gas. Mr. Saint-Martin also expressed the opinion that the petrol-electric drive would have a future, not only on local railways and tramways, but also on main lines. It was getting increasingly difficult to continue to raise the speed of steam locomotives to meet the demands for quicker travel, and electrification on long lines was very expensive, so that here was a unique opening for the petrol-electric car. The trains might consist of two or three motor coaches fitted with 400 H.P. to 500 H.P. engines and working on the "buffer-battery" principle, together with several trailers, the whole being controlled on the multiple-unit system. Such a train would be comfortable to [illegible] and could achieve speeds of 100 to 120 miles an hour.

Whether these prognostications are true or not, very good results have been obtained on a difficult line of the Grande Banlieue Railway, where records were kept of the performance of [illegible] months. During this time 9,400 miles were covered, giving a total of 236,000 ton-miles (taking into account the trailers drawn). The average consumption of benzol worked out at 0·011 gallon per ton-mile.

DEVICE FOR PROTECTING LOW VOLTAGE CIRCUITS AGAINST HIGH VOLTAGES.*

BY DR. FRITZ SCHRÖTER.

This device consists of a spark-gap which will allow an arc-like spark to pass at 130 volts, so as to protect telephone lines liable to come into contact with conductors (*e.g.*, lighting mains) at 220 volts. The device consists of a closed tubular glass vessel (Fig. 1), in the upper part of which there is supported in an insulating guard-tube, *b*, a vertical aluminium anode rod, *a*, connected to a platinum wire extending through the glass and forming an external terminal, *e*.

The lower end of the rod *a* stands at a few millimetres above the horizontal upper surface of a mass, *c*, of potassium, sodium or of an alloy containing alkali metal, which forms the cathode, and is connected to a platinum wire, *d*, extending to the exterior to form the other terminal. This alkali metal is introduced into the tube in a pure condition free from gas. The interior of the tube contains helium, neon or argon, or mixtures of these gases, at a pressure of

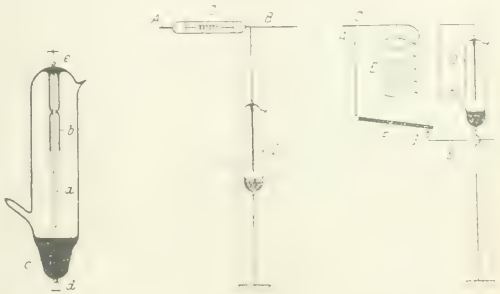


FIG. 1. FIG. 2. FIG. 3.

below 1 mm. to 3 mm. The rod *a* can be used as the cathode, and *c* as the anode if the surface of *c* be made small enough for sufficient vapour to be generated, when a discharge takes place, to cover the rod *a* with a deposit of alkali metal. The device may be used as in Fig. 2, where A is the external line, B the subscriber's wire, C a fuse which melts at, say, 0·5 A, and D the safety device. In Fig. 3 there is also a relay, E, F, G, having a coil, E, of high resistance (8,000 to 15,000 ohms) controlling the subscriber's circuit B. On the voltage reaching a dangerous value a kind of silent discharge takes place in D, the armature F is raised by the coil E, and the subscriber's circuit B is interrupted until the voltage falls. The critical voltage of the tubes remains constant after thousands of discharges. The author has made a tube with a critical voltage of 104 volts, in which the electrode *a* (Fig. 1) served as the cathode, and had a coating of potassium. It was arranged at 5 mm. distance from the electrode *c*, the tube being filled with a mixture of two-thirds neon and one-third helium at a pressure of 2 mm. absolute.

BOOKS RECEIVED.

[illegible]

[illegible] foreign books.]

[illegible] Shipbuilders. Edited by E. Fraser Smith (Newcastle-on-Tyne: The [illegible] Vol. XXXI. Part 3. [illegible]

[illegible] Series A. Vol. XCI. No. A 633. 2s. 6d.

[illegible] (New York: American Institute of Electrical Engineers.) Vol. XXXIV. No. 8. [illegible]

[illegible] The Western Electrician. Vol. V. No. 14. 80.60.

[illegible] Vol. XXXVI., p. 77.

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WHAT IS POWER SUPPLY?

The recent decision of Sheriff-Substitute J. DEAN in the action brought by the Alloa Corporation against the Alloa Theatre Co. (which we reported in our issue of the 23rd July, p. 598) has excited considerable interest in electricity circles. Many people criticise the judgment and maintain that it is wrong, while some uphold the SHERIFF'S decision. To enable our readers to understand the question at issue we briefly recapitulate the facts of the case. The Corporation sued for the payment of an account for the supply of electricity. Defendants had commenced to take electrical energy from the Corporation in November, 1913, and had been charged at the lighting rate until March, 1915, when defenders claimed to have the benefit of power rates for a portion of the electrical energy supplied. There were three meters on the theatre premises, two of them for electrical energy at 220 volts, the current being used for lighting the stage and the main building respectively; and one for electrical energy supplied at 440 volts for a motor generator, which, in turn, supplied current at 60 volts to the bioscope lantern. It was in regard to this portion of the energy supplied that the defenders claimed to be entitled to the power rate fixed by the Corporation. Electrical energy was in any case supplied to the defenders at a special rate, viz: 3d. per unit after 4,000 units, but they were not satisfied with this scale.

The decision in the case was to the effect that the electrical [illegible]

generally used on power networks. Many transformers, however, are used for lighting, and there are any number of auto-transformers supplying low voltage metal filament lamps in private houses to this day. It may be objected that the auto-transformer has only a single winding, and, therefore, the electrical energy from the station goes, to all intents and purposes, direct to the lamps; but this objection could easily be overcome by using a transformer with a double winding. If the Alloa judgment is to stand, the use of double-wound transformers in this way will provide the double incentive of more efficient lamps and cheap energy for lighting at power rates.

In looking into these matters, the fundamental characteristics of a lighting load are often forgotten. The station engineer does not object to a lighting load merely because the electrical energy is converted into light; it is simply a question of bad load factor that decides the question. If a consumer were willing to run his lighting at a 50 per cent. load factor, any station engineer would welcome the idea, and would (or should) supply energy for such a purpose at power rates; but if a motor generator or transformer is merely utilised for altering the pressure of supply, the energy being used at the same low load factor as is necessarily associated with lighting, then it is clear that the energy should be charged at lighting rates. It has sometimes been suggested that consumers would do well to take energy on favourable terms for charging accumulators at times of low load, the batteries being subsequently used to supply a lighting load. This proposition, however, means that, although energy is supplied for light in a roundabout fashion, the load on the station is improved, and consequently the tariff might be reduced.

On the other hand, if electrical energy is used for supplying illumination over periods which are not governed by the ordinary hours of light and darkness, it seems to us that it is only fair that the energy so used should be supplied on special terms. There are many cinematograph theatres which run performances continuously from 3 p.m. to 10 p.m. or 11 p.m., thus providing a load which has a far higher load factor than the ordinary lighting load. For this reason, and for this alone, we think that they should be supplied on terms approaching the power tariff, or possibly at power rates. It is certainly unfair that they should be charged at the ordinary lighting rate.

The Alloa judgment, as it stands, however, is unsatisfactory, and we think it may lead to a certain amount of difficulty. However, there can be no appeal from a decision in the small Debt Court of Scotland and it must be taken for what it is worth. In our Correspondence columns will be found a letter in which it is pointed out that the London companies to which the London Electric Supply Act of 1908 applies, cannot find themselves in this particular difficulty, as it is expressly laid down that electrical energy supplied at power rates shall not be used either directly or indirectly for lighting. When the charge for power is stated in an Act of Parliament the position becomes important, but under more ordinary conditions it can be met without much difficulty. It has already been met at Alloa by a revision of the tariff, though we confess that the revision is, in our opinion, on wrong lines. We notice also that the Salford Electricity Committee has decided that all power supplied to motors employed for driving electric generators producing energy for lighting is to be charged at lighting rates, except in the case of motor generators used in cinematographs. We do not doubt that other electricity undertakings will follow the example set by Salford.

TECHNICAL SCHOOL RESEARCH.

BY W. BECKIT BURNIE, D.SC. (ENG.).

On July 15th Mr. Lloyd George said in the House of Commons that arrangements were proposed whereby certain technical colleges would provide short courses of training for suitable unskilled workers, so as to enable them to be of greater use in the making of munitions of war. Thus after some considerable amount of asking, and the passing of nearly a year, these colleges are to be allowed to undertake a part of the work for which they are fitted, and a part of their capabilities is to be mobilised for war purposes.

It is to be hoped that in the industrial warfare which must follow the present conflict the mobilisation of the schools will not be correspondingly delayed, but that they will be allowed to do the work for which they are fitted and which they have been willing to undertake for some years past. Technical schools can be useful in two ways—by training young men for industry and by undertaking experimental work; but they can only be a means to an end, and whatever effectiveness they exercise can only be through the industries of the country. In both branches of their work their activities can be checked or encouraged by the leaders of industry; but in the one branch (training) the action of the industrial leaders is less conscious than in the other. If the schools obtain satisfactory students and train them properly, these students will be absorbed into industrial concerns, and ultimately influence production, even though the managers are not consciously friendly to the schools; but in experimental work, including research, definite good-will and confidence on the part of the business men is necessary for anything like full usefulness.

It was at one time usual for technical schools to make their own electricity, but most of them have found that they can get a supply more cheaply and better from the local central station, and, except for instructional purposes, generation of electricity in schools has in most cases been discontinued. Similarly, we may hope that presently works will understand that much experimental work can better be done in school laboratories than in the factory; and though certain businesses will maintain their own experimental and research stations, much of the research work required in a district will be centralised in the local technical school, which will be a sort of civic physical and chemical laboratory.

The reasons why in this country technical school research does not play an important part in industry are probably historical. It is not the fault of either the manufacturers or the schools, but due to the circumstances in which each came into being. General von Bernhardi, in "Germany and the Next War," alludes to the time when "Britain introduced machinery into industry." We know this was our country's performance, and are proud of it. We began, and we began necessarily in the works. Nobody could have foretold 80 years ago the part that science must play in the development [illegible] things were desirable in schools in order to help infant industries. The countries that were behind used their schools to help them, and England, being in front, did not feel the need [illegible]

the schools to undertake special work. The schools are provided with certain apparatus and facilities that are not available in the works. There are in every large technical school testing appliances which are needed for teaching, but can also be used for commercial purposes. Instruments can be checked, [illegible] schools: and manufacturers should give the schools this work, and should pay for it. At present some practical engineers think that they are in some way disgraced if they call in the help of the schools, and others think they are granting a favour if they allow schools to work for them free of charge. This needs altering. The manufacturers must realise that there is certain work the schools can do better than they can; they must admit it, and they must ask the schools to do it.

Then there is the question of research. This can be divided into two classes—that of immediate practical utility and that of no obvious usefulness. Meeting a problem in manufacture, the practical man tries to solve it by practical means. If he fails he sometimes gives it up, and sometimes asks the technical school to solve it, again frequently free of charge. Let the manufacturer at least give the schools a chance, with a prospect of sharing in the resultant profit, and let him remember that a successful result cannot be expected in every case; and if there is any capability in our schools we shall begin to use it.

The problem of research with no obvious utility is different. Often it demands special apparatus, heavy and expensive, such as the schools cannot or ought not to purchase. This difficulty leads to much research being done with models or their equivalents, and can only be met by makers loaning [illegible] under practical conditions. We do not wish to deprecate the research work that is at present done in the schools, but too much of it is carried on with makeshift apparatus, and fails, consequently, to gain the approval of the manufacturers. It is not enough for a large-minded producer to give to a school a piece of modern apparatus, and let the school keep it whilst it becomes obsolete. There must be a constant stream of modern apparatus passing into the schools, to be kept there for a while and then returned to the makers. This will irrigate the schools, and they in their turn will produce a constant crop of ideas for the benefit of industry.

FIRST REPORT ON LIGHTING IN FACTORIES.

[illegible] Book (Cd. 8,000). We give below an outline of the Report:—

[illegible] ing and clothing trades, although general principles common to all [illegible] great diversity in character and requirements.

[illegible] official witnesses included five inspectors of factories, one medical [illegible] fessional, technical and scientific witnesses consisted of six illuminating engineering experts, five representatives of professional and [illegible] employers, and nine of associations of operatives. Acknowledgment is made to 86 works of the industries mentioned, and 4,000 measurements were made at [illegible]

"Daylight Factor."—Among the definitions given of the scientific [illegible] the ratio of the illumination expressed as a percentage of what it would be outside the walls and not obscured by anything above the point to the unobstructed light of the sky. This factor generally remains roughly constant through the variations of the outside light, and depends mainly on the window area that admits light to the point in question.

Factors in Good Lighting.—The factors contributing to a good lighting system are summarised as:—

1. Adequacy.
2. A reasonable degree of constancy and uniformity of illumination over the necessary area of work.
3. The placing or shading of sources so that the light from them does not fall directly on the eye of an operative when engaged in his work, or when looking horizontally across the workroom.
4. The placing of lights so as to prevent the casting of [illegible] shadows on the work.

Adequacy (used in a quantitative sense) is considered as the most important of these requirements, the recommendations put forward dealing chiefly with this question.

Existing Requirements.—No provisions in respect of lighting (analogous to those concerning temperature and regulation) occur in the present Factory Acts, though in the regulations for some "dangerous trades" (among which is the generation of electrical energy) and for underground bakehouses there are some stipulations for adequate lighting in general terms.

Adequate lighting in general terms is required in the codes of Austria, Belgium, Denmark, France, Germany, Holland, Italy, Norway, Sweden and of most of the United States. For local lighting in certain trades definite standards are prescribed in Holland, [illegible] The Indian Factory Act of 1911 gives the Inspector power to require adequate lighting in factories, and a definite standard for the general lighting of factories is in force in New South Wales.

The evidence has shown that provisions in the London Building Act of 1894 and in the building regulations of many provincial authorities limiting window space, and also regulations for whitewashing the glass roofs of cotton cloth factories, cause in some cases serious difficulty in securing a sufficient amount of daylight.

The Board of Education, however, prescribe adequate window space for their school-buildings (one-fifth of the floor area for class rooms), as well as suitably placed windows and light-coloured walls, and the Local Government Board have similar regulations for workhouses and other buildings. The building bye-laws of local authorities often have provisions for all habitable rooms to have windows, and the Housing and Town Planning Act of 1909 empowers these authorities to make definite regulations for underground rooms used as sleeping places.

Present State of Lighting.—With regard to *natural* lighting, roof lighting, where possible, is preferable to lateral lighting, as in most trades the work is on a horizontal plane; but in cotton spinning mills, the yarns are in a vertical position, well adapted for horizontal light. In modern factories a large part of the wall space (sometimes 60 per cent.) is occupied by windows, but there is naturally a limit to the width of the room for a given height beyond which the illumination is insufficient. Also want of uniformity is a drawback of lateral lighting.

Generally it is found that sufficient *artificial* lighting is provided in well-equipped factories for the actual process of manufacture; but complaints have been made of inadequate illumination for some fine kinds of work (such as drawing-in and twisting, tailoring, sewing and lace-making). The evidence and the visits have also brought to light instances where glare and shadows result from the unsuitable placing of lights. Inadequate illumination is, however, more often met with in the general lighting of premises or in the lighting of stairways and passages. Incandescent gas and electric light are the commonest [illegible] isolated districts oil or petrol air gas installations are often found.

[illegible] lighting are: (1) Old and unsuitable buildings; (2) obstruction of light (externally by buildings and internally by objects such as stores and machines); (3) dirty windows; and (4) dirty walls and ceilings. The effect of light-coloured surfaces in reflecting the light is often overlooked.

It is found that work is often carried on entirely by artificial light, not only in trades such as the manufacture of photographic materials where this is necessary, but in other occupations when the natural light is insufficient. Though there is no definite evidence that this has been injurious to the health, many witnesses of all classes agree [illegible] Committee concur. Among high buildings it is difficult to obtain [illegible]

recommended that the windows should be large, as near the ceiling as possible, and kept clear [illegible] construction within. Also vertical light can be deflected into the room by means of reflectors or prismatic glass, and external walls can sometimes be whitened to reflect the light. Inside walls should be light and permanent working points arranged to secure as much daylight as possible.

Where there is a good deal of available daylight, the lighting up time can, of course, be made later. Factories with roof lighting average a daylight factor of 2 per cent., so that if inside illumination is to be at least 0·5 ft. candle, artificial light must be put on when outside illumination is less than 25 ft.-candles. This corresponds to the light at sunrise and sunset, so that these times form the correct daylight limits for such rooms as far as "general" illumination is concerned.

Artificial Lighting.—The chief causes of unsatisfactory lighting are as follows: (1) The provision of too few or too big light sources. (2) Antiquated methods of lighting. Gas jets are still often found which vitiate the air and are liable to flicker, and, moreover, are very uneconomical. (3) Inadequate supply due to low pressure in gas mains during periods of maximum consumption, or due to drop in mains where electrical energy is generated on the premises. (4) Neglect of upkeep, such as arises from deterioration in gas mantles and deposition of dust. (5) Inside obstructions, more particularly in natural lighting. (6) Shadows and placing of lights.

Effects of Unsatisfactory Illumination.—The effects of unsatisfactory illumination are shown in the following ways: (1) Accidents, which are more numerous when the lighting is insufficient. This view is confirmed by the fact that higher rates for insurance against workmen's compensation are charged where the lighting is bad. (2) Damage to sight and health. Complaints as to eye strain and headaches attributed to insufficient light are common, and numerous references are made in the evidence to discomfort and injury through glare. There have been many expressions of opinion that insufficient light and excessive light are responsible for injuries to the eyes. (3) Insanitary conditions, owing to the fact that dirt is allowed to accumulate where there is insufficient light. (4) Diminished output of work. In one instance the output was diminished 12 to 20 per cent. during the hours of artificial lighting, and in another the earnings of the workers increased 11·4 per cent. after the [illegible] other system of lighting. (5) Lack of discipline.

Recommendations.

In view of the present state of knowledge it is impossible to make recommendations in regard to definite values of illumination, but the Committee feel justified in recommending that a requirement in general terms for adequate and suitable lighting be applied to all factories and workshops. In many cases that have been investigated it is obvious that the illumination is inadequate and a general provision would lead to improvement in such cases. The requirements applicable to each industry can only be determined after careful inquiry. If a standard is to be established power to prescribe these by Order should be given to the Secretary of State, and the Committee recommend this to be done.

1. There should be a statutory provision (*a*) requiring adequate and suitable lighting in every part of a factory or workshop; and (*b*) giving power to the Secretary of State to make Orders defining adequate and suitable illumination for factories and workshops or for any parts thereof or for any processes carried on therein.

Lighting requirements vary so much that each trade must be considered on its merits, and it is, therefore, impossible to give more than general recommendations at present. From this point of view the illumination may be considered as under the following three heads; (1) Illumination of workrooms—*i.e.*, of the working area of the factory. (2) Illumination of passages and places where persons are liable to pass, but are not parts of working areas. (3) The illumination of open yards and approaches.

In the working area are included the gangways and alleys between or around such working places.

[illegible] general lighting (1) to give an approximately uniform effect throughout the room, (2) to localise general lighting in portions of the room, [illegible] bined local and general lighting. The average practice at present appears to be about 0·45 ft.-candle. For the purpose of an Order, however, the Committee have considered what may reasonably be [illegible] practice, and, consequently, they make the following recommendation:—

2. [illegible] measured on a horizontal plane at 0·25 ft.-candle, without prejudice to the illumination required for the work itself.

Ships under construction and workrooms for certain special purposes are excluded from this recommendation. The Committee have come to the conclusion that the above-mentioned illumination is insufficient for iron foundries and consequently the following recommendation was adopted:—

3. In all parts of iron foundries in which work is carried on or over which any person is ordinarily liable to pass, the illumination measured on a horizontal plane at floor level shall not be less than 0·4 ft.-candle.

Passages, Stairways and Lobbies.—As the result of visits to factories many instances of defective lighting in passages were noticed.

4. In all parts of factories and workshops (not included under recommendation 2) over which persons employed are liable to pass, the illumination measured on a horizontal plane at floor level shall be not less than 0·1 ft.-candle.

Open Yards and Approaches.—In the case of open spaces only a small illumination is necessary.

5. In all open places in which persons are employed during the period between one hour after sunset and one hour before sunrise, and in any dangerous parts of the regular road or way over a yard or other space forming the approach to any place of work, the illumination on a horizontal plane at ground level shall be not less than 0·05 ft.-candle.

6. There shall be power for the Department to allow exemption in individual cases.

7. All external windows of every workroom shall be kept clean, on both the inner and outer surfaces.

To meet exceptional cases there should be power to substitute for the last recommendation a definite scheme for cleaning the windows at reasonably fixed intervals.

The report is followed by a number of appendices giving a great deal of useful information. One of these gives the regulations in force in foreign countries in regard to the lighting of factories and schools. Appendix 10 gives a report by Dr. J. H. Parsons on "The Influence of Lateral Illumination on Visual Acuity." In Appendix 14 are given some results obtained at the National Physical Laboratory on the amount of illumination necessary for working continuously on different materials. Appendix 15 is a record of a number of investigations at factories, various trades being selected.

DR. HELE-SHAW'S ADDRESS TO SECTION "G" OF THE BRITISH ASSOCIATION.*

My own predecessor in this chair in his Presidential Address in Australia, used the words "The discoveries in pure science, and their innumerable applications to practical ends, are ever a potent factor working for the common good." This was after the war had begun, but the truth is that the great majority of us did not realise to what uses science would be put in the mutilation and destruction of our fellow creatures.

Still we are told by soldiers that practically any applications of science constitute legitimate warfare, and that the only way to escape from destruction ourselves is to employ all the resources of science in our own defence. It is on these grounds that the meeting of the British Association for the Advancement of Science has been held this year, because science is proving such an all-important factor in the present war.

The mere holding of this meeting, however, with a vague sort of idea that science is associated with war, does not seem to most of us to meet the real needs of the case. It behoves us all then who are members of it to show that the British Association, which has rendered such great services to the country in the past, can bear its share of the burden to-day. With this object in view I suggest that [illegible] do not institute a fresh one, forming instead a Special Committee, the purpose of which I propose to lay before you. The object of the proposed Committee is two-fold. The first of these would be to undertake any work which may be of use in an advisory capacity or by research, or indeed in any other way for direct assistance in the war. This would, of course, be a temporary object of the Com- [illegible] purpose [illegible]

* [illegible] Dr. H. S. Hele-Shaw, F.R.S., [illegible]

[illegible] refutation of the charge that we deliberately entered the war for sinister purposes, it will be very disastrous if we repeat our unpreparedness when the war ceases, and we shall deserve the worst that can happen to us. When peace is concluded, it will only be a prelude to another war, and a war which will recommence with far greater energy on the part of our enemy than before—viz., the war of commerce—and the latter will be almost as serious for us as the more [illegible]. [illegible] historian (Prof. Gardiner) has writen: "After a long war the difficulties of the victors are often greater than those of the conquered. The conquered have their attention directed to the reparation of losses and are inspired by a patriotic desire to submit to losses for the sake of their country. The victors are in the frame of mind which expects everything to be easy."

It does not want such published evidence to convince any practical person of the folly of thinking that a keen and virile nation having more than 100 million inhabitants is going to be crushed out of fierce and vengeful competition, whatever the end of the war may be. We shall better appreciate what this competition will mean if we consider the marvellous progress made by Germany during the last half-century in the arts and manufactures. Although we cannot say that this is absolutely measured by progress in the production of iron and steel, or even say that the corresponding rate of increase in production during that period by this country directly measures our progress relatively to Germany, still it does afford some indication in the case of the engineering industry. The rate at which Germany has been producing pig iron has been increasing rapidly in the last 50 years. When we come to the percentage relatively to the world's production, we see that while Germany is steadily rising, even in comparison with whole world output, the production of the United Kingdom is falling at an even more rapid rate than that of Germany is rising; for whereas 50 years ago it was more than half the production of the whole world, it is now only 13 per cent., whereas Germany's percentage, which 50 years ago was only 10 per cent., has now risen to 25 per cent. of the whole world production.

While the relative production in steel of this country is now only 10 per cent., Germany has kept for many years the satisfactory figure of a quarter of the whole world's production.

Now, when we look closely into the causes of Germany's great advance, we can learn lessons which we have been culpably slow to take to heart. Although there are other causes, first and foremost, and overshadowing all others, is the determined and whole-hearted organisation of German industry. It is undoubtedly in the matter of scientific organisation even more than the organisation of science that Germany has achieved such wonderful results, and it is therefore in this direction that we must leave no stone unturned if we wish to have any chance of holding our own in the future." I will indicate a few of the matters in which there is ample scope for doing useful work in the above direction.

Education.

A sign of the times is the inclusion of an Education Section in an association for the advancement of science. This has not been done on the narrow ground of improving the teaching of science in schools, but because it is now recognised, and this none too soon, that the whole problem of education must be treated in a scientific manner.

When the subject of engineering education is mentioned we are apt to think only of the training of such engineers as have been considered in a recent report issued by the Institution of Civil Engineers, and to exclude, as that report purposely does, the training of our artisans and foremen. We certainly do not connect the idea at all with the training of the artisan himself. As a matter of fact, while high scientific training of the professional engineer and manufacturer is of [illegible] importance, the proper education of the men whom he will have to control is scarcely less so. The latter education may not be of the same kind, but it is just as vital to the country, and its present condition is a serious evil,

It seems still to be a common idea that if a boy is unable to make any decent progress in the usual school subjects he can be sent to a technical school if he is useful with his hands, under the pathetic impression that the success of the engineer depends upon his hands [illegible] and the first year or two at a technical [illegible] about with work that ought to be done at a secondary school. It is not fair to put all the blame upon the school, for I have known students coming from the classical side of such [illegible] who have taken the highest places in the engineering course, and, after entering their practical work, rapidly risen in the profession, and this was because such men had been well trained to apply their mind [illegible].

Research.

If there is one thing more than another which the British Association can be congratulated upon it is the work which it has done in the matter of research, not only in actually fostering the work of research itself, but in obtaining the recognition which is accorded to-day. To-day there is a more general recognition of the importance of research, and the recent institution by the Government of a Committee for the organisation and development of scientific and industrial research is the latest indication that the nation is beginning to realise its importance.

So far from all this making our work less necessary, there is all the more reason why we should have a permanent Committee of Research. Because our members are drawn from all parts of the British Empire its influence should be correspondingly great. There is another reason for research being a subject of a permanent subcommittee, and that is that suggestions for new work are more likely to be matured, and work of an advisory nature made more practical than is possible at one annual meeting.

There is one subject which affects both education and research, and might be a matter to be reported on by our Committee. It is very rarely that a professor is both a good teacher and gifted with the power of original research. Even when a professor or lecturer is so gifted, however, it is almost impossible for a man to really devote himself properly to research and at the same time undertake the duties which are attached to a professorial chair. Why not face this subject boldly, even relieve the bad lecturer (there *are* men who admit their failure in this respect) of a certain amount of his work, provided he is doing well in research; or for the man who can do both well, see that he not only has efficient assistance, but even more, that he is given the opportunity of devoting long periods (for instance, alternate years) entirely to research.

There is one more subject that we might consider, and that is a better differentiation of researches on purely industrial work, such as are often of a most profitable nature to the professor or research student, and those which are of a purely scientific character. Some steps should be taken as to the fair and equitable distribution of the proceeds.

Exhibitions and Museums.

In recent years a large number of commercial exhibitions have been held of all branches of machinery, and it is satisfactory to note that one of the features of such exhibitions has been the holding of scientific lectures, and the inclusion of the exhibition of scientific instruments and apparatus, and also exhibits showing the relation of scientific experiments to engineering work. In some of the privately organised exhibitions with which I have been associated myself the scientific men have been invited to take part when the general lines had been settled on which the exhibition was to be run, and thus we had comparatively little influence. I have thought from time to time that it would be well if a permanent committee of such a body as the British Association existed which could exert more direct influence, chiefly, of course, by reports and recommendations. The managers and organisers of such exhibitions would value assistance of this kind, and in return would listen to suggestions which might materially add to the scientific value of such an exhibition.

It is sad to think that the great hopes held out of the Imperial Institute by the President of this Association, Sir Frederick Abel, at the meeting held in Leeds in 1890, have not been altogether fulfilled. It may be a very fitting time to bring forward the whole question, because it has often happened that an excellent scheme which has somewhat languished has upon its revival at a later time when its importance was better realised been crowned with success. Another matter which might be considered is the question of departmental museums at the technical schools and universities throughout the country. The organisation of these is simply a matter for the enterprise of the individual professor in each department. The museums in the engineering department of the colleges with which I have been associated were very much appreciated by the students, who constantly were the means of securing fresh specimens, and after they had left the college continued to contribute articles of great interest, such as fractures, corrosions, boiler plates, models, &c. This matter might be handled in a much more systematic manner, and possibly a report from our Committee with a recommendation to the proper quarters would be of use.

Patents and Patent Laws.

This subject is well worthy of the consideration of the proposed committee, since progress in engineering, certainly on the mechanical and electrical sides, is largely dependent upon invention, which is not likely to be seriously undertaken without adequate protection, not entirely for the inventor, but also for those who really make the

invention practical by means of [illegible]. It is of the greatest importance that this country should encourage useful invention and [illegible] for this country. From this point of view facilities for obtaining patents are important. Take, for instance, the case of Colonial patents: within the [illegible] patents made to work [illegible] being, as of old, separate patents with different regulations and fees for each separate colony. Small [illegible] specific invention, [illegible] this object. [illegible] of Colonial patent law as a whole. These are all different and differ from those of the Mother Country. It would be a splendid thing if we could bring about a conference leading to unification of these diverse patent laws and have one comprehensive patent law for the whole Empire.

There are many other matters, for instance, the question of extending the time of secrecy in the provisional patent. The "close" time of patents [illegible] of that great man, but for really many important patents the close time allowed is not enough. Another is one in which the German system has certain advantages—viz., in having two classes of patents. One of these is the patent "proper," which is only granted after the most severe search and criticism, and holds the usual period when granted. The other is a secondary patent granted for the shorter term of five years, and is given for one of the hundred and one minor improvements and devices which, though of real value, only constitute small modifications in detail, and not new applications of principle.

Organisation.

This, I venture to think, is by far the most important question of any I have raised, and I will go so far as to say that I believe it to be the all-important one, as it practically embraces the others. If you do not agree with me, I feel sure it is because we do not understand the same thing by the word "organisation." When you speak of organisation to most people they immediately seize upon some small feature which may be to them of more immediate interest.

Let me, therefore, take the dictionary definition. To organise is to "arrange or constitute interdependent parts, each having a special function, act, office, or relation with respect to the whole." If we accept this definition, which as a matter of fact we must, there is no question as to the all-important nature of organisation, for you will notice there are two outstanding things. The first "interdependent parts," and the second their "relation to the whole." Thus, the subject of organisation really includes the whole of industry. When we come, however, to these interdependent parts and their relation to the whole, it is there that we find the weak joint in our armour. It is in this respect that Germany can teach us a striking lesson in the *arrangement* of these interdependent parts with respect to the whole.

Taking only one detail, I remember, when at Liverpool, and the battle of the Manchester Ship Canal was being fought, what facts came out as to the difficulties in the transhipment and handling of goods. The late Mr. Alfred Holt, for instance, was one of the most earnest in pointing out that the want of co-operation and organisation in getting goods from our manufacturing centres was adding largely to their cost, and actually exceeded the cost of transporting these goods across the ocean. In Germany, on the other hand, the Government steps in, and, by means of special differential rates, gives the manufacturer every facility, and the lowest possible rates for obtaining raw material, and delivering the finished goods to all parts of the world.

Now, the German knows perfectly well there are innumerable individual cases of organisation in this country of equal efficiency to any in his country, and he is glad enough to learn from special cases. I do not believe the Germans despise us for [illegible] of the application of science to industry. I do not think they have much reason to; but what they do despise us for is the want of co-ordination, which I venture to say amounts to positive slackness, which they are keen enough to observe, permeating the whole of this country. They see different sections, instead of being united for a common end, quarrelling with each other, filled with mutual suspicion and distrust, with apparently no common bond of union; and whereas the German is proud of the Fatherland, he sees in this country large numbers who seem, either through self-consciousness or ignorance, to be ashamed to mention the subject of the British Empire, or, what is worse, to acknowledge that any love of their country is or could be a [illegible] to [illegible].

The other day Field-Marshal von Moltke stated, and there is no reason to disbelieve him, that, great as was the storage of ammunition and shells before the war, the enormous demand exceeded all expectations, and Germany found herself [illegible] the same plight as her enemies; but he further stated that Germany's emergence "from this dangerous position was largely due to the extraordinary organisation, which included not merely the adaptation of their factories for munition purposes, but *capacity for work of the people* and the *patriotic spirit of the German workmen*."

This brings me to consider what is probably the most serious feature in our national life to-day, which I have already alluded to under the heading of education—viz., the relation of employer and workman. It is hopeless, as long as such ideas prevail which seem to do at present, to think of any sound organisation of our industrial system taking place, because the interdependent parts are not arranged (and can never be arranged until we change radically) with respect to the whole. I am the last man to put this evil down entirely to the working man. I know individually he is just as capable of patriotism as any other class. The truth is that the canker which is eating the heart out of our industrial life is due to an entirely wrong attitude of mind. For instance, however much we may sympathise with men who see a loss of employment in the introduction of labour-saving machines, some means should be found by which they can share the benefits to the State and to their employers by the introduction of such machines. Again, the questions of piecework and overtime must be seriously considered by the State, and not allowed to become the subject of disastrous disputes. Once more there is the question of a standard wage. It is against the eternal laws of Nature to try and keep living beings at one dead level of equality and merit—*i.e.*, it is against the law of the survival of the fittest.

The matter of labour disputes is so serious as to demand plain speaking. It must be admitted that there are many employers and companies which, to satisfy themselves and their shareholders, extort the largest possible dividends and pay the smallest possible rate of wages, and do so apparently without the slightest idea that the men and boys under them are capable of education and personal influence. Can it be wondered, then, that men under these conditions are willing enough to listen to the orator who merely appeals to their fighting instincts, and join in the game of grab as against the employer? On the other hand, strikes have occurred when employers have honourably carried out their obligations and undertakings, and the men have shamefully departed from an agreement made by their chosen leaders, throwing over the leaders the moment they have fancied it to their own selfish interests to do so, and without a single thought of their duty to the community as a whole.

We have recently seen the Prime Minister and other leading statesmen struggling, sometimes in vain, to bring large bodies of men to a reasonable state of mind. Is not this (and I speak without the slightest reference to party questions) a case of Nemesis overtaking us for having in so many cases pandered to the selfish instincts of large bodies of men in order to secure their votes, instead of sternly telling them unpalatable truths?

The other day a writer in the "Spectator" said with great truth that "what Great Britain is suffering from acutely and dangerously at the present time is the absence of discipline." One of the tasks to which the British Association might bend its energies with the greatest benefit to the country is to bring about a reform of our educational system, so that while we do not kill individual enterprise and freedom of thought, which have contributed so largely to the political organisation and constitution of the British Empire, of the value of which we have had such wonderful evidence from our colonies and dependencies during this war, we seek to implant in the minds of young and old those ideas of discipline and service to the State, the want of which so seriously threatens the successful organisation of our industrial life.

In bringing my address to a close, I hope I have made it clear that I have had throughout a practical object. Expressed briefly, it is that the service of every agency is wanted for definite work at this crisis, both in the actual war and afterwards in the war of industry which will be waged with equal intensity in peace time. I have not the slightest faith in the mere formation of a committee which will content itself, let us say, with the mere offer of its services, even to a Government department, and the mere pious expression of certain opinions. If a committee does not want to become ridiculous, it must show that it is in earnest. We cannot all of us be, as so many would like, in the fighting line, either in France or the Dardanelles, but we shall be just as deserving of contempt as those who, having had the opportunity of service, have shirked their responsibilities, or the giving up of their sons, and are even thinking of the war as a matter of personal gain, either in purse or reputation, if we content ourselves with mere offers of service, and having, as we think, shelved responsibility by leaving initiative to others, we pass along our way sheltering ignobly behind those men and women who are doing their duty to their country.

CORRESPONDENCE.

STATE AID FOR INDUSTRIAL RESEARCH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: You have done me the honour to ask my opinion on the question "whether our industries are suffering from lack of research, and what steps our manufacturers should take to remedy this state of things if it exists: (1) by research departments in their own works or (2) by research in public institutions."

I take it that your question refers to engineering, and more especially to electrical engineering.

The answer to your question must largely depend on the meaning of the term research. If it means the kind of work that is being done by staff and students at all our universities, there is certainly no lack of research. Nor need there be lack of research if manufacturers will avail themselves of that public institution, the N.P.L., with its splendid equipment and highly trained staff of scientific men. You may perhaps object that, as far as research at universities goes, it is not of the right kind, because a student, or perhaps also a member of the junior staff, undertakes such work for a degree, and not with the object of helping the industry. The objection may be true in a few cases, but generally speaking, I feel convinced, that in the selection of an object of research the idea of usefulness does play a part, and although the man undertaking a research, or the professor recommending a particular object for research, may sometimes be mistaken in the estimate of its usefulness, he cannot always be mistaken; so that out of the great number of investigations that are made annually in our universities we may reasonably assume that a good many are of practical utility. As for the N.P.L., since no manufacturer will pay for a useless research, we may take it that the work done there is all helpful to the industry. Whether manufacturers are always ready to utilise the results obtained in research work is another question. As far as material for such utilisation goes there is no lack, and your question can, therefore, not refer to research of that kind.

There is, however, another kind of research, and possibly you had that in mind when you posed your question. The kind I mean is not research in the generally accepted meaning of the term, but had better be called "experiment on a large scale." Take, as an instance, the many details that have to be attended to in the construction of a 15,000 kw. turbo-alternator. Some of these might, perhaps, be worked out in the laboratory of a university, but many are quite beyond the resources of such an institution, or are of such a nature that they can only be settled in conjunction with other parts, so that really reliable results can only be obtained with the complete machines. Or take the production of nitrates by means of an alternating-current arc. It is no use playing with an apparatus of 20 kw. or even 100 kw., for the size of the plant has an enormous influence on efficiency. Obviously, neither the university nor the N.P.L. could help in this kind of research; the work must be done by the scientific staff of the manufacturer and with the actual plant made. To adopt your second alternative for this kind of research does not seem to me to be [illegible]. Apart from the enormous expense for the establishment of a laboratory for experiments on a large scale, there is the difficulty that principles to be investigated and actual methods of construction are so intimately connected that a solution applicable to all makes of machines or apparatus will seldom be reached.

[illegible] dividends have been earned are good enough to retain. We see the same tendency to experiment on a large scale in America. The General Electric Co. have an enormous research laboratory which has lately been described in their "Review." The work done there is of the highest utility and scientific value, as a glance through the pages of the "General Electric Review" will show. It is quite clear that such an institution detached from the manufacturing part of the establishment could not do its work properly. It is the combination of the works with the research laboratory which gives to each increased value. There is the question of expense in equipping and running such a laboratory. A manufacturer who prides himself on being a good business man will never hesitate to buy a new machine tool if he sees that by doing so he will get a return for his outlay. With the machine tool the return is tangible; the costing clerk can show to a penny how much the tool has saved in a year. Such a thing the good business man can understand, but if it comes to what may be termed intellectual tools, a staff of trained scientists and a well-equipped laboratory, there is no immediate tangible result. The costing clerk can only tell his master what it costs to run the scientific part of the works, but he cannot put the ultimate advantage into figures.

As far as the electrical industry is concerned, the attitude of the manufacturer is changing towards a better appreciation of science. Electrical plant made here is now quite as good as that made in America, and in some cases better than German plant. Manufacturers are now employing scientific methods to a greater extent than 10 years ago, but they might with advantage go further in the same direction, including the establishment of research laboratories. To employ more scientifically trained engineers, both in design and in research, will cost money, but it will pay in the end.—I am, &c.,

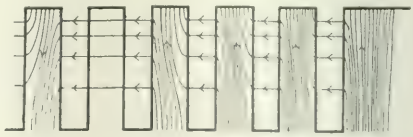
Birmingham, Sept. 2. GISBERT KAPP.

THE POLE LEAKAGE OF TURBO-ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Jakeman's article is of interest as it deals with a matter which, in the early days of cylindrical field turbo-alternators, was to a certain extent obscure.

A curious mistake occurs at the beginning of the article. Mr. Jakeman states that "*the outside coil of each pole produces only leakage flux, and no useful flux whatever.*" Actually the outside coils are the *most active*, and *produce more useful flux* than any of the others, since they embrace the greatest number of the rotor teeth.



So far as the leakage across the rotor slots is concerned, the phenomenon is even more interesting than would appear from Mr. Jakeman's article. The diagram given above indicates roughly the paths of the lines, non-magnetic wedges being assumed as a matter of convenience. From the diagram it will be seen that there is a leakage from tooth to tooth, practically the same distribution holding good across all the slots containing the rotor winding. The effect of this leakage is simply to transfer the magnetic lines from one tooth to the next, the final leakage taking place between the poles.

[illegible]

have such large wedges that the flux required to saturate them would also saturate the rotor teeth, a condition not likely to be realised in practice.

Since these teeth only carry altogether 2 or 3 per cent. of the total flux, however, the error obtained by omitting this small flux is not likely to be of great importance, but there is no justification in so doing, for normal machines.

One further point. May I suggest that the term "non-salient pole alternator" be abandoned? It is surely logical to employ a term which describes the construction of the machine, instead of a term which describes how it is *not* constructed. The machines might well be called "alternators with cylindrical rotors" or "cylindrical field alternators."—I am, &c.,

Rugby, Aug. 31. A. E. CLAYTON.

THE ALLOA DECISION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In arriving at his decision, the Sheriff appears to me to have been influenced by the following considerations:—

An owner of premises to be lighted, determining to *manufacture electricity* for the lighting of his premises, has to consider as to the nature of the power he will employ for that purpose and the following sources would naturally be discussed:—(*a*) Water power (if available); (*b*) Steam; (*c*) Gas; (*d*) Oil; (*e*) Electricity. He would then make his choice and instal a machine for the manufacture of electricity which could be operated by the chosen power. In each case, the power so selected would be *completely used up in the generating machine*, and a distinct and separate product evolved.

It, therefore, seems to me that, in the absence of any special restrictions either in the agreement for supply or in the private or public Electricity Supply Acts, he would be entitled to use the energy as "power."

The first sub-section of section VII. of the London Electric Supply Act of 1908 fixed the price to be charged for *power* at £6. 15s. per kilowatt per annum of the maximum power required to be supplied and 0·50d. per B.T.U. for all energy supplied. The section further provides:—

"For the purposes of this section the expression 'power purposes' shall include all purposes to which electrical energy may be applied *other than for use either directly or indirectly for lighting*."

By sub-section IV. of the same Clause 7 it is provided that: "Any supply given for power purposes under this section shall, if required by the authorised undertaker be measured by a separate meter or other apparatus and any person receiving a supply for power purposes who shall use the energy directly or indirectly for the purposes of lighting shall be liable to a penalty not exceeding £5 and to a further penalty not exceeding £5 for every day on which he uses such energy for such purposes in addition to the sum payable for the energy so used at the price charged by the authorised undertaker by whom the supply is given for a supply of lighting purposes."

To prevent this prohibition being evaded by the installation of a motor generator or other electrical device the word "indirect" was inserted in the section.

The object of the owners of the Variety Theatre at Alloa, in addition to the reduction of pressure and economies resulting was to obtain the current at power prices and to escape their liability to pay lighting rates, which they would have to pay under normal conditions of supply.

A practice has grown up among electricity undertakings of differentiating charges for power and lighting purposes respectively, and in the case of power it has been assumed that the power supply will have a considerably higher load-factor than the lighting supply, and therefore, for convenience and as a method of stimulating the use of electric energy for manufacturing and industrial purposes, a low price has been charged for "power" units. In most cases the provisional orders fix the maximum price in the schedule attached to the order. In some cases these are maximum prices for light and power combined, but in some of the later orders there are two different maxima inserted in the schedules, one for lighting and the other for power. In the earlier orders, therefore, it would be quite competent for the companies or local authorities affected to publish a new set of power rates which would meet the case. To do so, however, would create difficulties as to price with true "power" users. In cases where low power rates are fixed in the schedule to the provisional order a much more serious position will probably arise and one which could only be revised by Parliament.

Although Clause 7 and the principles involved were discussed in Committee of Parliament and inserted in the Special Act of 1908, the General Act of 1909 did not incorporate a similar clause for the protection of electricity undertakers, and if I am right in the views expressed in the earlier part of this letter, the position is likely to be a rather serious one for the unprotected companies and local authorities.—I am, &c.,

London, Aug. 25. OBSERVER.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Carl Hering, in your issue of the 3rd inst., refers to my letter in your issue of July 30, in which I "advance the suggestion . . . of an explanation as to why we should avoid drawing the conclusions which I [Dr. Hering] did—namely, that the conductor itself, physically, must cut the flux to produce induction, and that a cutting of the circuit alone, the conductor being at rest, will not produce induction." Dr. Hering quotes Prof. Blondel's experiment in support of his own deduction.

In my opinion Prof. Blondel's experiment No. 3 (THE ELECTRICIAN, June 11, p. 345) and Dr. Hering's experiment are both inconclusive. They are electrically very nearly identical, and the weak point in each is that the galvanometer is shunted—in the one case by the heavy copper block and in the other by the disc.

Dr. Hering predicts that the experiment I have suggested will give the results "I desire" owing to the presence of stray fields, &c. My experiment reduces the effect of stray flux to a minimum, and I think the results would show that there are no "eddy" currents, and hence no induction. If my surmise proves to be correct this experiment may then be said to confirm the theory expounded by Dr. Hering, and the deduction from Prof. Blondel's experiment.

Dr. Hering points out the similarity between Prof. Gheysens' experiment (Fig. 3) and "what is done in the ordinary direct-current generator by the commutator." Is not Dr. Hering's proposed experiment with the insulated laminæ very similar also, and for this reason unnecessary?

Prof. Gheysens, in your issue of August 6th, says my proposed experiment is useless because "if there was a current we should witness the production of Joule effect and mechanical energy (if we care to utilise the electromagnetic force in the block). In fact, energy cannot be developed, as there is no corresponding power to provide for it, and thus the electric currents cannot exist nor can there be any induced E.M.F." The first paragraph is not altogether clear, but, of course, there is no question that the heat effect would be present if the current flowed in the block and absent it it did not. Agreed also that heat or any other form of energy cannot be developed in the block without expenditure of power. Clearly the seat of power would be in the force producing motion of the sliders.

The point that I am interested in is summed up in the following paragraph of Prof. Gheysens: "In Mr. Hering's experiment the very existence of the E.M.F.s is questioned. If such E.M.F.s were induced they would be set up in the very mass of the block C or in unknown parts of the circuit. In my opinion, this increases the difficulties of the problem." I dismiss the question of currents or E.M.F.s "in unknown parts of the circuit," and suggest an experiment to settle the matter of currents in the block.

In conclusion, I can assure Dr. Carl Hering that, like himself and all others whose path in life is among the exact sciences, I am an earnest seeker after truth. Let us dismiss other aspects of the question to the region of politics!—I am, &c.,

Chelmsford, Sept. 5. HUMPHRY MACCALLUM.

SELLING ORGANISATION IN THE ELECTRICAL INDUSTRY AFTER THE WAR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir,—It [illegible] for your readers [illegible] these apply to the Spanish market, the general consequences bear also on all neutral markets and indirectly on the Allied markets.

You may [illegible] Lamp industry in Spain was, up to a few weeks ago, almost the following: Spanish industry produces Spanish made lamps at cheap prices, yet there was an opening for foreign industry in spite of the heavy import duties in Spain. Since the entry of Italy into the war German lamps have been almost entirely prevented from entering Spain. Now, however, I have definite information that German well-known brands are again finding their way into Spain from Switzerland, *where factories have been started* [illegible] *allowed to pass through France as being Swiss goods.* In this way these so-called Swiss lamps are offered approximately 30 per cent. cheaper than any other lamps from the Allied countries.

It is urgent that the attention of the French Government should be drawn to the fact that some Swiss products are not purely Swiss, but are of German origin. If we fail to stop this kind of competition during the war, what will happen after the war, when apparently all German [illegible] Swiss or Dutch? This question is of the highest importance, and steps should be taken in France to examine the position.

Incidentally, I would point out that the very low quotations adopted now by German manufacturers in the lamp business for their export goods show that, as has been disclosed in different quarters, the German industry is working heavily on stock and making ready to flood all neutral markets, and thence our own countries, after the war if we do not stop this effectively, not merely with certificates of origin, but by absolute control of the producing industries and their ultimate nationality.

We should be really too simple if, after the terrible strain put on all the Allied countries, we were not intelligent enough to reap the benefits of our sacrifices.—I am, &c.,

London, Sept. 2. R. STEYLAERS.

LONDON-BIRMINGHAM-LIVERPOOL TELEPHONE CABLE.

In consequence of the rapid growth of telephone traffic between London, Birmingham and Liverpool, the British Post Office [illegible] underground telephone cable between the three cities. Standard quadruply duplex cable, each unit formed of 31 insulated copper wires, have been laid between the centres.

The [illegible] copper conductors, [illegible] are twisted in pairs and the pairs then being twisted together to form a unit. In the [illegible] the units are laid in [illegible] layers. The number of units in each layer is as follows:

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	14	[illegible]	266
Second layer	... 12	.. ..	.. 150 ..
	24		900

[illegible] are designed for a working pressure of 2,000 volts. The [illegible] are protected by a lead sheath, and the cable has been [illegible] Post Office and the cable was laid by the Telegraph Construction and Maintenance Company, Limited, [illegible] Monarch. [illegible] Wireless Telegraph Company of New Zealand, Limited, [illegible] Wellington, New Zealand, [illegible] Wireless Telegraph Company of Australasia, Limited, [illegible] Australia, [illegible] Wireless Telegraph Company of Canada, Limited, [illegible] Canada, [illegible] Wireless Telegraph Company of South Africa, Limited, [illegible] South Africa, [illegible] Wireless Telegraph Company of India, Limited, [illegible] India, [illegible] Wireless Telegraph Company of Egypt, Limited, [illegible] Egypt, [illegible] Wireless Telegraph Company of Ceylon, Limited, [illegible] Ceylon, [illegible] Wireless Telegraph Company of Malta, Limited, [illegible] Malta, [illegible] Wireless Telegraph Company of Gibraltar, Limited, [illegible] Gibraltar, [illegible] Wireless Telegraph Company of Hong Kong, Limited, [illegible] Hong Kong, [illegible] Wireless Telegraph Company of Singapore, Limited, [illegible] Singapore, [illegible] Wireless Telegraph Company of Penang, Limited, [illegible] Penang, [illegible] Wireless Telegraph Company of Malacca, Limited, [illegible] Malacca, [illegible] Wireless Telegraph Company of Java, Limited, [illegible] Java, [illegible] Wireless Telegraph Company of Sumatra, Limited, [illegible] Sumatra, [illegible] Wireless Telegraph Company of Borneo, Limited, [illegible] Borneo, [illegible] Wireless Telegraph Company of Celebes, Limited, [illegible] Celebes, [illegible] Wireless Telegraph Company of Timor, Limited, [illegible] Timor, [illegible] Wireless Telegraph Company of Flores, Limited, [illegible] Flores, [illegible] Wireless Telegraph Company of Sumbawa, Limited, [illegible] Sumbawa, [illegible] Wireless Telegraph Company of Lombok, Limited, [illegible] Lombok, [illegible] Wireless Telegraph Company of Bali, Limited, [illegible] Bali, [illegible] Wireless Telegraph Company of Madura, Limited, [illegible] Madura, [illegible] Wireless Telegraph Company of Java, Limited, [illegible] Java, [illegible] Wireless Telegraph Company of Sumatra, Limited, [illegible] Sumatra, [illegible] Wireless Telegraph Company of Borneo, Limited, [illegible] Borneo, [illegible] Wireless Telegraph Company of Celebes, Limited, [illegible] Celebes, [illegible] Wireless Telegraph Company of Timor, Limited, [illegible] Timor, [illegible] Wireless Telegraph Company of Flores, Limited, [illegible] Flores, [illegible] Wireless Telegraph Company of Sumbawa, Limited, [illegible] Sumbawa, [illegible] Wireless Telegraph Company of Lombok, Limited, [illegible] Lombok, [illegible] Wireless Telegraph Company of Bali, Limited, [illegible] Bali, [illegible] Wireless Telegraph Company of Madura, Limited, [illegible] Madura.

Loading or inductance coils have been inserted in each circuit at 2½ mile intervals along the route, the cases containing the coils being accommodated in underground [illegible] chambers. All loading coils are of the Western Electric Co.'s type.

The [illegible] attenuation constants per mile and those actually obtained after completion of the [illegible] Birmingham length, are given below:—

Weight of each wire per mile	Attenuation constant per mile, 800 p.p.s.*	
[illegible]	[illegible]	Observed.
300 lbs.	0·00383	0·00408
200 ,,	0·00684	0·00664
150 ,,	0·00875	0·00884
100 ,,	0·01314	0·01074

*The [illegible] current strength per mile.

The results on the superposed (phantom) circuits are equally satisfactory, and the attenuation constants of such circuits are somewhat less than those of the physical loops from which they are formed.

Conversation between London and Birmingham direct over any loop in the cable is excellent, and no inductive disturbance is obtained from other loops in use. Speech trials have been made over various lengths of loop formed by doubling to and fro between London and Birmingham, thus:—

(*a*) London to Birmingham and back on two 300 lb. loops, equal to 221 route miles, or roughly equivalent to a London–Liverpool length. The speech was very loud and distinct.

(*b*) The same route length as in (*a*), but using 200 lb. loops. The speech was still very loud and distinct.

(*c*) London to Birmingham and back on four 200 lb. loops, equal to 442 route miles, or roughly equivalent to a London–Glasgow length. The speech was still very good.

(*d*) The same loops as used in (*c*), but with the addition in series of two 300 lb. loops between London and Birmingham, making in all 663 route miles, or roughly a London–Aberdeen length. Speech [illegible] which might be regarded as the [illegible] had. [illegible] which we had an opportunity of speaking over this circuit the speech was excellent.

(*e*) The same loops as used in (*d*), but further extended by two 200 lb. loops between London and Birmingham, making in all 884 route miles. In this case speech was just possible, but not quite commercial.

Similar trials made on the phantom circuits give equally satisfactory results as regards speech transmission, and although during the trials there were 21 trunk circuits working in the cable, there was no observable interference from other physical or phantom circuits.

One novelty in the cable is the provision of the heavy (300 lb.) conductor-loaded loops; the heaviest loaded conductors previously laid underground anywhere being slightly under 200 lb. per mile. The excellent results obtained are a credit to the engineering staff of the Post Office and to the contractors. Although equally good or better results may be obtained by using lines wholly overhead, it does not yet appear that equally good results can be obtained when the route has to be [illegible] partly overhead and partly of underground wires.

ANNUAL REPORT ON MINES AND QUARRIES.

Part I. of the 1914 [illegible] Inspection of Mines and Quarries has just been issued. This contains the divisional statistics for the year, and will be followed by other [illegible]

[illegible] 981,264

[illegible] 7,241,181 persons, [illegible] 21,365 [illegible] 1,745,828 [illegible] 114 [illegible] The total

number of [illegible] for more than seven days was 158,541 at mines under the Coal Mines Act, by which [illegible] persons were injured, at mines under the Metalliferous Mines Act, 1,612, by which 1,624 persons were injured; at quarries under the Quarries Act, 4,652, by which 4,664 persons were injured. Compared with 1913 there is a decrease of 18,327 in the number of persons injured at mines under the Coal Mines Act, of 149 at mines under the Metalliferous Mines Act, and of 576 at quarries under the Quarries Act.

The deaths put down directly to electricity amount to four underground and four on the surface in the coal mines, and only one (on the surface) in the metalliferous mines. No deaths from this cause have occurred in quarries. There were 36 persons injured by electricity in coal mines, but no non-fatal injuries from this cause in metalliferous mines or quarries.

LEGAL INTELLIGENCE.

The Effect of War on Contracts.

An important judgment was delivered in the [illegible] Mr. Justice Bray in the action brought by the Zinc Corpn. (Ltd.) against Aron Hirsch & Sohn for a declaration that a contract for the supply to a German firm of a large quantity of zinc concentrates was dissolved on the declaration of war on Aug. 4, 1914.

In the course of his judgment, Mr. Justice Bray said plaintiffs were a company registered in this country, whose main business was to make zinc concentrates at Broken Hill, Australia, and defendants were metal merchants and smelters carrying on their business at Halberstadt, Germany, and were therefore, when war was declared, alien enemies. On Dec. 14, 1908, a contract was entered into between defendants and a company of the same name as the plaintiffs (but registered in the State of Victoria, Australia) for the sale by that company to defendants of 355,000 to 385,000 tons of zinc concentrates produced or to be produced at Broken Hill. On June 20, 1910, a further contract was entered into between the same parties modifying the previous contract, and providing that the company should sell to defendants the whole of their production of zinc concentrates, and that so long as that agreement should be in force they should not sell zinc concentrates to anyone else than defendants. On July 9, 1911, plaintiff company was formed, and on April 4, 1912, a new contract was entered into between the first company, the plaintiff company and defendants, by which plaintiffs undertook to perform the two previous contracts with defendants. This contract was acted upon until a few days before Aug. 4, 1914, when defendants gave to the plaintiffs notice that they would discontinue taking ore, and deliveries of zinc concentrates by plaintiffs to defendants thereupon ceased. On the facts plaintiffs contended that the outbreak of war rendered the further performance of the contract illegal, and that it was dissolved. Defendants contended that it was merely suspended during the continuance of the war, and they relied mainly on clause 17 of the contract of 1908. His Lordship thought that, apart from that clause, the contract would be dissolved. After citing Janson v. Driefontein Consolidated Mines and Esposito v. Bowden, he said that if the performance of any term of the agreement or the exercise of any right or option given by it be rendered unlawful the whole agreement was dissolved. The Court could not substitute for the agreement made by the parties an agreement minus one of its terms. The parties had never so agreed. It was not contended that the agreement in question was severable, though defendants contended that the effect of clause 17 was to provide that all trading and all occasion for commercial intercourse would be suspended during the war, and consequently nothing illegal would be done under the contract during the continuance of the war. The contract would be performed without any illegality by either party, and, therefore, there would be no ground for its dissolution. He thought that contention would be sound if it were clear that that was the true effect of clause 17. It becomes necessary, therefore, to consider that clause, and after reciting the terms of the clause, he said he felt satisfied that if the parties had contemplated the outbreak of war between Great Britain and Germany they would have made special provision as to what was to happen. Apart from the [illegible] the specified causes for suspension which could include war were force majeure. He did not think that those words were apt words for war, particularly having regard to the context. "Restraint of Princes" was not to be found in the clause, nor was there any similar expression. If war was included it must be under the general words "or in the event of any cause beyond the control of either the sellers or the buyers." Was the rule ejusdem generis to apply? If it was not, those words were wide enough. He inclined to the view that war was not included in the clause as a cause, but he preferred to base his decision [illegible] by plaintiffs—namely, that assuming war to be included the meaning of the words "this agreement shall be suspended" was that deliveries were to be suspended and that in other respects the provisions of the agreement were to be in operation, in which case something illegal might have to be done. The natural meaning of the words "shall be suspended" was to [illegible] and that all rights and obligations of each of the parties were to cease during the continuance of the cause. He came to the conclusion that plaintiffs' contention was correct, and that suspension [illegible] meant only suspension of deliveries. On the whole, though not without much doubt, he construed the words of the clause as providing only for suspension of deliveries of ores, and that there would still remain things to be done and rights to be exercised, which after the outbreak of war between Great Britain and Germany, would be illegal. It resulted, therefore, that the contract was dissolved on Aug. 4, 1914, and that plaintiffs were entitled to a declaration to that effect.

Pocket Electric Lamps.

In the City of London Court last week, before Judge Rentoul, K.C., Mr. E. B. Holmes sued Mr. P. Patterson for the recovery of £1. 8s. 8d. for injuries alleged to have been caused to his clothing by a defective flash lamp.

For plaintiff (a special constable) it was stated that he bought a pocket electric lamp from defendant with a guarantee that it could be put into the pocket without danger of leaking. The first lamp leaked and plaintiff took it back, and a new accumulator was given to him which proved to be worse than the first, as the sulphuric acid leaked and burnt his clothes.

In his evidence, PLAINTIFF said that when defendant told him the lamp could not leak he showed that it was packed with gauze which would absorb the acid.

DEFENDANT said that the lamp was absolutely safe if used properly and carefully.

Judge RENTOUL said the bare fact that defendant had sold the lamp was a guarantee that it was fit for use, and a pocket electric lamp was not fit for use if it leaked.

DEFENDANT denied having sold the accumulator as being unspillable; they all had a percentage of sulphuric acid, and it was impossible to make an accumulator without it. No maker would guarantee such a thing, and there was nothing on the lamp to say that the acid was unspillable.

Judge RENTOUL thought the lamp ought not to leak; nobody would buy an electric flash lamp if he knew it was going to leak and burn holes in his clothes.

DEFENDANT, who gave a demonstration of the working of a lamp in court, said no manufacturer of pocket lamps would dream of undertaking any responsibility for leakage. Every accumulator had loose acid in it, and if it was turned upside down it would leak. Plaintiff had used his lamp carelessly and had caused it to leak.

Judge RENTOUL said the lamp on his desk had not leaked, but defendant was responsible for leakage unless he could prove that electric pocket lamps could not be made without leaking.

DEFENDANT said the lamp was not for carrying about in the pocket, but for household use and to put on bicycles.

Ultimately the JUDGE said that, in his view, unleakable lamps could be made, and electric pocket lamps should not be sold if they leaked. He therefore found for the plaintiff, with costs.

Employment of War Workers.

On the 2nd inst. Mr. Robert Wallace, K.C., chairman of the Metropolitan General Munitions Tribunal, sat to hear cases coming within the jurisdiction of the tribunal.

Messrs. Esther Bros., a [illegible] and founder, made a complaint against Messrs. Steel, electrical engineers, for employing one of their employés contrary to provisions of the Defence of the Realm Act. The representative of the employés stated that a youth named Arthur Sands commenced at Xmas, 1914, but he was sent to another firm, and it was pointed out to him that it was an offence. Shortly afterwards he left and went to Messrs. Steel, without the necessary certificate. Messrs. Estler wrote to Messrs. Steel asking them to cancel the engagement, and in their reply the latter firm asked for an explanation of "that impertinent letter."

For Messrs. Steel it was stated that they asked the youth if he was on war service, and he said he was not.

Mr. WALLACE, K.C.: Did you communicate with his firm?

The REPRESENTATIVE: No. We simply asked if he was on war service. Our men are not given certificates.

Mr. WALLACE: Well, they will have to find out that they have got to get them. You must get rid of this youth.

The REPRESENTATIVE: But we are short of men.

Mr. WALLACE: That is why the Act is passed—so that men shall not prey upon each other. Will you undertake to get rid of him?—I suppose we must.

Mr. Wallace said Messrs. Steel would be fined £10 on condition that he was got rid of the youth. The penalty would be heavier next time.

EDUCATIONAL NOTES.

University of London, King's College.—The faculty of engineering provides complete courses of study extending over either three or four years in civil, mechanical and electrical engineering, for the engineering degrees of the University of London, and for the diploma and certificate of the College. The four years' course provides, in addition to [illegible] opportunity for practical training in works. The next term begins on Wednesday, Oct. 6, and full particulars may be obtained from the Dean or the Secretary, King's College, Strand, W.C.

University of Edinburgh. The University provides courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. in engineering and extending over three years. The next session will open on Oct. 12. A preliminary or entrance examination is held this month. Full particulars from the Matriculation Office.

University of Bristol.—The following candidates have been successful at the examination for the award of Merchant Venturers' scholarships tenable in the faculty of engineering: Charles Longsford, Callington County School, and John Carley Read, Crewkerne Grammar School.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

Royal Technical College, Glasgow.—The day courses commence on 28th inst. and the evening classes on 23rd inst.

The diploma of the College is granted in civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, &c. The diploma course extends over three or four sessions, and the College is affiliated to the University of Glasgow, the degrees of the University in engineering and applied chemistry being open to its students. There are also full courses of instruction in the schools of navigation and wireless telegraphy. The calendar, price 1s. (post free 1s. 4d.), and prospectus (free) may be obtained from the Director.

The calendar for the 120th session (1915-16), which has just been published, contains full particulars of the courses of instruction in the day and evening classes, fees, bursaries, examination papers, &c. Prof. Magnus Maclean, M.A., D.Sc., is head of the electrical engineering department and is assisted by a competent staff of lecturers and demonstrators. There are well-equipped laboratories, with good facilities for practical work.

Northampton Polytechnic Institute.—The session 1915-16 will commence on October 4 next. In the engineering day college there are full-day courses in the theory and practice of civil, mechanical and electrical engineering.

The courses in civil and mechanical engineering include specialisation in automobile and aeronautical engineering, and those in electrical engineering include specialisation in radio-telegraphy. (These courses include periods spent in commercial workshops and extend over four years. They also prepare for the degree of B.Sc. in engineering at the University of London.) The entrance examination will take place on Sept. 28 and 29. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examination which will be held this month.

In technical optics there are full and part-time courses in all branches, and instruction is given in specially equipped laboratories and lecture rooms. An Aitchison scholarship (value £30) will be offered in this department at the entrance examination. Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to the principal, Dr. R. Mullineux Walmsley, St. John-street, London, E.C.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses, giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

Battersea Polytechnic, London, S.W.—At this Polytechnic there [illegible] for the B.Sc. Engineering Degree of London University, and for the Polytechnic Diploma, and two evening courses in d.c. and a.c. work, electrical design, generation and transmission, electric lighting, [illegible] may be obtained from the Secretary.

Bradford Technical College. The [illegible] of instruction at the College include diploma courses (which afford full training for the [illegible] engineering, and also courses in mechanical engineering, [illegible] engineering, and [illegible] engineering.

There are well-equipped chemical and physical laboratories, and arrangements have been made with the University of Leeds whereby students [illegible] the laboratories of that College have the use of certain [illegible] apparatus.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

[illegible]

1908. Siemens & Halske Akt.-Ges. Telephone [illegible] which the subscribers' [illegible] are connected [illegible] the frequency of the [illegible] (25 9 13. Addition to 28,751 12.)

16,661 Siemens-Schuckertwerke Ges. Means for pulling off electrical overhead conductors or contact wires. (12 7 13. Addition to 30,045 13.)

16,860 Siemens-Schuckertwerke Ges. Protective arrangements for electric installations. (15 7 13.)

Protective arrangements for electric circuits, in which the time lag of the release device of each of the circuit breakers depends on the current strength, but has a lower limiting value which is set in accordance with the position of the said circuit breakers in the circuit, so that this limiting value is progressively greater for the circuit breakers nearer to the main bus bars.

17,379 Siemens-Schuckertwerke Ges. Automatic protective devices or cut-outs for electric circuits. (23 7 13.)

17,548 Siemens-Schuckertwerke Ges. Arrangements for regulating the working of electric hauling or winding machinery. (26 7 13.)

17,602 Rockstroh. Controlling devices, especially applicable for use with electrically-operated printing and stamping machines. (Addition to 4,678 10.)

18,261 Johns. Motor-starting rheostat.

18,442 Oldham. Electro-magnetic unlocking and unscrewing apparatus for miners' lamps. (Addition to 2,249 14.)

18,504 Carpenter. Electric igniting-apparatus for gas burners.

18,509 Swyers. Electric switches.

19,506 Wilson. Electric condensers. (Cognate application 3,660 15.)

19,729 Deutsche Gasglühlicht Akt.-Ges. (Auerges.) Electric incandescent lamp. (13 9 13.)

20,374 Donath. Electric discharging tubes. (10 10 13.)

An electric discharging tube having an incandescent cathode consisting of a refractory container of good electrical conductivity made of thin perforated sheet or woven wire or the like, and filled and coated with metallic combinations.

20,556 Glendall. Switch for testing telegraph lines.

21,448 Ges. für Elektro-Osmose. Process for purifying and separating the constituents of glue, gelatine, or bodies like glue or containing glue, with aid of the electric current. (2 3 14.)

21,560 Marks. (Aluminium Co., of America.) Composite conductor cables and method of making the same.

22,113 Burdon. (Siemens-Schuckertwerke Ges.) Overhead conductor arrangements for use at cross-overs or switches on electric railways or the like.

23,160 Findlay. Electric sound for detecting presence of metallic bodies in living animal tissues.

A sound or probe for telephonically communicating the presence of metallic bodies in living animal tissues, comprising a metallic rod passing through a metallic tube and insulated therefrom by an intervening layer of insulating material, the conjoined insulated members being electrically connected with a telephone receiver and electric cell.

23,272 Tucker & Crabtree. Electric switches.

23,486 Burdon. (Siemens-Schuckertwerke Ges.) Electric insulators.

1915 Specifications.

611 Nicholson. Electrical telegraph or telephone vibrators or buzzers.

2,370 Kluijtmans. Fusible electric cut-outs.

2,482 Hellmund. Systems of electric distribution and control. (19 2 14.)

3,985 Rainey. Synchronising system, particularly applicable to multiplex telegraphy. (26 3 14.)

A synchronising system for maintaining two independently vibrated bodies at distant stations in synchronism, and in which apparatus controlled from such vibrating bodies operates to transmit and receive current impulses of changing polarity over a signalling circuit connecting such stations, the apparatus at one of such stations operating in response to changes in polarity in the current impulses to modify the rate of vibration of one of such bodies if such bodies are not in exact synchronism.

7,964 Deutsche Gasglühlicht Akt.-Ges. (Auerges.) Electrical cooking apparatus (12 12 14.)

[illegible] Westinghouse Electric & Manufacturing Co.) Alternating-current motors of the commutator type.

APPLICATIONS FOR PATENTS

*Specifications and [illegible] are not open to inspection before publication. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

July 31, 1915.

11,112 Kennedy. Mechanical buzzer for practising the Morse code.*

11,123 Crosbee & Sons & Spicer. Sparking plugs and the manufacture of the same.

11,139 Albion Motor Car Co. & Murray. Switch device for car-lighting and like dynamos.*

11,144 Igranic Electric Co. (Cutler-Hammer Mfg. Co., U.S.) Electric heaters.*

11,157 Longman. Wireless telegraphy.

11,158 Longman. Telephonic receiving apparatus.

August 3, 1915.

11,161 Wall. Generating high-frequency electric current.

11,168 Fewkes. Manufacture of electrical conductor or [illegible]-retaining bands and apparatus therefor.

11,172 British Insulated & Helsby Cables & Astley. Suspending and adjusting electric overhead conductors.

11,201 Burt. Mounting of switches and other electrical apparatus in wall boxes.

11,214 Chell. Electric light fittings.

11,218 B.T.-H. Co. (G.E. Co., U.S.) Arc lamp electrodes.

11,224 Bethenod. Magnetos applicable for the lighting of vehicles. (27,7/14, Belgium)*

August 4, 1915.

11,259 Murray. Signalling device for printing telegraphs.

11,262 Murray. Method of synchronism for printing telegraphs.

11,262 B.T.-H. Co. (G.E. Co., U.S.) Coating metals.

11,263 B.T.-H. Co. (G.E. Co., U.S.) Electricul windings.

[illegible] & Wilkins. Electrically-operated tools. (14 8 14, Germany.)*

[illegible] and train-controlling apparatus.

[illegible]

11,275 Vickers Limited. (Franz Krizik, Austria.) Train [illegible] systems.

[illegible]

11,314 Judd, Fraser & Eastern Telegraph Co. Electrolytic magnifiers.*

[illegible] machines.

[illegible]

11,333 Allen. Marine signalling apparatus.

[illegible] material.*

[illegible] thereto.*

August 6, 1915.

[illegible]

11,415 Marr. Telephone transmitters and the like.

August 9, 1915.

[illegible]

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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COMMERCIAL DEVELOPMENT AND STATISTICS.

We have already commented under this heading upon the active propaganda which is being undertaken by the Society for Electrical Development in the United States. This organisation has planned an Electrical Prosperity Week, of which we have previously given some preliminary particulars, and which is planned for November 29 to December 4, 1915. Quite apart from the publicity work which this Society is engaged upon—and all American publicity is done on a scale which completely outclasses anything ever attempted in this country—it appears to be doing a very useful work in the direction of compiling statistics which will be of general and specific value to the electrical industry. We notice in a recent issue of one of our American contemporaries reference to the fact that the Society has obtained information regarding the prospects for the uses of electrical energy on farms and in rural districts in the United States. These investigations have shown that there are nearly 6½ million farms in the country upon which electrical energy might be employed to minimise labour and increase the productiveness of the homestead. It is also pointed out that there are no less than 400 manufacturers of petrol and paraffin engines of small output, in convenient sizes and readily portable, for use in agricultural districts. Information of this character is helpful in giving electrical men a broad outlook upon the problems with which they are confronted. It should prove of value in enabling them to lay their plans for the electrification of this or that industry or group of commercial institutions.

The information of a statistical character which is available in this country, and which, if collated, would be of great value to electrical engineers, should receive the attention of the Development Committee, which is now in operation on behalf of the I.M.E.A. In any general publicity campaign, for example, it will be helpful to supply the manufacturing and contracting elements in the industry with lists of electricity consumers within the areas of public supply. Many central station engineers have repeatedly opposed any attempt made by manufacturers or contractors to obtain a list of their consumers. An extremely small minority of commercially minded engineers have copies of the list prepared, and will hand them over to interested parties, on payment of a small fee to cover the cost of either printing or typewriting, as the case may be. We do not overlook the importance of safeguarding the electricity consumer from anything in the nature of badgering, but as things are at present we doubt very much if he is at all worried by the receipt of trade literature or by the attentions of bagmen hawking, for example, cheap lamps. There has been in the past too great a measure of reserve in distributing information which is at the hand of certain individuals in the industry. Its release for general use would, we believe, confer a considerable number of advantages, and there would result a greater dissemination of information upon subjects with which even consumers who have been using the electric service for ten years or more are entirely ignorant. The Society for Electrical Development has evidently a keen appreciation of the value of statistics, and already it is beginning to get to work in this direction. We commend their efforts to the notice of their prototype in this country—the I.M.E.A. Electrical Development Committee. While the present time may not be entirely suitable for anything in the nature of a trade boom, such as the American Electrical Prosperity Week campaign, there is time and opportunity for getting together information bearing generally upon the electricity supply industry and the many other industries with which it is likely to be commercially identified in the near future. We take it that it is the object of the Electrical Development Committee to act, not only on behalf of the interests of the electricity consumer, both present and prospective, but also in the interests of manufacturers and contractors who require to make plans which will carry them forward over a considerable period.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week June 30, 1915, to Sept. 4, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

merated, £5,038—354 pkgs. *Switzerland:* Carbon candles, £490; unenumerated, £996. *Holland:* Elec. lamps, £1,202—23 pkgs.; wire and cable, £1,945; unenumerated, £90. *France:* Carbon candles, £225; elec. lamps, £160—50 pkgs.; lamp parts, £20; elec. machinery, £68; unenumerated, £24—13 pkgs. *Denmark:* Unenumerated, £311. *Italy:* Wire and cable, £141; elec. machinery, £284; unenumerated, £50. *Sweden:* Elec. lamps, 4 pkgs. *Japan:* Elec. copper wire, 384 pkgs.

SOUTHAMPTON.—*France:* Elec. wire, 6 pkgs.

EXPORTS.

enumerated, £305. *Melbourne:* Elec. machinery, £1,276; wire and cable, £2,041; unenumerated, £597. *Sydney:* Elec. machinery, £1,180; wire and cable, £256; telegraph material, £81; unenumerated, £638. *Wellington:* Elec. machinery, £43; wire and cable, £655; unenumerated, £213. *Brisbane:* Unenumerated, £10. *Christchurch:* Wire and cable, £415. *Perth:* Unenumerated, £50. *Dunedin:* Unenumerated, £93. *Hobart:* Elec. machinery, £964; unenumerated, £70. *Lyttleton:* Unenumerated, £85. *Adelaide:* Elec. machinery, £43; wire and cable, £588; unenumerated, £9,454. *Fremantle:* Elec. machinery, £32; wire and cable, £613; telegraph material, £63; unenumerated, £279. *Launceston:* Unenumerated, £22. *Dunedin:* Unenumerated, £93. *New Plymouth:* Unenumerated, £22. *Otago:* Elec. machinery, £10.

AFRICA.—*Durban:* Elec. machinery, £137; wire and cable, £420; unenumerated, £298. *Port Elizabeth:* Elec. machinery, £18; unenumerated, £142. *Cape Town:* Elec. machinery, £31; wire and cable, £25; unenumerated, £473. *Delagoa Bay:* Unenumerated, £91. *East London:* Unenumerated, £72. *Mombasa:* Unenumerated, £30. *Zanzibar:* Telegraph material, £11.

EGYPT.—*Port Sudan:* Unenumerated, £191. *Alexandria:* Wire and cable, £485; unenumerated, £25.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £1,504; unenumerated, £186. *Colon:* Unenumerated, £55. *Rio de Janeiro:* Unenumerated, £191. *Ascension:* Unenumerated, £15.

JAPAN.—*Kobe:* Unenumerated, £28

U.S.A.—*New York:* Unenumerated, £395.

CHINA.—*Shanghai:* Old telegraph wire, 25 t.; unenumerated, £156. *Hong Kong:* Unenumerated, £211.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £16; unenumerated, £314. *Calcutta:* Wire and cable, £177; telegraph material, £30; unenumerated, £484. *Madras:* Elec. machinery, £812; unenumerated, £299. *Karachi:* Unenumerated, £363. *Ceylon:* Elec. machinery, £47; telegraph material, £10; unenumerated, £196. *Singapore:* Wire and cable, £60; unenumerated, £99. *Penang:* Wire and cable, £67; unenumerated, £61. *Kilindini:* Elec machinery, £77; unenumerated, £312. *Port Swetenham:* Wire and cable, £49; unenumerated, £155. *Rangoon:* Elec. machinery, £430.

CANADA.—*St. John's:* Unenumerated, £521.

WEST INDIES.—*Trinidad:* Telegraph material, £46

FRANCE.—*Dieppe:* Elec. machinery, £89; unenumerated, £164. *Paris:* Elec. machinery, £187; unenumerated, £15. *Havre:* Telegraph material, £378.

MALTA.—Elec. machinery, £24; unenumerated, £24.

SPAIN.—*Cartagena:* Elec. machinery, £300.

MADAGASCAR. Unenumerated, £42.

PHILLIPINES.—*Manila:* Unenumerated, £291.

ITALY.—*Genoa:* Elec. machinery, £1,064; unenumerated, £997.

PORTUGAL.—*Lisbon:* Unenumerated, £294.

GREECE.—*Pirzeus:* Unenumerated, £193. *Patea:* Unenumerated, £77.

NORWAY.—*Christiana:* Wire and cable, £4,102; unenumerated, £210.

HOLLAND.—*Amsterdam:* Wire and cable, £243; unenumerated, £105. *Rotterdam:* Unenumerated, £34.

GIBRALTAR. Unenumerated, £86.

MAURITIUS.—Unenumerated, £205.

FOREIGN GOODS (duty paid and free).

Sydney: Unenumerated, £189. *Bombay:* Unenumerated, £501. *Brisbane:* Unenumerated, £73. *Madras:* Unenumerated, £176. *Wellington:* Unenumerated, £1,210. *Calcutta:* Unenumerated, £44. *Dieppe:* Unenumerated, £397. *Christiana:* Unenumerated, £212. *Genoa:* Unenumerated, £43. *Perth:* Unenumerated, £123. *Melbourne:*

IN TRANSIT.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to wire as described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

M. A. P. [illegible] attorney of 17, Staple-inn, London, W.C., [illegible]

The Manager [illegible] Mr. W. J. [illegible]

Plant Wanted. [illegible]

Bastian Electric Heating Apparatus. The Bastian Electric Heating [illegible]

Letter Sealing Machines. [illegible]

at present being used is of foreign manufacture, and is stated to work [illegible] rapidly than hand or treadle machines, but no spare parts are obtainable. Communications to H.M. Trade Commissioner for New Zealand, P.O. Box 369, Wellington, N.Z.

BANKRUPTCIES, LIQUIDATIONS, &c.

[illegible] of creditors of the British Electric Automatic Machines (Ltd.) will be held at 1, Broad Street-place, London, E.C., on Sept. 22.

Arthur Faraday Hawdon, electrical engineer, Yetholm, Elmfield-gardens, Gosforth, has been adjudicated bankrupt.

Claims against Geo. T. T. J. Parfitt, consulting electrical engineer, 11, Priory-road, Keynsham, are to be sent by Sept. 18 to Mr. C. H. King, 26, Baldwin-street, Bristol.

Read, Holliday & Sons (Ltd.) is being wound up voluntarily, and Mr. J. M. Thornton, Branxholme, Brockholes, near Huddersfield, has been appointed liquidator. A meeting of creditors will be held at St. Andrew's-road, Huddersfield, on Sept. 14. Claims to the liquidator by Oct. 12.

At the adjourned meeting of creditors of Venner's Electrical Cooking & Heating Appliances (Ltd.) (in liq.) yesterday (Thursday) it was resolved that the creditors be represented by a liquidator nominated by them to act jointly with the present liquidator (Mr. G. E. S. Venner), and Mr. E. H. Hawkins (Messrs. Poppleton, Appleby & Hawkins), 4, Charterhouse-square, London, E.C., was nominated the creditors' liquidator.

ELECTRICITY SUPPLY.

EXTENSIONS.

Horsham. The Council have [illegible] extension of the [illegible] the electricity [illegible]

Rawtenstall.—Plans for the extension of the electricity works at Hareholme have been approved by the Council.

Stretford. The Trafford Power & Light Supply (1902) (Ltd.), [illegible] to erect a substation in the Ellesmere [illegible]

GENERAL

Amble. The Urban Council have given instructions for the preparation of estimates for the electric lighting of the streets. It is proposed to take electric current from the Broomhill Collieries, Ltd.

Blackburn.—Corpl. J. Lomas, a Territorial employed at the Electricity Works, has been killed in the Dardanelles.

Bootle.—The Council have voted £50 to the fund for providing electrical treatment for wounded soldiers in the convalescent camp near Blackpool.

Cardiff. Owing to the increased cost of coal, &c., it has been decided to increase the price of electric current to all consumers [illegible] by the present contract [illegible] list price.

Dartford.—Acting on the advice of the Board of Trade, the Electricity Committee has decided to [illegible] 1,000 tons of coal and recommends the acceptance of certain tenders at prices varying from 24s. 6d. per ton for 500 tons Yorkshire main, and 20s. 9d. for 500 tons [illegible] slack.

Denby and Cumberworth. The Council have asked a representative of the Yorkshire Electric Power Co. to meet them in order to discuss the company's proposed application for a provisional electric lighting order for the district.

Eastbourne.—Asked by the Finance Committee to consider what [illegible] could be effected during the current [illegible] the Borough electrical engineer (Mr. J. K. Brydges) [illegible]

All possible [illegible] the Electricity Committee had decided to [illegible] the purchase of [illegible] plant, also [illegible] and the provision of a [illegible] power. [illegible] to be carried out [illegible] the present year.

Ely.—Owing to the increased cost of [illegible] capital and other charges [illegible] the supply of electrical energy has been increased from 1d. to 1½d. per unit for private and public [illegible] to 2d. per unit for power, heating and cooking.

The City Council will consider the question of such increase next [illegible] the Council [illegible] interest from [illegible] mutation work, but the raising of further monies for extensions of mains, &c., for ordinary [illegible] be postponed.

Huddersfield.—[illegible] for heat lighting will be remitted while the lighting restrictions are in force, but for the period between [illegible] to June 30th a reduction of 5d. per cent. has been allowed.

Luton.—The question of establishing a street fire alarm system in the borough is to be postponed for the time being.

Penryn.—Electricity supply was inaugurated on the 1st inst., current having been switched on by Mrs. Rickard for public and private lighting.

Salford.—Special agreements have been entered into with three firms for the supply of electrical energy for lighting and power. Instructions have been given for the undermentioned notice to consumers to be inserted in the printed tariff of charges :—

All energy supplied to motors and [illegible] generators producing energy for lighting purposes will be charged at lighting rates, except in the case of motors [illegible] during daylight hours, when the energy will be charged at the [illegible] per unit. In the case of energy supplied to motors supplied from [illegible] pressor installations, where the [illegible] for the purpose of illumination, the energy supplied to such motors will be charged for at lighting rates.

Thurlstone (Yorks).—At a recent meeting of the Urban Council Mr. W. B. Woodhouse, the manager and engineer of the Electrical Distribution of Yorkshire (Ltd.), attended and explained the company's proposal to apply for a provisional order to enable it to supply electric current in the district.

Mr. WOODHOUSE stated that the supply would be given on a sliding scale, from 1½d. per unit for street lighting to 5d. per unit for private lighting, but for cottage houses with four lamps there would be a fixed price of 1d. per lamp per week. It was decided to hold a conference of the districts grouped in the area, and the chairman (Mr. J. Wagstaff), Dr. A. G. Wilson and Mr. Geo. Hoyland were appointed to represent Thurlstone at this conference.

Wakefield.—On Tuesday it was decided to apply to the L.G. Board for sanction to a loan of £1,000 for a [illegible] and cooling tower at the electricity works.

It was also resolved to increase the price of electric current for power and lighting by 12½ per cent., and to insure the works against damage by aircraft to the amount of £50,000.

Mr. WOMERSLEY (chairman of the Electricity Committee) said the annual report of the electrical engineer (Mr. H. A. Neville) was very satisfactory under existing conditions. The increase in the price of current would simply bring them back to the charge made before April last. There was a debit balance of £336 on the past year's working, against a credit balance of £488 in the previous year.

LIGHTING & POWER NOTES.

Blackpool.—The Council have decided to defray the cost of equipping the South Shore Convalescent Hospital for electric massage treatment, estimated to cost £[illegible], and to supply the electric current for the treatment free of charge.

Electricity in Mining.—Messrs. Andrew Knowles & Sons are putting in additional electric haulage and power plant at their Pendleton and Pendlebury collieries.

Hetton le Hole.—The Council have renewed the contract for street lighting with the Sunderland District Tramways Co., but owing to the reduced number of lamps [illegible] the price has been increased by 2s. per lamp per annum.

Infirmary Lighting.—Reigate Guardians have decided to wire the new infirmary and a tender has been accepted for laying an supply cable to the building.

Liverpool.—The City Council propose to economise to the extent of £8,300 in the cost of lighting, viz., £2,000 on electric and £6,300 on gas lighting.

Wigan.—The Northern Coarse Spinners (Ltd.) propose to erect a new cotton waste mill in this district, and the whole of the machinery will be driven electrically.

TRACTION NOTES.

Belfast.—The Tramways Committee, in order to effect economies in working, propose to introduce [illegible] and so run more frequent services on some routes. The changes will effect a reduction of over £4,300 per annum in working expenses.

At a special meeting of the Council last [illegible] and it was decided to fix the fare for the [illegible] square North to Glengormley at 3d. Otherwise the fares and stages are to be as in 1914-1915, but any passenger commencing his journey within the city and paying his fare before 9 o'clock, shall be entitled to travel any distance within the city without change of car for 1d.

Brighouse.—The Council have decided to enter into an additional agreement with Huddersfield Corporation to postpone the latter's Bill for the construction of an extension tramway line through Rastrick until the 1917 session.

Bristol.—The Tramways Option Committee recommend the Corporation to take advantage of the special Act passed this year and piving power to the Board of Trade, on application by the Corporation, to postpone the date of the option to purchase the tramway undertaking for another 12 months.

Dartford.—The Chief Commissioner of Police has authorised the issue of summonses against the tramway manager for employing unlicensed conductors.

The Chief Commissioner will not issue licenses to persons under 21 years of age, and the Clerk has been instructed to suggest to Messrs. Balfour, Beatty & Co. (Ltd.) (the tramway lessees) that unless the Chief Commissioner will relax the rule for the period of the war, they should lay the whole of the facts before the Minister of Munitions and inform him that it will be impossible to provide proper facilities for conveying workmen to Messrs. Vickers and other munition works, so long as the Chief Commissioner continues his unreasonable attitude upon the subject of licenses.

L.C.C. Tramways.—In order to maintain tramway rights in Burdett-road (Stepney) and in Southwark Park-road the London County Council have had to run a car through those thoroughfares at least once in three months, but the Board of Trade have now, owing to special circumstances created by the war, absolved the Council from this obligation.

Mexborough and Swinton Trolley Omnibus Scheme.—Two new trolley omnibus routes of the Mexborough & Swinton Tramways Co. were officially inspected and opened for traffic last week.

The new routes extend from the junction of Swinton-road and High-street, Mexborough, to the Manvers Main Colliery on the west, and from the Mexborough Toll Bar to Elm Green, Conisbrough, on the east. The cars, which run half-hourly, hold 28 passengers, and they have been so designed that they can run over the permanent track through Mexborough which connects the two new sections.

Plymouth.—The first of the six new tramcars recently ordered by the Corporation was put into operation on the 1st inst.

The new cars are being supplied by the Brush Electrical Engineering Co., and in one respect [illegible] width, which has been secured by carrying the side coal to the maximum allowed by the Board of Trade, viz., 6 ft. 6 in., compared with 6 ft. 2 in. formerly. The seats have been rearranged and space has been left underneath for light luggage. The seats on the top are of the tip-up style. The electrical equipment is by the British Westinghouse Co., two 45 H.P. motors being employed.

Wharfedale Tramways.—The official opening of the new trolly omnibus route from Guiseley into Wharfedale took place on Wednesday.

The route is three miles, but there is still to complete a mile and a-half—from the junction at Menston to Burley. It is proposed to institute a 10-minute service in the morning and a 20-minutes service in the afternoon.

Women Tramcar Employes.—At a meeting of Darlington Council [illegible] there was a discussion on the question of the employment of women tramcar drivers.

Ald. C. W. STARMER, chairman of the Electricity Committee, said that as the shortage of men had been very acute during the past month, permission had been given to women to learn to drive tramcars in order that they would be ready if required. A large number of women were engaged as conductors. The motor men had taken exception to teaching women to drive. The department had had great difficulty in maintaining an efficient service, and if there were no women ready to drive it would probably mean closing the service.

Mr. T. CROOKS observed that the pressure had been so great that even their inspectors and traffic manager had been pressed into service as drivers. Nearly the whole of the conductors left at the beginning of the war.

Ald. C. H. LEACH did not think it was difficult to drive a tramcar, and [illegible] prepared to take one on a Saturday [illegible] prepared to do the same.

After [illegible] it was decided not to proceed unless it was absolutely necessary. The men were jealous and afraid of their positions, but the Committee had agreed to keep open the positions of all men who [illegible].

The question of employing women conductors at Pendlebury is being considered by a sub-committee of the Tramways Committee.

Arrangements have been made by the Council Manager of the Manchester Tramways, Mr. J. M. McElroy) to begin the experiment of employing women. On Wednesday morning two or three women started work as conductresses on cars.

EMPIRE NOTES.

Australasia.—Kyneton (Victoria) Shire Council has adopted plans prepared by Mr. H. Smith for the installation of the electric light, instead of gas, and has decided to borrow £10,000.

Thames (N.Z.) Council is making arrangements for the installation of a 100 kw. hydro-electric set, with an aluminium transmission line. The present installation consists of two 105 kw. d.c. generators direct coupled to Diesel engines.

Napier (N.Z.) Council has decided to submit to the ratepayers proposals to borrow £68,000 for tramway extensions, electric mains extensions and additions to power-house plant.

Perth (W. Australia) Council have received a report from their electrical engineer that units sold during the six months ended April 30 were 1,790,658, an increase of 3¼ per cent. over the corresponding half of 1913-14; and that the total number of consumers connected is 6,769.

The N.S.W. Minister for Public Works has authorised the extension of the Newcastle tramway from Maryville to the Newcastle steel works (1¼ miles, single track).

Auburn (N.S.W.) Council has decided to light the town electrically, an agreement having been entered into with Sydney Council for the supply of current by the latter for 10 years.

The Council of Hamilton (Queensland) have invited offers for the supply of electric light and power plant.

Samples of copper wire drawn in Japan have been received by a number of Australian firms. The copper produced in Japan last year was nearly 75,000 tons.

Wollongong (N.S.W.) Municipal Council did not receive any specific offer in answer to their invitation for the supply of electric current. The Council is endeavouring to get the Public Works Department to make an offer to supply from the new jetty power-house at Port Kembla. The Illawarra Coke Co., Coalcliff, has, however, promised to submit an offer.

Mr. C. Kearney, of London, has suggested to the N.S.W. Government that it should employ the Kearney high-speed method on the tube railway under Sydney Harbour.

The Australian Commonwealth Defence Department has approved of the expenditure of £935 for a Standard-Otis-Waygood electric lift for Randwick (N.S.W.) Military Hospital.

Sydney Electric Lighting Committee recommend the expenditure of £3,750 for main distributor lines for the supply of electricity within the municipality of Auburn.

Mr. W. Corin, electrical engineer of the N.S.W. public works department, has submitted a project to the Minister for utilising the water supply system of Grafton and South Grafton in connection with a hydro-electric scheme.

Fears having been expressed as to the effect of the provisions of the Greater Melbourne Council Bill with respect to taking over all electrical services in the metropolitan area, upon the interests of members of the Melbourne Electric Supply Co., a statement was made recently by the Premier of Victoria to the effect that there is no reason why shareholders in the company should be alarmed at the provisions of the Bill. The intention of the measure is to deal equitably with all interests affected. In 1925 the property of the company becomes available for purchase by the municipalities on payment for its then value. In order that effective electrical arrangements for the metropolis may be made, the Bill provides that, upon the metropolitan Council giving six months' notice, it may acquire the property at any time before the expiry of its franchise. The compensation scheme provides also for payment of an amount equal to the present value of the sum of which shareholders will be deprived owing to the curtailment of the lease. To decide the amount to be paid in addition to the property value, an account would be prepared to which all usual charges would be debited (including depreciation, &c.), but the amount to be charged as interest would not be that on any loan raisings, but a sum equal to 4 per cent. on the amount payable as property value. If the compensation clauses result in injustice being inflicted upon the company the Government is prepared to amend them.

India.—"Indian Engineering" says the success attending the electric pumping experiments, in the Amritsar district, as a remedy for waterlogging and its attendant evils of malaria, is attracting attention in Sind.

The value for irrigation purpose of the water raised is found to be a very fair return upon the cost of the electric pumping machinery.

Simla municipality are extending their electric supply mains to Summer Hill on the road to Sanjauli on the east, beside the Lodge. Mains are being laid on the south of Jakko. Larger transformers are being installed in all the sub-stations in Simla, while at Chabba a new 500 k.v.a. alternator will be erected shortly. The whole of the works is to be completed before the beginning of the next Simla season and the Municipality hope shortly to be in a position to meet all applications for current. It is intended to supply the wiring and fittings for installations and to supply current at one rupee (1s. 3d.) per lamp per month up to a maximum of five lamps, whether the consumer uses it by day or by night. Many shopkeepers have already availed themselves of the offer.

FOREIGN NOTES.

Chili.—The "South American Journal" reports that the conditions of trade during the past six months have been the reverse to what was expected in consequence of the European war.

A favourable reaction has set in, bidding fair to make things as near normal as possible under the circumstances. The Government have been able to meet their obligations. The coal and copper mines are in full swing, and the nitrate industry is recovering rapidly. The profits of the banks in the first six months of 1915 show a general improvement compared with 1914.

Italy.—The system of electric railways (about 84 miles in all) which is being constructed by the Soc. delle Ferrovie Vicinale to connect Rome with various surrounding localities is expected to be completed by the end of the current year. The electric equipment is being supplied by the Societa Italiana di Elettricita (Italian Thomson Houston Co.).

Rouen.—In order to expedite the transport of coal an electric loader has been erected at Rouen, which will discharge 2,000 tons of coal daily direct from the holds of vessels to railway trucks which will be in waiting along the bank of the Seine. The loader will be ready for regular work by Oct. 15.

MISCELLANEOUS NOTES.

Annual Outing.—On Saturday last the sixth annual outing of the employés of the Brimsdown Lamp Works (Ltd.) took place.

Rye House (Herts) was selected for the outing, and, favoured with ideal weather, a most enjoyable day was spent. After luncheon the usual loyal toasts were proposed by Mr. C. Rice, managing director of the company, and Mr. H. C. Sharrer then proposed the toast of "The Brimsdown Lamp Works (Ltd.) and its managing director."

Mr. C. Rice, in the course of his reply, reminded them how necessary it was that in these abnormal times they should all work together. Many difficulties had arisen, but, after all, what were difficulties created for but to be overcome. Many who were with them on the occasion of the last outing were now serving in H.M. Forces, but he hoped that they would return safely and would be able to join them on the occasion of their next outing.

After luncheon a cricket match was played, ladies v. gentlemen, the gentlemen bowling and fielding left handed and batting with sticks. The rest of the afternoon was spent in boating, visiting places of interest in the neighbourhood, &c. In the evening a concert and dance were given.

Inquests.—At Kirkcaldy Sheriff Court last week an inquest was held on George Fernie, an apprentice electrician, who was found dead inthe workshop at the power station at Kinglassie Colliery.

Fernie, who was 16 years of age, was found near the switchboard, and artificial respiration was attempted without success. Witnesses stated that a thorough examination of the cables had been made, but without finding any leakage or cause for the lad's sustaining an electric shock, and they could not account for his death. Besides being properly insulated, the cables were properly earthed.

Mr. HUGH GORDON FRASER, chief electrical engineer, said that a thorough inspection of the plant had been made, and it was impossible the boy could have been killed by electric shock.

Dr. A. R. WIGHT, who had carried out a post-mortem examination, said all the organs were perfectly healthy. There was nothing in the body to show the cause of death, but everything he found was quite compatible with death from electric shock. From what he found and learned he was of opinion that the boy died from electric shock. There was a mark of injury on the left thumb, but no other mark on the body or clothing.

The jury found that there was no evidence as to the cause of death.

An inquest was held [illegible] on Wednesbury on a crane driver named W. J. M. Cleary.

Deceased was helping to unload axles from a truck. The crane was stopped to allow a locomotive to pass, and a few minutes after deceased was seen lying on the top of the cabin.

A witness in the cabin stated that when the crane was not in use the switch must be pulled out. Deceased must have gone to do some oiling and, forgetting the switch had been left in, touched the live wires, thus receiving an electric shock.

The electrical engineer (Mr. Boffey) said there was no reason why a screen should not be placed above the cabin as an extra precaution.

The jury returned a verdict of "accidental death."

Presentation.—The employés of Messrs. J. H. Tucker & Co., of Hay Mills, Birmingham, gathered together on Friday, the 3rd inst., to bid "Good bye" and "Good Luck" to Mr. J. B. Tucker, the son of the founder and present head of the firm, who has been granted a com-

mission in the Royal Engineers, and who was leaving on the following day to join his regiment.

Mr. R. H. Lamb, who has been with the firm some 15 years, presided over the meeting, and referred to the esteem in which Mr. Tucker was held, and said that they were gathered there not only to wish him "God speed," but to ask him to accept a few tokens as evidence of the esteem and regard they all had for him.

Mr. Bisby, who has been with the firm 20 years, on behalf of the employés in the works, then presented Mr. Tucker with a Webley & Scott service revolver; Miss Jeffries, who has been in the service of the firm 14 years (on behalf of the office staff) presented a silver cigarette case suitably inscribed; and Mr. Willmott, the oldest official of the company, on behalf of the officials asked Mr. Tucker's acceptance of a sword, sword knot and scabbard, suitably engraved as a record of the occasion.

Mr. Tucker thanked them all very heartily for their good wishes and for their presents, and the head of the firm (Mr. J. H. Tucker) referred in terms of appreciation to the men who had already gone from the works and were now serving their country, also to those workers, who, though not in the same way, were equally serving their country and doing their duty. Whilst they honoured his son that afternoon, none of the others were forgotten.

TENDERS INVITED.

Diesel Engine.

PEMBROKE Urban District Council invite tenders for the supply of one 200 kw. Diesel Engine. Specification, general conditions and form of tender from the Clerk to the Council, Town Hall, Bellsbridge, co. Dublin, to whom tenders are to be addressed by noon, Friday, Sept. 17. *See also advertisement.*

Turbo-Generators, Boilers, Condensing Plant, &c.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. British port of (*a*) one Turbo-generator of not less than 5,000 kw. capacity, with Condensing Plant, &c.; (*b*) one or two Turbo-generators of about 10,000 kw. capacity, with Condensing Plant, &c. Copies of specifications and forms of tender from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, Westminster, S.W., to whom tenders (in duplicate) should be delivered by noon, Sept. 24.

JOHANNESBURG Municipal Council invite tenders by Sept. 25 for supply and erection of two 3,000-kw. Turbo-alternators, Condensing Plant, Switchgear, &c. Specifications from the Controller of Stores, and tenders to the Town Clerk.

JOHANNESBURG Council also require tenders by noon Sept. 30 for Two (or, alternatively, One) Water-tube Boilers, with Superheaters, Mechanical Stokers and Draught Plant. Specifications from the Controller of Stores, Municipal Offices, Johannesburg.

Meters.

REIGATE Corporation require tenders by Sept. 13 for 12 months' supply of a.c. Induction Motor Meters. Specification from the Borough Electrical Engineer, Wray Common-road Reigate.

Converter Plant and Transformers.

NEWPORT (MON.) Corporation want tenders for supply of Converter Plant and Transformers. Particulars from Mr. A. Nichols Moore, borough electrical engineer.

Electric Lamps and Fittings, &c.

The Guardians of the Poor of the Parish of KENSINGTON (London) invite tenders for the supply of Electric Light Lamps to their Infirmary, Marloes-road, W., for six months from Oct. 1, 1915. Forms of tender, &c., from the Clerk (Mr. W. R. Stephens), Guardians' Offices, Marloes-road, Kensington, W. Tenders by 3 p.m. of Thursday, Sept. 23.

EDMONTON Guardians require tenders by 9 a.m. Sept. 22 for six months' supply of Electric Lamps. Forms of tender from the Clerk, White Hart-lane, Tottenham, Middlesex.

SOUTH SHIELDS Guardians require tenders by 10 a.m. Sept. 27 for six months' supply of Electrical Fittings, Oils, &c. Forms of tender from the Clerk.

WARRINGTON Guardians want tenders by 10 a.m. Sept. 22 for six months' supply of electrical goods. Forms of tender, &c., from the Clerk, Bewsey-chambers, Warrington.

Switchgear, Transformers and Cables.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. British port of e.h.t. Switchgear suitable for 22,000 volts working pressure; e.h.t. Static Transformers (22,000 to 6,600 volts) of 4,200 k.v.a. and 2,000 k.v.a. single phase and 3,000 k.v.a. and 1,250 k.v.a. three phase; and Armoured Three-core Cable for 22,000 volts, with Boxes. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders are to be delivered by noon, Sept. 29.

Fuse Blocks, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Sept. 29 for 5,000 Fuse Blocks, 5,000 Spare Porcelain Bases and 10,000 Spare Fuse Clips (29,080). Specifications from the Commissioners' Offices, Spencer-street, Melbourne, Australia.

Generating Plant.

The AUSTRALIAN COMMONWEALTH Department of Defence require tenders by noon Oct. 25 for Power-station Plant and Equipment for the Naval Dockyard Cockatoo Island, Sydney, N.S.W., and by noon Oct. 27 for Machine Tools. Specifications from Director of Navy Contracts, Navy Office, Melbourne.

Condensing Water Tunnel, &c.

EDINBURGH Corporation require tenders by 10 a.m. Oct. 4 for the construction of Shafts and Tunnel for obtaining sea water for condensing at the new Portobello electricity works. Specification, &c., from the Engineer, Dewar-place station, Edinburgh.

Telegraph and Telephone Material, Wire, Instruments, &c.

The Postmaster-General's department of the Commonwealth of Australia invites tenders (until Sept. 23) for the supply of Condensers, Galvanometers, Relays and Sundries, and for Incandescent Electric Lamps, and (until Oct. 6) for the supply of Poles (iron or steel) and Fittings.

The Deputy Postmaster-General, Brisbane (Queensland), invites tenders until Oct. 6 for supply of Tinned Copper Wire (schedule 357) and Porcelain Pothead Insulators (schedule 360) for the COMMONWEALTH, Postmaster-General's Department.

The Deputy Postmaster-General, Melbourne, invites tenders by 3 p.m. Sept. 21 for Telephone Parts (schedule 1,225) and 50 Stop Clocks for use on switchboards (schedule 1,265), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Perth (W. Australia), requires tenders by Sept. 29 for Telephone Switchboards, &c.

Tender forms, in all cases, from the Commonwealth offices, 72, Victoria-street, S.W.

Engine and Dynamo, &c.

The Deputy Postmaster-General, Adelaide (South Australia), requires tenders by 2 p.m. Oct. 6 for Portable Internal-combustion Engine direct coupled to Dynamo, and for increasing capacity of Storage Batteries at Central Telephone Exchange, Adelaide, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications from the Deputy Postmaster-General.

Meters and Time Switches, Cut-outs, &c.

JOHANNESBURG Council require tenders by Sept. 25 for supply of 1,595 Electricity Meters and 50 Time Switches.

JOHANNESBURG (Transvaal) Council require tenders by noon Sept. 28 for supply of 1,000 Sets of Single-pole 25-ampere Ironclad House Service Cut-outs (contract 21). Specifications from the Controller of Stores, Plein-square, Johannesburg.

Electric Capstans.

SYDNEY Harbour Trust Commissioners invite tenders by 2 p.m. Oct. 25 for the supply of 6 Electrically-operated Wharf Capstans. Specification, &c., from the office of the Commissioners, Circular Quay, Sydney, N.S.W.

TENDERS RECEIVED AND ACCEPTED.

GLASGOW.—On the recommendation of the Tramways Committee the following tenders have been accepted by the Corporation: Chloride Electrical Storage Co., storage battery for Kinning Park sub-station; Mavor & Coulson, motor-generator and switchboard; Pirelli-General Cable Works, vulcanised rubber cables.

SALFORD.—The Corporation have accepted the tender of Bertram Thomas for the supply of switchgear required for rotary converter for the Broughton Copper Co.

the erection of a sub-station at £1,561. 5s.

MELBOURNE.—The City Council have authorised the following purchases :—

McIlwraith & Co., condenser fuses, schedule prices ; Commonwealth Art Pottery & Insulator Co., insulators, schedule prices.

Trust for the construction of the permanent way for the electric tramway from Melbourne to Burwood.

WAIRUA (N.Z.)—The Australian General Electric Co. has received an order from the Dominion Cement Co. for hydro-electric generating plant, sub-station equipment, &c., for their power house at Wairua (N.Z.) The plant will comprise two water-wheel driven a.c. generators of 1,250 k.v.a. (50 cycles, 500 revs. per min., 5,500 volts) and two d.c. generators of 30 kw. (1,000 revs. per min., 230 volts). Current will be stepped up to 22,000 volts for transmission.

Thomson-Houston Co. for 6,000 kw. turbo-generator set, and with Babcock & Wilcox for four boilers.

SYDNEY.—The City Council have received the following tenders for supply of 33,000 volt cable :—

Works Co. £18,770. 11s. 2d., Siemens Bros. £18,985. British Insulated & Helsby Cables £19,125. Western Electric Co. £19,290. 18s. 9d., British General Electric Co. £20,560. Australian General Electric Co. £21,663.

£16,808. 16s. 10d., Noyes Bros. (*rec. for acceptance*) £17,050. Western Electric Co. £17,641. 17s. 6d., Siemens Bros. £17,770. British Insulated & Helsby Cables £17,941. 8s. 2d., Australian General Electric Co. £18,900.

The Electric Lighting Committee also recommend the Council to accept following charges : Provision of superintending officer at £75 per month ; 140 joint boxes, £9. 1s. 6d. each ; two pumping sets, £85. 15s. each ; five spare boxes, £9. 1s. 6d. each ; two spare lengths of cable, each 163 yds., on contract basis of 15s. 1·86d. per yard ; five spare boxes, £9. 1s. 6d. each.

The Committee also recommend the acceptance of the tenders of F. S. Lee for 10,000 volt and 33,000 volt straight stem and 10,000 volt disc h.t. insulators : Australian General Electric Co. 33,000 volt disc h.t. insulators ; N. Guthridge, 5,000 volt 20 k.v.a. transformers, £64 ; 5,000 volt 50 k.v.a. ditto, £98 ; 10,000 volt 20 k.v.a. ditto, £64 ; 10,000 volt 50 k.v.a. ditto, £98 each, and oil for same at 2s. 3d. per gallon ; Australian General Electric Co., 5,000 volt 100 k.v.a. transformers, £202. 16s. each ; 10,000 volt 100 k.v.a. ditto, £238. 16s. each.

The Committee also recommend that two arcing ground suppressors for 33,000 volt 50-cycle circuits, with switches, transformers, relays, &c., be ordered from the General Electric Co. of America at £1,510 (exclusive and 200,000 yds. 19/14 bare copper cable be ordered from British Insu- according to fluctuations of prices of metal.

£1,589.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Dundee.

sinking, depreciation and other funds.

Revenue was £68,273 (compared with £69,504 in previous year), and working and general expenses were £43,358 (£43,338), leaving gross profit £322 (£210), and £1,000 (as in previous year) was contributed to Common Good. Sinking fund required £6,700 (£6,400), and £5,900 (£7,800) has been placed to renewals, £1,942 (£1,900) to depreciation and £60 (£12) to reserve. Traffic receipts per car-mile 11·504d. and working expenses, including power, 7·495d. Passengers carried were 18,753,140 (19,042,344) and car-miles run 1,388,345 (1,387,980). The Council are making up the pay of their employés who have joined H.M. Forces to the amount they received in the Corporation service, and these allowances and a war bonus to £1,116. Six new cars were added to the rolling stock.

Eccles.

leaving gross profit £4,840. After providing for interest, repayment of loans, sinking fund, income tax, &c., the net balance, transferred to

South Shields. The accounts of the electricity supply undertaking

Average price of coal was 12s. 3d. per ton (compared with 14s. 2d.), but

war service badges to every man of recruitable age in the service of the department whose services could not be dispensed with. Kelvin's generated were 5,849,477 (5,569,143) and sold 4,665,380 (4,569,798). Total costs were 0·90d. (0·88d.) per kelvin, or 1·57d. (1·53d.), including capital charges. Connections are equal to 8,015 kw. (6,934 kw.)

South Shields.—The accounts of the Corporation tramways for the year ended March 31 show total capital expenditure £181,096 (increase £7,497), of which £26,106 has been redeemed.

Revenue was £39,845 (compared with £38,330 in previous year), and working expenses, including war services, were £25,510 (£22,585), leaving gross profit £14,335 (£15,745). Interest and sinking fund required £8,741 (£8,638), net balance being £5,594, of which £2,400 is to be devoted to relief of rates. Average total revenue per car-mile was 10·308d. (increase 0·0638d.) and working expenses (including power) were 6·432d. Passengers carried were 10,479,421 (increase 474,257 exclusive of soldiers carried free, and car-miles run 927,728 (increase 29,713), and units used for traction 1,200,086.

Mr. W. T. ROUSON, general manager and engineer (who has since resigned, on his appointment as manager of the Southampton tramways), says in his report the decrease of £10 per week in the receipts since the outbreak of the war was the more noticeable because the omnibus service was inaugurated on July 30, but the increase in the number of top-covered cars has undoubtedly prevented a greater decrease. The popularity of the universal 1d. fare system is shown by the fact that no suggestion or request for alteration of fares has been made. The example of the Council in adopting the Edison accumulator omnibus has been followed in several other towns and the reliability and freedom from breakdowns, with the low running costs, have proved the wisdom of the course taken. During eight months the 'buses carried 156,203 passengers and ran 22,197 miles, the receipts being £607 (6·55d. per mile). This is barely enough to meet all charges, including depreciation, but the 'buses are feeders to the tramways, and it is probable that any apparent deficit is made up on the tramways. 39,000 units have been used on the 'buses

COMPANIES' MEETINGS AND REPORTS.

ABERDEEN SUBURBAN TRAMWAYS CO. At the meeting last week the

conditions, Notwithstanding the exceptional circumstances, they dividend. For many years their policy had been to restrict the dividend in order that they fund. That fund now to suit the changed conditions of the under

taking generally, the directors w[illegible] to write off in future years [illegible] the negotiations for the purchase [illegible] substantial progress had been made. In place of the late Mr. Jackson the directors had appointed Mr. James Sellar a director of the company. The report was adopted and a dividend [illegible] declared.

ALLGEMEINE ELEKTRICITÄTS GESELLSCHAFT [illegible] of this company at Berlin the scheme for acquiring the Berliner Elektricitäts Werke (A.G.) was approved. In the course of his speech the chairman (Dr. W. Rathenau) said that their anxiety concerning raw materials had completely gone and the blockade no longer affected them.

CLYDE VALLEY ELECTRICAL POWER CO.—Including £11,535 brought forward, the profit for the past half-year amounts to £54,095. After adjusting interest and transferring £18,709 to contingency fund for depreciation, &c., the directors recommend that £4,276 be transferred to reserve fund and £10,000 applied in writing down cost of legal charges, and after paying the dividend on the preference shares to 31st prox., £12,430 has been carried forward.

BISHOP'S STORTFORD, HARLOW AND EPPING GAS AND ELECTRICITY CO. At the recent meeting the chairman (Mr. E. L. Burton) said that they were on the point of supplying electricity, and it was not their fault that they had not been in a position to do so before. The contractors had been busy elsewhere on Government work, and their own installation had had to be deferred. They had, however, practically everything complete now, and hoped in a few weeks to be able to supply electricity provided a sufficient number of people in Bishop's Stortford required current.

MEXICAN NORTHERN POWER CO.—The directors announce that they will not be able to meet the interest on the first mortgage bonds due Jan. 1, 1916. With the proceeds from sales of prior lien bonds authorised in May, 1914, and loans made on the security of the bonds, the directors state that they have been able to make considerable progress with the completion of the dam and the transmission line to Parral, and it is hoped that the company will be able to deliver power to consumers about the middle of this month. It is manifest, however, that the company will not be in a position to pay the interest on the first mortgage bonds on Jan. 1, 1916, and therefore default will again take place. Some plan of reorganisation must, therefore, be devised.

MANAOS TRAMWAYS & LIGHT CO. (LTD.)—At the recent meeting the chairman (Mr. Geo. Watson) said that the receipts for the past year had declined 17 per cent., but the expenses had been reduced by about 14 per cent. The relationship between the company and the Government was cordial and contracts were loyally carried out. While the Amazon Valley had suffered severely on account of the rubber position, the country was now developing other industries, which would assist in securing the future prosperity of Brazil.

UNITED ELECTRIC CAR CO. (LTD.)—After charging £5,332. 8s. 4d. for depreciation (including £4,500 added to reserve), the profit for the year ended June 30 is £8,552. 15s. 9d., and with £2,154. 5s. 11d. from last year, the total is £10,707. 1s. 8d. Deducting the preference dividend for the six months ended Dec. 31, 1914 (£3,000), the available balance is £7,707. 1s. 8d. The directors recommend payment of the preference dividend for the half-year ending June 30 (£3,000), and the carrying forward of £4,707. 1s. 8d.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

SEEAR, SCOTT & CO. (LTD.) (141,463).—Reg. Sept. 1, capital £3,000 in £1 shares (2,250 7 per cent. preference and 750 ordinary), to take over the business of manufacturing electrical and general engineers, carried on by Seear, Scott & Co., Ltd. (old company), and to carry on the business of mechanical, electrical, telegraphic and general engineers, &c. Private company. First directors are J. Scott (chairman), E. C. Seear (secretary), and R. H. Yuile. Reg. office: 51A, St. Peters-street, South Croydon.

TORMO MFG. CO. (LTD.) (141,466).—Reg. Sept. 1, capital £20,000 in £1 shares, to carry on the business of manufacturers of and dealers in bearings for machinery and vehicles, shafting and hangars for power transmission, internal combustion, steam and electrical engines and motors, &c. Private company. [illegible]

MORTGAGES AND CHARGES.

DEFRIES & GOLDMAN (LTD.) [illegible] created Aug. 21, 1915, have been filed, amount of present issue being £900. [illegible] capital. No trustees.

ELECTRO-FLEX STEEL CO. (LTD.)—Issue on Aug. 20, 1915, of £5,100 debentures, part of [illegible]

PRITCHETT & GOLD AND ELECTRICAL POWER STORAGE CO. (LTD.)—Particulars of £30,000 [illegible] the amount of present issue being £[illegible] part a property and [illegible] Essex, with fixed and floating [illegible] No trustees.

RECEIVERSHIP.

BROWN & PARSONS (1913) (LTD.) [illegible] Mason, Wolverhampton-street, Dudley, as receiver on Aug. 27, 1915, under powers contained in debenture dated Oct. 13, 1913, [illegible]

CITY NOTES.

MEMORANDA (Sept. 8).—Bank rate 5 per cent. (since Aug. 8, 1914) Consols 65 7/16. Consols Pay Day Oct. 1. Stocks and Shares Ticket Days Sept. 28 and Oct. 13. Pay Days Sept. 10 and 29, and Oct. 14. Price of silver, 23 1/2.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.)—The directors have paid an interim dividend at the rate of 6 per cent. per annum (less tax) on the ordinary sh[illegible]

CANADIAN GENERAL ELECTRIC CO. (LTD.)—The directors have de[illegible] half-yearly dividend of 3½ per cent., being at rate of 7 per cent. per annum on the common and preference stocks.

CITY OF LAS PALMAS WATER & POWER CO. (LTD.)—A circular has been issued intimating that the debenture interest cannot be met, owing to delay in the execution of the work and the necessity to modify the contract. Delays were caused by the opposition of landowners, but the Municipal Council granted an extension of time for completing the works, on condition that modifications were made in the original plans, which involved considerable increase of expenditure. The contract with Messrs. Dick, Kerr & Co. had consequently to be modified. The contractors are prepared to execute the altered contract and to guarantee its completion within the time limit (April, 1916) allowed for £170,000, instead of £125,000 originally contemplated, and the contractors are also willing to provide the extra money if the company will furnish them with collateral security in Prior Lien bonds, with a certain margin of cover. Application has consequently been made to the Treasury for sanction of a prior lien bond issue, and when a reply has been held a meeting of debenture holders will be held. It is also proposed that the interest on the debenture stock should be paid for the next two years in prior lien bonds.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) The directors have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share (tax free), payable on the 15th prox. The share register will be closed from Oct. 7 to 14, inclusive.

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—The directors have declared an interim dividend of 4 per cent. per annum for the half-year ended June 30.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Sept. 8. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shares	Last Dividend	NAME.	Price, Wed. Sept. 8.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 7 6	Mar, Sept
1	4½	[illegible]	9	4 15 6	Feb, Aug
1	[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
5	10%	Brompton & Kensington Ord.	5⅜	6 1 [illegible]	Mar, Sept
St.	4	Central Elec. Supp. G. Deb. St.	90½	4 8 [illegible]	[illegible]
St.	4½	Charing Cross West End & City Debs.	95	4 1 11	Jan, July
5	2 3	[illegible]	4⅝	5 1 11	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	Aug, Feb
10	[illegible]	Con. [illegible] Elec. Ltd. Ord.	1[illegible]	7 5 5	Feb, Aug
1	[illegible]	[illegible] Pref.	12½	4 17 0	Mar, Sept
St.	[illegible]	Do. 5% Deb. St.	110	4 10 11	Jun, Dec
10	[illegible]	[illegible]	[illegible]	[illegible]	Mar, Sept
1	[illegible]	Do. 6% Pref.	1[illegible]	5 11 4	Feb, Aug
St.	4½	Do. 2nd Deb.	92	4 12 9	May, Nov
St.	4½ %	Edmundson's Elec. Supp. 4½% Debs.	[illegible]	5 16 3	July
5	[illegible]	Kensington and Knightsbridge Ord.	[illegible]	7 5 5	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	4 13 0	Jan, July
St.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	London Elec. Supp. 6% Pref.	[illegible]	5 13 1	[illegible]
St.	[illegible]	[illegible]	[illegible]	4 11 11	Jan, July
[illegible]	5½	Metropolitan E. Supp. Ord.	[illegible]	[illegible]	Mar, Aug.
St.	4½	Do. 1st Mort. Deb.	[illegible]	4 11 [illegible]	[illegible]
[illegible]	[illegible]	Midland Elec. Corpn., 1st Mort. Deb. St	[illegible]	[illegible]	Jan, July
[illegible]	[illegible]	Newcastle & Dist. E.L. 6% 2nd Dbs.	98½	6 1 11	Mar, Sept
St.	[illegible]	Newcastle-on-Tyne E.S. 5%2dMt.Db.St.	100	[illegible]	Mar, Sept
1	[illegible]	North Metropolitan E. P. Supp. 6% Pref	1[illegible]	5 11 [illegible]	April, Oct
St.	5%	South London E.S. 1st Mort. Debs.	[illegible]	5 5 3	Jan, July
St.	[illegible]	[illegible]	[illegible]	[illegible]	Apl, Oct
1	[illegible]	Waste Heat & Gas Elec. Gen. Stations.	[illegible]	[illegible]	Mar, Aug
[illegible]	[illegible]	Westminster E.S. Corp. Ord.	[illegible]	[illegible]	Mar, Sept
5	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
		Electric Railways & Tramways.			
[illegible]	[illegible]	British Elec. Traction 5% Debs.	[illegible]	[illegible]	Apl, Oct
[illegible]	[illegible]	Do. 6% Cum. Pref.	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	Central London Guar. Assented Ord.	73[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Do. do. Assented Def. Ord.	[illegible]	[illegible]	[illegible]
St.	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
St.	[illegible]	[illegible]	[illegible]	[illegible]	Jan, July
[illegible]	[illegible]	City & S. London Deb.	[illegible]	[illegible]	May, Nov
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	1½	[illegible]	[illegible]	[illegible]	Jan, July
St.	[illegible]	[illegible]	[illegible]	[illegible]	Mar, Sept.
St.	[illegible]	[illegible]	86	[illegible]	Jan, July
St.	1½	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Do. 3½% Pref.	[illegible]	[illegible]	Feb, Aug
[illegible]	[illegible]	[illegible]	73[illegible]	[illegible]	Feb, Aug
St.	3½%	[illegible]	[illegible]	[illegible]	Jan, July
St.	3½%	Do. 3½% Debs.	[illegible]	[illegible]	Jan, July
St.	[illegible]	Metropolitan Dist. Ry. Ord.	[illegible]	[illegible]	Feb, Aug
St.	4%	[illegible]	92	4 7 0	May, Nov

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Last Div.	NAME.	Price, Wed., Sept. 8.	Rate per cent Yielded.	Dividend Due.
	Electric Railways and Tramways	*-cont.*	£ s. d.	
St. 4½	Man[illegible] 4½ Pref.	[illegible]	[illegible]	Feb, Aug
St. 5	Do. 5% Pref.	12-¾	4 12 [illegible]	Jan, July
St. 4	Do. 4% Pref.	94	[illegible]	Jan, July
St. 4	Do. 4% Debs. (1903-5)	97½	4 11 [illegible]	Jan, July
St. 4	Do. 4% Debs.	98½	4 [illegible] 0	Mar, Sept
10	Underground E. Rys. of London Shares	14	[illegible]	[illegible]
1	Do. A	2	[illegible]	[illegible]
St. 6	Do. Cumulative	102½	5 [illegible] 1	Mar, Sept
[illegible] 6	Do. 6% Inc. Bds., ex. coup. 15	[illegible]	[illegible]	Mar, Sept
[illegible] 4½	Do. 4½ Bds.	98	4 11 [illegible]	Jan, July
5	Yorkshire W. Riding Ord.	3	[illegible]	March
5 6	Do. Pref.	4	[illegible]	Jan, July
	Electric Manufacturing, &c.			
1 [illegible]	Babcock & Wilcox Ord.	2½	[illegible]	Apl, Oct
1	Brit. Aluminium Ord.	1 A	[illegible]	Mar
100	Do. Pref.	103	[illegible]	Jan, July
1	Do. Def.	[illegible]	[illegible]	Jan, July
5	Brit. Insulated & Helsby Ord.	1[illegible]	[illegible]	Aug, Feb
5	Do.	[illegible]	[illegible]	Jan, July
1	Brit. L.M.E. Mfg. Co. Pref.	[illegible]	[illegible]	Mar, Sep
2	Brit. Westinghouse Pref.	1[illegible]	[illegible]	[illegible]
10	Do.	10[illegible]	[illegible]	Apl, Oct
St. 4	Do. 4% Pref.	73	[illegible]	Jan, July
5	Callender's Cable, &c., Co. Ord.	1[illegible]	[illegible]	Feb, Aug
5	Do. 5% Pref.	[illegible]	[illegible]	Feb, Aug
1	Do. Def.	[illegible]	[illegible]	May, Nov
1	Do. Def.	[illegible]	[illegible]	Sept
5	Do. Preference A £5	[illegible]	[illegible]	Feb, Aug
1	Elec. Construction Ord.	[illegible]	[illegible]	May
1	Do. 7% Cum. Pref.	1[illegible]	[illegible]	Jan, July
St. 4	Do.	6[illegible]	[illegible]	Jan, July
10	Crompton & Co.	[illegible]	[illegible]	Jun, Dec
5	W. T. Henley's Telegh. Wks. Co. Ord.	13[illegible]	[illegible]	Feb, Aug
5	Do. 4½ Pref.	4[illegible]	[illegible]	[illegible]
St. 4½	Do. 4½ Pref.	9[illegible]	[illegible]	Jun, Dec
10	India Rubber, G. P. &c., Ord.	[illegible]	[illegible]	Feb, Aug
10	Do. Pref.	[illegible]	[illegible]	Apl, Oct
100	Do. 4% Deb.	[illegible]	[illegible]	Apl, Oct
12	Telegraph Construction & Maint. Co.	3[illegible]	[illegible]	Mar, July
100	Do. 4% Debs.	[illegible]	[illegible]	Jan, July
1	Vickers Ord.	[illegible]	[illegible]	May, Aug
1	Do. 5% Pref.	[illegible]	[illegible]	May, Aug
St. 4	Do. 1st Debs.	[illegible]	[illegible]	Jun, Dec
100	Do. 4½% Debs.	[illegible]	[illegible]	Jun, Dec
	Telegraphs.			
100	Anglo-American Tel. Co.	[illegible]	[illegible]	Jan, July
St. 3	Anglo American 6% Pref. Ord.	[illegible]	[illegible]	Feb, May, Aug, N
St. 4	Do. Def. Ord.	[illegible]	[illegible]	Feb, May, Aug, N
St. 4	Commercial Cable 4% Debs.	[illegible]	[illegible]	Ja, Ap, Jly, O
10	Cuba Submarine Ord.	[illegible]	[illegible]	May, Nov
10	Do. Pref.	[illegible]	[illegible]	[illegible]
5	Direct Spanish 10% Pref.	[illegible]	[illegible]	[illegible]
10	Direct United States	[illegible]	[illegible]	Ja, Ap, Jly, O
St.	Eastern Tel. Co. Ord.	[illegible]	[illegible]	Ja, My, Jly, O
St.	Do. 8% Pref.	[illegible]	[illegible]	Ja, My, Jly, O
St.	Do. 4% Debs.	[illegible]	[illegible]	May, Nov
St.	Eastern Extension Tel. Co., 4% Debs.	[illegible]	[illegible]	Feb, Aug
10	Do. Def.	[illegible]	[illegible]	Ja, Ao, Jly, O
10	Gt. Northern Tel. Co. with Coup. 8	[illegible]	[illegible]	Ja, My, Jly
25	Do. 4%	[illegible]	[illegible]	May, Nov
1	Marconi's Wireless Tel. Co.	[illegible]	[illegible]	April
1	Do. 7% Pref.	[illegible]	[illegible]	[illegible]
10	West Indian & Panama Tel. Co.	[illegible]	[illegible]	May, Nov
10	Do. 1st Pref.	[illegible]	[illegible]	May, Nov
10	Western Telegh. Co.	[illegible]	[illegible]	Mr, Jly, O, Dec
St. 4	Do. 4% Deb. St.	[illegible]	[illegible]	Jun, Dec
25	Western U.	[illegible]	[illegible]	May, Nov.
	Telephones.			
[illegible] 52	American Telephone & Teleph. $100 Cap.	[illegible]	[illegible]	Ja, Ap, Jn, O
[illegible] 5%	Cuban Telephn. Co. 5% Bds.	[illegible]	[illegible]	Jan, July
1 7½	Metropolitan Telephone	[illegible]	[illegible]	Nov.
[illegible] 4½	New Telephone Co.	[illegible]	[illegible]	[illegible]
1	Provincial Telephone Corp.	[illegible]	[illegible]	Apl, Oct
St. 4	Do. Db. St.	[illegible]	[illegible]	Jan, July
St. 4½	Telephn. Co. of Egypt Db. St.	[illegible]	[illegible]	Jan, July
5	United River Plate Ord.	[illegible]	[illegible]	Apl, Oct
5 5	Do. 5% Cum. Pref.	[illegible]	[illegible]	Jan, July
St.	Do.	[illegible]	[illegible]	Jan, July
	Financial and Investment.			
10 6	Chartered & Tr[illegible]	[illegible]	[illegible]	Sp, Dc, Mr, Jn
10 6	Do. 6% Pf.	[illegible]	[illegible]	Sp, Dc, Mr, Jn
100 5	Mercantile Investment	[illegible]	[illegible]	Ja, Ap, Jly, O
[illegible]	Submarine Cables Trust	[illegible]	[illegible]	Ja, Ap, Jly, O
100	Submarine Cable Trust Certs.	125[illegible]	[illegible]	Apl, Oct
	Colonial and Foreign Railways, Tramways, &c.			
St. 5	Antofagasta & Bolivia Ry.	[illegible]	[illegible]	Jun, Dec
St. 4½	Buenos Ayres Great Southern	[illegible]	[illegible]	Jan, July
St. 4½	Do. 4% Debs.	[illegible]	[illegible]	Jan, July
	Buenos Ayres Western	[illegible]	[illegible]	Jan, July
	Central Argentine	[illegible]	[illegible]	Jan, July
10	Costa Rica Ry. Ord.	11	[illegible]	Feb, M, Aug, N
100 5½	Do. Pref.	[illegible]	[illegible]	Ja, Apl, Jly, O
	Brisbane Trams Ord.	[illegible]	[illegible]	May
	Do. Pref.	[illegible]	[illegible]	May, Nov
St. 4½	British Columbia 4½ Con. Debs.	[illegible]	[illegible]	Mar, Sep
	Calcutta Tramways	[illegible]	[illegible]	Feb, Aug
5 6	Madras Elec. Trams 6% Cum. Pref.	[illegible]	[illegible]	[illegible]
[illegible]	Mexican Tramways	[illegible]	[illegible]	Jan, July
[illegible]	Mexico Tramways Pref.	31	[illegible]	Feb, M, Aug, N,
	Do. Def.	[illegible]	[illegible]	Mar, Sep
St.	Montreal Street Ry. 4½% Debs. (1922)	[illegible]	4 13 10	Feb, Aug
12	Rio de Janeiro Tram, L. & P. 50 yr. Bds	[illegible]	4 17 0	Feb, Aug
	Colonial and Foreign Electric Supply, &c.			
5 3/0	Adelaide Elec. Supply 6% Pref.	[illegible]	[illegible]	Mar, Sept
St.	Brazilian Tr., Light & Power	[illegible]	[illegible]	Jan, July
	Do. Pref.	[illegible]	[illegible]	[illegible]
	Do. Def.	[illegible]	[illegible]	[illegible]
	Buenos Ayres Electric Tramways	[illegible]	[illegible]	May, Nov
	Do. Pref.	[illegible]	[illegible]	Mar, Sept
	Do. Def.	107[illegible]	[illegible]	Ja, Apl, Jly, O
	Do. Def.	[illegible]	[illegible]	June, Dec
St.	Do. Def.	[illegible]	[illegible]	Apl, Oct
	Do. Def.	[illegible]	[illegible]	Jan, July
	Do. Def.	[illegible]	[illegible]	Ja, Apl, Jly, O
St. 4½	Buenos Ayres Pacific	[illegible]	[illegible]	Jan, July
	Do. Pref.	[illegible]	[illegible]	[illegible]
	Do. Def.	[illegible]	[illegible]	[illegible]
	Do. Def.	[illegible]	[illegible]	May, Nov
	Do. Def.	[illegible]	[illegible]	Jan, July

METAL PRICES.

J. B. Cornelius & Sons, 132, Upper Thames-street, London, E.C., quote under the following as the present basis prices of

New Metals.	per lb.	Old Metals.	per ton.
Drawn Brass Tubes	13d.	English Lead	£24 0 0
Drawn Copper Tubes	13½d.	Antimony	Nominal.
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	15d.		
Brass Wire	13½d.	Clean Scrap Copper	£63 0 0
Copper Wire	13d.	Brazierly Copper Scrap	£57 0 0
Rolled Brass	13d.	Clean Scrap Brass	£50 0 0
Brass Sheets	13½d.	Old Lead	£17 0 0
		Old Zinc	£42 0 0
	per ton.	Hollow Pewter	£115 0 0
Copper Sheets	£98 0 0	Black Pewter	£75 0 0
Spelter	£74 0 0	Gun Metal	£59 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£75 0 0	Old Lead	£19 10 0
Clean Mixed Brass	£62 0 0	Tea Lead	£17 10 0
Clean Copper	£63 0 0	Zinc	£44 0 0
Brazierly Copper	£57 0 0	Hollow Pewter	£110 0 0
Gun Metal	£61 0 0	Shaped Black Pewter	£35 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £70. Commercial Tinman's Solder, £90; Blowpipe Solder, £103.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Inc. or dec.	No. of weeks.	Aggregate Amount.	Aggregate Inc. or dec (2)
		£		£	£
Aberdeen Corporation	[illegible]	1,927	13	25,211	– 185
Argentine	[illegible]	49,780	35	1,783,472	– 131,931
London (L.)	[illegible]	473	38	11,340	+ 434
Corporation	[illegible]	407	16	8,115	+ 75
Bath Electric Trams, Ltd	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Birkenhead Corporation	5	1,419	23	31,344	+ 1,986
Blackburn Corporation	4	14,599	23	306,614	– 28,838
Blackburn Corporation	1	1,238	23	30,816	– 1,047
Blackpool Corporation	[illegible]	3,540	23	46,610	– 3,687
Blackpool and Fleetwood	[illegible]	1,977	38	28,328	– 2,268
Bolton Corporation	[illegible]	2,760	23	61,646	– 3,954
Bournemouth Trams	1	2,663	22	49,733	– 546
Bournemouth Buses	1	41	22	703	– 140
Bradford Corporation	Aug. 28	6,748	21	145,207	+ 3,808
Brighton Corporation	Sept. 4	1,405	23½	27,545	– 268
Bristol Trams	3	4,745	35	165,186	– 4,376
Buses, &c.	3	5,620	35	170,918	+ 25,391
Burmah E. Trams & Ltg.	4	R3,726	35	R124,791	– R787
Burnley Corporation	4	1,653	23	51,267	– 843
Burton Corporation	5	285	23	6,691	– 394
Bury Corporation	5	1,403	23½	31,874	– 1,576
Calcutta Tramways Co.	4	£65,484	[illegible]	[illegible]	[illegible]
Camberwell Borough	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cardiff Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cork Electric Trams Co.	2	[illegible]	11	35 17,540	– 230
Coventry Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Croydon Corporation	Aug. 27	[illegible]	22	41,367	+ 2,050
*Derby Corporation	Sept. 4	[illegible]	22	24,240	– 170
Dover Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dublin & Lucan Railway	3	183	2	1,573	– 55
Dublin United Tramways	3	6,257	35	214,723	+ 6,463
Dundee Corporation	1	1,410	23	21,605	– 1,096
East Ham Council	4	1,335	22	30,248	+ 4,910
Exeter Corporation	3	424	22	8,973	– 414
Glasgow Corporation	4	22,530	143	296,496	+ 18,296
Gosport Trams	4	123	11	4,335	– 108
Gloucester Corporation	[illegible]	[illegible]	22	7,630	– 91
Halifax Corpn. Trams	Aug. 31	2,412	35	51,563	– 473
Halifax Corpn. Buses	31	[illegible]	[illegible]	1,165	– 41
Hastings Elec. Trams Co.	Sept. 2	1,375	35	34,270	– 875
Huddersfield Corpn.	4	2,734	1	61,999	+ 7,351
Hull Corporation	4	3,016	35	68,868	– 2,948
Ilford District Council	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ilkeston Corporation	1	114	22	2,979	– 15
Ipswich Corporation	[illegible]	[illegible]	22	13,[illegible]	– 1,611
Isle of Thanet	4	[illegible]	45	20,351	– 13,333
Johnstone Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lancashire Trams Co.	2	2,150	35	67,574	+ 717
Lancashire United	1	1,859	35	60,682	+ 2,556
Leeds Corporation	4	9,101	23	206,026	+ 13,146
Leicester Corporation	4	3,044	35	106,554	+ 3,663
Leith Corporation	[illegible]	785	22	12,777	+ 375
Lincoln Corporation	[illegible]	165	23	3,276	+ 246
Liverpool Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Llandudno & Colwyn Bay R	3	[illegible]	[illegible]	13,574	– 692
London County Council	[illegible]	+ 5,145	1	906,099	+ 77,130
Lowestoft Corporation	[illegible]	– 121	38	8,576	– 2,024
Maidstone Corporation	[illegible]	[illegible]	1	5,074	– 44
Manchester Corporation	[illegible]	18,530 + 1,495	[illegible]	407,871	+ 6,031
Nelson Corporation	[illegible]	[illegible]	[illegible]	4,467	– 333
Newcastle Corpn.	[illegible]	[illegible]	[illegible]	[illegible]	+ 26,000
Newport (Mon.) Corpn.	[illegible]	[illegible]	[illegible]	14,447	– 288
North Metropolitan	[illegible]	[illegible]	[illegible]	17,210	+ 3,660
Nottingham	[illegible]	[illegible]	[illegible]	84,475	+ 4,788
Oldham Corporation	[illegible]	[illegible]	[illegible]	[illegible]	16
Portsmouth Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Preston Corporation	[illegible]	[illegible]	[illegible]	21,330	+ 212
Rhondda & Swansea Bay	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rochdale Corporation	1	[illegible]	[illegible]	[illegible]	2,700
Rotherham Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Salford Corporation	[illegible]	[illegible]	[illegible]	206,988	+ 20,389
Sheffield Corporation	[illegible]	1,701	[illegible]	33,795	+ 1,944
Shrewsbury Corporation	Aug. 28	[illegible]	[illegible]	20,879	– 644
South Metropolitan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Southampton Corpn.	Sept. 5	[illegible]	[illegible]	[illegible]	– 1,231
South Shields Corpn.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Southport Corporation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Stockport Corporation	Aug.	[illegible]	[illegible]	[illegible]	[illegible]
Sunderland Corporation	Sept. 4	1,447	[illegible]	5,459	+ 30
Swansea Corporation	[illegible]	[illegible]	[illegible]	30,859	– 91
Walsall Corporation	[illegible]	743	[illegible]	20,934	+ 3,443
Warrington Corporation	[illegible]	[illegible]	[illegible]	22,251	+ 1,[illegible]
Wednesbury Corporation	[illegible]	[illegible]	[illegible]	10,123	– [illegible]
West Ham Corporation	[illegible]	3,184	[illegible]	71,009	+ [illegible]
Wigan Corporation	[illegible]	1,561	[illegible]	33,935	– [illegible]
Wolverhampton Corpn.	[illegible]	[illegible]	[illegible]	24,830	– [illegible]
Yorkshire W.R. Trams	[illegible]	1,657	[illegible]	57,253	+ 1,[illegible]

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes [illegible] purposes &c. ‡ Minus 2 days. ‖ Minus 3 days. ¶ Plus 3 days. ¶ Plus 2 days. ** Compared with one week more last year.

THE ELECTRICIAN:

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NOTES.

Fatigue of Workers.

AN interesting discussion took place before the Economic Science and Statistics Section of the British Association in regard to the effect of fatigue upon the output. The subject was fully discussed from the point of view of the number of accidents and amount of output at various hours of the day, and stress was laid on the importance of rest pauses in the day's work. Fatigue of our workers in normal times means a vast economic loss to the country, and at the present time might mean defeat. There are symptoms which show that there is an accumulation of fatigue going on in the country, and we agree with the suggestion, made by Prof. MUIRHEAD, that social unrest might reasonably be interpreted as the result of accumulated neglect of hygienic and humane conditions of labour. Mr. P. S. FLORENCE struck the correct note in advising the meeting to ascertain the limits of a workman's capacity and to determine the scientific limit, lest that in two months' time they might find the whole working population crippled. Certain of the speakers referred to a ten-hour day and seven days per week. To our knowledge a considerable amount of important Government work has been carried out on much longer working hours. The work has been paid for on a time basis and waste has been the inevitable result. A serious aspect, which was not dealt with by any of the speakers taking part in the discussion, is that the present high rate of wages—due to long working hours and to other causes—will undoubtedly tend to make the working classes dissatisfied when employers are compelled, as they will be compelled, to reduce the rate of payment to the level which ruled before the war.

THERE is undoubtedly a limit beyond which efficient labour cannot be given. It is generally admitted that a reduction of working hours, as with the one-break system, does not reduce the output in the same proportion, and an obvious solution of the problem is to engage more men. Prof. B. MOORE aptly remarked that the excuse for the present state of affairs might be that in this war we thought at first that we were in for a 100 yards race, where it was now seen that we had to settle down for a four-mile spin. For maximum output it is necessary to keep the machinery employed during the whole 24 hours, but employed by using unfatigued men. This could be accomplished by working three shifts of four hours "on" and eight hours "off," and in some respects this is preferable to three eight-hour shifts. In conversation with a representative of the "Daily Telegraph," the Right Hon. ALEXANDER CARLISLE, for many years General Manager and Chairman of Managing Directors of Harland & Wolff, Belfast, said that he had had practical experience and proof during the 40 years with which he was connected with shipbuilding and engineering, that continuous overtime, instead of increasing, actually decreased output. A workman may work overtime for perhaps a week or a fortnight consecutively, but after that he loses time in the morning for what he may put in late, and it is only natural that the workman should take advantage of the opportunity of putting in overtime chiefly for the sake of the extra money. People without practical knowledge, he said, probably think that manual work can be continued almost any length of time, and in his opinion the British Association had done well in drawing attention to the importance of arranging rest pauses, as well as of organising increased output.

Electrical Haulage on Canals.

ON another page we publish an account of the system of electric haulage now in use on the Trent and Mersey Canal. This is of interest, for, as far as we are aware, it is the first example of electric canal haulage in this country. The

canal in question is unusual in that it includes a tunnel over a mile in length. There was, consequently, more than usual reason to have some mechanical method of propulsion in this instance, and finally a haulage barge was adopted which hauls itself along a steel rope by means of electrically-driven drums. By this method about 30 boats, most of them with 20-ton loads, can be hauled at one time at about 2 miles per hour. At present this method is only used for that part of the canal running through the tunnel, but we hope that when its advantages are fully realised it may be extended to a greater length. From time to time there has been agitation in this country to make greater use of the canals, which have largely fallen into disuse owing to the cost of working and the competition by other means of transit. The whole subject was considered by a Commission some few years ago, but no great developments seem to have followed this inquiry. In Germany it is otherwise. On the Teltow Canal, the equipment of which was described in THE ELECTRICIAN in 1906, electric haulage is used on an extensive scale, and it is found that the cost of haulage, including the maintenance of buildings and machinery, amounts to only 0·054d. per ton-mile. Interest and sinking fund charges and depreciation of plant, as distinct from the canal, bring up the total to 0·104d. per ton-mile for a yearly traffic of 2,000,000 tons. The electrical plant, however, is of an extensive character, and includes electric tractors as well as electric tugs. In this country we do not suppose there would be scope for an installation of this kind, but it is not unlikely that a good deal more might be done by means of modest equipment like that used on the Trent and Mersey Canal.

Disposal of Electricity Supply Profits.

TUNBRIDGE WELLS Corporation have succeeded in getting a useful clause inserted in their Extension Provisional Order of this year. The clause, which was set out in full in a recent issue, relates to the disposal of the surplus profit of the undertaking and the formation of what is termed a working capital fund. Though similar powers have been obtained by means of a private Bill, this is, we believe, the first instance of such powers having been granted in a provisional order. Hitherto municipal electricity supply undertakers have been somewhat hampered by statutory restrictions as to the disposal of surplus profits, but we hope that the Tunbridge Wells precedent will be frequently followed. However, we should like to see the clause modified so as to prevent the allocation of profits to the relief of rates, or at all events, until there is an adequate reserve fund. The present clause should, even so, prove quite useful, as it will enable local authorities to encourage the use of cooking and heating apparatus and any new developments of electricity among its consumers; it will also enable new consumers to be connected up pending the receipt of sanction to new loans. We welcome this departure of the Board of Trade, as it seems to indicate a desire to look with sympathy on the demand which has been made, and which has constantly been supported in these columns, for full powers for municipal electricity undertakings to carry on their business on up-to-date commercial lines.

Edison Batteries for Submarines.—It is stated that the first official tests have been carried out on the Edison nickel batteries to be fitted in the submarines of the United States Navy, and that the results are highly satisfactory. Three vessels will, therefore, be fitted with these batteries for cruising tests.

A Pocket Size Blasting Machine.—In the "Mining and Engineering World" is described an electric blasting machine so small that it can be carried in the pocket, the dimensions being 4½ in. by 3⅜ in. by 2¼ in., while the weight is only 4½ lb. It can fire from three to five blasting caps, and is worked by giving a sharp twist to a handle, which generates the current and fires the shot. The handle is removable so as to make the machine fool-proof.

Coating for the Interior Surface of the Ulbricht Globe.—A Commission of the Verband Deutscher Elektrotechniker on Lighting, as a result of experiments (detailed by Mr. A. Utzinger in the "Elektrotechnische Zeitschrift"), has made the following recommendations as to the Ulbricht Globe :—

Its diameter should be not less than 1·5 metres. 2·5 metres is, however, preferred. It should be constructed of galvanised sheet iron, that known as "Columbus sheet" being very suitable; and its inner surface coated with zinc-white. The coating should consist of a ground colour of white-lead or a white-lead substitute, such as permanent white (baryta-white), rubbed in varnish and thinned with a mixture of equal parts by weight of copal lac and turpentine. This is covered with three coats of a surface-colour prepared as follows :

(1) 100 parts of zinc-white are stirred with 8 parts of water.

(2) 100 parts of colourless fresh animal or vegetable size are dissolved in 500 parts of water.

(3) 100 parts of the zinc-white-water mixture (1) are added to 6 parts of the solution of size (2), and the mixture thoroughly stirred.

This surface-coating should be renewed once a year, the soiled surface-coating being first removed by washing with water. The ground of oil-colour remains permanently on the sheet-iron wall of the globe.

For the ground, 95 grammes per square metre of the white varnish is required; and for the finishing coats, 260 grammes of the zinc-white-water colour per square metre.

A New Cottonless Gunpowder (?)—The following has found its way into our office, and although we think it was possibly intended, judging by its appearance, for one of our lay contemporaries, we feel it is in any case worthy of publication :—

SIR : It seems to me extraordinary that no notice has been taken of Dr. Kravjaroff's invention; no doubt it is due to sex prejudice. As I happen to be familiar with science as well as something of a linguist, I enclose a translation. In Prof. Lewes' recent Papers at the Royal Society of Arts, just published, you see the learned author fully realises that the explosion goes down, but he is quite innocent of any knowledge how to utilise this property.—Yours truly, MILLICENT W. TAYLOR.

P.S.—I would have sent this to Lord Fisher's Committee but it has not a single woman scientist on it.—M. W. T.

This great invention is due to a young lady scientist, Dr. S. Kravjaroff. She took her degree in organic chemistry at a very early age and has devoted herself to research work since. On the outbreak of the war she had a small laboratory equipped in an unfrequented wood. Meals are brought to her twice a day, and she can thus devote her entire intellectual energy to the subject in hand without interruption or distraction.

Essential details of her inventions to keep profoundly secret, but the general principles are now known. Every reader of the scientific articles in the press knows that the force of high explosives goes downward, just as heat goes up. Dr. S. Kravjaroff was experimenting with trinitromannite and other nitrates, sometimes more accurately called ethers, of the sugar group. She succeeded in getting great power, but the force was still sent mainly downward. In a moment of inspiration she thought of nitrating invert sugar, and to her delight, she obtained a high explosive which sent its force almost entirely upward. This set her on the right path, and she soon found that an admixture of dextrose or levulose, so called, as is well understood, because they have the power of rotation to the right and left respectively, gave her elemental component such that the force varied in magnitude and direction as the cosine of the proportion of invert sugar to dextrose or levulose. This explosive is not only made without cotton, but it can be fired with a much lighter gun. The inventor claims that a charge posed with proper orientation with the right proportion of dextrose to give the deflection corresponding with the range, explodes violently, sending all its force in the direction away from where it was pointed; so that the gun barrel, whose function is merely directive, can be made extremely light. We are inclined to think the enthusiasm of a great inventor may have led her, perhaps, a little too far. That a charge of this explosive should send out the whole body of power as a sort of long rod of force of the same size as the gun bore is very nearly inconceivable. We cannot but think that there would be a good deal of errant force, or stray field, as scientists call it, which will need a barrel of appreciable substance to keep it within the necessary bounds. Absolutely full information as to the actual has perhaps not unnaturally,

been denied us; but we feel from what has been disclosed that we have here an invention which, if we go to war, may be the means of saving the fate of Bulgaria, but of most of the rest of Europe.

British Standard Specification for Electricity Meters.—Under the above title Report No. 37 of the Engineering Standards Committee, revised August, 1915, has just been issued. The revision has been undertaken by the Sub-committee on Electrical Accessories, of which Mr. C. H. Wordingham is chairman, and it has been found necessary to redraft entirely the first edition issued in 1907 and also to extend it in view of the growth of the size of electrical installations. The specification is intended to apply to the sale of meters by the manufacturer to the purchaser, but has been drawn up so that meters conforming to these requirements may be expected to fulfil the conditions imposed by the Board of Trade on meters used by public supply undertakings. It has been found necessary to distinguish between the portion of the main circuit in the meter and that outside the meter; consequently, besides definitions of "main circuit" and "pressure circuit," definitions are also given of "meter current circuit" and "meter pressure circuit." The standard sizes of meters include sizes for currents up to 5,000 amperes. The registering mechanism is dealt with at some length and the limits of error are specified in a concise table, the formula used in the first edition of this specification having been discarded. Meters are required to have the testing constant plainly marked. Appendices have been added dealing with the precautions to be taken in the erection of meters, and notes are given on the testing of meters. The Report, the price of which is 7s. 9d. post free, may be obtained direct from the offices of the Committee, 28, Victoria-street, Westminster, S.W.

Current Topics.

Subjects of current interest dealt with in this issue include the following:

Dr. J. F. H. Douglas contributes an article on "Leakage Flux Calculations" (p. 880).

We give a report of the meeting of the British Association at Manchester by our special correspondent (p. 887). Our Leading Article deals with the work of the Association (p. 884).

We reproduce the following Papers read before the British Association last week: "The Capacity of Aerials of the Umbrella Type," by Prof. G. W. O. Howe (p. 870); "A Self Adjusting Commutating Device," by Prof. Miles Walker (p. 872); "Exposure Tests of Light Aluminium Alloys," by Prof. E. Wilson (p. 886); "Transformer Core Loss as affected by Triple Harmonics," by Messrs. H. M. Lacey and C. H. Stubbings (p. 874); "The Heating of Iron when Magnetised at Very High Frequencies," by Mr. N. W. McLachlan (p. 877); and "A Note on Earth Resistance," by Prof. E. W. Marchant (p. 882).

We describe the electric haulage system now in operation on the Trent and Mersey Canal (p. 875).

Companies' Meetings and Reports.—Meetings of the Dumbarton Burgh and County Tramways Co. and Electro Bleach & By-Products are reported, and the directors' reports abstracted include those of Bolckow, Vaughan & Co., Dundee Broughty Ferry & District Tramways Co., Nairobi Electric Power & Lighting Co. and Southern Electric Tramways Co. of Buenos Ayres (p. 899).

OBITUARY.

MATTHEW H. GRAY.—We regret to record the death of Mr Matthew Hamilton Gray, which took place at Glenquoich, Perthshire, on the 2nd inst. Deceased, who was 61 years of age, was born at Glasgow, was educated at Greenock and University College School, London, and was trained as a mining engineer. Having acquired experience in South America and the United States he took up an appointment at Borneo. After a few years he returned and entered the service of the India Rubber, Gutta Percha & Telegraph Works Co. as engineer and later as engineer-in-charge in the company's submarine cable laying department. He was in charge of many submarine cable laying and repairing expeditions, and was responsible for the laying of several important cables. He retired from active service some years ago. He was buried on the 6th inst. in the family vault at East Wickham, where the late Mr. Robert Kaye Gray and many other members of the family are laid to rest.

SIR WM. VAN HORNE.—The death is announced of Sir William Van Horne, president and chairman of the Canadian Pacific Railway Co. until 1910. Deceased began work as a telegraph boy in the service of the Illinois Central Railroad, but he rose rapidly through the various grades of the service, and in 1881 he became general manager of the Canadian Pacific Railway, in the completion of which he took a prominent part.

KILLED IN ACTION.—Sapper Geo. N. Halliwell, of the 1st E. Lancashire Field Co., Royal Engineers, has been killed in the Dardanelles. Deceased was a mechanical engineer who, at the outbreak of war, was employed at the British Westinghouse Co.'s works at Trafford Park, Manchester.

APPOINTMENTS VACANT AND FILLED.

Shanghai Municipal Council require a chief assistant clerk and accountant for their electricity department. Salary 400 taels (about £46) per month. Applications, with copies of testimonials, &c., to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., by Tuesday, Sept. 28. *Further particulars are given in an advertisement.*

A mechanical engineer is wanted for the tramway power house of the Chatham & District Light Railways Co. Commencing salary £2.15s. per week with 2s. war bonus. Applications to the Company, Power Station, Chatham. *See an advertisement.*

Mr. R. E. Livesley, of Whalley Range, has been appointed shift engineer at Stretford electricity works, in place of Mr. T. Woodhill, resigned.

Mr. A. Wilson has been appointed "power-house economist" at the Sydney municipal electricity works, at £375 per annum.

In consequence of the resignation of Mr. A. E. Wilson, Deputy City Electrical Engineer at Bristol, consequent upon his appointment as electrical engineer to the chief engineer of the Southern Command, Bristol Electrical Committee recommends the Council to promote Mr. A. J. Newman, who has been in the service of the Committee for 11 years, to the vacant position at £350, rising to a maximum of £400 per annum; to promote Mr. A. J. Ostler to the position of sub-station engineer at £200, rising to £250; and to promote Mr. I. A. D. Pedler, to the position of mains engineer at £175, rising to £250.

Senor Alvarez Cortés has been appointed as manager of the Uruguay Government's electric power stations.

INSTITUTIONS AND SOCIETIES.

Electric Vehicle Association of America.—Most of this Association's 16 sections suspended meetings during the summer months, but there has been considerable section activity, especially through local committees. Most sections will begin their autumn session within the next few weeks. Very practical work of great value has been accomplished by the Chicago section in the matter of their "parking system," whereby users of electric vehicles may leave their vehicles at the electric shop of the Commonwealth Edison Company, where uniformed, licensed chauffeurs take them to the park and return them whenever ordered. Mr. M. R. Berry, chairman of the Exhibition Committee, has reported that there seems to be a strong demand for an exhibition of electric vehicle batteries, charging apparatus, measuring and registering instruments, tyres and accessories, and, consequently, tentative plans are under way to hold exhibitions at the Hotel Statler, Cleveland, the headquarters of the sixth annual convention.

ARRANGEMENTS FOR THE WEEK.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding: Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week commencing Sept. 20, 1915:

Drills 6.30 to 7.30; 7.30 to 8.30 p.m.

Monday: Section III., Technical Instruction. Section I., Musketry at Range. Sections II. and IV., Squad Drill or Signalling.

Friday: Section IV., Technical Instruction. Section II., Musketry at Range. Sections I. and III., Squad Drill or Signalling.

Attention is called to the fact that the War Office has now decided to employ certain Volunteer Training Corps in guarding waterworks, railways and prisoners.

THE CAPACITY OF AERIALS OF THE UMBRELLA TYPE*

BY PROF. G. W. O. HOWE, D.Sc.

[illegible] Science and Technology, South Kensington.

Summary.—The author calculates the capacity of aerials of the umbrella type according to a general method which he published last year. The calculated results agree with those of measurement within the errors of observation and estimation.

The author has recently published † a method of calculating rapidly the approximate capacity of aerials of various types. Although not rigorously correct, the accuracy obtained is more than sufficient for all the purposes of radio-telegraphy, and in most cases will be found to agree with the measured capacity within the errors of observation. In addition to describing the method in general, curves and formulæ were given so that the capacity of aerials of

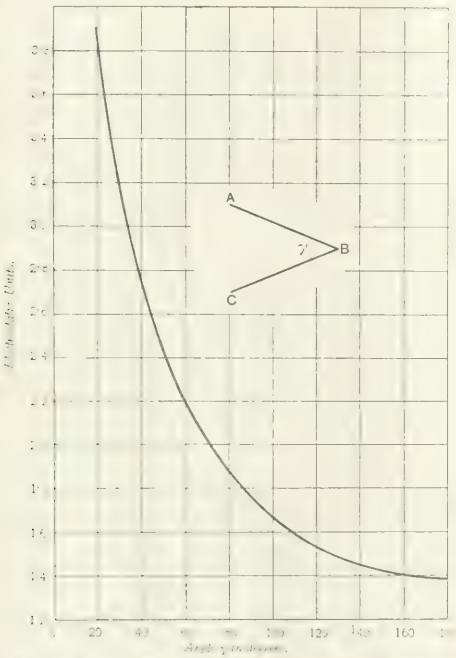


FIG. 1.—AVERAGE POTENTIAL OF AB DUE TO UNIT CHARGE PER CENTIMETRE ON BC.

[illegible] could be determined in a few minutes. The umbrella type, however, was not specially considered, and it has been suggested to the author that the usefulness of the original Paper would be considerably increased if curves and formulæ could be given for aerials of this type.

The method is briefly as follows: The whole aerial is assumed to have a uniformly distributed charge, and the average potential taken over the whole aerial under this fictitious condition is then calculated. It is assumed that if the total charge, while remaining unchanged in amount, be allowed to have its own natural distribution, it will assume a uniform potential approximately equal to the average potential. The proximity of the earth is taken into account by assuming that the image of the aerial in the earth is uniformly charged with electricity of opposite sign, and calculating its effect on the average potential of the actual aerial.

The umbrella type consists of a vertical wire and a number of radial ribs sloping downwards from the top towards the earth. [illegible] and the ribs may be made up of a number of wires. We shall consider in the first place the simple case of a single vertical wire and a ring of n equal ribs inclined to the vertical at an angle α. The average potential of each rib is made up of five components:—

1. Due to its own charge.
2. Due to the charges on the other ribs.
3. Due to the charge on the vertical wire.
4. Due to the image of the ribs.
5. Due to the image of the vertical wire.

The average potential of the vertical wire is made up of four components:—

1. Due to its own charge.
2. Due to the charges on the ribs.
3. Due to its own image.
4. Due to the image of the ribs.

Our object is to plot curves from which each of these components may be written down at once for any given aerial.

All the nine component potentials can be found from curves given in the original Paper, with the exception of the second, third and seventh.

With regard to the second, the average potential of any rib due to unit charge per centimetre of length on any other rib could be found from Fig. 28 in the original Paper, if the angle between them did not exceed 52 deg.

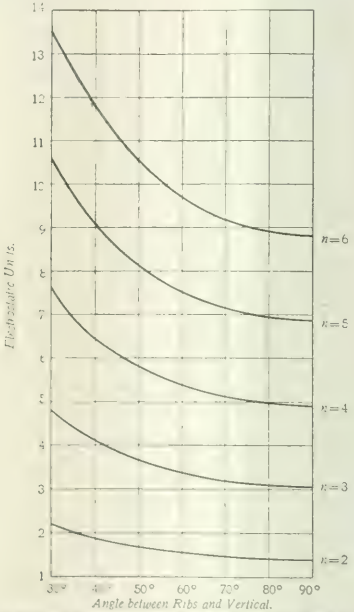


FIG. 2.—AVERAGE POTENTIAL OF ONE RIB DUE TO UNIT CHARGE PER CENTIMETRE ON ALL THE OTHER RIBS.

Since the angle will usually be larger than this, it will be necessary to extend the curve for angles up to 180 deg., but before doing this it will be convenient to find the angles between various ribs for various values of n and of α. If there are n ribs the angle between any rib and the adjacent rib may be called θ_{12}, while that between any rib and the rib next but one to it may be called θ_{13}, and so on. The values of θ are given in Table I.:—

Table I. [illegible] Ribs.

Angle α with vertical.	$n=2$	$n=3$		$n=4$			$n=5$				$n=6$			
	θ	θ	θ_{13}	θ	θ_{12}	θ_{13}	θ_{14}	θ	θ_{12}	θ_{13}	θ_{14}	θ	θ_{12}	θ_{13}	θ_{14}
90 deg.	180	120	90	180	72	144	60	120	180						
75 ,,	150	113·4	86·2	150	69·2	133·3	57·8	113·4	150						
60 ,,	120	97·2	75·6	120	61	111	51·2	97·2	120						
45 ,,	90	75·5	60	90	49	84·5	41·4	75·5	90						
30 ,,	60	51·2	41·4	60	34·2	56·7	28·95	51·2	60						

We have shown * that when [illegible] of equal length meet at an angle γ, the average potential of one of them, due to unit quantity per centimetre on the other, is given by the formula:

$$V_{av} = 2 \log_e \frac{l}{\lambda} + \lambda \left[\frac{1}{l} - \frac{\gamma}{2} \cot \frac{\gamma}{2} \right].$$

* THE ELECTRICIAN, Vol. LXXIII., p. 909.

* A Paper read before Section G of the British Association [illegible] Australia, 1914. THE ELECTRICIAN, August 28, 1914, page [illegible] commencing.

This has been worked out for values of γ up to 180 deg., and the result is shown in Fig. 1.

By means of this curve and Table I., the potential of the rib can be found due to each of the other ribs, and, adding these together, the total potential due to all the other ribs is found. This is given in Table II., and plotted in Fig. 2 :—

Table II.—*Average Potential of One Rib due to all Other Ribs, with Uniform Charge of 1 Unit per centimetre.*

Angle α with vertical.	$n=2$	$n=3$	$n=4$	$n=5$	$n=6$
90 deg.	1·385	3·06	4·905	6·86	8·835
75 ,,	1·42	3·13	5·02	7·01	9·03
60 ,,	1·53	3·38	5·41	7·52	9·69
45 ,,	1·76	3·88	6·15	8·55	11·10
30 ,,	2·195	4·78	7·585	10·53	13·475

To find the potential of the rib due to the charge on the vertical wire, or vice versa, we have the last formula on p. 908 (*loc. cit.*), viz. :

$$V_{ar} = \sinh^{-1}\beta + \sinh^{-1}\left(\frac{1-a'}{a'}\beta\right) + \frac{\cos\gamma}{a'}\left\{\sinh^{-1}\left(\frac{a'(1+\beta^2)}{\beta}\right) + \sinh^{-1}\beta\right\}$$

which may also be written thus :—

$$V_{ar} = \sinh^{-1}\frac{a'}{\sqrt{m^2-a'^2}} + \sinh^{-1}\frac{1}{\sqrt{m^2-a'^2}} - \frac{1}{m}\left\{\sinh^{-1}\frac{m^2-a'}{\sqrt{m^2-a'^2}} - \sinh^{-1}\frac{a'}{\sqrt{m^2-a'^2}}\right\},$$

where γ is the angle between the two wires

$$m = \frac{\text{length of uncharged wire.}}{\text{length of charged wire}}$$

β cotan γ

and a' $m \cos\gamma$ (*see* Fig. 27, *loc. cit.*).

The values given by this equation have been worked out for a number of cases and are plotted in Figs. 3 and 4.

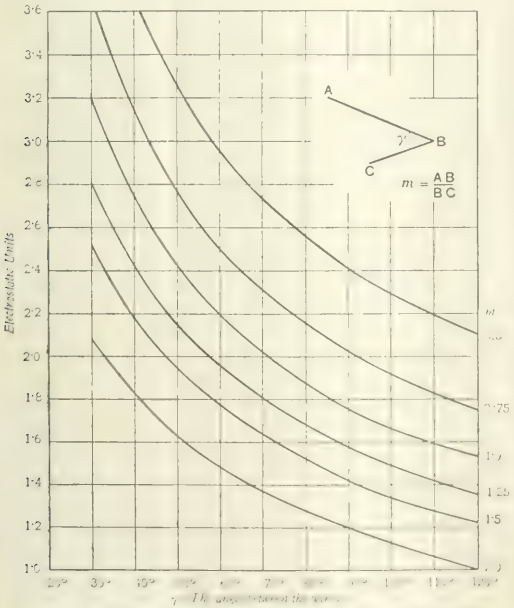


Fig. 3.—Average Potential of AB due to Unit Charge per Centimetre on BC.

We shall now illustrate the use of the curves by calculating the capacity of two aerials of the umbrella type, one a simple portable aerial and the other a larger and more complicated type.

Fig. 5 shows the principal dimensions of the aerial with six ribs, each making an angle of 60 deg. with the vertical. Both vertical wire and ribs have a diameter of 3 mm. We assume a uniform charge of unit quantity per centimetre.

1. Potential of a rib due to its own charge (*See* Fig. 3 in original Paper).		19·2
2. Potential of a rib due to all other ribs (*See* Fig. 2 in this Paper.)	=	9·35
3. Potential of a rib due to vertical wire. (m=30/26. *See* Fig. 4 in this Paper.)	=	1·95
4. Potential of a rib due to image of ribs (Charge = −18,000 ; distance about 42·5 m.)		−4·2
5. Potential of a rib due to image of vertical wire (Charge = −2,600 ; mean distance about 36 m.)	=	−0·7
Total potential of a rib	=	25·6

1. Potential of vertical wire due to its own charge (*See* Fig. 3 in original Paper.)	=	19·0
2. Potential of vertical wire due to the six ribs (m=26/30. *See* Fig. 4 in this Paper.)	=	13·5
3. Potential due to its own image (*See* Fig. 21 *et seq.* in original Paper.)		−1·0
4. Potential due to image of the six ribs. (Charge = −18,000 ; distance 35 to 36 m.)	=	−5·1
Total potential of vertical wire	=	26·4

We have, therefore, 180 metres of wire at an average potential of 25·6 and 26 metres at a potential of 26·4, or, in total, 206 metres

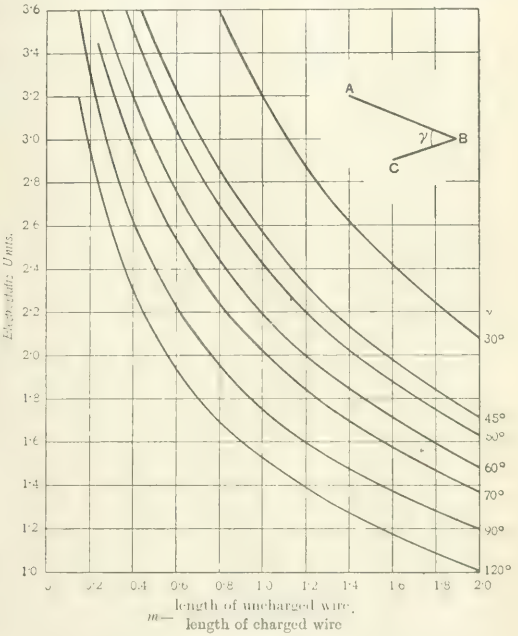


Fig. 4.—Average Potential of AB due to Unit Charge per Centimetre on BC.

at an average potential of 25·7. The capacity is, therefore, $\frac{20{,}600}{25{\cdot}7}$ = 802 cms., or 0·89 milli-mfd.

With regard to the last component potential of −5·1, it may be pointed out that, instead of finding it in the approximate manner there indicated from the charge and the average distance as estimated from Fig. 5, it can be calculated accurately by means of the curve in Fig. 4. If the vertical wire were 52 metres long—*i.e.*, twice its actual length—its average potential due to the six ribs would be 6 × 1·55 = 9·3, since m would then be $\frac{52}{30}$. We have already seen that the average potential of the actual vertical wire due to the six ribs is 13·5, whence the average potential of the other half of the 52 metres, remote from the ribs, must be (2 × 9·3) − 13·5, or 5·1. Hence, this will be the potential of the vertical wire due to the image of the ribs as already found above.

As a second example we shall calculate the capacity of the antenna shown in Fig. 6, assuming that there are five ribs each consisting of four wires situated at the corners of a square of 2 metres side, the angle between the ribs and the vertical being 60 deg. To

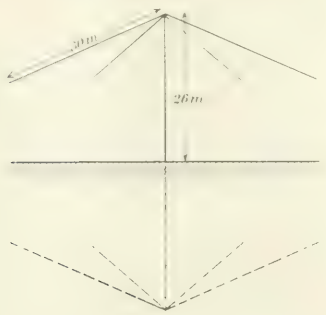


Fig. 5.

make the calculation more general we shall assume that the ribs consist of 10 mm. wire, while the vertical wire has a diameter of 20 mm.

We shall assume that the whole aerial is charged to a uniform surface density, the ribs having unit charge per centimetre of length,

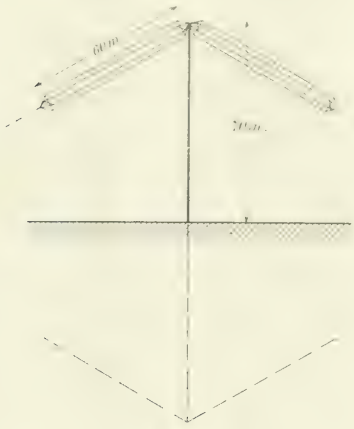


Fig. 6.

and the vertical wire two units per centimetre. The charge is equally but oppositely charged.

1. Potential of four-wire rib due to its own charge...=	36·0
(see below.)	
2. Potential of rib due to all other ribs	30·0
(4×7·5; *see* Fig. 2.)	
3. Potential of rib due to vertical wire	4·74
(2 + 2·37; see Fig. 4; see also 70.)	
4. Potential of rib due to charge on ribs	16·43
(Charge = 20 = 6,000; distance = 11·5 m.)	
5. Potential of rib due to image of vertical wire .....=	−1·51
(Charge = 2 × 7,000; distance = 92 cm.)	
Total potential of rib ...	58·8
1. Potential of vertical wire due to its own charge ...=	34·0
(2 × 17; see Fig. 3 in original Paper.)	
2. Potential of vertical wire due to ribs	10·5
(4 × 2·62 = 4 × 70·00; see Fig. 4.)	
3. Potential due to its own image	2·0
(See Fig. 2 in original Paper.)	
4. Potential due to image of ribs	1·27
(Charge = 20 = 6,000; distance = 95 cm.)	
Total potential of vertical wire ...	59·8

[We regret to say that the capacity of four-wire box-type aerials was investigated in the original Paper (see Figs. 16 and 17, and it was shown that the average potential is $2(\log_e \frac{l}{r} + Y)$, where Y depends on the ratio l/d, d being the distance between adjacent wires. In our case $l/d = 60/2$, and Y is found from Fig. 17 to be 8·6 ... = 6,000 0·5, and $2 \log \frac{l}{r} - Y$ ... 36. This can also be found directly from Fig. 18 by noting that the average potential of any four-wire box-type aerial is equal to 135·6, divided by the ordinate of Fig. 18. With regard to the last item of −12·7, this can also be calculated accurately as explained in the previous example. The other items will present no difficulty.

Summing up, we have on the ribs a charge of 20 × 6,000 units, at a potential of 58·8, and on the vertical wire a charge of 2 × 7,000 units at a potential of 59·8, or a total of 134,000 units at an average potential of 59. The capacity is therefore $\frac{134,000}{59} = 2,270$ cms., or 2·52 mille-mfd.

It will be noticed that with the uniform distribution of charge which we have assumed, the average potentials of the ribs and vertical wire are nearly equal, viz., 25·6 and 26·4 in the first example, and 58·8 and 59·8 in the second. This shows that in the actual condition of uniform potential, the charges will be distributed between the vertical wire and the ribs very nearly as we have assumed.

Tests on actual aerials have shown that the values of the capacity as calculated by this method agree with the measured values within the errors of observation and of estimation as to the allowance to be made for connecting wires, &c.

A SELF-ADJUSTING COMMUTATING DEVICE.*

BY MILES WALKER.

Summary.—A device is described for overcoming defective commutation due to the commutating pole becoming saturated. By means of double brushes the exciting current is varied according to the load so as to give the required commutating field.

It is well known that a continuous-current generator fitted with commutating poles (sometimes called interpoles) will not, without readjustment, commutate very heavy overloads owing to the magnetic saturation which occurs in the iron of the interpole. When the excitation becomes very great, the saturation of the iron interferes with the proportionality that should exist between the current to be commutated and the commutating flux.

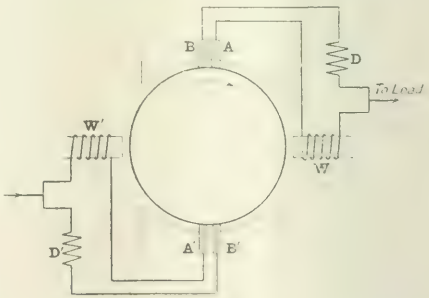


Fig. 1.

The rating of a frame, regarded from the commutating point of view, may be very much increased if for all loads the excitation of the interpole can be automatically varied so as to give for all loads the right commutating field.

We tried at the Manchester School of Technology the device shown diagrammatically in Fig. 1, which automatically produces the right amount of commutating flux over very wide ranges of load. So effective is the correcting influence that, even where a diverter connected in parallel with the commutating pole winding is deliberately put out of adjustment (whether it be short-circuited or given a resistance equal to five times the proper resistance), the flux will be preserved at approximately the correct value.

As seen from Fig. 1, the brush (say the positive brush) consists of two parts, one part (A) being slightly in advance of the other (B) on the commutator and lightly insulated from it. The winding on the

* Abstract of a Paper read before Section G of the British Association.

commutating pole has twice as many turns as one would ordinarily have, and the cross-section of the copper conductor is only sufficient to carry one-half the current continuously. Thus the weight of copper on the commutating pole is the same as on machines as at present constructed.

The part of the brush B may be connected through a diverter, D, having the same resistance as the winding W, or the diverter may be dispensed with altogether. The direction of rotation of the machine in Fig. 1. is supposed to be clockwise. The action is as follows :—

Assuming that the number of turns on the commutating pole is such as to give the right commutating flux when half current is passing through them, then it will be found that the current will divide evenly between brushes A and B, because the correct excitation of the commutating pole gives an even distribution of current over the face of the compound brush AB. If, however, the number of turns in W is too great, there is a tendency to over-commutation ; that is to say, the current in B becomes greater and the current in A less. This has the effect of automatically weakening the commutating pole, and the pole remains of just such a strength as to bring about the required distribution of current between A and B.

It will be found that on machines of ordinary rating, and more particularly on machines of very large rating, the "correcting" voltage between A and B necessary to bring about a suitable division of current between the two brushes, is normally very small, being of the order of 0·5 of a volt, whereas the voltage which can be generated between A and B by a pole being too weak or too strong may easily amount to 5 volts or more. Thus, a very little disturbance in the equality of loading on brushes A and B is sufficient to yield the desired "correcting" voltage.

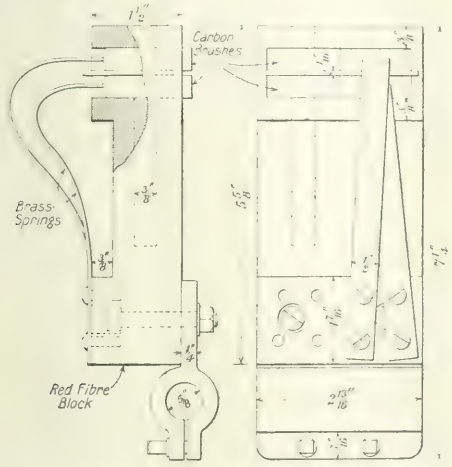


Fig. 2.—Type of Brush Holder for Double Brushes.

If for any reason the commutating pole tends to become too weak owing, let us say, to the saturation of the iron of the pole, the self-induction of the armature coils carries the current forward to brush A, and tends to automatically increase the excitation of the commutating pole. We can imagine an extreme case, though it would be difficult to attain in practice, in which the whole of the current would be carried forward to brush A. This would give an excitation on the commutating pole equal to double the excitation that would be obtained with the same load on an ordinary machine. We see that right up to this extreme case we would obtain good commutation—that is to say, up to the point at which the saturation of the pole required a doubling of the ratio between commutating pole ampere-turns and armature current.

The other brush (say the negative brush) may be either a simple one or it may be divided into brush A′ and B′. In this case half the commutating poles would be in series with A and the other half in series with A′. A number of experiments were carried out by Mr. H. G. Bell on a 12·5 kw. 220 volt continuous-current generator in order to determine the amount of "correcting" voltage that could be obtained between brushes A and B. The brush-holder employed is shown in Fig. 2 and the result of the experiments in Fig. 3. The plan adopted was to change the resistance of the diverter D. The change of the [illegible] corresponding change in the current flowing through the diverter, there being only comparatively small change in the value of the current taken by A and B, and this small change affected the excitation of the commutating pole to such an extent as to generate between A and B a "correcting" voltage, and this voltage forced the current through the higher resistance of the diverter.

In Fig. 3 are plotted the values of the "correcting" voltages at different loads for the different resistances of the diverter marked on the curves. Suppose that a current passing through W brings about a commutating pole strength which tends to divide the current so as to give I_B amperes to B and I_A amperes to A. Let the

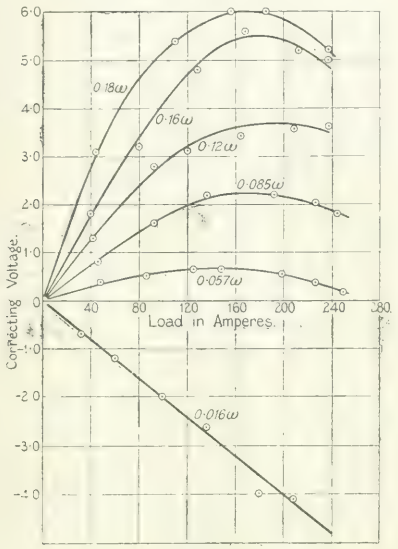


Fig. 3.

resistance of the diverter be R_D and the resistance of W be R_W. Then, if $I_B R_D = I_A R_W$, there will be no "correcting" voltage. If the value R_D be less than necessary for this equation, we will have what is called a "negative" correcting voltage, and if it be greater we will have a "positive" correcting voltage.

It will be seen that if there were no saturation of the commutating pole the value of R_D, which would require no "correcting" voltage, would be a constant. As soon as saturation occurs this ideal value of R_D is increased, as can be seen from the way in which the positive curves in Fig. 3 turn over with increase of load.

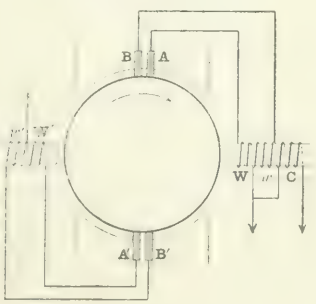


Fig. 4

A number of oscillograms were taken by Mr. Bell showing the behaviour of a generator provided with the correcting device described in this Paper, and without the correcting device.

It was found that with the correcting device the machine would take nine times full-load current without sparking, whereas with a normal adjustment of the diverter the machine sparked badly at a lower load.

A 500 kw. 500 volt rotary converter, built by the British Westing

house Company, was fitted with the double-brush gear arranged as in Fig. 1, and was found to give most excellent results. The machine was loaded by circulating the power through a 1,000 kw. converter provided with an alternating-current booster. It was found that with 3,000 amperes (the largest current which could be circulated through rotaries and transformers with the existing arrangement) flowing the commutation was sparkless. The device is being at present installed on a 1,500 kw. rotary converter, on which the commutating conditions would otherwise be rather difficult.

An alternative arrangement is shown in Fig. 4. Here the current coming from B passes round the coil w, so as to give some opposing ampere-turns on the interpole. If the W turns are sufficiently great to wipe out the w turns and give the required excitation, then the arrangement works as described in connection with Fig. 1. If it is desired to keep W and w the same, then the extra turns C can be added as shown in Fig. 4. It is found in practice that the simple arrangement shown in Fig. 1 is quite sufficiently effective in practice.

TRANSFORMER CORE LOSS AS AFFECTED BY TRIPLE HARMONICS.*

BY H. M. LACEY, B.SC. (ENG.), AND C. H. STUBBINGS, B.SC. (ENG.).

Summary.—It is shown that there is a considerable saving in the core loss of star connected three-phase transformers if the neutral point is insulated. In the particular case investigated this saving amounted to 22·5 per cent.

It is a well-known fact that either the current or the E.M.F. wave-forms of a transformer must contain higher harmonics, mainly the third harmonic, and that saturation of the core of the transformer tends to increase their magnitude. This subject was dealt with recently by Mr. Nicholson in a Paper published in the "Journal" of the Institution of Electrical Engineers, dated February 1, 1915.

Experiments were made in the Siemens Electrical Engineering Laboratory, of King's College, London, to further investigate the effect of these harmonics on the hysteresis and eddy-current loss, and for this purpose a Siemens 35-5 U.R. alternator was three-phase star-connected to a three-phase choking coil. On open circuit this alternator gives a wave having many ripples but practically no lower harmonics.

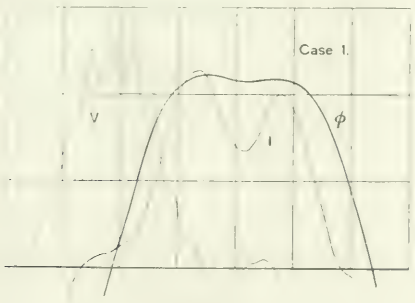


Fig. 1.

The star centres were connected through a switch, current measuring resistances being placed in the neutral wire and in one of the outer leads. Voltmeters and ammeters were also inserted, and the various conditions were kept as nearly as possible constant throughout the experiment. The following two experiments were made.

The centres of the stars were insulated by breaking the switch in the neutral wire, and the wave-forms of the phase volts and phase current were determined by means of a contact maker used in conjunction with a Kelvin quadrant electrometer.

The switch in the neutral wire was now made, and the wave-forms again taken, in addition to the wave-form of the current in the neutral wire. The curves thus obtained were remarkable in many ways.

In a balanced three-phase star system, the algebraic sum at any instant of the currents in the three arms will equal three times the [illegible] of the third harmonic in one of the arms, neglecting higher harmonics. It is thus obvious that in the first [illegible] the presence of the third harmonic, the presence of the [illegible]

[illegible] harmonics would be a direct contravention of Kirchhoff's First Rule. The accuracy of this conclusion is clearly verified by the experimental results, for an analysis of a mean curve drawn to exclude the ripples or higher harmonics gave (Case I.) the following :—

Volts : 3rd harmonic, 48·9 per cent. ; 5th harmonic, 4·12 per cent.
Amperes : 3rd harmonic, 3·6 per cent. ; 5th harmonic, 21·1 per cent.

Thus we see that while the triple harmonic in the current curve is (within the limits of accuracy) completely suppressed, it is very pronounced in the volt curve.

Taking the second case in which any third harmonic in the current is allowed to escape along the neutral wire, we obtain (Case II.) the following results from an analysis of the curves :—

Volts : 3rd harmonic, 5·07 per cent. ; 5th harmonic, 2·88 per cent.
Amperes : 3rd harmonic 48·2 per cent. ; 5th harmonic, 13·94 per cent.

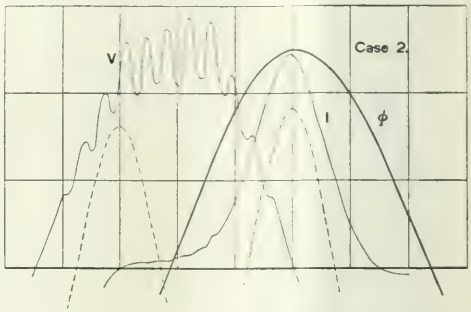


Fig. 2.

Also the wave of current in the neutral wire was practically a pure sine wave of triple frequency, thus amply justifying the statement that the triple harmonic escapes along the neutral wire. Its amplitude was also found to be approximately three times that of the third harmonic in the current curve. It is very significant also that the percentage triple harmonic in the volt curve in case I. is practically the same as that in the current curve in case II. It would, therefore, appear that the triple harmonic is inevitable, and if suppressed in the current curve is forced into the volt curve.

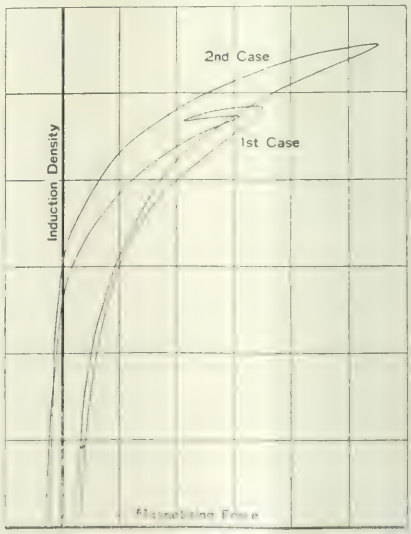


Fig. 3

Fig. 1 shows the wave forms obtained when the centres of the stars were insulated. The volt and current curves are marked V and I respectively, and the induction curve was obtained by integration of the volts, copper drop being negligible. The presence of the third and fifth harmonics in the volt and current curves respectively can be clearly seen from the diagram, the third harmonic causing the volt curve to descend below the zero line at one point. Fig. 2 gives

the wave forms obtained with the switch in the neutral wire closed. The third harmonic is very pronounced in the current curve, and the current in the neutral wire is represented by the dotted line.

The question now arises as to what effect this will have upon the hysteresis and eddy current loop for the iron cores of the choking coils.

Fig. 3 shows the loops obtained from the curves; these are not in B and H units, but they are both drawn to the same scale. The extraordinary shape of the loop for case I is largely due to the triple harmonic in the volt curve.

The following readings were taken:—

Case I.—Line volts, 185·5; magnetising current per phase, 3·9 amperes.

Case II.—Line volts. 186·6; magnetising current per phase, 4·88 amperes.

Value of $B_{max.}$ in case II. is 1·144 times the value in case I.

In order to compare the core losses in both cases, the areas of these loops were found, and are in the following ratio :—

Area of loop 1=0·775 × area of loop 2.

It will thus be seen that a saving of 22·5 per cent. in the core loss is effected by insulating the neutral point. The actual value of B for this percentage saving was not actually determined, but the shape of the loops obtained indicate a value of $B_{max.}$ for case II. of approximately 15,000.

Each reading on the volt curve was multiplied by the corresponding reading for the current, and the average watts thus found for each case. These watts are dissipated in core loss, copper loss being negligible, and they were found to be as follows :—

Case I., 54·2 watts. Case II., 71·5 watts.

The ratio of the losses thus obtained gives the value 0·757, which is sufficiently near the figure obtained by the other method to justify the supposition that this is correct.

The experiments thus show that the losses in a transformer are considerably reduced by employing an insulated neutral point. Also, they may be made to give the same voltage with a smaller value for the induction density.

ELECTRIC HAULAGE ON THE TRENT AND MERSEY CANAL.

The Trent and Mersey Canal, formerly known as the Grand Trunk Canal, was one of the earliest in this country, having been constructed between the years 1766 and 1777 by James Brindley. The total length of the main canal from Preston Brook, where it leaves the Bridgewater Canal, to Shardlow, where it joins the river Trent, is about 93¼ miles. The branches to Newcastle-under-Lyme, Leek, and Froghall, bring up the total to 119 miles. When the promoters of the North Staffordshire Railway went to Parliament in 1846 for powers to make their railway they had to buy off the opposition of the canal company by purchasing the canal on very onerous terms. A considerable traffic is carried by this canal to and from the Staffordshire potteries and ironworks, consisting chiefly of coal, clay, flint, limestone, iron-ore and earthenware. There is also a large traffic in general merchandise, the canal forming an important link in the communication between the Birmingham district canals and Liverpool, and also between those cities and the Humber. The old Harecastle Tunnel, which was opened in 1777, is 8 ft. 6 in. diameter, and as it has no towing path it has been necessary for boats to be propelled through it by the primitive method of "legging," and no less than four hours has been occupied in a single journey. The second tunnel although constructed under powers of an Act passed in 1812 and opened in 1827, Telford being the engineer, is still called the "New" Harecastle Tunnel. It is 14 ft. in diameter, of which 3 ft is taken up by a towing path, leaving a waterway of 9 ft. The towing path is, however, constructed upon arches which allow a considerable further circulation of water during the passage of boats. The two tunnels are respectively 2,897 yds. and 2,926 yds. in length. The boats which, during recent years, have used the canal have had a beam of 7 ft. and their maximum load is 30 tons, when they draw about 3 ft. 9 in. water. The average headway above water-level in the New Tunnel is 9 ft. 6 in., and the depth of water 5 ft. 6 in. The time occupied by a single journey, each boat being hauled by a horse, was 90 minutes. The boats coming up from the sea pass through the old, and those coming down through the new, tunnel.

Owing to the objections of the boatmen and the time occupied in passing through the tunnels, some system of haulage to supersede the "legging" process has been under consideration by the North Staffordshire Railway Co. for many years, but, owing to the absence of ventilating shafts, neither steam nor any form of petrol engine could be employed on account of the poisonous fumes coming off. The difficulty has now, however, been surmounted by the utilisation of electrically-driven motors which, we understand, have been doing the work satisfactorily since the beginning of December last. A motor barge hauls

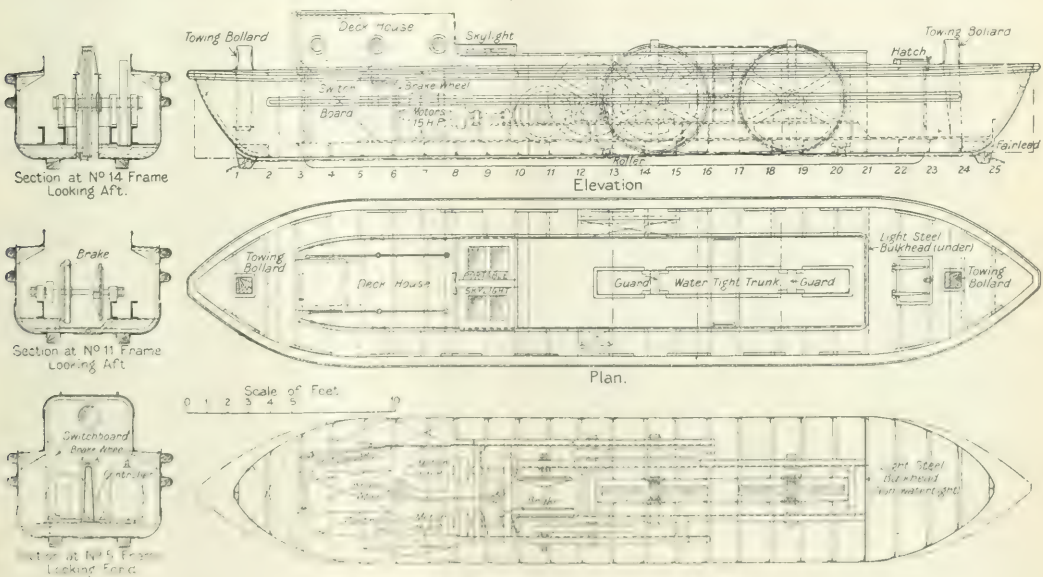


FIG. 1.—GENERAL ARRANGEMENT OF STEEL HAULAGE BARGE.

itself along a fixed steel cable which is laid on the bed of the canal and made fast a short distance beyond each end of the New Harecastle Tunnel. Electric motors work the haulage machinery in the barge ; the current for these is obtained from another boat containing accumulators and this follows immediately behind the tow barge. There is not sufficient head-

The haulage barge, which has been designed and supplied by Messrs. Bullivant & Co., is of steel and measures 40 ft. long, 7 ft. wide and 4 ft. deep. It has two drums and gearing for hauling itself along the steel rope. The drums are driven by two 15 H.P. Royce electric motors, and these can be worked either singly or in combination to suit the load that requires

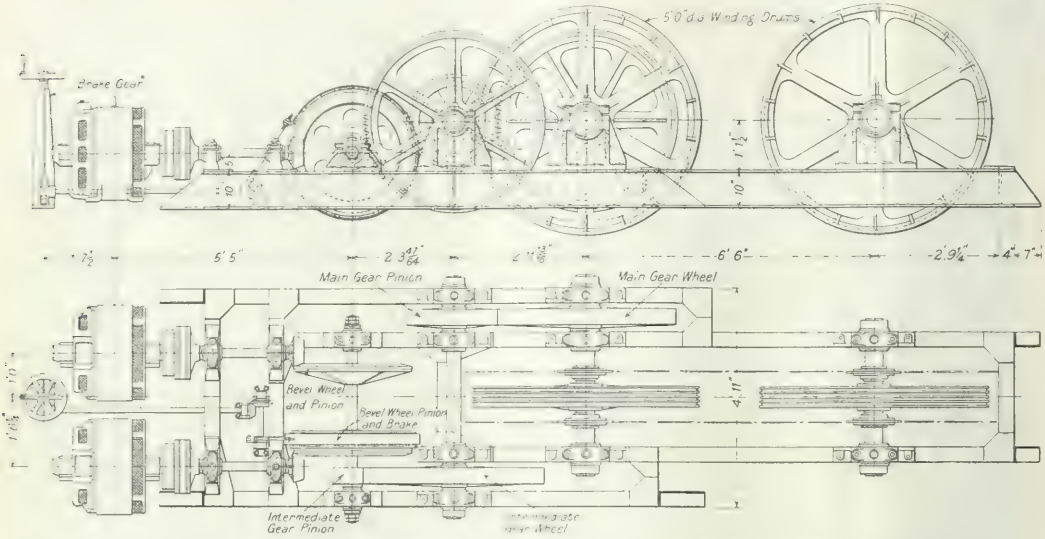


FIG. 2.—GENERAL ARRANGEMENT OF MOTORS AND GEARING IN HAULAGE BARGE.

room in the tunnel for overhead trolley collection cables. A generating station, 45 ft. by 30 ft., for charging the accumulators, has been erected on land between the two tunnels at Chatterley, and there is a gas-producer house, 20 ft. by 30 ft., and other buildings for the storage of coal, &c. The generating

to be hauled. A cabin is provided for the chargeman in the front of the barge and it contains the motors, controllers and switchboards. The barge is of somewhat unique design, having an open trunk through its centre to accommodate the rope drums. By this arrangement the rope can lead off the



FIG. 3.—VIEW OF HAULAGE BARGE WITH COVERING REMOVED.

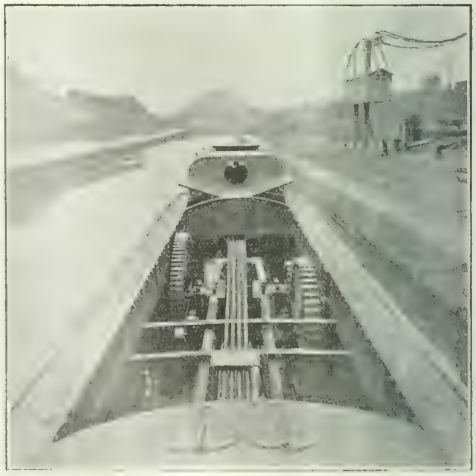


FIG. 4.—VIEW OF HAULAGE BARGE, LOOKING TOWARDS MOTORS AND CONTROL CABIN AND SHOWING PART OF THE GEARING.

bottoms of the drums, thus rendering it necessary to lift the rope but very little from the canal and at the same time maintain the deck clear of all moving parts. Other advantages gained by this under boat lead are those of stability and trim and

straight running, as, by the arrangement of roller fairleads, placed both fore and aft at the extreme ends of the under side of the barge and on the fore and after centre line, the pull is transmitted through the most suitable point. It is, perhaps, hardly correct to speak of the fore and aft, as the barge is made with both ends alike and runs backwards and forwards on the rope, the motors being reversible. From this it will be gathered that the fairleads act alternately as guide for the barge on the taut side of the rope and paying-out guide on the slack side of the rope. In addition to these fairleads, two rollers are placed close to the drums, which hold the rope clear of the bottom of the barge. The arrangements are shown in detail in Figs. 1 and 2.

In the original anchorage gear, the end of the rope was led through a tube from the canal bed to the ground level where it was drawn tight by means of a winch and a set of blocks and tackle. Brakes were originally fitted on the barges, but were afterwards removed, being found unnecessary, as, there being no current in the canal, when the motors were cut off the barges soon came to a standstill. The steel rope supplied by Messrs. Bullivant & Co. is 2 in. in circumference and 3,500 yds. long, having been specially constructed for haulage purposes and with a guaranteed breaking load of not less than 11 tons.

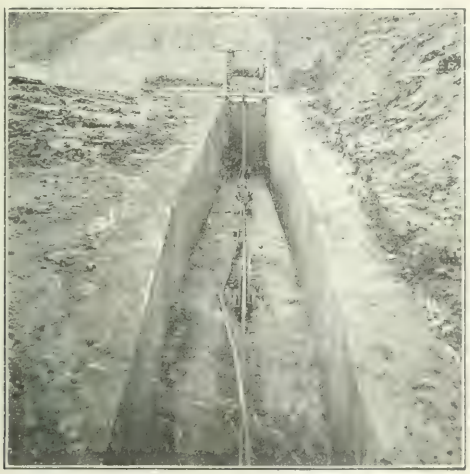


Fig. 5.—Anchorage and Tension Gear.

There are two accumulator barges, each 72 ft. long, 7 ft. wide and 4 ft. deep, and each containing 115 Chloride cells in lead-lined teak boxes. The accumulators in each barge, which are capable of a discharge of 150 amperes for about seven hours, weigh 18 tons. The accumulators on one boat are on charge whilst the other set is working in the tunnel. A special basin has been made close to the generating station for the boats to stand in whilst the accumulators are being charged, and iron piles were driven into the canal at the Harecastle end of the tunnel to form a wide curve so that the boats will leave the tunnel easily. Views of the barges are shown in Figs. 3 and 4 and of the anchorage gear in Fig. 5.

By means of this scheme about 30 boats, most of them with 20-ton loads, can be hauled through at one trip at the rate of about 2 miles per hour, but the usual load is from 15 to 18 boats. At present the plant is worked only 18 hours daily, six trips being made in each direction. The old canal tunnel is closed for traffic purposes, but used as a by-pass for the circulation of the water displaced by the towage through the new tunnel. Ultimately, it is intended to take out the towing path from the new tunnel, thus providing an unrestricted waterway 14 ft. in width throughout its length.

THE HEATING OF IRON WHEN MAGNETISED AT VERY HIGH FREQUENCIES.*

BY S. W. McCULLAN, B.Sc., ENG., A.M.I.E.E.

Summary.—[illegible] tests made to ascertain the heating effects of high frequency, between $3 \cdot 10^5$ and $5 \cdot 10^5$ cycles. Various general results are described as regards losses, permeability and skin effect.

The present Paper is the outcome of tests made by the author to ascertain the magnetic behaviour of stalloy and Lohys at very high frequencies using a Poulsen Arc generator. Tests have been carried out at frequencies between $3 \cdot 10^5$ and $5 \cdot 10^5$ periods per second. Although the "apparent" maximum flux density is small, owing to the screening effect of eddy currents, the rate of rise of temperature of the iron is very large on account of the high frequency of the magnetising current producing correspondingly large hysteresis and eddy current losses.

Theoretically the eddy current loss (which is the larger of the two at such high frequencies) for a given thickness of plate and number of turns per centimetre length, is proportional to the square root of the frequency, specific resistance and permeability, and to the square of

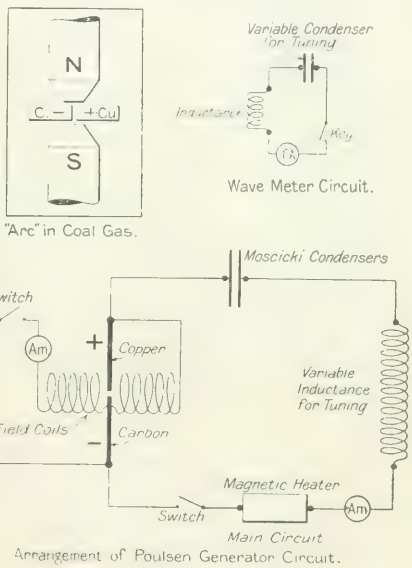


Fig. 1.

the magnetising current. Moreover, since the frequency of the oscillations in the shunt circuit of the generator increases with the current† (for a given value of the capacity), and the loss increases as the square root of the frequency and the square of the current, it was essential, in order to obtain a large heating effect, that the current should be large.

The Poulsen-Arc generator circuit is arranged as shown in Fig. 1. The field magnet coils producing the magnetic blast are in series with the copper-carbon arc, which burns in an atmosphere of coal gas. The air gap between the poles of the magnet is 19 mm. and the electrodes are each 15 mm. diameter.

The oscillatory or shunt circuit is connected across the arc and consists of one or more Moscicki condensers and a plate glass condenser, a variable inductance for tuning to the desired frequency, a magnetic heater (to which reference is made hereafter) or other [illegible] and a hot wire ammeter is used merely as an indicator for purposes of demonstration. The true value of the current is obtained by means of a current transformer with a core of stalloy discs 0·5 mm. thick, having a transformation ratio of 100:1. This is used in conjunction with a Duddell portable thermo-ammeter reading to 100

* A Paper read to Joint Section G of the British Association.

† When the inductance in the shunt circuit decreases the current and frequency increase, and vice versa.

[illegible] amperes. Owing to the self-induction of the shunt of a hot wire instrument, the wire takes more than its usual share of the current, thereby making the readings too large. In the case of an ammeter reading to 15 amperes, the author found that at 2×10^5 cycles, the readings were 40 per cent. high. An ammeter taking 6 amperes on the wire alone gave good results at 2×10^5 cycles; at 6×10^5 cycles the readings were 6 per cent. high. (Current transformers with iron cores for high frequency measurements were first used by Messrs. Campbell & Dye. *See* "Proc." Roy. Soc., A. Vol. 90. 1914.) Fig. 7 shows a photograph of some of the apparatus.

In order to ascertain the frequency a loose coupling is made between the variable inductance and the coil of a Lorentz wave-meter. The wave-length is then determined by adjusting the variable condenser of the wave-meter until resonance is obtained.

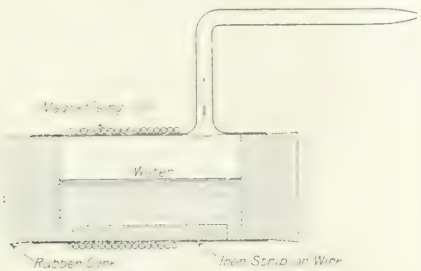


Fig. 2.—Magnetic Heater.

By using various wave-meter coils, it is possible to analyse the current in the shunt circuit. If the coil constants are known, the relative magnitudes of the fundamental and the various harmonics can be determined. The most prominent harmonics are the second and third. Since there is an even harmonic, the positive and negative half waves are not similar. However, by adjusting the arc length so that the current through the arc is as large as possible for steady burning, the harmonics may be reduced.

The heater, Fig. 2, consists of a glass tube 1½ in. diameter on which is wound 20 turns of 22 S.W.G. The tube contains a bundle of iron strips or wires and also a quantity of water. The ends of the tube are plugged by means of rubber corks. A more elaborate arrangement, in which tubes have been added to facilitate the circulation of the water, is shown in Fig. 3.

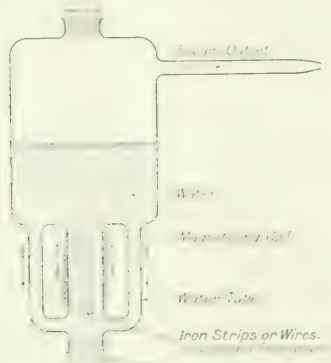


Fig. 3.—Magnetic Heater.

[illegible] matter. It can be shown experimentally that, for values of the "apparent" magnetizing force from 2 up to 6 C.G.S. units, no serious error is involved in taking the watts lost as the product of total current through the circuit and voltage due to the iron alone. Several coils, some having cores of Stalloy and others of Lohys, have been constructed in such a manner that the ratio of the [illegible] portion of the core and the IR pressure-drop is negligible, and the watts lost per kilogram obtained in this way.

By using a modified 3-voltmeter method of measuring power and [illegible] the voltage to be [illegible] be demonstrated that

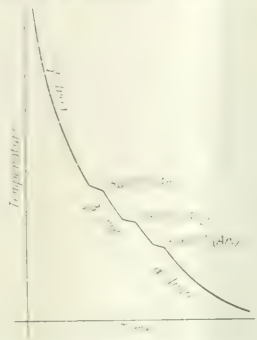


Fig. 4.—Cooling Curve for Mild Steel. (After J. W. Mellor.)

the power factor for the coil is nearly unity. The phase difference between the total current and the voltage across the coil is such that the energy current is practically equal to the total current, while the true magnetising current is a fraction of the latter.

The losses in the iron might also be estimated by lagging the heater well to minimise radiation, and passing a quantity of water through in a certain time maintaining the inlet and outlet temperatures constant. Provided the difference of temperature was fairly large, say, 30°C., the watts lost per kilogram ought to be obtained fairly accurately. This procedure could only be adopted in cases where a sufficient rise in temperature was obtainable.

The Recalescence Point Ac_1.

When iron is heated above a temperature of about 700°C., *i.e.*, above the point Ac_1*, it passes from the alpha-state to the beta-state. The former is magnetic while the latter is non-magnetic. Just before reaching the point Ac_1, the permeability, provided the

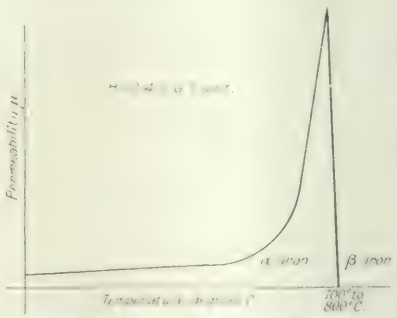


Fig. 5.—Permeability Temperature Curve.

[illegible] magnetising force is weak, say, 0·4 C.G.S. unit, increases very rapidly for a comparatively small increase in temperature, attains a maximum value somewhat after the manner of a resonance curve, and then suddenly drops to unity when the iron reaches the non-magnetic state. This is illustrated in Fig. 5. For stronger fields, say, 4·0 C.G.S. units, the increase in permeability is comparatively small. This case is illustrated in Fig. 6. [illegible] Figs. 5 and 6 are based on

* Ac_1 is that point on the heating curve of iron corresponding to the recalescence point Ar_1 on the cooling curve. Fig. 4 shows the nature of the cooling curve for mild steel containing 0·02 per cent. carbon. In this case there are three recalescence points or points of arrest, viz. Ar_3, Ar_2, Ar_1. (Taken from Prof. S. P. Thompson's Paper, "The Magnetism of Permanent Magnets." Journal I.E.E. Vol. 47, p. 102. 1911.)

Hopkinson's researches regarding the effect of [illegible] on the magnetic properties of iron, and the forms of the curves have been taken from Ewing's "Magnetic Induction in Iron [illegible] Metals."

The following experiment illustrates the increase in permeability up to a certain temperature and the decrease at higher temperatures:

A ring of Lohys 4 in. external diameter, 3¼ in. internal diameter and 0·36 mm. thick, is covered on both sides with asbestos rings and wound with copper wire. In order to prevent short circuiting on the iron, the wire is wound lightly and the whole ring squeezed up in a vice, thereby diminishing the thickness. This procedure also lessens the area of the non-ferric portion of the ring, which must be as small as possible if quantitative results are to be secured, owing to the small apparent permeability of the iron at such very high frequencies. The ring is connected up in the Oscillatory circuit of the Poulsen generator with a voltmeter across its terminals.

When the current is switched on in the shunt circuit it attains a certain value. At the same time the voltmeter records the value of the voltage across the coil. The temperature of the iron increases rapidly until a point is reached,* when the current falls steadily and the voltage rises until both become stationary. On the attainment of a still higher temperature the current rises until it reaches a definite higher value. When the current increases, the voltage decreases until it attains a steady value.

The first decrease of current, with its corresponding increase in voltage, is due to augmentation in the apparent permeability caused by rise in temperature. The subsequent rise in current, with its corresponding decrease in voltage, is due to diminution in the apparent permeability caused by a still further increase in temperature.

During the experiment the arc is left untouched except when the shunt current is approaching its highest value. The length may then be increased slightly to get the largest possible value of the shunt current.

The above phenomena are of a complex nature and are not due to variation in permeability alone, but also to the effect this may have on the arc. This, however, is of secondary importance.

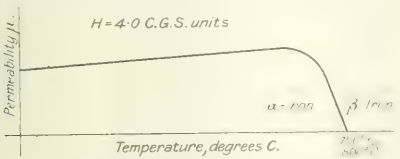


Fig. 6.—Permeability–Temperature Curve.

The approximate figures given below will enable the changes to be followed more easily.

$B_{max.}$ apparent.	$H_{max.}$ apparent.	μ_0 apparent.	Watts per kilogram.†	Frequency per second.
3,500	21	170	48,000	1·9 10⁵
4,300	17	250	44,000	1·7 10⁵
3,200	25	130	57,000	2·1 10⁵

$B_{max.}$ calculated on the assumption that the magnetism is uniformly distributed across the section gives an "apparent" value, while $H_{max.}$ calculated from the total current is not the true magnetising force, since the true magnetising current is a fraction of the total current.

In calculating the above quantities the wave forms of the current through the coil and the voltage across its terminals have been assumed to be sinusoidal. If the current wave was sinusoidal, the E.M.F. wave would be peaked, and the form factor greater than 1·11‡. This would mean a reduction in the apparent values of $B_{max.}$ as given in the table.

It was found impossible to have the variable inductance and the ring connected in the shunt circuit simultaneously in order to ascertain the frequency, since this reduced the current to such a value that the above phenomena did not occur. Moreover, the only plan to be adopted was to adjust the variable inductance to give the desired values of the current, when the ring was not in circuit, and obtain the corresponding frequencies. These may not be numerically equal to those when the ring is connected up, for in one case the inductance is consuming power, while in the other it is not. Nevertheless, the relative values ought to be substantially the same. Although the tabular results are not accurate in the absolute sense, they serve as a basis of comparison.

An inspection of the table shows that the apparent permeability increases 30 per cent. with rise in temperature up to a certain point, the watts lost per kilogram decreasing 9 per cent. For a further rise in temperature the apparent permeability decreases 50 per cent., its value being lower than that at normal atmospheric temperatures, while the watts lost per kilogram increase 30 per cent.

The change of apparent permeability is not entirely due to temperature,* but also to alteration in the value of the magnetising force and the frequency. To what extent it is due to the former is impossible to estimate from the given data, but experimental results indicate that the apparent permeability increases with the apparent magnetising force for a given frequency and ordinary temperatures. On the other hand, an increase in frequency for a given value of the apparent magnetising force produces a decrease in the apparent permeability.

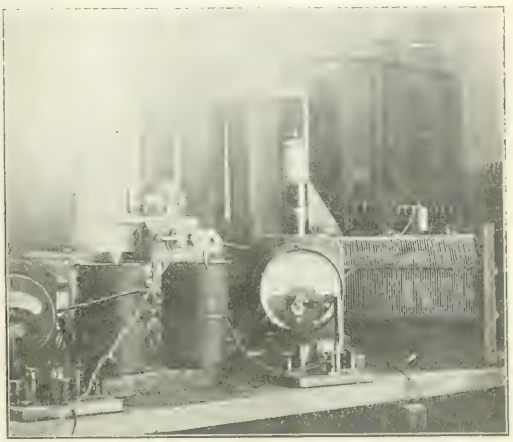


Fig. 7.—View of Apparatus showing Poulsen Generator.

It is quite evident that although the *critical point* at which the iron becomes non-magnetic has not been reached, the iron is being worked on the drooping portion of the curve Fig. 6. If the heat radiation was lessened considerably, there is every reason to expect that the permeability could be reduced still further.

Skin Effect.

The following experiment demonstrates the variation in skin effect with the thickness of the iron: A number of strips of Lohys and a single iron wire of the same weight and length but different thickness are inserted in succession in a Jena glass tube on which a solenoid is wound. This is connected in the shunt circuit of the Poulsen generator and the current switched on. By taking the values of the current through the solenoid and the corresponding voltages across its terminals the skin effects in the two cases may be compared. The figures given below were obtained in the manner indicated above.

Brand of iron.	Thickness. Mm.	Current through solenoid. Lowest.	Highest.	Volts on solenoid terminals. Lowest.	Highest.
Lohys	0·33	1·9	5·7	120	150
Ordinary..	3·0	4·5	6·4	90	105

Current through solenoid with air core 7 amperes, voltage 115.

The relative skin effects obtained when a Poulsen-Arc generator is used depend upon the self-induction of the solenoid when the iron is inserted in the tube. Since a large skin effect means a correspondingly small self-induction, a large current is obtained in the shunt

* The iron being red hot.

† The author has not ascertained if the [illegible] method of estimating the losses, viz., product of volts on coil and current through it, holds [illegible] to quantities lower than 3·10 [illegible] and apparent magnetising forces greater than 6 C.G.S. units. [illegible] adopting this procedure as in the present instance the [illegible] large.

‡ N. W. McLachlan. "The Magnetic Behaviour [illegible] Alternating Magnetisation of Sinusoidal Wave Form." [illegible] E.E., Vol. LIII., p. 809, 1915. The Electrician, 27 Oct., p. 781.

* The effect of temperature is two-fold: (1) it increases the specific resistance, thereby decreasing the skin effect; (2) it affects the iron as shown in Figs. 5 and 6.

circuit and *vice versa*. The relative skin effects from this standpoint may be seen at a glance in columns 3 and 4.

temperature rise of the iron. The shunt circuit is completed after removing the iron core, the current attaining a value of 7 amperes. A strip of Lohys or Stalloy placed in the glass tube becomes red-hot in about 3 seconds. Owing to the increase in self-induction when the iron is introduced, the current falls slightly, but rises quickly, due to diminution in the apparent permeability caused by rise in temperature.

In conclusion, the author wishes to thank Prof. E. W. Marchant, D.Sc., for reading over and criticising the Paper in MS.

LEAKAGE FLUX CALCULATIONS.

BY JOHN F. H. DOUGLAS, PH.D.

The leakage flux of a dynamo, from the operating point of view, decreases the available voltage and impairs the regulation. From the designer's point of view it renders necessary a larger amount of ampere-turns upon the field. It is recognised that present leakage calculations are crude. It is the object of the present article to show that greater accuracy in these calculations is desirable, and to suggest two improvements in the theory.

It must be admitted that, for rough calculations, simple assumptions possess many advantages. However, for many problems greater accuracy must be attained. Up to the present time the bulk of the theoretical work upon dynamo calculations has been devoted to the study of the air-gap reluctance. However, by considering the following example, it will be seen that it is desirable to know the leakage factor of a dynamo to a precision even greater than that of the air-gap factor.

A machine is calculated to require 6,000 ampere-turns, of which 70 per cent. are for the air-gap and 20 per cent. are in the pole-core. These figures were obtained, say, for an assumed leakage factor of 1·2, and a maximum density in the pole core of 16 kilo-lines per square centimetre. An error of 4 per cent. in the air-gap reluctance might make an error of 4 per cent. × 70 per cent. × 6,000 ampere-turns, or 168 ampere-turns. An error of 1 per cent. in the leakage factor might raise it to 1·04 × 1·2, or 1·25, and the flux density in the pole core to 16·6 kilo-lines. This would increase the M.M.F. in the pole-core from 40 to 56 ampere-turns per centimetre for average qualities of steel, or 480 ampere-turns in all. The error introduced is nearly three times as great as a corresponding error in the air-gap factor.

The best methods at present for making leakage flux calculations may be found in Hawkins and Wallis' "The Dynamo,"* and in Karapetoff's "Magnetic Circuit."† These methods, however, alike make two serious errors. In the first place the leakage permeance is considerably underestimated. Secondly, the leakage flux is assumed to be concentrated at the pole tips. In reality the leakage flux is distributed over the whole length of the pole core. As a consequence, the flux density in the pole-core is a variable and much less than the value calculated by the above methods. This is especially true for points in the pole-core near the pole tips. While these errors tend to neutralise each other, it cannot be claimed that they do so entirely, for all proportions of pole-pitch, width and length, and for all the relative saturations of pole-yoke and pole-core. A leakage factor based upon knowledge of one line of machines would, therefore, be useless for a machine of a different type. Separate allowance for each of these effects should, therefore, be made.

The permeance of the leakage field is, at present, estimated by assuming the lines of force to be either straight, arcs of circles, involutes and other parallel curves. In this way the magnetic field is constricted considerably. This artificial "cramping" of the field is, in effect, equivalent to imagining the flux lines to be guided [illegible] partitions embedded [illegible]

[illegible]

The permeance obtained for any assumption of the lines of force is too small. The chief criticism of previous methods is that they cramp and confine the field quite considerably, and that the permeance is much too small. This is not necessary, since the writer has shown* a method of obtaining the permeance of an irregular magnetic field under any assumed shape of the lines of force. It is possible, with proper assumptions, to get values of permeance decidedly larger than present values. Thus, while it must be admitted that the results given in this Paper are still too small, it is claimed that they are much nearer the truth.

For rectangular poles a very convenient assumption for the lines of force is to have them radial and fan shaped, as shown in Fig. 1. The lines M N are the traces of the planes of symmetry between the poles. The arcs and straight lines below the horizontal represent the lines of force as at present assumed.

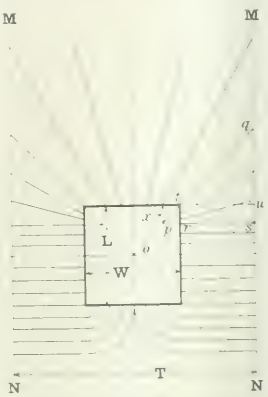


FIG. 1.—ASSUMED LEAKAGE FLUX DISTRIBUTION IN A MACHINE WITH RECTANGULAR POLES.

The permeance of the leakage field is the sum of those of all the diverging pencils. The reluctance of each pencil is the sum of those of all the rectangular elements in that pencil. The reluctance an element of the field is

$$dR = \frac{1}{\mu r} \frac{dr}{d\omega}.$$

and that of the whole diverging pencil is

$$R_\omega = \int_{W \sec\theta}^{\cdots} \frac{dr}{\mu r d\theta} \quad \text{or} \quad \int_{\cdots}^{\cdots} \frac{dr}{\mu r d\theta},$$

according to whether θ is greater or less than 45 deg. Integrating,

$$R_\omega = \frac{1}{\mu d\theta} \text{Log.} \left[\frac{T \sec\theta}{W \cdots \sec\theta} \right] \quad \text{or} \quad \frac{1}{\mu d\theta} \text{Log.} \frac{ps}{rs}.$$

To find the total permeance of the field we integrate the reciprocal of the above expressions from 0 deg. to 45 deg., and from 45 deg. to 90 deg. respectively. This gives the permeance of only one quadrant. The permeance for the whole four quadrants is

$$P = 4\mu \left[\int_{\cdots}^{\cdots} \frac{d\theta}{\text{Log.} \left[\frac{T}{W \tan\theta} \right]} + \int_{\cdots}^{\cdots} \frac{d\theta}{\text{Log.} \frac{ps}{rs}} \right] = 4\mu \frac{pr}{\cdots} \frac{2L}{rs} \quad \ldots \quad (1)$$

In the above equation and in Fig. 1 the point p is arbitrary. It should be chosen so that the value of the above expression is the lowest possible. The value found to be when $pr = 0{\cdot}22rs$. Under these circumstances the above equation becomes

$$P = 4\mu \left[\int_{\cdots}^{\cdots} \frac{d\theta}{\text{Log.} \left[\frac{T}{W \tan\theta} \right]} + 0{\cdot}96 \frac{2L}{\cdots} \right] \quad \ldots \quad (2)$$

* "Physical Review," N.S., Vol. IV., No. 4, October, 1914.

The part (2L σ_x) of the above formula [illegible] the apparent permeance between the poles, the balance is what is known as the "fringe" of the leakage flux permeance. The above equation was integrated graphically and the result is given in Table I.*:—

Table I.—*The Leakage Permeance from Rectangular Poles per Centimetre height of Pole-core.* P K H. T W. K

Ratio, W/T	0·10	0·20	0·30	0·40	0·50	0·60	0·80
K. New Method	1·94	2·22	2·40	2·81	3·40	3·90	4·81
K. Old Method	0·40	0·80	1·20	1·75	2·40	3·20	5·00

The case of circular poles was worked out by the writer in the Paper referred to above. The assumption of sine shaped lines of force was made and the results in Table II. were obtained :—

Table II.—*Values of Leakage Permeance from Circular Poles per Centimetre height of Pole-core.*

T is the Pole-pitch. D is the diameter of Pole-waist.

	Ratio (D/T).						
	0·10	0·20	0·30	0·40	0·50	0·60	0·70
Permeance, new method...	2·4	3·24	4·20	5·10	6·40	8·10	10·7
" Pohl's formula	0·6	1·30	2·20	3·30	4·70	6·30	9·1

From an inspection of Table II. it will be seen that previous results for circular poles, for the usual ratio of pole-width to pole pitch is some 90 per cent. in error. In the case of rectangular poles the error is some 30 per cent. when we consider the usual proportions of pole length to pole width. The error which may be expected in the leakage factor may vary, therefore, all the way from 6 per cent. to, say, 15 per cent.

The effect of the distributed leakage from the pole-cores is to cause the flux density in the pole to vary. The average number of ampere-turns used up per centimetre length of the pole core, is, therefore, less than that obtaining at the root of the pole. It would be useful to have a series of saturation curves showing the relation between the maximum flux density in the pole and the average number of ampere-turns required per centimetre height of core.

A somewhat analagous electrical case is that of a transmission line. We have there a distributed capacity which causes the current in the line to vary from point to point. As a consequence the drop in the line cannot be calculated on the basis of the current in either end of the line. The difficulty in the case of the transmission line is met by assuming that half of the capacity is at each end of the line or else that all of it is at the centre of the line. A similar rule in the case of distributed pole leakage would be useful, though it could not be expected that the same fractional parts would obtain. A tentative suggestion along these lines has been made by Prof. V. Karapetoff in one or the problems of his "Magnetic Circuit."† He proposes that the leakage be considered as occuring one-third of the distance from the air-gap. It will be shown below that the centre or the pole is nearer to the truth.

The flux density in the pole-core of a dynamo varies in an approximately parabolic manner, as may be seen below. The free M.M.F. between the poles varies from practically nothing at the root of the poles to a maximum value, M, between the pole-tips, usually in a uniform manner.‡ At a distance, x, from the root of the pole the M.M.F. is $M_x = M(x/H)$, where H is the radial height of the pole. Let P′ be the leakage permeance per centimetre of the pole-length, as obtained from the above tables. Then, the flux leaking from the pole in a distance, dx is

$$d\varphi = M_x P' dx = MP'(x/H)dx$$

The flux in any section of the pole core, in terms of the flux in the yoke (φ_y) (which is also the maximum flux in the core) is

$$\varphi = \varphi_y - (MP/H)\int_0^x x\,dx = \varphi_y - \frac{MPH}{2}\left(\frac{x}{H}\right)^2 \quad . \quad . \quad (3)$$

At the tips of the poles when the distance x is equal to H, the flux that remains in the core is φ_H

$$\varphi_H = \varphi_y - MPH/2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This result is already well known and is mentioned in the books of Karapetoff and Hawkins and Wallis mentioned above. Returning to equation (3) it will be seen that the flux density in the core varies in a parabolic manner.

In Fig. 2 at the left is shown the flux density distribution in the pole-core of a dynamo, for a maximum density in the core of 16 kilolines per square centimetre, for various distances x along the core. The construction shows how, for the assumed saturation curve for cast steel, the curve of the intensity H is plotted. It is to be noted that H is plotted in ampere-turns per centimetre. The customary assumption that B and H are constant in the pole-core and equal to their maximum value is seen to be greatly in error.

The area c, r, p, q under the curve of H gives the average value of the intensity of the field in the pole, which is plotted at d. This gives us the curve of average H shown connecting the points d and r.* This one curve serves to give us the value of H_{av} for several values of the leakage factor. For instance, with a leakage factor of 1·3 the flux density at the pole tips is (16·0/1·3)=12·3. This gives us at the point e an average M.M.F. of 26 ampere-turns per centimetre. This is transferred to the figure at the right, giving us the point f on curve

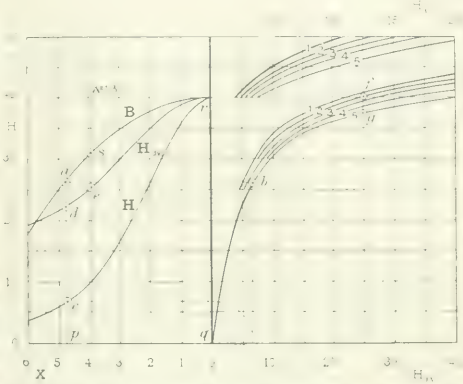


Fig. 2.—Flux Distribution in the Cores of Field Poles, and Chart for Finding Pole Core M.M.Fs.

No. (2). In this way the curves shown in Fig. 2 were all obtained. Curve (1) is drawn for a leakage factor of 1·6, and curves (2), (3) and (4) for leakage factors of 1·3, 1·2 and 1·1 respectively. Curve (5) is the original saturation curve. The point g gives what may be called the "Equivalent pole-core density" for a leakage factor of 1·3 and a maximum flux density of 16 kilo-lines per square centimetre. That is to say, a uniform density of 15 kilo-lines per square centimetre, as there shown, would cause the same M.M.F. drop in the poles as the actual variable density.

The curves shown in Fig. 2 may be used directly in leakage calculations. It is more convenient, however, to use these curves to obtain coefficients to reduce the actual distributed leakage to an equivalent concentrated leakage. We may, for instance, concentrate a part of the leakage at the pole-tips and the remainder at the yoke: on the other hand, we may, if we wish, concentrate all of the leakage at a certain point part way at the pole-core. This is achieved in a very simple manner, as the following example will show. It is to be noted that some such rule is highly desirable, since the average H in the pole-cores varies from 55 to 80 per cent. of the maximum

* For another method [illegible] written in A.I.E.E. "Proc.," May, 1915, pp. 807-809.

† "Magnetic Circuit," Chap. II., p. 28, prob. 10.

‡ For other possible assumptions, see R. Pohl [illegible]

* The method of integrating graphically under saturation curves seems to be due to W. B. Hird, who has applied it to finding the M.M.F. required by tapered armature teeth, in "Journal" Inst. E.E., Vol. XXIX., p. 939.

value of H in the pole-core according to the leakage factor and the saturation.

Let it be assumed that, in a certain machine, the maximum flux density in the core is 16·0 kilo-lines per square centimetre, the leakage factor is 1·3, and the minimum flux density in the core is consequently 12·3 kilo-lines per square centimetre. Let it be required to find the fraction Y of the total leakage flux which may be assumed to take place at the pole-tips, and also the fraction X of the distance along the pole-core from the air-gap at which we may assume that the leakage takes place. We may use the formulæ,

$$Y=\frac{B_{av}-B_{min}}{B_{max}-B_{min}}\quad;\quad X=\frac{H_{av}-H_{min}}{H_{max}-H_{min}}\qquad(5)$$

Referring to the curves in Fig. (2) we see that the maximum value of H is 40 ampere-turns per centimetre, and the minimum is 10 ampere-turns per centimetre. The equivalent flux density is $B_{eq.}=15$ kilo-lines per square centimetre, and the average value of field intensity $H_{av.}=26$. Substituting these values into the above equations we obtain

$Y=(15-12{\cdot}3)/(16-12{\cdot}3)=2{\cdot}7/3{\cdot}7=73$ per cent. of the flux.
$X=(40-26)/(40-10)=14/30=46$ per cent. of the distance.

This process was carried out for a wide range of values of flux density and leakage factors, and the results are given in Table III.

Table III.

Concentrated distribution of leakage flux equivalent to distributed pole-core leakage.

Concentrate Y per cent. of the total leakage flux at the pole-tips, or else concentrate all of the leakage flux at a distance X per cent. of the height of the pole from the air-gap.

Flux density		12	14	16	18	20
Leakage factor	1·1	Y=67	70	71	69·5	66
	1·2	Y=68·5	71	72·5	71	68·5
	1·3	Y=69·5	72	73·5	73	71
	1·6	Y=71	74	76	76·5	75
Leakage factor	1·1	X=35	38	40	42	43
	1·2	X=38	41	43	44	46
	1·3	X=41	43	46	48	49
	1·6	X=44	48	52	54	56

In studying the above table it will be noticed that there is no one figure for either Y or X which will answer the purpose. Nor can it be claimed that the values in the above table would apply to all qualities of cast steel. It would, moreover, be too laborious a work to evaluate tables such as the above for every grade of steel. The writer consequently set himself the task of ascertaining by trials what values of X and Y could be assumed with the least error, and to determine what was the likelihood of error in using these figures.

It was found that if we assume 72 per cent. of the leakage at the pole-tips, that the error in any case within the working range was never over 10 ampere-turns per centimetre, and usually less. If the figure 75 per cent. be taken instead, the error is usually less than 10 ampere-turns per centimetre, but occasionally amounts to 20 ampere-turns per centimetre. If the leakage be assumed to occur exactly half way between the pole-tips and the pole-yoke the error was found to be never greater than 10 ampere-turns per centimetre. The latter assumption seems to be the preferable one of the three.

From the above considerations the following conclusions may be drawn :—

1. Accuracy in leakage calculations is as important as in any other (say, embodiment) in an electric machine.

2. The customary formulæ for leakage flux permeance give values which are much too small. A table of leakage permeance is given in this Paper with values of permeance much nearer the truth. The most convenient way to use these would be to express the values in the form of a curve.

3. The effect of distributed pole-core leakage may be taken into account by assuming that 72 per cent. of the leakage occurs at the pole-tips, or else that all the leakage occurs at a point exactly half way between the pole-tips and the pole-yoke.

A NOTE ON "EARTH RESISTANCE."*

BY E. W. MARCHANT.

If an earth plate in the form of a hemisphere is embedded in a homogeneous medium, with a flat bounding surface, the flat face of the hemisphere coinciding with the flat surface, it may easily be shown that the resistance between this surface and a very distant surface also of hemispherical form is $\rho/2\pi a$, where ρ is the specific resistance of the material, and a is the radius of the hemispherical earth plate. This may be written $\rho/2\pi a=\rho a/2\pi a^2$.

$\rho/2\pi a^2$=Specific resistance/Area of hemispherical earth plate.

a is the length of the unit area, but $2\pi a^2$, which would have the same resistance as the earth plate, may be called the "Equivalent length of the earth resistance," which in this case is equal to the radius of the hemisphere. For other forms of earth than the sphere, this equivalent length of earth may be determined. The earth resistance of an earth plate will depend almost entirely on the specific resistance of the material immediately surrounding the earth plate, and if its value is known, the resistance of the earth at any place may be determined, if the specific resistance of the soil in the neighbourhood of the earth plate is found.

In connection with the wireless station at Liverpool, some experiments have been made recently on the resistance to earth of three different type of earth plate. The earth most used was the water-pipe system of the building; in addition to this, an earth was formed by 14 2 in. cast-iron pipes, pointed and driven about 1 ft. into the ground, which, in Liverpool, is a good yellow sandstone, a third earth was formed by a copper plate 1 ft. 6 in. wide and 4 ft. 6 in. long, buried vertically at a depth to the top edge of 6 ft. below ground, to this was riveted two copper strips, laid at a depth of 6 ft., each 1 in. wide and 40 ft. long. In both cases described the earth was made by burying the plates direct in the wet sandstone, without a surrounding volume of coke such as is usually recommended. If good conducting material were used to surround the plate it would, of course, considerably reduce the "effective length" of the earth resistance. The specific resistance of the sandstone, when excavated from the soil and firmly pressed into a wooden box with copper plates at opposite faces was 375 ohms per foot cube, the percentage moisture in the sand being 10 per cent. By measuring between these earths in succession and by assuming that the earth resistance of each was some definite quantity, the resistance of each of the three can be estimated. The earth resistance was measured first between A and B with A positive, then with A negative, and so on, and the earth resistances were calculated on the assumption that the earth currents flowed from A to B, from B to C and from C to A.

Calculating from the measurement so made, the following results were obtained :—

Earth resistance of copper plate and strip	6·1	ohms.
,, ,, iron pipes	42	,,
,, ,, water pipes	3	,,

Assuming that the current flowed the other way the earth resistances were :—

Earth resistance of copper plate and strip	7·1	ohms.
,, ,, iron pipes	40	,,
,, ,, water pipes	2·7	,,

The water-pipe earth has very much the lowest resistance, as might have been expected from the large area of water pipe embedded in the soil. In comparing the two earths formed by the iron pipes and the copper plates, it was calculated that the area of surface exposed to the soil was 5·8 sq. ft. in the case of the iron pipes, and about 27 sq. ft. in the case of the copper plates. The equivalent length of earth as defined above, may be easily calculated from the above data :—

For the copper plate earth the mean equivalent length is	0·51 ft.
,, iron pipes	0·63 ft.

It is impossible to estimate the equivalent length of the water-pipe earth, since the area of surface of the water pipes exposed to the ground is unknown, and in any case the calculation of the equivalent length for such a complicated network would have no practical value. The earth resistance of these plates has not been measured over a very long interval of time, the greatest variation in earth resistance found so far is for the copper plate which is buried in ground exposed to rain. After a very dry spell of weather the earth resistance was found to be about 6 per cent. greater than it was after the most rainy conditions had prevailed for some weeks.

The reason for the smaller equivalent length of the copper plate earth is clear, the large copper strip making contact to a large area

* A Paper read before Section G of the British Association

of soil, whereas the pointed iron pipes were close together. The determination of the equivalent length of earth for various forms of earth plates provides a simple means of comparing their effectiveness.

I am indebted to Prof. Wilberforce for the suggestion of the example quoted of the hemispherical earth electrode, and to Prof. Morris for the "strip" form of earth which we have tested.

GLASGOW CORPORATION ELECTRICITY SUPPLY ACCOUNTS, 1914-15.

The figures published in the annual accounts of the Glasgow Corporation Electricity Department for the financial year ending May 31 last, show a steady progress of the undertaking. At that date the number of consumers was 32,030, as against 30,098 in 1914, or an increase of 6·42 per cent. The sales to private consumers amounted to 85,718,795 units, compared with 73,988,649 units, or an increase of 15·85 per cent. The total [illegible] 101,148 kw. as compared with 89,592 kw. in 1914, or an increase of 12·9 per cent. The maximum load on the 'bus bars was reached on December 7 last when the demand was 39,750 kw. The load factor has improved and now stands at 25·5, which shows a notable advance on the previous figure of 22·8.

With regard to tariffs, the various prices at which the output is sold is shown in detail in the following table :—

Units Sold to Private [illegible]		
Lighting –		
8,798,978		3½d. per unit.
2,270,937		3d. ,,
32,347		2½d. ,,
148,065		2d. ,,
1,752,065		1½d. ,,
41,718		1d. ,,
6,805,675		½d. ,,
19,849,725		
Power and Heating –		
9,059,486		1½d. per unit.
2,750,104		1d. ,,
17,080,379		0·75d. ,,
333,609		0·675d. ,,
14,507,466		0·5d. ,,
22,138,026		Kw. rate.
65,869,070		

It is noticeable in the figures we give below that the cost of fuel per unit has fallen, notwithstanding the increase in the price of coal. The latter will no doubt be felt more seriously during the present year, as also the rise in cost of materials, rates and taxes, &c., and in order to meet these increased costs 15 per cent. has been added to all tariffs. Apart from this it is satisfactory to note that there is a slight steady decrease from year to year in the total costs per unit, excluding capital charges.

During the year the units generated by the various stations were as follows :—

Port Dundas	63,104,604
Pollokshaws Road	30,078,497
Kelvinside	142,008
Govan	7,112,774
Partick	2,602,046
Corporation Tramways Department	1,187,495
Total	104,227,424

	Year ended May 31,		
	1915.	1914.	1913.
Number of units sold			
To private consumers	85,718,795	73,988,649	60,133,955
Public lamps	2,756,400	2,689,797	2,837,426
By contract	359,075	342,425	211,682
TOTAL OUTPUT	88,834,270	77,020,871	63,183,063
Total number of units generated	104,227,424	92,286,953	77,610,855
Units used on works	3,990,286	3,990,412	3,187,321
Units lost in distribution, &c.	11,402,868	11,365,540	11,240,471
Per cent. of these to units generated	10·94	12·32	14·48
Total maximum load	39,750	38,612	
Load factor of whole supply	25·5	22·8	
TOTAL NUMBER OF CONSUMERS	32,030	30,098	27,848
TOTAL CONNECTIONS, IN KW.	101,148	89,592	82,016

The number of units lost in distribution has remained about the same for the past three years, but as the total output has increased the percentage loss in this direction has dropped from 14 per cent. to under 11 per cent.

We give below a complete analysis of the output and the costs. It will be noticed that a substantial sum has been written off for depreciation as usual.

	Total 1914-15.	Per unit sold. 1914-15.	Per unit sold. 1913-14.
Generating Expenses.			
Fuel with carting	£81,248	0·22d.	0·25d.
Oil, waste, water, &c.	4,517	0·01d.	0·01d.
Salaries and wages [illegible]	24,805	0·07d.	0·07d.
Repairs and maintenance	19,728	0·05d.	0·04d.
Tramway [illegible] cost of coal [illegible] sold	1,948	0·01d.	0·01d.
Total Generating Expenses	£135,246	0·36d.	0·38d.
Distribution Expenses.			
Salaries of [illegible]	£4,523	0·01d.	0·01d.
Repairs [illegible], &c.	10,494	0·03d.	0·03d.
Repairs of [illegible]	3,697	0·01d.	0·01d.
Total Distribution Expenses	£18,714	0·05d.	0·05d.
Management Expenses.			
Salaries	£8,977	0·02d.	0·03d.
General establishment charges	9,015	0·03d.	0·02d.
Stationery, printing, &c.	1,559	0·01d.	0·01d.
Total Management Expenses	£20,051	0·06d.	0·06d.
Rents, rates and taxes	£34,655	0·09d.	0·10d.
Attending public lamps	7,103		
Attending private, street and stair lights	1,771	0·03d.	0·03d.
Repairs on motors and lamps let for hire	288		
National Insurance Act	690	0·00d.	0·00d.
TOTAL COSTS (*ex.* capital charges)	£218,518	0·58d.	0·61d.
Capital Charges.			
Interest	£66,883	0·20d.	0·22d.
Sinking fund, &c.	67,686	0·17d.	0·17d.
Total Capital Charges	£134,569	0·37d.	0·39d.
TOTAL COSTS (*inc.* capital charges)	£353,087	0·95d.	1·00d.
Revenue.			
Sale of current by meter	£383,408	1·04d.	1·11d.
Public lighting	20,943	0·05d.	0·06d.
Rental of motors and lamps let for hire	966	0·00d.	0·00d.
Rents of property	56	0·00d.	0·00d.
TOTAL REVENUE	£405,373	1·09d.	1·17d.
Balance	£52,286	0·14d.	0·17d.

£52,745 (0·1425d. per unit sold) is written off for depreciation, which makes a deficit for the year of £459 (0·0012d. per unit). To meet this a sum has been transferred from the Reserve Fund Account, which, as reduced by this amount and a further sum of £15,434 transferred to the Sinking Fund Account, now stands at £48,854.

The capital expenditure during the year amounted to £173,150, bringing the total capital expenditure as at May 31, 1915, to £2,577,187, after deducting the depreciation written off up to date, and the capital realised. This amount is made up as follows :—

Land and buildings	£364,097
Machinery and plant	688,071
Accumulators	11,520
Mains	1,346,012
Meters	86,111
Electrical instruments	4,401
Laboratory equipment	2,662
Counting house furniture	2,982
Transformers in consumers' premises	61,979
Motors, lamps and heaters for hire	3,817
Showrooms	115
General stores	2,177
Engineers' fees, &c. (Partick station)	3,213
TOTAL CAPITAL EXPENDITURE	£2,577,187

Prevention of Oil-Switch Explosions.—In the "Elektrotechnische Zeitschrift" Mr. A. Wedmore suggests filling the space above the oil in the container with nitrogen; or filling the container completely with oil, and connecting the interior through a pipe to a reservoir standing about 1 to 2 metres above it. By this means, no oxygen is present for combining with the hydrocarbon vapours to form an explosive mixture.

The Electrician.

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THE WORK OF THE BRITISH ASSOCIATION.

In spite of the war clouds which darkened its proceedings, the British Association has once more asserted its usefulness as a permanent feature of our scientific life. Many of its members met and spoke under the shadow of personal bereavement. All felt the seriousness and solemnity of the occasion. Of gaiety there was not a trace ; but throughout one felt a new and inspiring note of calm determination and steadfast purpose. The war claimed its part in all the sectional proceedings, from war finance in the section of Economics to the utilisation of women's labour in the Educational Section, and the treatment of the mental phenomena of shell shock discussed in the sub-section of Psychology. The comparative scarcity of young men, the substitution of Girl Guides for the usual attendants, the ruthless cutting out of all pleasure excursions, and the reduction of the time of the meeting to a bare four days were outstanding features which marked the first great war meeting in the history of the Association.

It is only natural that the British Association, like every other scientific society in this country, should wish to assist the Government during the present struggle, and consequently the almost inevitable committee is being proposed. This committee, however, differs from other committees of its kind, in that it is to deal not merely with matters of importance during the war, but with those that must be considered when the war is over. When that time comes we shall find that we are faced by serious competition, and it is essential that we should look forward and prepare for this time as soon as possible. What, it may be asked, will be the attitude of labour when the present time of stress is over, when there will be less urgent work, and when wages

in all probability will stand at a lower level? Last week Mr. LLOYD GEORGE gave evidence of the regrettable restrictions imposed, even at the present time, by trade union workers, if not by trade unions themselves. If these practices cannot be dropped at such a moment as the present, this shows how deeply imbued such principles have become. It must be realised that restrictions of this kind, by which the skilled workman is not permitted to do as much as he will, must have a very important influence upon raising the costs of production. Will there be corresponding restrictions on the part of German workmen? We doubt it, and if that is so the difficulty of competing against German products after the war will be doubly difficult for the British manufacturer. It is important that labour should look at these matters internationally. LORD SYDENHAM refers to this matter in a letter to *The Times* of last Tuesday, and pertinently asks—"Is the denial of a man's right to do what he is fully capable of doing compatible with the elementary conditions of liberty?"

Then there is the much-discussed question of organisation. In his address to Section G, Dr. HELE-SHAW pointed out that the individual British manufacturer is not devoid of the power of organisation. We have many examples of most excellent work in this direction. Where, however, we have failed is in the relation of the various inter-dependent parts of industry. As an instance, Dr. HELE-SHAW mentions the fact that some years ago the lack of co-operation and organisation in getting goods from our manufacturing centres exceeded the cost of transporting these goods across the ocean. We remember also that there was an instance a few years ago at Liverpool, where the installation of special machinery for handling goods was not worth while, because the various interests were not working in sufficient harmony. When, however, such matters are in question in Germany, the Government steps in and sees that proper facilities are given so that the costs are reduced to a minimum. There appears indeed to be a sort of general organisation between the Government departments, the banks, the railways, shipping and other interests so as to give German commerce the very best possible chance.

Returning to the meeting itself, it can hardly be said that many of the sections, as such, suffered very seriously from the special circumstances under which they carried on their deliberations. Section A, especially, maintained a large and steady attendance throughout, and the Economics and Educational Sections were crowded. While the discussion on the classification of stars was somewhat inconclusive, that on thermionic emission was most instructive, and the discussion in the Geology Section on the age of the earth, in which such men as RUTHERFORD, JOLY, SODDY and SOLLAS took up somewhat divergent attitudes, provided the audience with a feast of personal controversy, marked by a few moments of unrestrained merriment. The Chemistry and Engineering Sections also brought out some Papers of importance, both from the electrical and purely physical points of view, particulars of which will be found elsewhere. Finally, the presence of such great Frenchmen as PIERRE WEISS and YVES GUYOT, as well as a number of Belgian men of science, reflected the close bonds between the Allies on the field of battle.

REVIEWS.

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1. **Questions and Answers in Wireless Telegraphy. Series I.**
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Each of these series consists of a set of questions printed on cards in groups of six, and a book of model answers to them.

Series I. of the questions, entitled "Elementary Principles," covers approximately the same ground as the excellent little book, "Elementary Principles of Wireless Telegraphy," by R. D. Bangay, reviewed in this journal on July 2, 1915. The questions have been prepared with considerable care and ability, and are well calculated both to *examine* the student, by drawing from him an exposure of what he understands and does not understand, and to *teach* him by stimulating him to co-ordinate his existing knowledge and to realise the gaps which must be filled.

The questions, and particularly the model answers, are somewhat colloquially worded—for example, as an insulator or conductor wood is said to be "a kind of mongrel"—but the same scientific accuracy and literary precision which are such praiseworthy features of Mr. Bangay's book are also to be found here. To an intelligent beginner in wireless, the mere thoughtful perusal of the questions would be quite instructive; while a serious attempt to write down answers to them, with a subsequent reference to the model answers, will be most helpful.

There are 228 questions, many of them with diagrams. Question 24, demanding a description of a diagram showing a complete transmitter is premature in Card 4. Question 158 asks what is wrong in a diagram showing a crystal detector connected so as to be capacity-shunted for high-frequency currents. This oft-made mistake is well exposed in the answer; but in Answers 187 and 189 the author himself makes a similar slip in giving diagrams for buzzer-excitation wherein earth-capacities are added by the buzzer and its battery to *each* terminal of the condenser. The point of the buzzer should, of course, always be connected directly to one—the non-earthed—terminal of the buzzer inductance.

Amongst the answers, in 185, for no apparent reason, irregularity of sparking is shown as a characteristic of plain-aerial, as opposed to coupled-circuit, transmitters. In 205 and 211, the inefficiency of a loaded antenna is said to be due to large increase of inductance; more accurately, it is large increase in wavelength, which leads to a different conclusion when the virtues of large antenna-capacity are being considered. In 220, Fig. 1 is badly drawn, for the areas above and below the line should be equal. In general the figures are plentiful and good.

Series II. is something of a puzzle. It is not a continuation of Series I., as might naturally be expected, but seems to be quite independent. The questions are entitled "Elementary Principles and Practical Questions on Apparatus"; there are 287, and of these no fewer than about 100 deal with general elementary electricity; the last 30 or so refer to operating procedure as defined in the P.M.G. Handbook; and the remaining 160 odd cover the ground of Series I. with some more advanced work in addition. The technical wireless questions are said to be based on the "Handbook of Technical Instruction for Wireless Telegraphists," by J. C. Hawkhead, a book with which the reviewer is not acquainted.

The questions are not very skilfully selected or well worded, and the answers are sometimes incomplete, are often much too brief for instructive purposes, and are insufficiently provided with diagrams.

Question 53 asks why must the "full current" not be put into an armature at once. The armature is, of course, subjected to the full current (and more) at once; but not to the full P.D. There is a similar confusion between current and E.M.F. in Answer 70. The Planté cell (101) might have been omitted. In Questions 199 and 200, "receiver" is written where "detector" is meant.

Answer 74 defines the henry as the inductance "in which

[illegible] E.M.F. of one volt," without reference to rate of change of current. In 221, it is explained that a D'Arsonval ammeter cannot be used in the antenna because of the inductance and self-capacity of the coil: the unsurmountable obstacle, that it is not deflected by alternating current, is not mentioned.

Series II. is a mediocre work which will probably be of some help to would-be operators. It suffers by raising expectations that it is a sequel to Series I., a position which neither the subject-matter nor the quality of its treatment warrants.

L. B. T.

Submarines, Torpedoes and Mines. By W. E. Dommett. (London: [illegible].)

This little volume is one of many which is appearing at the present time describing the various implements used in war. The author in this instance gives an interesting account, in popular style, of the submarine, including some of the methods now being used in defence in this new mode of warfare. The general working of the submarine and the torpedo is described, and there is a section on mines and auxiliary vessels.

EXPOSURE TESTS OF LIGHT ALUMINIUM ALLOYS.*

BY [illegible] WILSON.

[illegible]

The physical properties of certain light aluminium alloys have formed the subject of several communications,† and, as stated therein, a specimen of each alloy has been placed on the roof of King's College, London, in order to investigate the influence of exposure upon electrical resistance. All the specimens are in the form of wire 0·126 in. (3·2 mm.) diameter. The results are set forth in the accompanying table.

Copper-Manganese-Magnesium.—Specimen 25 has steadily increased its electrical resistance to 17·2 per cent. in 13 years. As is well known, all commercial aluminium contains traces of silicon and iron.

Copper.—It has already been pointed out that the electrical resistance of the copper series in a given time increases with the percentage of copper. Specimen 15, containing 2·61 per cent., had so far corroded in 1911 that it broke when being bent into a loop for attachment to the bridge. Specimen 14, containing 1·86 per cent., has now so far corroded as to become practically useless as an electrical conductor. The tests emphasise the opinion already expressed that alloying commercial aluminium with copper alone, except in very small quantity, is not to be recommended. (*See* specimens 4 and 16.)

Copper-Magnesium.—The alloys [illegible] have steadily increased their resistance to [illegible] in 14 years. No. 23 is interesting, as it has a fairly high breaking load of 35,000 lb., and is apparently in good condition.

Copper-Nickel.—Specimen 22 has a breaking load of 45,900 lb., and has somewhat diminished its electrical resistance, the percentage being now 12·4, as against 19·4 in 1908.

Copper-Zinc.—Specimens 1, 2, 3, 5 show a reduction of electrical resistance.

Copper-Zinc-Nickel.—Specimen 19 has diminished its electrical resistance to 14·6 per cent. from 33·5 per cent. in 1908. The extent to which specimens 18 and 19 have varied their electrical resistance is shown by the following figures:—

Year	1901.	1903.	1904.	1908.	1911.	1913.	1915.
No. 18	917	947	954	1,128	1,052	1,063	1,063
No. 19	962	995	1,013	1,285	1,125	1,102	1,102

Copper-Manganese-Magnesium.—The alloy known as "Duralumin" is stated to contain about 0·5 per cent. Mg, 3·5 to 5·5 per cent. Cu, 0·5 to 0·8 per cent. Mn. A breaking load as high as 90,000 lb. can be obtained, according to treatment. Specimen 26 has steadily increased its electrical resistance to 9·6 per cent. in four years. It is, however, so brittle that a small loop cannot be bent without fracture. Its temperature coefficient (0·173) is the same as that of the Cu-Ni alloy No. 22.

Copper.—The author is, unfortunately, unable to report on the copper exposure, as the specimen has been stolen from the roof.

* A Paper read before Section G of the British Association.

† See "Journal" of the Inst. Elec. Eng., 1902, Part 154, Vol. XXXI. Also B.A. Reports, 1901, 1902, 1903, 1904, 1908, 1911, 1912, 1913. Also "Journal" of the Royal Society of Arts, December, 1901.

No. of specimen	Analysis. Sn.	Pb.	Cu.	Ni.	Mn.	Zn.	Mg.	Sp. resistance in [illegible] before exposure and heating.	Average temperature coefficient per 1°C. between 0°C. and 50°C. per cent.	Average temperature coefficient per 1°C. between 0°C. and 100°C. per cent.	Percentage increase of electrical resistance taken on value in 1901 at 15°C. during 1901–1908.	during 1901–1915.	Percentage extension with 16,250 lb. per sq. in. of cross-section.	Limit of elasticity in lbs. per sq. in. of cross-section.	Breaking load in lbs. per sq. in. of cross-section.
16	0·31	0·37	0·11	...	...	...	...	2·92	0·354	0·318	5·65	11·3	0·177	19,500	26,600
4	0·38	0·25	0·16	...	...	...	...	2·88	0·341	0·324	6·05	10·6	0·200	17,900	25,700
13	0·38	0·25	1·58	...	...	...	...	3·34	0·295	0·283	11·3	14·3	0·194	32,500	39,000
14	0·40	0·41	1·86	...	...	...	...	3·25	0·302	0·303	15·4	25·3	0·185	32,500	40,600
15	0·40	0·40	2·61					3·34	0·311	0·296	24·3		0·186	34,500	43,500
1	0·38	0·22	0·17			0·62	...	2·86	0·369	0·357	16·6	10·8	0·286	23,600	28,100
2	0·43	0·28	0·39			1·20	...	2·94	0·346	0·320	19·0	17·0	0·171	20,300	30,500
3	0·43	0·39	0·69			2·04	...	3·07	0·319	0·325	18·4	15·7	0·171	20,700	26,000
7	0·37	0·25	0·05	0·75				3·05	0·328	0·320	9·84	10·2	0·189	20,300	29,700
8	0·35	0·29	0·09	1·19			...	3·24	0·337	0·320	11·4	6·75	0·237	23,600	33,700
20	0·37	1·10	0·06	2·25				3·18	0·335	0·329	8·33	9·7	0·189	20,300	38,600
24	0·35	1·16	0·09	...		...	...	2·97	0·365	0·357	5·34	10·8	0·194	20,300	31,300
3	0·37	0·28	0·59	...		0·29		3·06	0·327	0·306	16·6	5·75	0·180	22,300	30,500
6	0·39	0·31	0·63			1·20		3·12	0·324	0·316	10·2	10·0	0·237	24,400	30,900
17	0·41	0·53	0·10	0·83		0·90		3·03	0·324	0·320	6·51	14·5	0·191	18,300	31,700
12	0·41	0·29	0·19	1·09		0·73	...	3·33	0·330	0·318	6·73	12·4	0·197	24,500	31,700
18	0·43	0·30	0·21	1·13		1·94		3·24	0·332	0·319	23·6	1·69	0·189	22,300	34,500
10	0·35	0·23	0·11	2·01		1·77		3·26	0·263	0·238	33·5	14·6	0·180	20,300	36,200
11	0·39	0·56	0·24	2·31		0·38	...	3·48	0·308	0·300	9·4	6·92	0·194	24,400	34,500
22	0·37	0·43	1·08	1·29				3·41	0·173	0·178	19·4	12·4	0·146	36,600	45,900
21	0·39	2·57	0·16	1·89				3·24	0·352	0·320	7·35	8·43	0·194	24,400	42,200
19	0·41	0·54	0·02	...	0·05			3·09	0·322	0·311	5·41	9·08	0·191	22,700	29,200
9	0·36	0·35	0·03	...	0·35			3·30	0·311	0·291	5·20	10·6	0·185	22,300	30,500
23	0·43	0·58	0·09	...	1·18			3·49	0·273	0·245	5·30	9·6	0·186	24,400	35,300
25	0·34	0·31			0·41	Al. [illegible]		2·702	...	0·393	8·06‡	17·2‡	0·190	19,376	28,200
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0·173	0·181	[illegible]	9·61§	[illegible]	[illegible]	67,000

† [illegible] 1902.

‡ After four years' exposure.

THE BRITISH ASSOCIATION AT MANCHESTER.

[From our Special Correspondent.]

Tuesday, September 7th.

The meeting this year differs from all previous ones owing to its severely practical nature. In an atmosphere of war social functions are out of the question, and the minds of members naturally turn to the many problems of national importance with which we are confronted at the moment. Nevertheless there was an attendance of about 1,000 to hear the Presidential Address of Prof. Arthur Schuster. At this, the first function of the meeting, a loyal address was moved and carried as follows :—

"We humbly desire to express our [illegible] person and to your Majesty [illegible] affairs. Landing in Australia at the [illegible] we witnessed the extraordinary manifestations of loyalty which were displayed throughout that great Commonwealth. During our earlier visits to Canada and South Africa [illegible] fellowship found expression in the cordiality of the reception given to us. By these visits we have endeavoured to strengthen the bonds which unite parts of your Majesty's Empire. We beg leave on the present occasion to assure your Majesty that the Association as a whole and every individual member thereof are whole-heartedly anxious to devote all their energies to assisting your Majesty's Government in the task of bringing the war to a victorious conclusion."

The Presidential Address was received with much cordiality, which was probably rendered the greater by the recent unwarranted attacks on Prof. Schuster. The numerous epigrams were appreciated and the audience was struck with Prof. Schuster's new definition of the function of science ("to predict the future"). Our readers will find an abstract of the address in our last issue. There was quite an ovation when the Lord Mayor (Alderman MacCabe) referred to the recent severe wounding of the President's son at the Dardanelles in "fighting bravely for this country."

Wednesday, September 8th.

This morning the following gratifying reply to the address was received from his Majesty the King :—

"The President of the British Association, Manchester :

"I have received with much satisfaction the message you have forwarded on behalf of the members of the British Association testifying to their loyalty to the Crown and to my Government in this time of national crisis. The outbursts of loyalty which the members witnessed in their past visits throughout Canada and South Africa have been gloriously demonstrated by those imperishable deeds achieved on the heights of Gallipoli, in the trenches of Flanders, and upon the waterless plains of German South Africa.

"In gratefully accepting the resolution that the Association, one and all, will do everything in their power to bring the war to a final victory, I recognise with deep appreciation the valuable services which are being rendered to this end by men of science.—George, R.I."

The various sectional addresses were delivered this morning. That of Dr. H. S. Hele-Shaw to Section G was given in abstract in our last issue. The address by Sir F. W. Dyson to Section A was concerned wholly with astronomy, and therefore it is somewhat beyond the scope of our columns. In the absence of Prof. H. B. Baker, chairman of Section B, the address was delivered by Prof. Bone.

In the evening there was a reception by the Lord Mayor.

Thursday did not present features of electrical interest.

Friday, September 10th.

To-day was the day of greatest interest to those concerned with electrical and kindred matters.

Section A assembled under the chairmanship of Sir E. Rutherford, when a discussion took place on

Thermionic Currents.

Prof. O. W. Richardson, in opening the discussion, said there were two different emissions of ions by pure metals in a vacuum which had no connection with each other. One was the emission of positive ions of atomic dimensions, which was strongest on the first heating, and usually due to impurities such as sodium and potassium atoms. [illegible] emission of (negative) electrons, which continued indefinitely, as in the Coolidge tube. This latter emission increased geometrically as the temperature rose arithmetically, so that an emission from, say, tungsten, amounting to $2{\cdot}3\times10^{-13}$ amperes per cm.^{2} at 1,050°abs. became 0·7 ampere/cm.^{2} at 2,300°abs., an enormous increase. The laws governing this thermionic emission of electrons were quite similar to the laws of evaporation. The electronic current density i was expressed by the formula,

$$\log i - \tfrac{1}{2}\log T = \log A - b/T,$$

or,

where T is the absolute temperature, and A and b are constants which could be determined by measurements analogous to the measurement of latent heat.

This emission was very sensitive to some gaseous contaminations. In the case of platinum, the presence of hydrogen increased the emission, while in the case of tungsten the emission was diminished by hydrogen and unchanged by argon.

Alternative Theories.

Was the emission, the opener asked, of a physical or chemical origin? One view was that it was simply the projection of electrons with the velocity of heat agitation which they possessed within the metal. Another was that the emission was a phenomenon accompanying a chemical action of residual gas upon the metal, this being the origin of the energy of emission. Both these hypotheses were capable of accounting for the variation with temperature.

The latter or chemical view derived some support from a recent observation (1912) of Haber and Just, who found that sodium and potassium were acted on by steam or certain other vapours. A thermionic explanation of this phenomenon was, however, found untenable on examining the distribution of kinetic energy among the electrons so liberated, which did not obey Maxwell's law. The analogy was photoelectric rather than thermionic. Besides, Fredenhagen had been able to reduce the emission to a millionth by continued heating. The Haber and Just phenomenon was, therefore, primarily a chemical phenomenon.

The Tungsten Experiments.

In the case of tungsten, on the other hand, a chemical theory was, in the speaker's opinion, utterly inadequate. The tubes containing the tungsten filament were prepared by Coolidge's method of heating to 600°C. for 24 hours. The filament itself was kept for some time at 3,000°C., and the copper gauze surrounding it was subjected to cathode-ray bombardment. Besides this, all the usual precautions were taken for securing a high vacuum. The result was that a current of $\frac{1}{20}$ ampere through the filament did not raise the pressure by as much as 10^{-7}mm. of mercury. The pressure and the resistance of the filament were measured continuously so as to control the amount of gas and the disintegration of the filament. The results showed that

(*a*) 260 million electrons were emitted for every molecule of gas present ;

(*b*) 15,000 electrons were emitted for every molecule of gas impinging upon the filament ;

(*c*) 984,000 electrons were emitted for every atom of tungsten evaporated, so that the mass of electrons emitted was three times the mass of tungsten lost.

Finally, the action was never increased by admitting gas to the tube.

All these observations, the speaker urged, definitely eliminated chemical action as an explanation of thermionic emission.

Another alternative, that of a "complete photoelectric emission," due to the filament's own complete radiation, would also account for the temperature curve, but broke down on the question of magnitude, as shown by the figures obtained by Langmuir and by H. A. Wilson. Concluding, Prof. Richardson said that his experiments proved the thermionic emission

trons having a close analogy to evaporation.

Discussion.

Dr. F. A. Lindemann said he had followed with interest the clear exposition of what was known as the "Richardson effect" by its author. He wished, however, to draw attention to certain difficulties inherent in the various electronic theories of metallic conduction (including the "chain" theory) which had a certain bearing on these experiments. The atomic heats of metals did not differ from those of dielectrics by more than 1 per cent. The atomic heat was undoubtedly due to the oscillations of the atoms themselves, only 1 per cent. or less being due to the electrons. We could not abandon the equipartition law in this case, as that would at once cancel the remarkably successful derivation of the Wiedemann-Franz law. Even on the chain theory, the calculation of the specific resistance offered some insuperable difficulties, as either the atomic heat came out 500 times too great, or the length of the doublets became 100 times their distance apart. What we wanted was a mechanism which conducted heat without containing it, something solid, like the diamond. If the electrons in a metal could be regarded as forming a solid body, most of the difficulties would disappear.

Mr. E. Newbery strongly advocated the chemical view. The choice of tungsten for these crucial experiments was, he said, unfortunate, as reversible chemical changes of great vigour were going on in the region surrounding the filament. Tungsten could never be made chemically clean and free from oxide. The current curve could be equally well derived from van't Hoff's equation, which gave

$$i = a^{\frac{1}{2}T}.$$

Here the factor $T^{\frac{1}{2}}$ did not enter, indeed, but as the errors exceeded the discrepancies caused by this omission, this did not matter. Platinum could be made clean, but it would be better to use a substance like carbon, whose compounds would all be volatile and therefore removable.

Dr. J. A. Harker said that in these discussions those electrons which attached themselves to atoms after emission should not be lost sight of, as they were of considerable importance in solar theory, such as that of the reversing layer. It seemed now quite probable that temperatures equal to that of the sun (5,700°abs.) or even higher, might be experimentally obtained. He cited the experiments of La Rosa (Palermo) and of Lummer, who had apparently attained 6,000°K. or 7,000°K. by burning an arc at a pressure of 22 atmospheres.

Prof. F. Soddy pointed out that the impact of positive ions must also be considered as a cause of emission.

Prof. J. C. Maclennan recalled the fact that an emission from "clean" zinc failed when the zinc was deposited from zinc vapour in a vacuum.

The Chairman (Sir Ernest Rutherford) said the discussion had fulfilled all expectations as to liveliness. Prof. Richardson had been subjected to both frontal and flank attacks, but as he knew him to be well able to take care of himself, he did not propose to intervene. (Laughter.)

Replying, Prof. Richardson said he was glad the discussion had become controversial. As regards Dr. Lindemann's [illegible] and the thermionic theory did not stand or fall with any electron theory of metallic conduction, but was purely a matter of thermodynamics. In reply to Mr. Newbery, he said he had little confidence in the interpretation of Pring and Parker's [illegible] Dewar and Jones had obtained very different results with carbon. Tungsten was undoubtedly a poor substance chemically, but at the temperatures in question all its products were volatile, and were, therefore, eliminated. Finally, the emissions due to [illegible] did not exceed 0·1 per cent. of the whole emission.

The discussion concluded with a vote of thanks to the opener.

Sir F. W. Dyson, having resumed the chair, called upon Prof. Bragg to give an account of his researches on X-rays and crystal structure. He did so in a paper which, much to the regret of Prof. Bragg's friends, could not be published at the present time.

Prof. Bragg then gave an informal lecture on the lines of his recent Bakerian lecture, after which Sir Joseph Larmor read a Paper on "Optical Dispersion as Conditioned by Group Velocity."

After an adjournment for luncheon, Prof. Pierre Weiss, of the École Normale Supérieure, Paris, gave a lecture in excellent English on "New Views of Magnetism," the chairman (Sir F. W. Dyson) introducing him as the renowned author of the Magneton Hypothesis.

New Theories of Magnetism.

Prof. Weiss, who was received with marked cordiality, said that the molecular theories of magnetism due to Ampère, and later to Ewing, had received a new interpretation since it had become possible to regard the magnetic moment of the atom as due to the circuital motion of electrons. In the case of paramagnetic bodies there was a certain alignment of the magnetic axes of the atoms in the direction of the field, but this alignment was subject to disturbance by heat agitation. Fundamental data could, therefore, not be expected, except at very low temperatures, and that was the reason why Prof. Kamerlingh Onnes and he (the speaker) had made their measurement of magnetic moments at the temperature of liquid air or even liquid hydrogen. In the course of the earlier experiments (1909) on the magnetic moment of iron and nickel atoms in solution the values obtained for the gramme-atom were

Fe .....11×1,123·6
Ni ..... 3 1,123·3

units of magnetic moment, which at once indicates a common factor. On dividing this common factor by the number of atoms present in the gramme-atom we obtain

$$\frac{1,123{\cdot}5}{60 \times 10^{22}} = 18{\cdot}5 \times 10^{-22}.$$

This quantity, the common factor of the atomic magnetic moments of paramagnetic substances, the author proposed to call the "magneton."

On examining the alloys of iron and cobalt and iron and nickel with respect to their molecular magnetic moments it was found that there was no continuous variation on altering the proportions of the constituents, but that the curve consisted of a series of discontinuous lines having their intersections at points corresponding to definite compound molecules, each characterised by a different magneton number. Thus, in the Fe-Ni series, with pure iron at 11 and pure Ni at 3, Fe_2Ni had 10 magnetons and FeN_2 7 magnetons. In the Fe-Co series, the values for a high content of iron did not point towards 11 magnetons, but towards 10 magnetons, thus suggesting that in these alloys the iron occurs in a new magnetic state, forming, in fact, a new ferromagnetic substance. The molecule Fe_2Co, on the other hand, had 12 magnetons.

Further light was thrown upon the various forms of the ferromagnetic metals by plotting the reciprocal of the susceptibility against the absolute temperature. The curve so obtained consisted of a series of straight lines beginning at a certain temperature called the "Curie point," and whose inclination to the T axis gave the "Curie constant." The sudden change in this constant at certain temperatures indicated a transition from one form of the substance to another. Thus, in the case of nickel, where the Curie point was at 350°C., the form $Ni\beta_1$, with 8 magnetons, was followed at 1,200 deg. by the form $Ni\beta_2$, with 9 magnetons. Similarly, there was a substance, $Co\beta_1$, characterised by 5 magnetons instead of 9.

In iron there was a still more complex system. In β iron no less than three stages could be specified:

β_1, 12 magnetons; β_2, 10 magnetons; β_3, 20 magnetons.

These figures did not depend upon a single method. Thus, the value 12 for $Fe_2\beta_1$ was deduced from direct measurements ranging from 11·98 to 12·08, and the limit indicated by the Fe-Co alloys (11·97). In magnetite there was a similar series in the ratio of the numbers

4 : 1·25 : 1·52 : 2·00 : 2·51.

Magnetic Properties of Solutions.

The remarkable observations of Pascal, who claimed to have found that all iron salts can be exactly classified according to integral numbers of magnetons, had, unfortunately, been shown to be fallacious by Picard and Weiss's re-determination of the water constant. The more recent work of two Spanish physicists, Messrs. Cabrera and Moles, undertaken in the speaker's laboratory, had, however, cleared up the part played by hydrolysis. This was, in fact, eliminated by the addition, at various concentrations of the salt, of concentrated acid. This, assisted by a special device for obtaining a clean meniscus in the magnetic field, and another device for compensating its displacement, had enabled them to arrive at a true value for the magnetic molecular moment. While corroborating the previous values, this had also revealed certain remarkable exceptions to the magneton system. One of them was $FeSO_4$, where the highest of 15 determinations gave 26·57, the lowest 26·45 and the mean 26·51, thus clearly indicating half the usual unit. Ferro-ammonium sulphate also gave 26·49, and copper gave the extraordinary figure of 9·62 magnetons.

Gaseous Magnetons.

When we come to gases, however, the magneton hypothesis received an accession of strength, oxygen giving two clear values, 14·014 and 7·007, while NO gave 9·039.

In conclusion, Prof. Weiss said he hoped that, handicapped as he was by his imperfect English, he had given the section some idea of this new line of investigation, which he hoped in the future would bear further fruit. (Loud applause.)

The chairman having opened the discussion,

Prof. O. W. Richardson said Prof. Weiss might aptly be called the Dalton of magnetism, having revealed to the world the existence of what appeared to be another fundamental natural unit of universal importance. He would like to ask whether in the case of copper, for instance, the diamagnetism of the element had not masked the effect sought.

Dr. Bohr, being called upon, said he did not feel justified at present in venturing on any guess at a connection between his unit of atomic angular momentum ($92{\cdot}7\times10^{-22}$) and the magneton ($18{\cdot}5\times10^{-22}$).

Mr. Chalmers said that he and Dr. Allen had already suggested a solution of certain of the difficulties mentioned by Prof. Weiss, and was inclined to be more sanguine than the latter with regard to future progress.

Dr. Fournier d'Albe asked Prof. Weiss to give the meeting some idea of the strength of fields employed. In view of the very far-reaching character of these investigations, it was desirable to know whether they could be carried further with the means available in England.

Prof. Weiss, in replying, said the known diamagnetism of the substances had already been carefully allowed for, and unless some new diamagnetic property existed, no further correction could be looked for in that direction. The fields employed were mostly of the order of 25,000 units, and though stronger fields had been attained by the use of pole-pieces of cobalt steel, most of the results could be satisfactorily obtained with moderately strong field.

The President conveyed the cordial thanks of the section to Prof. Weiss for his kindness in giving them that stimulating address, which he said formed a fitting climax and finish to the work of a very enjoyable and, he hoped, instructive meeting.

Radiotelegraphic Investigations.

The report of the Committee on Radiotelegraphy dwelt on the interruption of the work by the war after only three months, and the financial loss thus occasioned. Such statistics as were available showed that there appeared to be two kinds of "X-storm" occurring in the daytime: (1) Those produced by convective conditions within, perhaps, 100 miles of the station (local X-storms); and (2) those occurring at a distance. The general conclusion is that the observation of strays in the daytime constitutes a method of feeling the fringe of a region of convective weather, and so anticipating thunder and rain a day or two in advance.

SECTION G.

The proceedings in Section G to-day were concerned chiefly with electrical Papers. These our readers will find in another column or in our issue of next week. The chair was taken by Dr. Gisbert Kapp.

Prof. G. W. O. Howe read a Paper on "The Capacity of Aerials of the Umbrella Type," showing how the capacity of such aerials could be calculated. The Chairman having opened the discussion, Prof. Schuster said it had struck him that the theoretical values obtained by the author were always on one side of the observed values.

Prof. Howe, in reply, said that was so. The rule was that the biggest values of the capacity were always the nearest. He had been himself impressed by what was a remarkable degree of accuracy in these determinations.

A Paper was then read by Prof. E. W. Marchant on "Earth Resistance," in which he recommended the determination of earth resistance by measuring the specific resistance of a sample of the soil. In the discussion, Prof. Howe said it seemed to him that the distribution of the stream lines in the different cases would have to be more carefully considered. Mr. Frith remarked that the static values of the earth resistance could not be applied to high frequencies. Dr. Eccles preferred measurement by means of alternating current and telephone to a direct-current method for determining these resistances; while Prof. Kapp asked whether there would not be a "contact resistance," even with alternating currents.

Replying, Prof. Marchant said his primary aim had been to find some sort of relative standard. Resistances would have to be determined for different forms of plates and different wave-lengths. In any case, there was little difference on reversing the direction of the current.

In the afternoon the chair was taken by Dr. Hele-Shaw, and Prof. Miles Walker read a Paper on "Mutual Induction Between Masses." The object of the author was to see if a body which was given an accelerating motion of rotation caused any motion in a coaxial body near it. The Chairman expressed his satisfaction that Prof. Walker had had the courage to undertake an experiment yielding a probably negative result. He compared the work to that of Sir O. Lodge on ether drift, and to Faraday's numerous negative experiments.

Prof. Schuster said he had followed the account with much interest, and although there had not been, as in some other cases, any theoretical probability of a positive result, it was valuable to have the result, such as it was, on record.

Replying to the objection that a fixed wooden screen between the discs might "shield" one of the discs from the other, Prof. Walker said, if the analogy were complete, the wooden screen would represent an open circuit in electrical induction, which would have no perceptible screening effect.

OTHER SECTIONS.

In Section B (Chemistry), Dr. H. J. S. Sand exhibited a cadmium vapour arc lamp which he recommended for polarimetric and other purposes. It was, he said, comparable in general principle with the well-known mercury-vapour lamp. The lamp was constructed of quartz-glass, and the cadmium was freed from oxide and dissolved gas by a process of filtration while at the pump. It was hindered from adhering to the glass by the presence of a small amount of a loose powder (zirconia) in the lamp. The metal was melted by external heating before starting, and maintained itself in the molten condition by the heat of the current. Once started the lamp might be kept burning for an indefinite time.

In the same section, a discussion on Smoke Abatement called forth, among other contributions, a short Paper by Prof. Haldane Gee on the "Electric Precipitation of Smoke," including the work of Cottrell and Nesbit (*see* Electrician, p. 544, July 16, 1915). He exhibited at the Municipal School of Technology a model of an apparatus for electric precipitation, and also, together with Mr. Adamson, a new form of sky photometer, in which daylight, filtered through a film of gelatine, stained a suitable reddish colour, is compared with the light

from an electric pocket lamp, the readings being taken direct from a trigonometrical scale divided into three parts.

On Friday afternoon an interesting discussion took place in Section C (Geology) on the radioactive evidence concerning the age of the earth. Prof. Sollas, who presided, said the physicist, after being a "hard parent" like Lord Kelvin, had now given them an embarrassing wealth of years to draw upon. Among the physicists who took part were Sir E. Rutherford, Prof. Soddy and Prof. J. Joly.

CORRESPONDENCE.

THE FIELD LEAKAGE OF TURBO-ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am obliged to Mr. Clayton for pointing out the somewhat loose wording at the beginning of my article. The sentence he quotes should read: "The outside coil of each pole produces only leakage flux and no useful flux whatever, *in that part of the rotor on which it acts alone.*" This meaning is, of course, quite obvious on reading the article further, as Mr. Clayton admits indirectly in the later part of his letter.

I did not deal with the path of the lines of force very fully, because it has already been treated in Dr. Smith's Paper, but my object was to explain that the flux passing across the slots and wedges is *not* leakage flux, except in the case of the outermost teeth embraced by the winding, since it all passes into the stator, and is interlinked with the stator winding.

The flux-per-tooth method of calculation, which again I did not describe very fully, depends on the assumption that the flux does not pass across the slots. This will evidently make very little error at the parts where the densities are low, and results justify the asumption over the whole pole-pitch. The passage of the flux through the bottom of the slots where the density at the roots of the teeth is very high is, of course, taken into account in the usual way in calculating the AT/cm. On this assumption, then, my approximation is based, when I say that the outermost teeth embraced by the winding carry only leakage flux. Actually these teeth will carry useful flux which passes across from the adjacent teeth through the slots and wedges, and this accounts for the oscillograms of the E.M.F. induced in a single conductor having regular steps. The outside coil, where it acts alone, will still only produce leakage flux and therefore should be omitted in calculating the E.M.F. poduced.

The error obtained by not omitting the outside coil in the calculation is quite considerable. Dr. Smith obtained a mean density of 3,950 without taking this assumption into account, while my corresponding figure is 3,700, a difference of 7 per cent.

The justification of the assumption lies in the agreement of calculation with test results for a large variety of machines.—I am, &c.,

Birmingham, Sept. 10. ROBT. G. JAKEMAN.

THE LAWS OF INDUCTION."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As one of those who seven years ago discussed Mr. Hering's so-called "new experiments," I feel that the letter in your current issue ought not to remain without comment.

Mr. Hering refers to some "amusing elements in the discussion." To my mind the element which, were it not so sad, would be extremely amusing is the nature of these experiments of Mr. Hering. A rectangular plate of copper is fixed between the poles of a ring-shaped magnet. The magnet and plate are mounted rigidly, contacts are moved about opposite edges of the plate to the terminals of a galvanometer. Mr. Hering reports to various learned societies that the galvanometer gives no deflection! Apparently it did not occur to Mr. Hering to think what a deflection would have been if the galvanometer *had* given a deflection. Energy would have been created. The energy actuating the galvanometer would have resulted from the moving of two current-carrying wires against no force (for there was no magnetic flux in the region of the brushes).

Anyone with first-year knowledge of electrical principles would have told Mr. Hering just what result such an experiment would give. It is worse than waste of time to make such experiments, and past understanding how they can be supposed to add in any way to our knowledge.

I trust I am right in saying that to the average engineer any attempt to show disagreement between the "looping" and the "cutting" rules of induction must by the very nature of the case be a mere quibble.—I am, &c.,

London, Sept. 8. F. M. DENTON.

THE DIRECTION FINDER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read the article published by Dr. Bellini in the issue of THE ELECTRICIAN, dated August 27, 1915. The apparatus described in this article as an invention of Bellini and Tosi is covered by the Italian patents by Artom, Nos. 88,765 and 88,766 of April 11, 1907.

Now, in a recent action, Artom v. Bellini, Agnelli and Scarfiotti, with the intervention also of Mr. Tosi, tried before the Court of Appeal of Turin (July 18-24, 1914), it was decided (and the judgment confined by the Supreme Court of Cassation of Turin on June 25, 1915) that the said inventions have been acknowledged also by Dr. Bellini, according to a declaration signed on April 5, 1912, before the Public Notary Rolando, as belonging to my inventive skill.

Please, therefore, publish the aforesaid so as to defend my rights and establish the truth.—I am, &c.,

Turin, Sept. 8. ALESSANDRO ARTOM.

LEGAL INTELLIGENCE.

Rate in Aid of Electricity Works.

An appeal heard by his Honour County Court Judge Law Smith, at Limerick Quarter Sessions, against the striking of the improvement rate by the Corporation is of some importance.

Mr. D. T. SHERLOCK, for appellants, said the appeal was against the rates being utilised for the purpose of meeting the deficit on the working of the electric lighting concern. The grounds of appeal were that, under their provisional electric lighting order the Corporation had power to charge up to 8d. per unit for current, and until that figure was reached the order did not contemplate that any charge should be made on the rates. In that case there was no necessity, and the result was that the Corporation had to come to the rates to make good the deficit.

His HONOUR: They are not charging the maximum price allowed by the provisional order?

Mr. SHERLOCK replied in the negative, and stated that it was not fair to ask the general body of the ratepayers who were not electric light consumers to pay for those that were. There were some 7,000 ratepayers and only 267 consumers of electricity. The present charge for current was 5d. per unit, with discounts varying from 25 to 5 per cent., whereas under the statute they were entitled to go up to 8d. before they could call on the rates to make up the loss on working, which for the last financial year was £1,576.

Mr. MICHAEL O'BRIEN stated that the sum borrowed for the electric supply undertaking was £34,500, and the loss on the working to date was £15,700, which had to come out of the rates. When the department was created he believed the staff only consisted four, whereas the number employed now was about 20, and the wages bill reached £25 a week. He attributed the loss on working to the management pure and simple.

In cross-examination, he said what he wanted was to have a price fixed which would make the concern pay. He could not say from what he knew now that the vast majority of the consumers of the Corporation did not take the trouble to ascertain in what condition the department was—they did not take the trouble to inquire.

In reply to his Honour he said that if 6d. per unit on the present consumption would be 6000 more to pay.

Mr. SHERLOCK: And if the price was reduced by 2d. the department would be able to pay it very well.

The ANSWER: If the price was reduced to 6d. and the discount reduced to 10 per cent. it would pay.

Mr. L. B. LINDSAY, barrister-at-law, produced the Board of Trade returns for electric supply undertakings for various towns in the United Kingdom. The scale of charges in Limerick was fixed by the Electricity Committee, and in the United Kingdom in which cheap light and power was given the average price per

unit was 4½d. Where profits were made in the working of the electric light concerns of 172 towns in Great Britain the average price per unit was 3½d. The consumption in the winter was 410,000 units.

In reply to Mr. SHERLOCK, Witness said he was confident of making the concern pay without increasing the price of current. The method he was adopting justified that hope.

His HONOUR: How can you when there was a loss of £1,500 last year?

WITNESS asserted that he could, and added that if the price of current was raised it would mean a falling off in the number of consumers. It would not be expedient to increase the figure at the present juncture.

Mr. E. O'TOOLE, city treasurer, supplied statistics as to the working of the concern for the past three years. For 1911 the loss was £2,000 and last year it was £1,500. For the current year the estimated deficit was £900, and, assuming that the capital belonged to the Corporation, the department would give a return of something over 2 per cent.

Mr. WM. M. NOLAN, J.P., town clerk, produced the minutes of the Committee meeting at which the price of current was fixed. An amendment moved by Mr. O'Brien to raise the figure to 6d. with a discount of 10 per cent. was defeated.

The mayor (Ald. P. O'DONOVAN) said he did not consider it at all advisable at the present time to increase the price of electric current, in view of the statement by the engineer, who was a very capable man. With the method employed by Mr. Thornhill he was certain the price would pay in a short time. This year's deficit was estimated at between £700 and £800.

His HONOUR, in giving judgment, thought Mr. O'Brien had discharged a very useful duty in bringing the matter forward. He agreed with the contention of Mr. Sherlock that the Electric Lighting Committee were not entitled to create an artificial deficit, as had been done in that case. He held that the Corporation had outstepped the limits of the statute when they placed an extra rate of 5d. on the ratepayers to make good the deficit on the working of the electric light department, and therefore he would quash the rate so far as it applied to that additional sum, and he gave appellant his costs.

Electricity Works Valuation.

At the annual Valuation Appeal Court for the burgh of Hawick on Monday the Urban Electric Supply Co. appealed against the assessor's valuation of their works at £2,420, and proposed that it should be returned at £1,180, the amount last year having been £1,700.

Mr. EDGAR HOWARD COLLINS, rating surveyor, said he had made a valuation of the electricity works and had prepared a statement of account on a revenue basis. He took the gross receipts at £11,632, from which he made deductions of expenditure for £4,993, making the mean receipts £6,639. From this he deducted 15 per cent. on tenants' capital of £27,909 for interest and repairs and renewals, viz., £5,686, leaving £953, and from this he deducted 20 per cent. for tenants' profits (£190), leaving for valuation purposes £763. Making up the tenants' capital, he allowed £868 for four months' extra stock of coal, which he considered essential in view of labour troubles and transport difficulties. He thought that certain machinery excluded by the assessor should be included in tenants' capital. He did not consider that 15 per cent. was too much to allow for interest on tenants' capital, repairs and renewals.

For respondent, Mr. WILLIAM PARK, said he arrived at the valuation of the works, which were owned and occupied by the same party on a revenue basis. He allowed 12½ per cent. as interest on tenants' capital, repairs and renewals, which was the amount laid down in the Arbroath case. There was no expenditure in the current accounts for extra stock of coal, and he considered that was covered by the five months' working expenses allowed. The machinery in dispute he considered as heritable.

Mr. JAMES THOMSON, C.E., said he had examined the Hawick works and had gone into the accounts, and he brought out the assessable rental at £2,503, which was more than the sum at which the assessor put it.

At the close of the hearing the valuation was fixed at £2,300. The agent for appellants intimated an appeal to the Court of Session.

EDUCATIONAL NOTES.

University of London, King's College.—The faculty of engineering provides complete courses of study extending over either three or four years in civil, mechanical and electrical engineering, for the engineering degree of the University of London and for the diploma and certificate of the College. The four years' course provides, in addition to academic training, opportunity for practical training in works. The next term begins on Wednesday, Oct. 6, and full particulars may be obtained from the Dean of the Faculty, King's College, Strand, W.C.

University of Edinburgh.—The University provides courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. in engineering and extending over three years. The next session will open on Oct. 17. Applications for entrance bursaries is held this month. Full particulars from the Matriculation Office.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At the College there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

University of Aberdeen.—Mr. Wm. Jackson, engineer of Aberdeen, who died in June last, left personal estate of the value of £77,052, and after leaving legacies of about £2,500 he bequeathed one-half of the residue of his property for the establishment of a Chair of Engineering in the University of Aberdeen.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses, giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

Heriot Watt College, Edinburgh.—This college provides theoretical and practical training for mechanical, electrical and mining engineers, chemists, &c. The diploma course in engineering lasts for three years, and arrangements exist for shortened apprenticeships with local mechanical and electrical engineering firms. The course in mining extends over three years, and is recognised by the Home Office as equivalent to two of the five years' underground training required of candidates for the colliery manager's certificate. The training in mining is also recognised by the University of London for the purposes of the B.Sc. (Lond.) degree in mining. There are complete courses of instruction, extending over four years, for those who are studying for the fellowship of the Institute of Chemistry. An entrance bursary of £25 per annum is offered for competition on Sept. 20. Particulars of courses, fees, &c., from the clerk (Mr. R. Macnaughton, S.S.C.), Heriot Trust Office, Edinburgh.

Royal Technical College, Glasgow.—The day courses commence on 28th inst. and the evening classes on 23rd inst.

The diploma of the College is granted in civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, &c. The diploma course extends over three or four sessions, and the College is affiliated to the University of Glasgow, the degrees of the University in engineering and applied chemistry being open to its students. There are also full courses of instruction in the schools of navigation and wireless telegraphy. The calendar, price 1s. (post free 1s. 4d.), and prospectus (free) may be obtained from the Director.

Northampton Polytechnic Institute.—The session 1915-16 will commence on October 4 next. In the engineering day college there are full-day courses in the theory and practice of civil, mechanical and electrical engineering.

The courses in civil and mechanical engineering include specialisation in automobile and aeronautical engineering, and those in electrical engineering include specialisation in radio-telegraphy. These courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. Eng. at the University of London. The entrance examination will take place on Sept. 28 and 29.

In technical optics there are full and part-time courses in all branches, and instruction is given in specially equipped laboratories and lecture rooms. Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to the principal, Dr. R. Mullineux Walmsley, St. John-street, London, E.C.

South-Western Polytechnic (London).—This Polytechnic will re-open on Sept. 27 for day and evening classes. The engineering courses include lectures in electrical and mechanical engineering, physics, chemistry and mathematics and practical instruction in the fully-equipped laboratories of the Institute. There is a three years' day course, leading to a diploma or university degree, in electrical engineering; also a four years' evening course for electrical engineering and wiremen's examinations of the City and Guilds Institute.

Students are prepared by recognised teachers of the University of London for the B.Sc. degree in engineering of the university, for the examination for admission to the various engineering societies and the examination of the City and Guilds of London Institute. The evening courses include, in addition to the engineering courses as above, classes in electrical wiring, building construction, and other trade subjects. In the electrical wiring department an advanced course has been arranged for the preparation of candidates for the final wiremen's examination of the City and Guilds of London Institute. The laboratories and workshops of the Institute may be inspected by intending students. Prospectus may be obtained from the secretary, Manresa-road, Chelsea, S.W.

Doncaster Technical College.—This new technical college, which has been erected at a cost of about £13,000 was opened by the Mayor of Doncaster last week.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

[illegible] Members Members Edits & Pay's Chemical [illegible]

[illegible] at the Patent Office the former is given in brackets after the title.

1914 Specifications.

[illegible] & Members [illegible]

A relay arrangement for alternating currents, particularly suitable for wireless telegraphy and telephony, having an electric relay operating by means of an ionised gas path in which the current strengthened by the relay is led with unchanged frequency directly or indirectly to the primary circuit of the relay again, so that the whole of this current or a part thereof repeatedly passes through the relay and is thus further strengthened.

12.277 Sykes & Ford. Apparatus for electric signalling and for controlling the current in electric circuits, especially applicable to wireless telegraphy. (Cognate application, 24,259/14).

18.464 Landis & Gyr (S.A.). Prepayment electricity meters. (9/8/13.)

18.660 Harry W. Cox & Co. & Donnithorne. Electro-medical apparatus.

18.737 Mortley. Dynamo-battery electric systems.

18.780 Green & Landon. Electric visual and audible signalling appliances, more particularly for use in mines. (Cognate application, 4,253/15.)

18.872 Van Haersma Buma. Electric mercury switches.

18,887 Creedy. Variable pole dynamo-electric and like machines.

18,924 Parsons. Rotors suitable for high surface speeds.

18,954 Gardner. Electromagnetic circuit controlling devices for railway signalling and other purposes. (Cognate applications, 20,006/14 and 24,787/14.)

19,057 British Thomson-Houston Co. (General Electric Co.) Speed-controlling devices for electric motors

Speed controlling mechanism for a direct-current motor, comprising a regulator of the "Tirrill" type adapted to intermittently short-circuit a resistance in the shunt field circuit, said regulator being controlled by a current proportional to the armature current and a current proportional to the motor speed.

19,737 Lines, Longford, Longford & Clark. Sparking plugs for internal-combustion engines and the manufacture of the same.

19,794 British Thomson-Houston Co. (General Electric Co.) Electromagnetic switches.

19,818 Walker. Electrically-driven clocks.

19,849 Ges. fur Electro-Osmose. Treatment of materials for impregnating them electro-osmotically. (19/9/13.)

20,786 Arno. Methods and apparatus for the determination of the complex energy delivered by alternating currents. (Addition to 9,580/10.)

20,959 Wilson & Wright. High-tension windings for electrical apparatus.

21,189 Ges. fur Elektro-Osmose. Method of influencing the electrical charge of a diaphragm for processes depending on electro-osmosis. (6/11/13.)

21,389 British Thomson-Houston Co. (General Electric Co.) X-ray devices.

A method of preventing over-heating of the focal spot in an X-ray tube, which consists in causing the cathode rays to automatically renew the target surface during the operation of the tube.

21,798 Bennett & Jeffcoat. Electric incandescent lampholders.

23,283 Be[illegible]n & Chas. MacIntosh & Co. Telephone receivers.

1915 Specifications.

5,591 Benitez. System for the generation of electric currents. (Addition to 17,811/14.)

5,717 Tucker & Crabtree. Electric switches. (Divided application on 21,175/14, Oct. 19.)

7,088 Midgley & Vandervell. Electric diaphragm horns.

7,091 Svenska Turbinfabriks Aktieboiaget Ljungstrom. Motor regulating resistances. (31/8/14.)

8,312 Claude. Neon tubes. (16/7/14.)

An electric lamp comprising a neon tube of any desired shape, and a neon and mercury tube of same shape and diameter, but of double the length (or two neon and mercury tubes of the same length), mounted in series in the same high-pressure circuit.

8,332 Midgley & Vandervell. Holders for electric incandescent lamps.

9,477 Frankfurter Maschinenbau Akt.-Ges. vorm. Pokorny & Wittekind. Means for cooling electrically-operated tools. (30/6/14.)

APPLICATIONS FOR PATENTS

*Note.—The undermentioned Applications to which the word "open" is applied will be open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

August 9, 1915.

11,454 Thompson. Actuating signals on and communicating with trains. (Addition to 18,443/14.)

11,457 Hochstadter. Electricity distributing networks.*

11,473 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors.

11,480 Bosch. Band resistance for use with electric pedal switches. (Divided application on 2,236/15. 29/7/14, Germany.)*

11,510 U.S. Light & Heat Corpn. Dynamo-electric machines. (14/8/14, U.S.)*

11,512 Kretz. Electric connections for electrically-heated irons and like utensils.

August 10, 1915.

11,544 B.T.-H. Co. (G.E. Co., U.S.) Manufacture of incandescent electric lamps.

11,553 Quain. Electrically operating alarms and signals.

11,555 Vreeland. Production of undamped or sustained electrical oscillations.*

11,560 Naylor & Naylorgraph Limited. Apparatus for displaying advertisements, signs, notices, outline moving pictures, or the like, or for communicating messages or signalling both during light and darkness.*

[illegible] magnetic ignition. (16/9/14, France.)*

11,568 Schaanning & Harlow. Electrical transformers.

August 11, 1915.

11,598 Raven. Electrical transmission gears.

11,600 Relay Automatic Telephone Co., Ward, Bryant & Inman. Automatic telephone systems.

[illegible]

August 12, 1915.

11,655 Relay Automatic Telephone Co. & Aitken. Telephone systems.

11,658 B.T.-H. Co. (G.E. Co., U.S.) Pneumatically-operated controllers.

[illegible]

[illegible]

August 13, 1915.

[illegible]

11,723 Cuth. Lamp-holders for electric lamps. (21/1/15, U.S.)*

August 14, 1915.

11,768 B.T.-H. Co. (G.E. Co., U.S.) Systems of control for electric motors.

[illegible]

August 16, 1915.

11,790 Lancashire Dynamo & Motor Co., Whitmore & Roberts. Short-circuiting and brush lifting gear for alternating-current motors.

11,794 Lytton. Magnetic and mariners' compasses and the like.

11,798 Prentice & M'Kechnie. Cut-out [illegible] holding roses, cut-outs, connectors, rosettes and like electrical fittings.

11,818 Mellersh-Jackson. (American Smelting & Refining Co., U.S.) Electrolytic refining of tin.*

11,821 Marconi's Wireless Telegraph Co. & T[illegible] Transmitters for wireless telephony.

August 17, 1915.

11,837 Holly & Drucquer. Electric or gas light fittings.

August 18, 1915.

11,910 Earl. Accumulator cell boxes for train lighting and other purposes.

11,935 Neuland. Dynamo-electric machine.*

11,938 Lucas & Breeden. Electric distributing systems for motor road vehicles.

August 19, 1915.

11,961 Wall. Generating high-frequency electric currents.

11,974 Rhodes & Firth. Controlling dynamo-electric machines or the like.

11,976 Liddle. (Universal High-power Telephone Co., U.S.) Sound-transmitting means.*

11,981 Reed-Lethbridge. Electrical flasher.*

12,000 Marks. (Motor Ignition & Devices Co., U.S.) Electric supply systems.*

August 20, 1915.

12,013 Stuart. Railway signalling apparatus.*

12,039 Mackenzie. (Otto G. H. E. Kehrhahn, U.S.) Electric signalling apparatus.

August 21, 1915.

12,055 Happe. Sparking-plug for internal-combustion engines.

12,075 Vandervell. Sealing means, more particularly for use in connection with accumulator cases.

August 23, 1915.

12,100 Pike. Traction trolley wheels.*

12,103 Frampton. Localisation of faults on electric cable networks.

12,119 Watkins. Sparking-plugs for internal-combustion engines.

12,120 Watkins. Connectors for electrical conductors.

12,133 Palmer & Ferranti. Electrical instruments.*

12,143 Graham. Electrical switchgear.*

12,153 Fargo. Connector for the adjacent portions of two or more wires, cables, or the like.*

12,151 Fargo. Connector or coupling for the adjacent end portions of two or more wires, cables, or other members.*

August 24, 1915.

12,184 B.T.-H. Co. (G.E. Co., U.S.) Vapour electric devices.

12,193 Woodhouse. Insulators for electrical resistances and conductors.

12,201 Morse & Indo-European Telegraph Co. Electric alarm or calling devices used in telegraph receiving apparatus and more particularly in wireless receiving apparatus.

August 25, 1915.

12,232 Hutchison & Hutchison. Electric switches.

12,240 Crosbee & Sons & Spicer. Sparking-plugs and the manufacture of the same.

12,246 B.T.-H. Co. (G.E. Co., U.S.) Systems of electrical distribution. (Addition to 4,133/14.)

12,252 Gauntlett. Electrolytic processes and apparatus.

12,253 Oldham. Secondary galvanic batteries.

12,256 Aernout, Lynden & Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Thermic telephones and like instruments.

12,267 Renault. Controller and circuit making and breaking device having a closed field. (Addition to 24,121/14. 26/8/14, France.)*

August 26, 1915.

12,276 Bullers (Ltd.) & Dagnall. Attachment of insulator-carrying arms to telegraph and like poles.

12,282 Jameson. Appliance for cataphoresis and anaphoresis by fixed electrode.

12,299 B.T.-H. Co. (G.E. Co., U.S.) Electric cable couplers.

12,301 Gabet. Electromagnetic clutches. (27/8/14, France.)*

12,309 Ross. Electric switch apparatus.

12,314 Palmer, Denham & Ferranti. Electrical instruments.

12,318 Nobbs & Nobbs. Electric heating and cooking apparatus.

August 27, 1915.

12,340 British Westinghouse Electric & Mfg. Co. Electrical control systems. (25/9/14, U.S.)*

12,343 Govan. Apparatus and method for electric telegraphy.

12,351 Minchin. Automatic electrical signalling on railways.

12,354 Esnault-Pelterie. System of utilising the energy of tides. (25/5/15, France.)*

12,355 Esnault-Pelterie. System of utilising the energy of tides.*

12,361 B.T.-H. Co. (G.E. Co., U.S.) Systems of electric ship propulsion.

August 28, 1915.

12,377 Trautmann. Flash lamps.

12,379 Wilkinson. Electrically-operated mercury switches.

12,383 O'Toole. Means for transmitting and/or receiving signals and the like.

12,402 Electric & Ordnance Accessories Co. & Langrish. Electric-motor controllers.

12,404 Datzevitch. Telephone systems.*

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from The Electrician Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Standard Handbook for Electrical Engineers." By F. F. Fowle. (London: Hill Publishing Co.) Pp. xxi. + 1,984. 21s. net.

"On the Relation of Imports to Exports." By J. Taylor Peddie. (London: Longmans, Green & Co.) Pp. v. + 88. 2s. 6d. net.

"Journal of the Franklin Institute. Edited by R. B. Owens. Philadelphia: The Franklin Institute.) Vol. CLXXX., No. 3. 50 cents.

"Interference Measurements of Wave Lengths in the Iron Spectrum (2,851.3,704). By K. Burns. (Washington: Government Printing Office.) No. 251. Pp. 27. 25 cents.

"Testing of Rubber Goods." (Washington: Government Printing Office.) No. 38. Pp. 89. 15 cents.

"Specific Heat and Heat of Fusion of Ice." By H. C. Dickinson and N. S. Osborne. (Washington: Government Printing Office.) No. 248. Pp. 32. 10 cents.

"Proceedings" of the American Institute of Electrical Engineers. (New York: American Institute of Electrical Engineers.) Vol. XXXIV., No. 9. 8[illegible]

"The Physical Review." (Lancaster, Pa.: The American Physical Society.) Vol. VI., No. 3. $0.60.

American Journal of Science. Edited by E. S. Dana. (New Haven: Tuttle, Morehouse & Taylor Co.) Vol. XL., No. 237. $6 per year.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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ENEMY TRADING METHODS.

Such information as is allowed to filter through with the censored paragraphs, misnamed "war news," contains from time to time references to the activities of the manufacturing interests of the Central Empires in branding their products with neutral names, or with proclaiming their source as factories in neutral countries. The virility with which these methods appear to be pursued, at a time at which we are led to believe that the enemy is at his last gasp for materials of vital consequence to the carrying on of the fight, is indicative of the measure of organisation with which he has pursued his course throughout this mighty upheaval. It may be also taken as reflecting the means which he is intending to adopt, and will not scruple to apply vigorously, as the war begins to assume a more favourable aspect for the Allies. As a matter of fact, German commercial methods do not appear at present to be likely to be deprived of their force whichever way the result of the conflict may turn.

In our last issue we published a letter from Mr. R. Steylaers, in which he pointed out that when the Italians entered the war German lamps were almost entirely prevented from entering Spain. Nothing daunted, the Germans set to work to establish factories in Switzerland (or bogus factories), whence the German lamps emanated, and were imported into Spain after passing through France as Swiss goods. This latter proceeding is a reflection upon the Commercial acumen of one of our Allies, or it may be that the French agents in question are suffering from a lack of patriotism. Whatever the cause, the very fact that such avenues are open to enemy trade suggests the need for definite and concerted action on the part of the manufacturing and commercial houses of the Allies in the West. We believe that certain steps are being taken in this country to ensure a predominance for British trade in markets which the Germans have hitherto almost exclusively enjoyed. The interests of international trading are, however, so many and various, and the interchange of commodities as between one nation and another is so little a matter of intense patriotism, that certain keen observers of the situation have frankly admitted that the outlook is confusing and baffling in the extreme. This opinion need not put any check upon the work of organising the trade and commercial forces of the Allies. We think that such organisation has a greater chance of success if it is dissociated from any feelings which are intensified by race hatred or by emotions arising out of German disregard of international pledges and also out of German atrocities and methods of frightfulness. It is natural that such emotions should be uppermost in the breasts of men who claim membership in civilised communities, but there is a danger that the sway which they may exercise will be an assistance rather than a hindrance to the enemy.

We should like to see some attempt made to bring Italian, French and British trading interests together at an early date in order to agree, if possible, upon some simple yet effective method of checking the attempts which Germany is undoubtedly making to flood the markets of the world with her pent-up products at the Peace. In the year 1906 a social international entente was organised by the Institution of Electrical Engineers. Since that date the Continental countries which participated, of course excluding Germany, have drawn into closer touch with British commercial affairs, and this fact should be helpful in bringing about such a meeting as we have in mind.

Proposal to Dam the Niagara Gorge.—According to the "Electrical World," a plan to develop 2,000,000 H.P. by damming the lower Niagara River just above Queenston, Ontario, and Lewiston, N.Y., has been presented to the New York State authorities. The proposal calls for the expenditure of £20,000,000. It is proposed to construct a dam about 90 ft. high, which, while it would wipe out the famous whirlpool rapids, would not interfere with present developments near the cataract. The drop of the river from the falls to Lewiston is 100 ft., and the proposed dam would back up the water to within a mile of the falls. It is claimed that the creation of a new falls at Queenston will compensate for the loss of the rapids. About 1,000,000 H.P. will be available to New York State and a like amount to the Province of Ontario. It is suggested that by imposing a tax of £1 per horse-power developed a maximum of £1,000,000 would be derived yearly by each Government.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Sept. 6, 1915, *to* Sept. 11, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible] pkgs.

[illegible] telephone materials, £409; elec. lamps, £430; insulated cable, 47 pkgs.; elec. bulbs, 278 pkgs.; elec. trucks, 7 pkgs.; unenumerated, £631—82 pkgs. *Switzerland:* Elec. machinery, £389; unenumerated, £126. *Holland:* Elec. lamps, £2,201—565 pkgs.; elec. machinery, £47; unenumerated, £408. *France:* Carbon candles, £566; elec. lamps, [illegible] machinery, £76. *Spain:* Unenumerated, £274.

MANCHESTER.—*U.S.A.:* Carbon electrodes, 45 pkgs.

EXPORTS.

[illegible] Elec. machinery, £545; wire and cable, £43; unenumerated, £1,220. *Sydney:* Elec. machinery, £154; wire and cable, £76; unenumerated, £853. *Wellington:* Elec. machinery, [illegible] unenumerated, £800. *Brisbane:* Elec. machinery, £35; unenumerated, £86. *Christchurch:* Elec. machinery, £2,972; unenumerated, £885. *Perth:* Unenumerated, £194. *Dunedin:* Unenumerated, £55. *Hobart:* Elec. machinery, £49. *Lyttleton:* Unenumerated, £71. *Adelaide:* Elec. machinery, £55; unenumerated, £220. *Fremantle:* Unenumerated, £240. *Belawain:* Unenumerated, £55. *Nelson:* Unenumerated, £24. *Wanganui:* Elec. machinery, £254. *Otago:* Unenumerated, £39. *Secoondee:* Elec. machinery, £12; unenumerated, £54.

AFRICA.—*Durban:* Wire and cable, £295; unenumerated, £587. *Port Elizabeth:* Wire and cable, £465; unenumerated, £117. *Cape Town:* Elec. machinery, £99; wire and cable, £93; telegraph material, £713; unenumerated, £177. *East London:* Elec. machinery, 159; unenumerated, £178. *Zanzibar:* Unenumerated, £290. *Mossel Bay:* Wire and cable, £44. *Chinde:* Unenumerated, £25.

EGYPT.—*Port Sudan:* Unenumerated, £49. *Alexandria:* Unenumerated, £175. *Port Said:* Wire and cable, £159; unenumerated, £200. *Suez:* Unenumerated, £6. *Port Sambo:* Wire and cable, £14; unenumerated, £14.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £3,035; unenumerated, £2,270. *Rio de Janeiro:* Unenumerated, £359. *Batavia:* Elec. machinery, £77; unenumerated, £169. *Callao:* Unenumerated, £69. *Monte Video:* Elec. machinery, £71. *Pernambuco:* Unenumerated, £163. *Vera Cruz:* Unenumerated, £116. *Calara:* Unenumerated, £37. *Rio Grande do Sul:* Unenumerated, £99.

JAPAN.—*Osaka:* Unenumerated, £16.

U.S.A.—*New York:* Unenumerated, £28.

CANADA.—*Montreal:* Elec. machinery, £95; unenumerated, £278. *Toronto:* Unenumerated, £33. *Vancouver:* Unenumerated, £58.

[illegible] SETTLEMENTS. *Bombay:* [illegible] £2,197; elec. machinery, £229; unenumerated, £1,225. *Calcutta:* Wire and cable, £50; elec. machinery, £422; unenumerated, £1,173. *Madras:* Wire and cable, 28; unenumerated, £13. *Ceylon:* Elec. machinery, £72; wire and cable, £401; unenumerated, £89. *Singapore:* Wire and cable, £401; telegraph material, £15; unenumerated, £98. *Penang:* Elec. machinery, £159; wire and cable, £20; unenumerated, £1. *Kilindini:* Elec. machinery, £40.

WEST INDIES.—*Barbados:* Unenumerated, £43. *Jamaica:* Unenumerated, £19.

FRANCE.—*Dieppe:* Unenumerated, £53. *Paris:* Elec. machinery, £298; unenumerated, £69. *Preport:* Unenumerated, £463. *Gravelines:* Telegraph material, £2,698

MALTA.—Unenumerated, £130.

SPAIN.—*Cartagena:* Wire and cable, £55. *San Sebastin:* Unenumerated, £79. *Seville:* Unenumerated, £14.

ITALY.—*Genoa:* Unenumerated, £2,740. *Leghorn:* Unenumerated, £104.

JAVA.—*Buitzwanti:* Unenumerated, £20. *Sourabaya:* Unenumerated, £22. *Samarang:* Unenumerated, £84.

SWEDEN—*Gothenburgh:* Elec. machinery, £17.

HOLLAND.—*Amsterdam:* Unenumerated, £882. *Rotterdam:* Unenumerated, £84.

RUSSIA.—*Archangel:* Unenumerated, £1,999. *Petrograd:* Unenumerated, £349

GIBRALTAR.—Elec. machinery, £22.

FOREIGN GOODS (duty paid and free).

Sydney: Unenumerated, £17. *Wellington:* Elec. glow lamps, 1,425 (No.). *Genoa:* [illegible] *Amsterdam:* [illegible] £1,277. *Boulogne:* Unenumerated, £166. *Buenos Ayres:* Unenumerated, £238. *New York:* Unenumerated, £260. *Petrograd:* Unenumerated, £38. *Port Elizabeth:* Unenumerated, £31. *Singapore:* Unenumerated, £131. *Zanzibar:* Unenumerated, £55. *Paris:* Unenumerated, £230. *Rio de Janeiro:* Unenumerated, £13. *Rotterdam:* Unenumerated, £21. *San Sebastin:* Unenumerated, £431.

IN TRANSIT.

[illegible] £30

NOTE.—The large number of items in these official returns under the [illegible] headings "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Plant Wanted. [illegible]

[illegible] Power Development. [illegible]

Sale by Auction. [illegible] War, at 11 a.m., unserviceable and obsolete stores, including iron and steel scrap, cupro-nickel and lead-bullets and bullet envelopes, white metal, zinc, electric cable, car bodies, steam lorry, rubber tyres, canvas, rubber, paper, rope, felt, leather, harness, &c. The lots may be viewed on the Monday, Tuesday and Wednesday previous to and on morning of sale. Catalogues from Armament-buildings, Whitehall-place, S.W.; Imperial House, Tothill-street, S.W.; Ordnance Office, Tower; and Ordnance Office, Royal Arsenal, Woolwich. *Further particulars are given in the advertisement.*

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination of Herbert Page, electrical engineer, 63, Queen Victoria-street, London, E.C., took place last week. Statement of affairs showed liabilities £2,157, and net assets £90.

The discharge of Vernon Geo. Cobb, electrical engineer, trading with Wm. Longdon as Longdon & Cobb, 101A, Derby-road, Nottingham, is suspended for two years and six months, ending Feb. 19, 1918.

A receiving order has been made against John Taylor Peddie, mechanical engineer, Exhibition-buildings, Aldwych Site, London, W.C. The first meeting of creditors will take place on Sept. 22, and the public examination on Oct. 22, both at Bankruptcy-buildings, London, W.C.

Claims against the Spiral Regulating Dynamo Co., Ltd. (in liq.), are to be sent by Sept. 30 to Mr. H. C. Bound, 61 and 62, Lincoln's Inn Fields, London, W.C. A meeting to receive an account of the winding up of the Spiral Regulating Dynamo Co. (Ltd.) will be held at the offices of Messrs. Chantrey, Chantrey & Co., 61 and 62, Lincoln's Inn Fields, London, W.C., on Oct. 11.

ELECTRICITY SUPPLY.

EXTENSIONS.

Halifax.—The L.C. Board have sanctioned a loan of £20,000 for the purchase of a new turbo-generator and other plant at the electricity generating station. There is a great demand for power by manufacturers of munitions.

Wallasey.—At a special meeting of the Council on Monday it was decided to authorise the Electricity Committee to sanction the expenditure of a further £9,000 for the extension of the electricity undertaking.

Mr. W. J. BELLIS, chairman of the Electricity Committee, said that when the new additions were completed they would have an adequate supply of energy for all purposes and their electrical supply would be well assured for the future.

Walsall.—As the new station and plant will not be in operation this year the Electricity Committee has decided to postpone work on the e.h.t. change over, and concentrate the staff upon the laying of a third wire to 105 volt mains and the balancing up of 105 volt consumers on the three-wire system. An extension of mains estimated to cost £180 has been approved.

Worcester.—The Council have sanctioned an expenditure of £250 on the extension of the electric cables to the Severn Bank tannery.

GENERAL

Barnet.—The North Metropolitan Electrical Power Distribution Co. has allowed the Council an abatement of £39 in respect of diminished public lighting during the June quarter.

Bolton.—The Electricity Committee has arranged with the L. & Y. Railway Co. for the construction of a coal siding from the railway to the new electricity works at Kearsley Brook.

Bristol.—In consequence of the resignation of the deputy city electrical engineer (Mr. A. E. Wilson), various alterations and promotions of the staff have been made.

The Electrical Committee has reported to the City Council that it is desirable, owing to the large increase in the business of the electric supply undertaking, to appoint a [illegible] engineer, whose duties will be chiefly to supervise the [illegible] with a view to further economy in steam raising, and recommend the appointment at a salary of £200 per annum.

Dublin.—At the meeting of the Corporation last week the Lighting Committee recommended amalgamation of the Committee with the Electricity Supply Committee, but the matter fell through, the necessary two thirds of the Council not being present.

Mr. COLE, chairman of the Committee, said the recommendation was brought forward on the ground of economy. The Citizens' Association

was anxious for economy, but when the matter came to a vote the members walked out of the Council Chamber.

Hove.—Last week the Council decided to increase the charges for electric current by 20 per cent.

Councillor PAYNE, chairman of the Lighting Committee, said that owing to the restricted lighting there had been a great decrease in consumption, and the cost of production, owing to coal, stores and other expenses being dearer, was very much up. The new charges would be for the period of the war.

Kilmarnock.—At the meeting of the Council last week Mr. Blackwood asked the convener of the Electric Committee for an assurance that consumers who were at present relying on electric current for power might depend on it, and that the connecting up of new consumers would not in any way be detrimental to them.

In reply, Mr. Jones said that they were arranging for the installation of a new generating set. The contractors promised that they would have it running by the end of September, but there had been further delay. The contractors told them that they would get a permit from the Admiralty and the War Office, and they got a letter from the War Office with a promise that it would be completed on Sept. 28. The best promise they could now get from the contractors was that delivery would be made at the end of October, but the manager led him to believe that it would take probably four weeks after that before the set was in running order. Although, after the outbreak of the war the demand on the department went down by 25 per cent., and they had made ample provision for all the contracts they had entered into to supply new consumers at the end of last year. But the demand had now become so abnormal by the different factories producing munitions, and they had been backed in their demands by the Admiralty, who had directly requested the Corporation to take them on, with the result that the day load at present had run up to somewhere about 1,400 kw. The Corporation was doing its duty in considering the demands of the Admiralty and the War Office, although indirectly, and meeting the demands of those who were making munitions. There were something like 14 firms producing munitions who were in a position to demand that the Corporation should do the best they could to keep their works running. Their engineer (Mr. Bexon) thought that if they should be face to face with any difficulty there might be a possibility of requiring to reduce the street lighting considerably, and there might also be a possibility of running the old sets as far as their steam power would admit, but all that they could promise to run satisfactorily was to put out about 2,000 kw. per day on the present load. It was an absolute necessity that the new set should be hastened on. They had considerable difficulty in the department owing to the abnormal conditions existing on account of the war, and he thought it was time that the Munitions Committee should take the department under control and give them a proper chance of keeping hold of their men, because after they had learned the work they went away where there were better facilities and higher wages, and they were left to take on new men.

Increase of Prices.—Swindon Council have decided to increase the price of electrical energy by 10 per cent. for public lighting and traction and by 12½ per cent. for private lighting.

Hove Corporation have sanctioned an increase of 20 per cent., and Motherwell and Bexhill Corporations an increase of 10 per cent. on their charges. At Eccles there has been an increase of 10 per cent. for lighting and of 20 per cent for power and heating, and at Yarmouth an increase of ½d. per unit.

Trowbridge.—The Council have decided to allow the Trowbridge Electric Supply Co. to erect overhead wires in the side streets and outlying districts, provided the poles used to carry such wires be approved by the Lighting Committee, but underground cables must be laid in the main streets. The streets in which overhead wires will be allowed will be settled at the next meeting of the Committee.

LIGHTING & POWER NOTES.

Ashstead.—At the meeting of the Parish Council last week, the chairman made an explanation as to the tender for street lighting.

He pointed out that the Gas Company [illegible] per lamp, whereas that of the Electric Lighting Company was £2 1s. 9d. per lamp. Under the present system they would save the roads being torn up, and, in addition, they had nine lamps which had been fitted for the electric light, and if they had new lanterns [illegible]. These were, therefore, saving £13 a year by accepting the Electric Lighting Company's tender.

Belturbet (Ireland).—The Urban Council have renewed their electric lighting contract for six months on the same terms as for the past three years.

Chesham.—Hitherto the street lighting has not been affected, but the Urban Council are now desirous of economising street lighting, and the Chesham Electric Light Co. will be asked to restrict the lighting.

Irish Hydro-Electric Scheme.—Brief particulars have been published of a scheme for the utilisation of the falls of Lough Erne at Belleek, and of the Shannon near Limerick in the generation of electrical energy.

It is proposed to apply for Parliamentary powers to supply electricity throughout a large portion of Ireland. Canals above the falls will carry the head water to fixed places lower down. Mr. Theo. Stevens is consulting engineer, and Mr. P. J. McAndrew, Sheen Lodge, Bundoran, superintending engineer, with Mr. Blayney Winslow as secretary of the promoting company. The necessary capital has been subscribed by the company, and men are engaged in mapping the route of the necessary canals, &c.

Library Lighting.—Weston-super-Mare Free Libraries Committee recently considered tenders from the local gas and electric lighting companies for lighting the ground floor of the Free Library, and recommended the adoption of electric light on account of "the improved atmospheric conditions which may be expected from its use and also from the point of view of preservation of the books."

The recommendation was duly adopted.

Lurgan.—There is considerable dissatisfaction with the present system of gas lighting, and the question of adopting electric lighting will be considered at the next meeting of the Urban Council.

Plymouth.—At the meeting of the Corporation on Monday Mr. Debnam complained that an engineering firm had laid down plant to make munitions, but the Electricity Committee had refused to supply them with power.

The chairman of the Committee (Mr. EYRE) explained that they had not refused to supply electricity. The Committee had left the matter in the hands of the engineer and himself, and they were negotiating for a three years' agreement. They had received a letter from the firm on the subject, and they were to consult about it that afternoon.

Several members expressed the opinion that the enterprise of firms desiring to make munitions should be facilitated as far as possible by the supply of electric power. Ultimately the matter was left in the hands of the chairman and engineer.

TRACTION NOTES.

Bristol.—On Tuesday the Council considered a report by the Tramways Option Committee on the purchase of the tramways.

There was a long discussion on the report, in the course of which it was stated that the Treasury would not consent to the raising of the necessary purchase money either by the issue of stock or otherwise, although the Board of Trade intimated that, so far as they were concerned, they could see no reason why they should not consent to the giving of the statutory notice required under Sec. 43 of the Tramways Act, 1870.

Ultimately the report and recommendation were adopted.

Burton-on-Trent.—The Local Government Board inquiry was held here last week into the application of the Corporation for a provisional order empowering them to run omnibuses and motor cars within the borough.

The town clerk (Mr. J. B. CHEAPMAN) explained that by the Corporation Act of 1901 they were permitted to run omnibuses and motor cars in connection with the Corporation tramways when the running of the latter was impracticable, and the local authority now desired to remove those restrictions. The Corporation had been approached from time to time as to the extension of the tramways along the Derby and Shobnall-roads, and they had been petitioned to run a service of motor 'buses to serve Shobnall-road district.

Mr. T. HALL, borough electrical engineer, said he favoured the electric 'bus. The capital expenditure on such a vehicle was about £1,200, compared with £6,000 per mile in the case of laying tramway tracks and providing a car. The accumulator 'bus would carry its own electricity, and there would be charging stations at the depots at the end of the tramway routes. The speed would be about 12 miles per hour, and about six up gradients of 1 in 10. The special features of the system were the economy, the very sound running and the general cleanliness and simplicity.

The inspector (Mr. R. C. MAXWELL): How long would the 'bus last?

Mr. HALL: 10 years. He added that in a certain town £500 was paid for petrol for one car annually, while the cost for electricity was £365. The present staff would be able to carry out the work.

Manchester.—A Board of Trade inquiry was held last week into the tramcar accident which occurred at the corner of Alexandra-road South and Wilbraham-road on the 23rd inst.

Mr. PERCY M. HEATH (deputy town clerk) said there was no loss of life and the most seriously injured passenger appeared to be Mr. Whittaker, a member of the Council. The driver (John Washington) had been driving the car for five weeks after receiving three weeks' training. The track was in perfect order. Owing to some 2,000 employés having joined the colours the Tramways Committee had to work under difficulties. The part of the road where the accident occurred was not illuminated as the Committee would desire, and seeing the illumination of the streets was not controlled by the Corporation he thought there was some excuse for the mistaken judgment.

The driver said that in the dark he was not at all confident as to where the compulsory stop was, and at night he identified it by the last request stop. On the night in question he had not been called upon to stop, and

that misled him. He caught sight of a light, and the next moment saw the curve. He at once applied the hand brakes but not the electric brake, hoping by that means to keep the car on the metals. He denied travelling at 14 or 15 miles an hour.

The conductor expressed the opinion that the car was travelling from 12 to 15 miles an hour.

The MANAGER (Mr. J. M. McElroy) said the lamp that had not been lighted before had since been lit. Drivers were allowed 16 miles an hour on that particular part of the route. He expressed the opinion that the accident would never have occurred if the lamp on the east side had been lit instead of the other one; it was a case of lighting the wrong one. There was no question of making up for lost time as the driver on the Alexandra-road clock was exactly to time.

Plymouth.—On Monday the Tramway Committee submitted a scheme for the temporary working of the tramways on the union of the Plymouth system with the Devonport and district undertaking, revising the service and fares in the Devonport area, &c.

The chairman (Mr. S. H. PHILLIPS), in moving confirmation of the report, mentioned that the tramway receipts in the Plymouth area showed an increase of about £120 per week, due almost entirely to the war. In regard to the Devonport tramways, he said they hoped at one time through running would be possible from the commencement, but owing to the war it was impossible to get the points and other things necessary to make the physical connections of the lines. Therefore they were obliged for the time to work the tramways as independent systems. They would, however, lose no time in getting the necessary arrangements made for through running. In their scheme the underlying principle on which they had acted was to make the fares in the Devonport area similar to those in the old Plymouth area. On the whole, the fares were slightly higher in Devonport than in Plymouth., but roughly they were practically equal. He gave details of the proposed changes in fares. It was proposed to abolish the ½d. fare between Drake-circus and the theatre; the general experience of tramways throughout the country was eloquently against ½d. fares. Referring to the proposal to increase the hours of inspectors to 60 per week, Mr. Phillips explained that the Committee had decided to adopt the conditions in Devonport, where the inspectors work longer hours and received higher wages than in Plymouth.

Mr. JOHNSON opposed a proposal to discontinue advertisements on the tramcars. He believed they got £600 a year from that source.

Mr. PHILLIPS explained that the new cars were so handsome that they thought it a pity to disfigure them with advertisements. It was estimated that the weight of the advertisements was practically equivalent to one passenger on all journeys. The cost of that was equal to £400 or £500 a year. The advertisements brought in £614 per annum, but the carrying of them considerably reduced that sum.

The minute was agreed to, but the proposal to abolish the ½d. fares as from Oct. 2 was lost.

Rochdale. The Treasury recently declined to sanction a loan for the extension of the tramcar depot.

The Tramways Committee approved of the postponement of the work after levelling certain brickwork and fixing roof girders over the front shops, but the Corporation have now decided to proceed with the work after consideration of a report from the tramways manager, Mr. G. Webster, which stated that it was urgently needed and that the shell of the building would suffer from depreciation if kept unfinished throughout the winter.

Women Tramcar Conductors.—Nottingham Tramways Committee have decided to employ women conductors. They will be paid at the full rate of pay hitherto in operation.

Birkenhead Corporation are also employing women conductors, but they are all wives of soldiers.

Southampton Corporation are also to engage women conductors at 5d. per hour for eight hours a day and six days a week.

The Metropolitan Police Authorities decline to license women conductors for London and the Metropolis. The London United & Metropolitan Electric Companies would employ women if they could obtain licences.

TELEGRAPH NOTES.

Telephone Service.—The Postmaster-General has decided to [illegible] new telephone subscribers.

[illegible] extended to last during the war, and is applicable to the whole of the kingdom. Everybody requiring a new telephone service will be called upon to make an initial minimum payment of £4, but this sum may be exceeded if the installation is likely to entail much outlay. [illegible] owing to the [illegible] of labour, there having been, owing [illegible] a considerable reduction in the number of men available for telephone extension. The object is to sift out applications, and reject those which are not urgent, so that whatever money is [illegible] be used in the best advantage. The advantage must be purely [illegible] the installation being made the ordinary tariff rates are enforced.

EMPIRE NOTES.

Australasia.—Yarra Junction (Victoria) Council has decided to take steps to secure power for an electric light scheme from Britannia Creek.

The quarterly report of the Prahran & Malvern (Victoria) Tramways Trust to June 30 shows revenue for 16 weeks preceding that date £37,474 (=12·4d. per car-mile) from 5,770,482 fares, the car-mileage was 668,043 and operating expenses were 10·3d. per car-mile. The agreement for extensions in Kew and Camberwell has been executed by the Councils. Arrangements have been made with the Melbourne Tramway & Omnibus Co. for the issue of tourist tickets, covering round trips on both the company's and the Trust's systems.

Takapuna (N.Z.) Council recently discussed a letter from the Tramway & Ferry Co. asking for a concession to supply the borough with electric light and power. The Electric Lighting Committee were instructed to meet the directors and obtain further information.

In an article in the New Zealand "Official Year-Book" Mr. R. Speight says few of the rivers in New Zealand are fitted for navigation except near their mouths, but in many places they furnish ideal sites for electric power plants. Since 1908 the sole right to use water power has been owned by the Government, but this power has been delegated in some cases to local authorities free of royalty and in others to companies or individuals at a royalty of $\frac{1}{20}$d. per unit generated. The total horse-power in use in 1903 was 10,000, and in 1913 35,000, of which electric supply accounted for 26,000 H.P. The largest plant is that of Dunedin Corporation on the Waipari river (9,000 H.P.), but this will be exceeded by the Government's Lake Coleridge scheme in the Southern Alps which will develop 12,000 H.P. and can ultimately be increased to 58,000 H.P. A large scheme has also been under consideration for the North Island, but all the schemes yet contemplated embrace only a small fraction of the water power available.

Maldon (Victoria) Shire Council has decided to call tenders for lighting the town by electricity or gas.

An order in Council has been issued authorising Coolangatta Council to supply electricity.

The Commonwealth Postmaster-General states that he has been able to effect a saving of £25,000 by utilising in the departmental workshops scrap materials that formerly went largely to waste.

As the result of a report submitted by Mr. G. H. Morgan, telephone manager in Melbourne, and Mr. S. L. Monaghan, assistant telephone manager in Sydney, the attended pay station (as distinguished from the penny-in-the-slot system), and the "no delay" trunk service will probably be adopted.

In moving the second reading of the (Sydney) City & Suburban Electric Railways Bill in the N.S.W. Legislative Assembly recently the Minister for Public Works stated that the train, tram and ferry traffic calculated on the past four years' increase would practically double itself in 6½ years, as before the city railway had developed.

Messrs. McCarty, Underwood & Co. have been appointed consulting engineers in connection with the Footscray (Victoria) Council's tramway scheme. The cost of construction is put at £37,690.

Echuca (Victoria) Council has decided to postpone taking a plebiscite of the ratepayers on the question of establishing electricity works until after the war.

MISCELLANEOUS NOTES.

British Westinghouse Employees' War Relief Fund.—The accounts of this fund from Aug. 22, 1914, to Aug. 31, 1915, show receipts £14,647, of which £10,133 was contributed by employees and £4,490 by the company, the remainder being bank interest.

£8,598 has been paid to dependents and £2,500 transferred to widows and orphans fund, £630 given to outside funds, £561 for Christmas gifts and £18 paid as wages for Red Cross workers. 1,572 employees have joined H.M. Forces and 621 families are receiving relief.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade have issued weekly lists, Nos. 37 and 38, of articles of which the sources of supply or markets have been interfered with by the war, and copies may be obtained by the United Kingdom manufacturers and exporters of British goods from the Director, 73, Basinghall-street, London, E.C.

Trading with the Enemy.—A fresh Proclamation has been issued relating to trading with the enemy in territory for the time being in hostile occupation.

It is declared that for the purposes of the proclamation for the time being in force relating to trading with the enemy, the expression "enemy" is declared to include and to have included any incorporated company or body of persons, wherever incorporated, carrying on business in an enemy country or in any territory for the time being in hostile occupation.

TENDERS INVITED.

Turbo-Generators, Boilers, Condensing Plant, &c.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. British port of (*a*) one Turbo-generator of not less than 5,000 kw. capacity, with Condensing Plant, &c.; (*b*) one or two Turbo-generators of about 10,000 kw. capacity, with Condensing Plant, &c. Copies of specifications and forms of tender from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, Westminster, S.W., to whom tenders (in duplicate) should be delivered by noon, Sept. 24.

JOHANNESBURG Municipal Council invite tenders by Sept. 25 for supply and erection of two 3,000-kw. Turbo-alternators, Condensing Plant, Switchgear, &c. Specifications from the Controller of Stores, and tenders to the Town Clerk.

JOHANNESBURG Council also require tenders by noon Sept. 30 for Two (or, alternatively, One) Water-tube Boilers, with Superheaters, Mechanical Stokers and Draught Plant. Specifications from the Controller of Stores, Municipal Offices, Johannesburg.

Electric Lamps and Fittings, &c.

The Guardians of the Poor of the Parish of KENSINGTON (London) invite tenders for the supply of Electric Light Lamps to their Infirmary, Marloes-road, W., for six months from Oct. 1, 1915. Forms of tender, &c., from the Clerk (Mr. W. R. Stephens), Guardians' Offices, Marloes-road, Kensington, W. Tenders by 3 p.m. of Thursday, Sept. 23.

EDMONTON Guardians require tenders by 9 a.m. Sept. 22 for six months' supply of Electric Lamps. Forms of tender from the Clerk, White Hart-lane, Tottenham, Middlesex.

SOUTH SHIELDS Guardians require tenders by 10 a.m. Sept. 27 for six months' supply of Electrical Fittings, Oils, &c.

WARRINGTON Guardians want tenders by 10 a.m. Sept. 22 for six months' supply of electrical goods. Forms of tender, &c., from the Clerk, Bewley-chambers, Warrington.

WESTMINSTER Guardians require tenders by noon Sept. 22 for six months' supply of Electric Lamps, Fittings, &c. Forms of tender from the Clerk, Princes-row, London, S.W.

WOLVERHAMPTON Guardians want tenders by 10 a.m. Sept. 21 for six months' supply of Electric Fittings, &c. Forms of tender, &c., from the Clerk.

WEST DERBY Guardians require tenders by 5 p.m. Sept. 21 for six months' Electric Supplies. Envelopes for tenders, &c., from the Clerk, Brougham-terrace, Liverpool.

MANCHESTER Guardians want tenders by Sept. 21 for six months' supply of Electric Lamps. Forms of tender from the Poor Law Offices, New Bridge-street, Manchester.

Tenders are invited by Sept. 27 for six months' supply of Electric Fittings, Fittings and Material for Machinery, &c., to the Midlothian and Peebles District Asylum, ROSSLYNLEE. Forms of tender from the Clerk, 19, Heriot-row, Edinburgh.

MERTHYR TYDVIL Guardians require tenders by Sept. 21 for six months' supply of Electrical Accessories. Forms of tender from the Master of the Workhouse, Merthyr Tydvil, or the Superintendent, Cottage Homes, Llwydcoed, Aberdare.

TOXTETH PARK Guardians want tenders by Sept. 25 for three months' electrical supplies. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

Repair of Incandescent Lamps.

The COMMISSIONERS OF H.M. WORKS, &c., invite tenders for the Repair of Incandescent Electric Lamps. Forms of tender, conditions of contract, &c., from the Controller of Supplies, H.M. Office of Works, 18, Queen Anne's-gate, Westminster, S.W. Tenders by 11 a.m. Oct. 1 to the Secretary, H.M. Office of Works, Storey's gate, London, S.W. *No. 29 already issued.*

Electricity Supply.

The Obras Sanitarias Department, BUENOS AYRES, require tenders by Sept. 24 for the supply of Electric Energy for the sewage pumping stations in the lower district of the new public health works radius.

Compressor and Motor.

MANCHESTER Guardians require tenders by Sept. 2 for a Compressor and Electric Motor for Refrigerating Apparatus at their Crescent-road institution, Crumpsall, Manchester. Specifications from Mr. A. J. Murgatroyd, 23, Strutt-street, Manchester.

Switchgear, Transformers and Cables.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. British port of e.h.t. Switchgear suitable for 22,000 volts working pressure; e.h.t. Static Transformers (22,000 to 6,600 volts) of 4,200 k.v.a. and 2,000 k.v.a. single phase and 3,000 k.v.a. and 1,250 k.v.a. three phase; and Armoured Three-core Cable for 22,000 volts, with Boxes. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders are to be delivered by noon Sept. 29.

Fuse Blocks, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Sept. 29 for 5,000 Fuse Blocks, 5,000 Spare Porcelain Bases and 10,000 Spare Fuse Clips (29,080). Specifications from the Commissioners' Offices, Spencer-street, Melbourne, Australia.

Generating Plant.

The AUSTRALIAN COMMONWEALTH Department of Defence require tenders by noon Oct. 25 for Power-station Plant and Equipment for the Naval Dockyard Cockatoo Island, Sydney, N.S.W., and by noon Oct. 27 for Machine Tools. Specifications from Director of Navy Contracts, Navy Office, Melbourne.

Condensing Water Tunnel, &c.

EDINBURGH Corporation require tenders by 10 a.m. Oct. 4 for the construction of Shafts and Tunnel for obtaining sea water for condensing at the new Portobello electricity works. Specification, &c., from the Engineer, Dewar-place station, Edinburgh.

Telegraph and Telephone Material, Wire, &c.

The Postmaster-General's department of the Commonwealth of Australia invites tenders (until Oct. 6) for the supply of Poles (iron or steel) and Fittings.

The Deputy Postmaster-General, Brisbane (Queensland), invites tenders until Oct. 6 for supply of Tinned Copper Wire (schedule 357) and Porcelain Pothead Insulators (schedule 360) for the COMMONWEALTH, Postmaster-General's Department.

The Deputy Postmaster-General, Perth (W. Australia), requires tenders by Sept. 29 for Telephone Switchboards, &c.

Tender forms from the Commonwealth offices, 72, Victoria-street, S.W.

The Deputy Postmaster-General, Brisbane (Queensland), requires tenders by Oct. 6 for 2,860 yds. Silk and Cotton Insulated Switchboard Cable (schedule 353) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Engine and Dynamo, &c.

The Deputy Postmaster-General, Adelaide (South Australia), requires tenders by 2 p.m. Oct. 6 for Portable Internal-combustion Engine direct coupled to Dynamo, and for increasing capacity of Storage Batteries at Central Telephone Exchange, Adelaide, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications from the Deputy Postmaster-General.

Meters and Time Switches, Cut-outs, &c.

JOHANNESBURG Council require tenders by Sept. 25 for supply of 1,595 Electricity Meters and 50 Time Switches.

JOHANNESBURG (Transvaal) Council require tenders by noon Sept. 28 for supply of 1,000 Sets of Single-pole 25-ampere Ironclad House Service Cut-outs (contract 21). Specifications from the Controller of Stores, Plein-square, Johannesburg.

Electric Capstans.

SYDNEY Harbour Trust Commissioners invite tenders by 2 p.m. Oct. 25 for the supply of 6 Electrically-operated Wharf Capstans. Specification, &c., from the office of the Commissioners, Circular Quay, Sydney, N.S.W.

TENDERS RECEIVED AND ACCEPTED.

AYLESBURY.—The Urban Council received eight tenders for the wiring of the Town Hall, &c., and that of Thomas Robinson has been accepted at £129.

WALSALL.—The tender of H. Gough & Son (at £455) has been accepted for alterations to sub-stations.

KING'S ABBEY.—For wiring the new sanitorium and other buildings at the fever hospital, the Council have accepted the tender of O. Melville, Robb & Scott at £70. 17s.

WEYMOUTH.—The Council have accepted the tender of R. Cox & Son for 100 service boxes at 9s. each.

STRETFORD.—The tender of Belliss & Morcom has been accepted for the supply and fitting of new valves for the intermediate cylinders of the engines of the last 500 kw. set, at £70.

BETHNAL GREEN.—The Guardians have accepted the tender of Pope's Electric Lamp Co. for 700 metal filament lamps, at 1s. 3½d. each; and that of Drake & Gorham for 300 Tantalum lamps, for £19. 8s. 6d.

QUEENSTOWN (TASMANIA).—The Council has placed a contract for 20 meters of the I 14 type with the Australian General Electric Co.

G.P.O. Lamp Contract.—The tender of Siemens Brothers Dynamo Works has been accepted for the supply of Wotan lamps to the G.P.O. for the ensuing six months.

The G.P.O. have also placed a contract for Royal Edison drawn wire lamps with the Edison & Swan United Electric Light Co.

Osram Lamps.—The General Electric Co. (Ltd.) advises us that for the seventh time it has received the G.P.O. (six-monthly) contract for the supply of Osram drawn-wire lamps.

The G.E.C. has also received contracts for the supply of thousands of Osram and Robertson lamps to the Admiralty and War Office.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Commonwealth Postmaster-General's Department:—

Melbourne.—G. Weymouth & Co., Ltd., two generators at £643. 18s. each, and two transformers at £195 each, for use in connection with the radio-telegraph stations at Townsville and Woodlark Island.

Sydney.—Hans & Eggers, patents for galvanometers, £9; phosphor bronze for suspension of coil £4; Siemens Bros. Dynamo Works, two Wheatstone receivers £69 each, two Wheatstone transmitters £6 each.

Perth.—J. Battram & Son, Ltd., cords £27. 1s. 8d.; Siemens Bros. Dynamo Works, 1,100 yds. submarine cable £122; General Elec. Engineering Co., 1,500 dry cells 3s. 3d. each; India Rubber, Gutta Percha & Telegraph Works Co., 20 battery syringes £14 each; A. W. Dobbie & Co., 5,000 zincs, 1s. 4½d. each.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Aberdeen.—The accounts of the electricity supply department for the year ended July 31 were adopted by the Corporation last week.

The Convener of the Electricity Committee, in moving that the report and the various books be adopted, said he regretted that the number of consumers had decreased by 1,644 [illegible] to the staff and employees, 33 [illegible] had joined H.M. Forces, and that a percentage of 57 per cent. of the men between 18 and 40 who had not been medically fit for service. The shutting down of practically all public lighting and the [illegible] had caused a decrease of £3,800 in revenue, 164 [illegible] and the number connected by meter increased by 1,644 [illegible]. The units sold amounted to 8,000,000 more than the previous year, but notwithstanding the increased output, the total working expenses were reduced by £1,027. The decrease was the result of their latest generating plant and better load factor. A section of the Council argued that the policy adopted in regard to large power consumers was wrong and would lead to financial trouble, but he pleaded them for the necessary time to prove the soundness of the Committee's action. In 1913-14, they sold a very large number of cheap power units, but the [illegible] a still further increase of cheap power units, the [illegible] per unit on record, and [illegible] only exceeded by the previous year's return. He thought there was a satisfactory [illegible] for the policy adopted by the Committee. It was to be regretted that the [illegible] creased price per unit, but the Committee had no alternative in view of the considerable increase of costs for the coming year.

The proposal to increase the prices was, however, referred back for further consideration.

Bradford.—The accounts of the tramways department for the year ended March 31 show total capital expenditure £1,043,054 (increase £2,936), of which £409,169 has been redeemed.

[illegible] £17,133 [illegible] £30,000 (£31,141). Working [illegible] £74,182 (£70,479), and [illegible] £1,000 (£1,128), [illegible] £2,000 (£1,000), [illegible] fund contribution £25,020 (£31,821), the net profit being £32,442 (£29,447) [illegible] £24,000 (£23,000), [illegible] fund, and £10,000 (£17,200) devoted to relief of city rate. £5,434 interest [illegible] car-mile was 12·425d. (12·166d.), and working expenses were 8·774d. (8·376d.). Passengers carried were 70,077,271 (67,675,166), car-miles run 6,194,057 (6,206,239), and units used 12,278,121 (12,041,279).

The report of the [illegible] the year [illegible] £12,740. The [illegible] of the year [illegible] Mr. Spencer [illegible] Alderman [illegible] the [illegible] misunderstanding of the position seems to be apparent. It was urged against the rail-less tracks in Bradford that they did not pay, and that appeared to be borne out by an examination of the accounts. It would not be correct to state that either a profit has been made or a loss incurred on rail-less traction routes in Bradford, because the feeding value, which is an important function of these cars, is not and cannot be taken into consideration in the accounts, but even if a loss is incurred on these routes the following should be considered. The routes along which the cars run are undoubtedly routes upon which tramways could not be laid without incurring heavy capital expenditure, and this method of traction was primarily adopted because of its cheapness in capital construction and operation, and not because it was better than a tramway. An efficient means of transit has been afforded to districts which could not expect a tramway service. Petrol 'buses would have been an alternative, but judging by the published cost of various motor omnibus enterprises throughout the country, the Corporation were running rail-less cars at a less figure per car-mile, and giving an equal if not a better service. The total costs per car-mile as between petrol 'bus and trolly car are governed to some extent by the density of car-miles per mile of route operated. Another point of criticism is that the roads are damaged considerably by these vehicles. Experience has certainly proved that water-bound macadam roads are not suitable for modern heavy traffic, but given a road properly constructed to carry the ordinary heavy motor traffic of to-day, the rail-less trolley vehicle, or omnibus, with their rubber tyres, are not extraordinary wearers of roads. Extensions of rail-less system, amounting to 8 miles 330 yds., have taken place during the year. Out of 1,369 men, 339 have left the service of the department for H.M. Forces or munition work. The parcel-carrying department handled 887,114 packages (increase 55,679), income being £10,836 against £9,885).

The effect upon accidents of the introduction of the new brake power has been very marked. The brake was designed mainly in the interests of public safety. Its main principles are that no skill is required on the part of the driver for its application. If anything happens to the mechanism, the result is the application of the brake, and consequent stoppage of the car. In case of need, the conductor can apply the brake against the driver, but he cannot take it off against him. It is possible without any fear of skidding to pull up a car fitted with this brake in a remarkably short distance. 75 cars are fitted with this brake. Quite apart from the question of preventing serious runaways and disasters, the brake has proved extremely valuable in keeping down and reducing the seriousness of inevitable street collisions, which take place on every system. With intelligent handling the increase in current consumption of cars fitted with this brake is so small as to be practically negligible. The cost [illegible] to be in excess [illegible] the more or less [illegible] which it has been found necessary to re-design and improve, there is no reason to think that the cost of maintenance will be seriously in excess of that of the mechanical brake which it has replaced, for whilst, on the one hand, there is an [illegible] there is a considerable saving in the wear of tyres. It has been found that the increased life of steel tyres in consequence of this brake is in the neighbourhood of 85 per cent. The drivers are unanimously in favour of the [illegible] the outbreak of war has prevented the continued fitting of cars.

Warrington.—The electricity department's accounts for the year ended March 31 show total capital expenditure £127,800 (increase £17,185), of which £39,281 has been redeemed.

Revenue was £25,419 compared with £25,177 in previous year), and

working and [illegible] expenses were £16,515 [illegible] gross profit £8,561 (£9,199). Interest [illegible] £2,926 [illegible] sinking fund £4,184 (£4,063), and the net profit was £1,818 (£2,935). Average prices obtained were 1·914 [illegible] per unit for power [illegible] 1·254 (1·22d.) from private consumers, and 1·50d. (1·50d.) for traction. Units sold, exclusive of traction, were 3,743,197 (3,870,042). Maximum load was 2,351 kw. (2,474 kw.). Total costs, exclusive of capital charges, were 0·729d. (0·685d.) per unit sold.

COMPANIES' MEETINGS AND REPORTS.

BOLCKOW, VAUGHAN & CO. (LTD.)—The [illegible] to the year ended 1 June 30 states that the profit available for distribution is £223,315, which, with £145,538 brought forward, gives a disposable surplus of £368,853. The total expenditure upon open-hearth steel furnaces, blast furnaces, exhaust steam turbines, by-product coke-ovens, electrical installations, &c., during the year was £123,449. After paying debenture interest and preference dividends and at rate of 6 per cent. on the ordinary shares, writing off expenditure on various extensions, new plant, &c., (£17,609), a balance of £135,707 has been carried forward.

DUMBARTON BURGH & COUNTY TRAMWAYS CO. (LTD.)—At the meeting last week the chairman (Mr. Geo. Balfour) said that the total receipts for the past year showed a decrease of £304. Traffic and power expenses had increased by £340, and general expenses by £44; but maintenance expenses showed a decrease of £485, due to the large expenditure made during the previous year. A dividend on the preference shares at the rate of 6 per cent. per annum for the half-year to July 31, 1915, and a dividend on the ordinary shares at the rate of 1½ per cent. for the year, were declared.

DUNDEE, BROUGHTY FERRY & DISTRICT TRAMWAYS CO. (LTD.)—The accounts for the year ended July 31 show a divisible balance of £3,599 after providing for debenture interest. Payment of dividends of 6 per cent. on the preference shares is recommended, the addition of £400 to renewals fund and £400 to sinking fund, carrying forward £100.

ELECTRO BLEACH & BY-PRODUCTS (LTD.)—At the first annual meeting last week the chairman (Mr. H. J. Mackinder, M.P.) said the company did not commence manufacturing until January. During the eight months of the year an interim dividend had been paid, which told the meeting that, in the directors' opinion, they had not worked at a loss, but they had had difficulties.

NAIROBI ELECTRIC POWER & LIGHTING CO. (LTD.)—The number of units generated in 1914 were 1,020,038, against 723,852 in 1913, the number of customers connected being 633 against 610. The motors connected were 422 B.H.P. (against 373), the private lights connected (8 c.p. equivalent) were 22,808 (against 13,745), and for street lighting 2,000 8 c.p. (against 2,000). The schemes for the utilisation of the Thika Falls, for which tenders were received and necessary financial arrangements made, had to be stopped owing to the outbreak of war. Sanction was, however, obtained for the issue necessary to provide the auxiliary steam plant to be erected at Nairobi to prevent the inconvenience which would be caused by complete stoppage of the developments of the undertaking. Two of the directors, Lieut.-Commander R. C. Bayldon, R.N. (managing director), and Col. A. W. Mayo-Robson, A.M.S., have been called up for war service, and the board have, therefore, elected their consulting engineer (Mr. E. W. Monkhouse) to be a temporary director of the company.

SOUTHERN ELECTRIC TRAMWAYS CO. OF BUENOS AYRES.—The report for the year ended June 30 shows a credit balance (after depreciating plant and machinery by 10 per cent.) of $87,364, to which had to be added $23,293 brought forward. The sum of $1,747 has been transferred to reserve and $4,368 to contingency account, and a dividend of 2 per cent. has been declared, leaving $20,565 to be carried forward.

CITY NOTES.

MEMORANDA (Sept. 15).—Bank rate 5 per cent. (since Aug. 8, 1914) Consols 65. Consols Pay Day Oct. 1. Stocks and Shares Ticket Days Sept. 28 and Oct. 13. Pay Days Sept. 29 and Oct. 14. Price of silver, 23 ⅞d.

BRITISH INSULATED & HELSBY CABLES (LTD.) [illegible] have declared an interim dividend of 5 per cent. actual on the ordinary shares on account of the current financial year.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The units sold to consumers during the five weeks ended July 30, 19[illegible] were 2,[illegible],[illegible] units, compared with 1,851,329 units in the corresponding [illegible] 1914.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The board have decided to pay, in addition to the dividend at the [illegible] per annum on the preference shares, an interim dividend at the rate of 1 per cent. per annum (tax free) on the ordinary shares, both for the half-year ended June 30, and payable on 1st prox.

DIRECT WEST INDIA CABLE CO. (LTD.)—A final dividend of 3 per cent. (1s. 6d. per share), tax free, has been declared, making 6 per cent. for the past year, carrying forward £63,319.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—A final dividend of 3 per cent. (3s. per share) tax free, has been declared, making 6 per cent. for the past year, and carrying forward £10,049.

MANILA ELECTRIC RAILROAD & LIGHTING CORPN. (LTD.)—The directors have declared a dividend of 1½ per cent. for the quarter ended 30th inst. on the common stock.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—The directors have declared an interim dividend for the half-year ended June 30 last at the rate of 10 per cent. per annum on the ordinary shares, 4 per cent. per annum on the first preference, and 5 per cent. per annum on the second preference shares.

S. SMITH & SONS (MOTOR ACCESSORIES) (LTD.)—During the week applications were invited for the sale of 100,000 ordinary shares of £1 each (balance of £200,000 authorised capital) in the above Company, who are famous as manufacturers of all kinds of motor accessories, and are also contractors to the Admiralty and War Office for the manufacture of munitions, motor and aeroplane accessories, speedometers, carburreters, self-starters, lighting sets, &c. This issue is made at the price of 21s. per share, of which 2s. 6d. is payable on application, 3s. 6d. on acceptance, 5s. Oct. 1 and 10s. on Dec. 1, 1915. It is pointed out that no debentures or preference shares can be issued without the sanction of the ordinary shareholders. Copies of the prospectus and a form of application can be obtained from the London City & Midland Bank (Ltd.), Threadneedle-street, London, E.C., and branches, and the issue is made by the British, Foreign & Colonial Corporation (Ltd.), 57, Bishopsgate, London, E.C., purchasers of the shares. Applications from customers of the company will receive special consideration.

WESTERN UNION TELEGRAPH CO.—A quarterly dividend of 1¼ per cent. has been declared.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Sept. 15. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Wed. Sept. 15.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9⅜	7 2 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9⅛	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. Pref.	12⅛	6 3 9	Feb, Aug
5	10%	Brompton & Kensington Ord.	5⅜	6 0 2	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	83½	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	3⅛	6 0 10	..
5	5%	Do. O.	4	6 5 0	Aug, Feb
10	9%	City of London Elec. Lt. Ord.	13⅜	7 5 5	Feb, Aug
10	6%	Do. 6% Pref.	12½	4 17 0	Mar, Jly
St.	5%	Do. 5% Deb. St.	110	4 10 11	Jun, Dec
10	7%	County of London Ord.	10⅛	6 15 0	Mar, Sept
10	6%	Do. 6% Pref.	9⅞	6 2 3	Feb, Aug
St.	4½%	Do. 2nd Deb.	97	4 12 9	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	96½	5 17 8	July
5	9%	Kensington and Knightsbridge Ord.	6⅝	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, Jly
5	3/0	London Elec. Supp. 6% Pref.	5⅛	5 13 1	..
St.	4%	Do. 4% Mort. Debs.	84½	4 11 11	Jan, Jly
5	3½%	Metropolitan E. Supp. Ord.	4	7 0 0	Mar, Aug.
St.	4½%	Do. 1st Mort. Debs.	95½	4 14 0	Jan, Jly
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, Jly
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs.	95½	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	5%	North Metropolitan E. P. Supp. 6% Pref	1⅛	5 11 7	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs.	95	5 5 3	Jan, Jly.
St.	4½%	Urban Elec. Supp. 4½% Db. St.	84	5 0 10	Apl, Oct
1	..	Waste Heat & Gas Elec. Gen. Stations.	1⅛	7 11 7	May, Aug
5	7%	Westminster E.S. Corp. Ord.	7⅝	9 7 6	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4⅜	5 7 6	Jan, Jly
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	79	.. ..	Apl, Oct
St.	..	[illegible]	[illegible]	8 12 5	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	[illegible]	5 10 9	..
St.	4%	[illegible]	[illegible]	.. ..	..
1	..	[illegible]	[illegible]	4 10 ..	Jan, Jly
..	..	[illegible]	[illegible]	.. ..	Jan, Jly
..	..	[illegible]	[illegible]	1 15 3	May, Nov
..	..	[illegible]	[illegible]	.. ..	Feb, Aug
10	5%	Liverpool Tramways	9⅛	5 17 11	Feb, Aug;
10	1%	London Electric Ry. Ord.	1	1 12 ..	Jan, July
St.	4%	Do. 4% Pref.	62½	.. 7 3	Mar, Sept,
St.	4%	Do. 4% Debs.	85	4 13 1	Jan, Jly.
St.	4%	Metropolitan Ry. Con. Ord.	93⅝	4 4 11	Feb, Aug
St.	4½%	[illegible]	7⅛	4 10 6	Feb, Aug
St.	5%	[illegible]	74½	4 14 3	Feb, Aug
St.	4½%	[illegible]	98	4 4 9	Jan, July
St.	4½%	[illegible]	89½	4 4 1	Jan, July
St.	4½%	Metropolitan Dist. Ry. Ord.	14	.. ..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov

† Ex [illegible] † interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	NAME.	Price, Wed., Sept. 15.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways.	*—cont.*	£ s. d.	
St	4½	Metropolitan Dist. Ry. 4½% First Pref.	73½	6 2 5	Feb, Aug
St	6%	Do. 6% Perp. Deb.	124½	4 12 8	Jan, July
St	3%	Do. 4% Deb.	74	5 8 2	Jan, July
St	4%	Do. 4% Debs. (1903-5)	87½	4 11 1	Jan, July
St.	4%	Do. 4% Cons. Stock	79½	5 0 0	Mar, Sept
1/-	..	Underground E. Rys. of London Shares	1½	.. ..	..
1/-	..	Do. A Ord.	½	.. ..	..
St.	6%	Do. 6% 1st Pref.	103	5 16 7	Mar, Sept
..	6%	Do. 6% 1st Pref. Stock (Coup. Pt.)	104	8 6 2	Mar, Sept
..	4½	Do. 4½% Bds.	76	4 11 1	Jan, July
5	..	Yorkshire W. Riding Ord.	4	.. ..	March
5	6%	Do. Pref.	4½	6 17 2	June, Dec
		Electric Manufacturing, &c.			
1	3½	Babcock & Wilcox Ord.	2½	6 4 5	Apl, Oct
1	..	Brit. Aluminium Ord.	1	4 16 5	Mar
100	5%	Do. Prior Lien Debs.	93½	5 7 9	Jan, July
1	6%	Do. 6% Pref.	..	6 12 ..	Jan, July
5	15	Brit. Insulated & Helsby Ord.	13½	7 0 4	Aug, Feb
5	3%	Do. 3% Cum. Pref.	8½	7 9 1	Jan, July
1	5%	British L.M.Ericsson Mfg. Cm.6% Pref.	4½	6 6 8	Mar, Sep
5	7½	Brit. Westinghouse Pref.	1	9 12 ..	Apl, Oct
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5 9 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	1½	6 17 2	Jan, July
5	2 6	Do. 5% Pref.	4	6 5 0	Feb, Aug
1	15%	Castner Kellner	..	5 5 1	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	..	7 13 7	Sept
5	..	Edison & Swan U. Elec. Ltd. A. £3 pd.	1	.. ..	Feb, Aug
1	6%	Elec. Construction Ord.	9½	9 1 2	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	64½	5 15 6	Jan, July
10	6%	General Electric 6% Pref.	..	6 9 3	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 8 6	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4½	5 0 0	..
St.	4½%	Do. 4½% Deb.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	6½	6 1 2	Feb, Aug
10	5%	Do. Pref.	9½	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	95	4 1 8	Apl, Oct
12	2%	Telegh. Con. & Main. Co.	30½	7 16 9	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½	Vickers Ord.	4½	4 12 1	May, Aug
1	6%	Do. 6% Pref.	1½	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	84½	4 18 3	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	97½	4 10 3	Jun, Dec
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	9½	6 1 5	Fb,My.Aug,N
St.	11½	Do. Def. Ord.	21½	6 17 11	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	85½	4 13 3	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	6	6 5 0	May, Nov
10	..	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	5½	6 15 5	Ja,Ap,Jly,O
St.	7	Eastern Tel. Co. Ord.	11½	6 1 2	Ja,My,Jly,O
St.	17.6	Do. 3½% Pref.	6½	5 7 8	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	80	5 0 0	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77	5 3 11	Feb, Aug
10	7%	Do. Ord.	11½	6 1 3	Ja, Ao, Jly, O
10	22%	Gt. Northern Tel. Co. with Coup. 8	33½	6 13 4	Ja, My, Jly
25	13%	Indo-Europ.	52	6 10 ..	May, Nov
1	1½	Marconi's Wireless Tel. Co.	1½	5 6 8	April
1	7½	Do. 7% Pref.	1½	3 19 0	July
10	9½	West India & Panama Ord.	11½	8 17 9	May, Nov
10	6%	Do. 1st Pref.	8½	6 16 2	May, Nov
10	7½	Western Telegh. Co.	11½	6 10 9	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	79½	5 0 4	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	1.0	4 13 ..	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	124½	6 3 7	Ja,Ap,Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	77½	6 9 0	Jan, Jly
1	7½	Monte Video Telephn. Ord.	..	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	99½	4 11 4	May, Nov
1	10%	Oriental Telephone Ord.	9½	5 1 7	Apl, Oct
St.	4%	Do. Db. St.	80	5 0 0	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 8	Jan, July
5	8%	United River Plate Ord.	6½	7 7 0	Apl, Oct
5	6%	Do. 6% Cum. Pref.	5½	5 3 3	Jan, July
St.	4½	Do. Deb. Stk.	99½	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	9½	6 2 4	Sp.Dc.Mr, Jn
10	6%	Do. 6% Pf.	9½	6 3 1	Sp.Dc.Mr, Jn
100	5%	Mexican Telephone Co. Ltd.	80½	6 5 0	Ja, Apl, Jly.O
..	4%	Do. $10 Pref.	67½	5 18 6	Ja, Ap, Jly, O
100	6%	Submarine Cable Trust Ltd.	125½	4 15 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	97½	6 14 5	Jun, Dec
St.	4½%	Do. 4½%	80	5 12 6	Jan, July
St.	4%	Do. 4% Debs.	..	5 10 ..	Jan, July
5	2/4	Do. 5½% 1st Pref.	3½	6 17 6	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3½	7 15 6	Jan, July
100	1½	Brazilian Traction Ord.	47	8 13 7	Fb,M,A,S,N
100	5½	Do. Pref.	..	7 .. 4	Ja,Ap,Jly,O
5	..	Brisbane Trams Ord.	4½	5 10 ..	May, Nov
5	2½	Do. Pref.	4½	5	..
St.	4½%	British Columbia 4½% Con. Debs.	90	5	..
5	9½%	Calcutta Elec. Trams. Ord.	8½	7 .. 4	Mar, Sep
..	5%	Manaos Elec. Rys.	..	6 13 ..	Feb, Aug
..	6%	Madras Elec. Trams 6% Cum. Pref.	4½	6 0 0	..
100	5%	Manaos Tramway	4½	7 4 11	Jan, July
..	..	Mexico Tramways	..	.. ..	Fb,M,Aug,N,
..	5%	Do.	11½	11 16 7	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	84½	5 4 11	Feb, Aug
100	..	Rio de Janeiro Tramway	21½	4 13 11	Jan, July
100	4½	Taubaté Ord.	2½	4 17 6	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	4½	Anglo American Electric Corp.	4½	6 1 4	Mar, Sept
St.	6%	Do.	104	.. ..	Jun, Dec
..	..	Do.	..	.. ..	..
..	..	Do.	101	5 18 ..	..
5	..	Do.	..	7 11 3	May, Nov
5	..	Do.	4½	5 4 4	Mar, Sept
5	..	Do.	107½	6 19 3	Ja, Apl, Jly, O
St.	..	Do.	..	.. ..	June, Dec
5	..	Do.	..	7 .. 4	Apl, Oct
..	..	Do.	..	5 1 ..	Jan, July
..	..	Do.	12½	4 .. 4	Ja, Apl, Jly, O
St.	4½	Do. 4½% Deb. St.	..	4 15 ..	Jan, July
St.	4½	Do.	..	5 .. 3	May, Nov
1	..	Indo-European Telegraph Co.	1½	.. ..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	..	.. ..	Jan, July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Sept. 15 the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	13d.	English Lead	£24 0 0
Solid Drawn Copper Tubes	13½d.	Antimony	Nominal.
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	15d.	**Old Metals.**	per ton.
Brass Wire	14d.	Clean Scrap Copper	£63 0 0
Copper Wire	13d.	Brazlery Copper Scrap	£57 0 0
Rolled Brass	13½.	Clean Scrap Brass	£50 0 0
Brass Sheets	12½d.	Old Lead	£17 0 0
		Old Zinc	£42 0 0
	per ton.	Hollow Pewter	£115 0 0
Copper Sheets	£98 0 0	Black Pewter	£75 0 0
Spelter	£74 0 0	Gun Metal	£59 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Sept. 14, the following prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£80 0 0	Old Lead	£20 0 0
Clean Mixed Brass	£51 0 0	Tea Lead	£18 0 0
Clean Copper	£65 0 0	Old Zinc	£40 0 0
Brazlery Copper	£59 0 0	Hollow Pewter	£110 0 0
Gun Metal	£62 0 0	Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £70; Commercial Tinman's Solder, £90; Blowpipe Solder, £100.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	Aggregats. No. of weeks.	Aggregats. Amount.	Aggregats. Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	Sept 8	1,869	+ 204	14	27,080	+ 461
Anglo-Argentine	..	49,469	— 4,171	36	1,832,941	— 135,102
Ashton-under-Lyne	..	..	..	..	..	..
Ayr Corporation	.. 11	444	— 117	17	8,558	+ 183
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	.. 12	1,499	+ 247	24	32,943	+ 2,227
†Birmingham Corporation	.. 11	18,551	+ 4,217	24	322,129	+ 29,800
Blackburn Corporation	.. 8	1,364	+ 89	24	32,240	— 1,035
Blackpool Corporation	.. 9	4,203	+ 1,654	24	50,814	— 1,973
Blackpool and Fleetwood	.. 11	2,146	+ 845	36	30,474	— 1,423
Bolton Corporation	.. 12	3,423	+ 508	24	65,069	— 3,445
Bournemouth { Trams	.. 8	2,618	+ 534	23	52,352	+ 1,079
Bournemouth { Buses	.. 8	34	+ 5	23	737	+ 145
Bradford Corporation	.. 11	6,983	+ 985	23	153,722	+ 5,576
Brighton Corporation	.. 12	1,496	+ 221	24§	29,042	— 647
Bristol Trams { Trams	.. 10	4,773	+ 129	36	169,959	— 279
Bristol Trams { Buses, &c.	.. 10	5,291	+ 1,107	36	176,209	+ 30,098
Burmah E. Trams & Ltg.	.. 11	₹3,832	+ ₹857	36	₹128,630	+ ₹874
Burnley Corporation	.. 11	1,909	+ 440	24	53,176	+ 983
Burton Corporation	.. 11	312	+ 11	24	1,002	+ 383
Bury Corporation	.. 12	1,635	+ 151	24§	33,509	— 1,425
Calcutta Tramways Co.	.. 11	₹66,662	+ ₹366	..	..	..
Camborne-Redruth	.. 11	150	+ 25	36	4,958	+ 46
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	..	1,...	+ 10	36	18,150	— 220
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	.. 8	1,...	+ 77	23	42,928	+ 2,127
Derby Corporation	.. 11	1,136	+ 118	23§	25,376	+ 289
Dover Corporation	.. 4	335	+ 49	22	7,436	+ 1,359
Dublin & Lucan Railway	.. 1	171	+ 17	10	1,744	— 38
Dublin United	.. 10	6,561	+ 534	36	221,284	+ 6,938
Dundee Corporation	.. 7	1,443	+ 149	17§	23,049	+ 751
East Ham Council	.. 11	1,372	+ 125	23§	31,620	+ 5,040
Exeter Corporation	.. 10	433	+ 56	23	9,406	+ 470
Glasgow Corporation	.. 11	22,947	+ 2,339	15§	319,443	+ 20,485
Gloucester Trams	.. 11	145	+ 19	37	4,580	— 88
Gloucester Corpn.	.. 8	347	+ 15	23	7,977	— 76
Halifax Corpn. { Trams	.. 7	2,515	+ 205	23	54,078	— 269
Halifax Corpn. { Buses	.. 7	..	+ 5	23	1,212	— 14
Hastings Elec. Trams Co.	.. 9	1,517	+ 254	36	35,757	— 620
Huddersfield Corpn.	..	..	..	..	..	..
Hull Corporation	.. 11	2,992	— ..	23	71,861	— 3,007
Ilford District Council	..	..	+ ..	23	15,890	+ 2,489
Ilkeston Corporation	.. 8	144	+ 14	23	3,124	— 1
Ipswich Corporation	.. 11	..	+ 143	22	13,750	+ 1,900
Isle of Thanet Co.	.. 11	..	— 447	49§	21,222	— 10,550
Kilmarnock Corporation	.. 11	191	+ 44	17	3,019	+ 30
Lanarkshire Trams Co.	.. 9	2,251	+ 376	36	69,825	+ 1,067
Lancashire United	.. 8	2,241	+ 448	36	62,927	+ 14,962
Leeds Corporation	.. 11	..	+ 1,517	24	215,405	+ 14,688
Leicester Corporation	.. 11	3,247	..	37	109,802	+ 4,175
Leith Corporation	.. 11	827	..	17	13,604	+ 474
Lincoln Corporation	.. ..	..	..	..	..	..
Liverpool Corporation	.. 4	13,913	..	35§	470,217	+ 871
Llandudno&ColwynBayR	.. 10	605	+ 141	41	14,179	+ 1,033
London County Council	.. 11	46,219	— 3,...	..	952,318	— 19,746
Lowestoft Corporation	.. 11	..	..	1½§	8,730	+ 2,119
Maidstone Corporation	.. ..	..	+ ..	22	5,327	— 20
Manchester Corporation	.. 11	1...	..	23	426,673	+ 7,620
Nelson Corporation	.. ..	..	..	..	..	..
Newcastle-on-Tyne Corpn	.. 11	....	..	24§	149,615	+ 21,738
Newport (Mon.) Corpn.	.. 11	....	..	24	20,227	— 233
Northampton Corporation	.. ..	....	..	23§	17,961	+ 3,763
Nottingham Corporation	.. 11	....	..	24	88,127	+ 5,371
Oldham Corporation	.. 11	....	..	23	58,216	+ 430
Portsmouth Corporation	.. ..	..	..	..	..	..
Preston Corporation	.. ..	....	..	23**	22,528	+ 156
Rawtenstall	.. ..	..	..	..	..	..
Rotherham Corporation	.. ..	1,193	..	23	26,716	+ 2,806
Salford Corporation	.. 11	5,657	+ 1,025	24§	126,235	+ 2,814
Southall Corporation	.. 11	9,519	+ 2,190	24	216,507	+ 125,477
Southampton Corpn.	.. ..	..	+ 278	23	35,477	+ 2,221
Southend Corporation	.. ..	1,074	..	23	21,953	— 6,743
Southport	.. ..	..	..	23	18,542	+ 157
St'lyb'dge, Hyde, &c., Jt. B.	.. ..	..	..	..	..	..
Sunderland Corporation	.. 12	1,...	..	24	30,285	— 1,073
Swansea District	.. ..	....	..	46	28,667	— 788
Swindon Corporation	.. ..	..	..	..	..	..
Tynedale Tram Co.	.. ..	....	..	23	6,111	+ 277
Wallasey Corporation	.. 11	1,...	..	23	32,344	— 340
Walsall Corporation	.. 11	....	..	37	26,745	+ 3,631
West Ham Corporation	.. 11	....	..	24	23,226	+ 2,708
Warrington Corporation	.. ..	..	..	..	..	..
West Ham Corporation	.. ..	1,...	..	23*	74,284	+ [illegible]
Wigan Corporation	.. 11	1,...	..	23	35,527	+ 1,028
Wolverhampton Corpn.	.. 11	1,...	..	23	29,964	+ 904
Yorkshire N.R. Trams	.. 12	1,...	..	37	58,999	+ 4,797

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses &c. ‡ Minus 2 days. § Minus 3 days. ‖ Plus 3 days.

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NOTES.

Validity of Rate in Aid of Electricity Works.

ONE of our gas contemporaries has been making much of a rating appeal which raised the validity of a rate struck by a local authority to meet a deficit on its electricity supply undertaking. It would appear that the electricity works of the Borough of Limerick have not been a financial success. Like all provincial towns with a load which is mainly lighting, it was badly affected by the advent of the metal filament lamp, and in addition we are rather inclined to think that errors of judgment were committed by those responsible for the administration of the undertaking. This does not, however, apply to the present state of affairs, for the undertaking has made good progress during the past year or two, while under the control of Mr. E. B. THORNHILL, and if it were not for the war it would probably be now in a position to meet all annual running expenses, including interest and sinking fund. As reported, we are not impressed by the arguments in the case, or by the decision of Judge LAW SMITH, that a rate in aid of the electricity works was invalid unless the maximum price allowed by the Provisional Order had been charged. Appellants' case was based on a section of the Towns Improvement Clauses Act, 1847, which consolidated into one Act certain provisions usually contained in Acts for paving, draining, cleansing, lighting and improving towns.

THE Act, however, extends only "to such towns or districts in England or Ireland as shall be comprised in any Act of Parliament hereafter to be passed which shall declare that this Act shall be incorporated therewith." Now, the Act in question has not been incorporated by the Electric Lighting Acts, 1882 to 1909, or by the Limerick Provisional Electric Lighting Order of 1892, under which the Corporation are supplying electrical energy; and, with great deference to the learned Judge, we have our doubts as to the validity of his judgment. Again, the Corporation are obliged to give a supply of electrical energy, and there is nothing said in the Provisional Order as to the price at which this is to be given, except that it *must not* exceed 8d. per unit ; it is not laid down that the electricity undertakers must charge this figure, only that it may do so, and provision is made in sec. 7 of the Electric Lighting Act, 1882, for defraying the expenses of a local authority under the Act out of the local rate. It is, therefore evident that the Electric Lighting Act of 1882 contemplated cases where a rate would be necessary to cover expenses. However, the position at Limerick was peculiar, for the rates are high in the borough and the improvement rate must not exceed 5s. We hasten to add that we are not advocates of rate-aided competition, and we think that when local authorities cannot manage such undertakings as gas and electricity supply works successfully they should hand them over to a company. However, it may take a few years to place some of them on a sound financial position, and it may also happen that, through industrial or political crises, municipal authorities may be compelled temporarily to subsidise public services such as electricity supply, or gas works, or tramways out of the rates. In fact, our present issue gives one or two instances of this character, and it is just and reasonable that the legislature should have made provision for the payment of these deficits. Our gas contemporary would naturally like its readers to believe that the Limerick judgment is of wide application ; but owing to the peculiar circumstances we think it need not greatly disturb electricity supply undertakers in this country.

Radiotelegraph Investigations.

THE report of the British Association Committee on Radiotelegraphic Investigations this year is much less comprehensive than we hoped would be the case rather more than a year ago. At that time arrangements were made to carry out many interesting observations, partly in connection with a solar eclipse and partly to provide, in various parts of the world, a continuous record of strays. The

occurrence of strays, or atmospheric disturbances, is only too well known to every operator in radiotelegraphy; but there is still a good deal to be learned as to their origin. The report, which we publish elsewhere, gives some interesting information in this connection. From the meteorological point of view, the chief interest lies, perhaps, in the extension of the idea that strays may be used as an indication of the weather to come. For example, a report from Esperance, in Australia, states that during the daytime rain is preceded in at least 80 per cent. of cases by intermittent disturbances. It seems to be conclusively proved that thunder and rain may be foretold a day or two in advance of their occurrence by observing the strays. This is not a new idea, but in discussing the underlying phenomena it is interesting to note that the atmospheric disturbances which are observed are not due to electrical discharges at great distances, but are frequently due to very local discharges of quite a weak character.

Calculations of Sudden Short-Circuit Phenomena.

In an informative Paper presented at the Panama-Pacific Convention of the American Institute of Electrical Engineers, Mr. N. S. DIAMANT briefly considered the theory and explanation of the electromagnetic phenomena involved in the sudden short-circuit of alternators, as given by BERG and BOUCHEROT. A praiseworthy feature of the Paper is the rational basis on which the calculations of sudden short-circuits have been put, and the attempt to test the correctness of the theories given is commendable. DIAMANT shows how complex the different resistances and reactances are that enter the equations of sudden short-circuits, and develops new methods for the experimental determination of these quantities by simply determining the rise of direct current in the field and armature circuits. New simple methods are given, based on theoretical equations, for the calculation of short-circuit phenomena directly from oscillographic records. Interesting data relating to the short-circuit of a 45 k.v.a. alternator are given, and an ingenious device, used in most of the tests, for short-circuiting a machine at any desired point of the E.M.F. wave is described.

The Effect of Transient Voltages on Dielectrics.

Students of high voltage engineering are indebted to several eminent American engineers and scientists, not only for a considerable volume of strikingly original work on Dielectric Phenomena, but also for invaluable data on the subject. The outstanding feature of this work, apart from its fascinating interest, is that as a rule it has been presented in such a form as to be of immediate use to engineers. An active worker in the field of high-voltage engineering is Mr. F. W. PEEK, whose book is reviewed on another page of this issue. Experience shows that failures of dielectrics are generally caused by transient voltages, and it is, therefore, of great practical importance to determine the various phenomena affecting the strength of dielectrics, and to find [illegible] when they are subjected to [illegible] voltages. In the most recent Paper presented at the Panama-Pacific Convention of the American Institute of Electrical Engineers, Mr. PEEK discusses these problems. He also gives a summary of the general laws of breakdown of dielectrics by transient voltages, and describes an impulse generator by means of which impulse voltages of any desired characteristic can be obtained. The matter bearing upon the strength of air between spheres and needles for impulses of different front and length of tail is well-found, and the treatment of transient spark-over and corona voltages leaves little to be desired. Designers will find the records of transient spark-over voltage and time for oil and various solid dielectrics helpful to them in the proportioning of high-voltage apparatus and equipment.

The Budget.

INDIRECTLY, of course, the Budget proposals to meet the necessities of the nation's present case just as seriously affect the electrical profession and industry as any other section of the commercial classes; directly, however, there is nothing which will affect the industry abnormally. It may be reasonably assumed that, although we are not particularly included in the present set of taxation proposals, so much more will have to be done than is at present contemplated to meet the needs of the situation created by the war, that it is too much to hope that the electrical field will be omitted from the CHANCELLOR OF THE EXCHEQUER'S future range of operations. There is little, if anything, to be said against the justice or the merits of the Budget of 1915-16, except, it may be, that it would be well to inculcate in the masses a closer acquaintance with the terrors of direct taxation, and for this reason we think it would have been politic to have lowered the incidence of the income tax—perhaps, however, this is reserved for a future occasion. In one indirect way the widely spread industry of electricity will suffer heavily from the re-arrangement of postal and telegraph charges. There are few trades whose publicity depends more upon the post than that of electrical accessories and sundries, and manufacturers, factors and general dealers in the smaller classes of electrical goods will be badly hit by the abolition of the halfpenny post and the substitution of higher rates for letter and parcels post, This applies also to the technical journals and publications, which form an important feature of electrical publicity. These journals and publications have undoubtedly been seriously affected by the war in many directions, and the new postal and telegraph arrangements will serve to emphasise this disconcerting feature of literary and journalistic work. But it is gratifying to know that we are all suffering for the same cause, and that it is only by readily providing the necessary funds to prosecute the war to a victorious finish that we shall reach the time when lasting peace will be proclaimed and when the hideousness and frightfulness of this great conflagration will have left us ready to benefit from the lessons with which its terrors have acquainted us. The Budget proposals now being discussed by Parliament are a step on the road towards this consummation so devoutly to be wished. We can only hope, even against hope, that it may be the last of the British Super War Budgets for many years.

Electric Cables with Iron Conductors.—In Germany, by reason of the present scarcity of copper, [illegible] are now being employed cables with iron and steel conductors. In order to reduce the impedance for alternating currents, the iron is coated with copper, zinc or tin, that coated with copper being known as the Monnot copper-armour steel wire.

Train Disasters and Electric Light.—In his report to the Board of Trade on the Gretna troop train disaster of May 22 last, Lieut.-Colonel Druitt repeats recommendations previously made. He again suggests the provision of electric lighting in all new stock, and gas lighting in existing stock to be abolished, and electric lighting to be provided as opportunity admits.

Production of Mica in 1914.—According to a statement by Mr. D. B. Sterrett, of the United States Geological Survey, the value of the mica produced in that country in 1914 was £65,800. This is a decrease of £21,500 on that in 1913. The output of sheet mica amounted to 556,933 pounds, as compared with 1,700,677 pounds in 1913. There was also a decline in the unmanufactured and trimmed mica imported.

Long-Distance Wireless Telephony.—According to the "Telephone Engineer," Prof. M. J. Pupin recently expressed the opinion that in the very near future the wireless telephone will be used for all very-long distance conversation. Prof. Pupin, whose work on the development of long-distance telephony is well known, stated that [illegible] had invented an instrument for wireless telephony that, he felt confident, would make conversation possible over practically any distance.

Wireless Auxiliary to Telephone System.—The Pittsburgh & Alleghenny Telephone Co. has developed a wireless system as an aid to its business organisation. During bad storms the company's lines have repeatedly been blown down, isolating towns and aggravating the trouble by making it necessary to send reports or instructions by messengers. To ensure continuous direct communication with the various districts, therefore, a main wireless station has been established at Pittsburgh, Pa., and eight branch stations in Western Pennsylvania, Eastern and Central Ohio, and in West Virginia. The longest range is to Erie, Pa., which is 200 miles away.

Massachusetts Hydro-Electric Companies.—The hydro-electric power companies in Massachusetts, U.S.A., have now a total capitalisation of £3,000,000, as shown in the thirtieth annual report of the Gas and Electric Light Commission of the State. There are eight companies or groups, of which that serving the largest area is the New England Power Group. In this group are the Connecticut River Power Co., owning a 20,000 kw. plant at Vernon in Vermont, and the New England Power Co., with four stations on the Deerfield River, totalling 21,000 kw. Another large group is the Turner's Falls Group, of which the generating company is the Turner's Falls Company, which owns a large hydro-electric plant on the Connecticut River, and will shortly put into operation another station of 36,000 kw.

Electric Soaking Pits for Steelworks.—In a Paper read before the Engineers' Society of Pennsylvania, Mr. T. F. Bailey, of the Electric Furnace Company of America, gave a review of the development of the electric furnace in the United States. He mentioned as a type of furnace with a great future before it the electric soaking pit for steel ingots in rolling mills. Electric pits, he said, showed a great saving in cost of operation as compared with gas-fired pits for the same work. He gave some calculated results for a pan hole [illegible] for heating 16 3½-ton ingots, through which 648 tons passed in 24 hours. When the ingots are stripped hot and the interior is still molten the energy required would be less than 20 kw.-hours per ton of ingots. However, if the temperature was 1,650 deg. the consumption would be 100 kw. per ton. For cold ingots 315 kw.-hours per ton would be required. The author also dealt with reheating furnaces, for which, he said, the resistance type (in which the heating element is quite separate from the material heated) was of great use, because of the precision with which the temperature could be regulated, though the cost of heating was sometime higher than in combustion furnaces. He mentioned the automatic continuous type, in which the material treated when brought to the desired temperature is automatically discharged into the air or some other quenching medium.

Committee on Hours and Fatigue of Workers.—The prominence given to the question of the fatigue of munition workers at the meeting of the Economics Section of the British Association has evidently had its effect in official circles, for it was announced last Friday that the Minister of Munitions, with the concurrence of the Home Secretary, had appointed a Committee "to consider and advise on questions of industrial fatigue, hours of labour and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops." The Committee will consist of the following members :—

Sir George Newman, M.D., Chairman.
Sir Thomas Barlow, Bt., K.C.V.O., F.R.S.
Mr. G. Bellhouse, Factory Dept., Home Office.
Prof. A. E. Boycott, M.D., F.R.S.
Mr. J. R. Clynes, M.P.
Mr. E. L. Collis, M.B., Factory Dept., Home Office.
Mr. W. M. Fletcher, M.D., F.R.S., secretary of Medical Research Committee.
Mr. Leonard E. Hill, M.B., F.R.S.
Mr. Samuel Osborn, J.P., Sheffield.
Miss R. E. Squire, Factory Dept., Home Office.
Mrs. H. J. Tennant.

Mr. E. H. Pelham has been appointed secretary to the Committee, which will hold its meetings at the offices of the Board of Education. All communications should, therefore, be made to Mr. Pelham at this address.

Current Topics.

Subjects of current interest dealt with in this issue include the following :—

We give a full description of the large electric winder installed at the Cwm colliery of the Great Western Colliery Co. (p. 909). Our Leading Article deals generally with electric winders (p. 920).

Dr. C. C. Garrard continues his article on "Apparatus for Protecting Electrical Machinery Against Abnormal Electrical Conditions" (p. 916).

We give an account of the radiotelegraphic investigations undertaken by the Committee of the British Association (p. 907).

We publish a Paper on "Electric Oscillations in Coupled Circuits, a Class of Particular Cases," by Dr. W. H. Eccles and Mr. A. J. Makower, which was read before the British Association (p. 905).

A full abstract is given of a Paper on "Four Years' Operating Experience on a High-tension Transmission Line," by Mr. A. Bang (p. 922).

We publish a description of the Siemens Schuckert Quick Regulator, by Mr. G. E. Grau (p. 918).

OBITUARY.

JOHN GARDNER.—We regret to record the death of Mr. John Gardner, who had been manager of the Chester Corporation tramways since their inauguration in 1903.

WILLIAM H. H. HUDSON.—We also regret to announce the death of Mr. William Henry Hoar Hudson at Croydon on Tuesday last. He was formerly Professor of Mathematics at King's College, London. At St. John's, Cambridge, he was third Wrangler in 1861, and next year was elected to a Fellowship at St. John's, which he held until 1875. After being Mathematical Lecturer at his college from 1869 to 1881, he was appointed to the King's College chair of mathematics, in 1882, which he occupied until 1903. He has written several mathematical works.

KILLED IN ACTION.—Principal Sir Oliver J. Lodge and Lady Lodge will receive universal sympathy in their bereavement caused by the death of their youngest son, a lieutenant, in Belgium. He was aged 26. Second-Lieut. Raymond Lodge belonged to the 3rd but was attached to the 2nd South Lancashire Regiment. He had passed through a course of engineering at Birmingham University, and was a member of the firm of Lodge Bros. & Co., Birmingham.

Trooper Osborn K. Fowler, of the Royal Gloucester Hussars, who was killed at the Dardanelles on Aug. 21, was engaged at the Gloucester Corporation Electricity Works. After serving his apprenticeship with Messrs. W. Sisson & Co., he went to the Stratford-on-Avon Electricity Works, but after a time returned to Gloucester.

Mr. A. N. S. Knight, B.Sc., a shift engineer at Burton-on-Trent Electricity Works, was killed in Flanders on July 30.

PERSONAL.

Sir H. F. Donaldson, K.C.B., has temporarily vacated his position as Chief Superintendent of Ordnance Factories to act for the time as Technical Adviser to the Minister of Munitions.

Mr. Vincent L. Raven, who recently resigned the position of Chief Mechanical Engineer of the North-Eastern Railway to take up important work under the Ministry of Munitions, has been appointed Chief Superintendent of Ordnance Factories, at Woolwich, in succession to Sir H. F. Donaldson.

We are pleased to learn that Mr. Herbert H. Berry, of Messrs. Berry, Skinner & Co., has now returned to the office after an absence of nearly 18 months through illness due to an accident.

APPOINTMENTS VACANT AND FILLED.

An electrician (used to construction and repair of small dynamos and motors) is wanted by a Leeds firm. *See advertisement.*

A switchboard attendant is required at Derby. Applications to Borough Electrical Engineer, Full-street, Derby. *See advertisement.*

Vacancies exist at Crosshaven Camp, co. Cork, for an engine-driver (£2 per week) and a wireman-linesman (30s. per week); and for an engine-driver (£1. 10s. per week) for the Aghada Camp, co. Cork. Applications in the case of the vacancies at Crosshaven Camp to the Division Officer, Royal Engineers, Fort Camden, near Crosshaven, co. Cork; and in the case of the Aghada vacancy to the Division Officer, Royal Engineers, Aghada, co. Cork. *See an advertisement.*

District electrical a d mechanical engineers are required for military hutment camps; also an assistant engineer, linesman jointer, fitter-drivers, fitters, wiremen, engine-drivers and switchboard attendant. Applications to the Chief Engineer, Southern Command, Salisbury.

A professor of organic chemistry (pure and applied) is required for the University of Sydney. Salary £900. Particulars from the Agent-General for New South Wales, 123, Cannon-street, London, E.C., to whom applications m s be sent by Oct. 13.

Shanghai Municipal Council require a chief assistant clerk and accountant for their electricity department. Salary 400 taels (about £46) per month. Applications, with copies of testimonials, &c., to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., by Tuesday, Sept. 28.

A mechanical engineer is wanted for the tramway power house of the Chatham & District Light Railways Co. Commencing salary £2.15s. per week with 2s. war bonus. Applications to the Company, Power Station, Chatham.

Mr. J. R. Groves, manager of the Worcester Tramways, has been appointed general manager of the Gravesend & Northfleet Electric Traction Co.

Mr. H. Hooper, senior charge engineer at Walthamstow electricity works, has resigned, and Mr. A. R. Manwaring, switchboard attendant, is to be promoted to fill the vacancy at 40s. per week, rising by 2s. 6d. annually to 50s.

Mr. M. C. Henderson was recently promoted from the position of assistant electrical engineer to that of city electrical engineer of Dunedin (N.Z.). Mr. G. T. Edgar, draughtsman, has been appointed assistant electrical engineer.

INSTITUTIONS AND SOCIETIES.

Institution of Mining Engineers.—At the annual general meeting of the Institution held at Leeds on Sept. 15, the Institution medal for the year was presented to Dr. J. S. Haldane, F.R.S., in recognition of his investigations in connection with mine air. The new President, Sir T. H. Holland, K.C.I.E., F.R.S., in presenting the medal said that Dr. Haldane's work had a great scientific as well as a humanitarian value. He mentioned Dr. Haldane's new method of blood-gas analysis, and how much his researches had done towards the improvement of the self-contained rescue apparatus. Dr. Haldane had also done a great amount for workers in other dangerous occupations. In acknowledging the award Dr. Haldane said that nothing gave greater pleasure to men engaged in pure science than to see their work applied in a practical way to the benefit of humanity. Among the papers read at the meeting was one by Mr. M. H. Mills on the use of gas producers or engines for obtaining power and by-products from mond gas fuel. Mr. Mills said that there was evidence that low-grade coal could be gasified and the gas sufficiently purified for heating and power purposes. To utilise our coalfields in the most economical manner we must make use of the possibilities of the gas engine and gas producer for turning this otherwise unsaleable coal into power at a very low cost.

Municipal Tramways Association.—The annual conference of this association commenced yesterday (Thursday) and will be continued to-day. It is being held at the Surveyors' Institution, Great George-street, London, S.W. Yesterday the presidential address was delivered by Alderman H. Linsley, J.P., the chairman of the Salford Corporation Tramways Committee, who spoke of the useful work undertaken by the Council of the Association during the year and of the effect of the war upon tramways. He stated that over 16,000 (or 30 per cent.) of municipal tramway employés had joined the Army, and that the war service allowances had amounted to £380,000. Referring to female labour, he mentioned that upwards of 1,700 women are at present engaged in traffic work alone in connection with our municipal tramways. The address was followed by a discussion on "Tramway Labour Problems as Affected by the War," opened by Mr. J. Dalrymple, general manager of the Glasgow Corporation tramways. After lunch a discussion took place on "Financial Problems as Affecting Tramways during War Time," the subject being introduced by Mr. A. Baker, general manager of the Birmingham Corporation tramways. To-day will be devoted to a business meeting. There will be no social functions this year. We hope to publish the Papers and a report of the discussions in our next issue.

Institute of Metals.—The thirteenth half-yearly volume of the "Journal" of the Institute of Metals has recently been published. For the most part the volume is a record of the Papers read at the recent London meeting of the Institute, and of the discussion that took place then, and subsequently by correspondence, on these Papers. There is also an important communication on "Bronzing Processes Suitable for Brass and Copper," read before the Birmingham Section. The section of the book containing international abstracts of scientific and practical Papers dealing with copper, brass and other non-ferrous metals is remarkably complete, and contains much information on electro-metallurgy, electro-chemistry, electric furnaces and pyrometry. The membership list, which includes 636 names, is noteworthy in that it now contains no names of German or Austro-Hungarian members, as the membership of these is suspended during the war. The Institute is also affected temporarily by the patriotism of 12 per cent. of its members whose names are given in a roll of honour in the "Journal." The volume is published by the Institute of Metals, Caxton House, Westminster, S.W., price 21s. net. The autumn meeting of the institute was held on Friday evening when the chair was taken by the president, Admiral Sir Henry Oram, Engineer-in-Chief of the Fleet. Mr. W. B. Parker read a Paper on "Specifications for Alloys for High-speed Superheated Steam Turbine Blading," in which he traced the development of metals used for this purpose, and gave practical suggestions for specifications. Dr. C. H. Desch presented a Paper on "The Micro-Chemistry of Corrosion," written in collaboration with Mr. H. Hyman, bringing forth many interesting facts in connection with the electrolytic method of accelerated corrosion. Mr. C. H. Tonamy described his method of "Detection of Internal Blowholes in Metal Castings by Means of X-rays," giving several photographs to show the success he had obtained. Two Papers were also read on brasses containing tin, one by Prof. S. L. Hoyt, and the other by Dr. O. F. Hudson and Mr. R. M. Jones.

ARRANGEMENTS FOR THE WEEK.

TUESDAY, September 28th.

ASSOCIATION OF SUPERVISING ELECTRICIANS.

8.0 *p.m.* Presidential Address by Mr. A. H. Dykes, M.I.E.E., at St. Bride's Institute, Ludgate-circus, E.C.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week commencing September 27th:—

Drills: 6:30 to 7:30, 7:30 to 8:30 p.m.

Monday, September 27th.—Section 1, Technical; Section 3, Squad. Signalling Class.

Tuesday, September 28th.—Section 2, Technical; Section 4, Shooting.

Thursday, September 30.—Section 3, Technical; Section 1, Shooting.

Friday, October 1st.—Section 4, Technical; Section 2, Squad. Signalling Class.

Saturday, October 2nd.—Company Parade 2.30 p.m.; Route March.

ELECTRIC OSCILLATIONS IN COUPLED CIRCUITS—A CLASS OF PARTICULAR CASES.*

BY W. H. ECCLES, D.Sc., AND A. J. MAKOWER, M.A.

Summary. The conditions are investigated under which circuits coupled electrically and magnetically may give rise to oscillations of a single frequency.

The investigations that form the subject of this Paper arose during an examination of methods of coupling that might give rise to single-frequency oscillations.

The use of circuits coupled both electrically and magnetically made it advisable to carry out the calculations in terms of the inductances and capacities of the circuits rather than in terms of the coupling coefficients that are commonly used. It will be shown that in some of the cases both methods of notation lead to the same results with equal ease, but that in other cases the definition of the "coupling coefficient" becomes a matter of some difficulty. This will be seen by referring to Fig. 1, in which each capacity and inductance may be regarded as being common to several circuits. The difficulty is not removed by drawing the circuits in equivalent manners as shown in Fig. 2, or in three dimensions in Fig. 3.

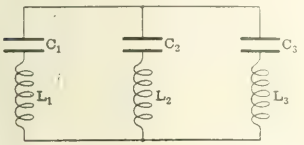


FIG. 1.

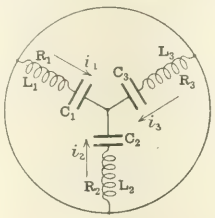


FIG. 2.

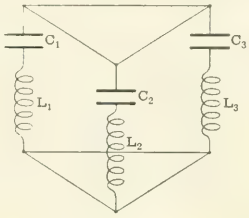


FIG. 3.

Let $\zeta_1 = L_1D + R_1 + \frac{1}{C_1D}$, where $D = \frac{d}{dt}$, be the resistance operator of the branch 1 (Fig. 2), with similar expressions for the branches 2 and 3, then, if an E.M.F. e act in the branch 1, the current flowing will be given by :—

$$i_1 = \frac{1}{\zeta_1 + \frac{\zeta_2\zeta_3}{\zeta_2+\zeta_3}} e = \frac{\zeta_2+\zeta_3}{\Sigma(\zeta_1\zeta_2)} \cdot e$$

and $i_2 = -\frac{\zeta_3}{\zeta_2+\zeta_3} i_1 = -\frac{\zeta_3}{\Sigma(\zeta_1\zeta_2)} e$, with a similar expression for i_3.

The equation giving the frequency of the oscillations produced is $\Sigma(\zeta_1\zeta_2)=0$, or, neglecting the resistances,

$$\Sigma(L_1L_2)D^2 + \Sigma\left(\frac{L_1}{C_2}\right) + \Sigma\left(\frac{1}{C_1C_2}\right)\frac{1}{D^2} = 0 \quad . \quad . \quad . \quad . \quad (1)$$

where $\Sigma\left(\frac{L_1}{C_2}\right) = \frac{L_1}{C_2} + \frac{L_1}{C_3} + \frac{L_2}{C_3} + \frac{L_2}{C_1} + \frac{L_3}{C_1} + \frac{L_3}{C_2}$

and $D^2 = -\omega^2$; $\frac{\omega}{2\pi}$ being either oscillation frequency.

Solving for ω we get

$$\omega^2 = \frac{\Sigma\left(\frac{L_1}{C_2}\right) \pm \sqrt{\left\{\left[\Sigma\left(\frac{L_1}{C_2}\right)\right]^2 - 4\Sigma(L_1L_2)\Sigma\left(\frac{1}{C_1C_2}\right)\right\}}}{2\Sigma(L_1L_2)}$$

The expression under the radical sign may be written

$$A = \alpha^2 + \beta^2 + \gamma^2 - 2\beta\gamma - 2\gamma\alpha - 2\alpha\beta \quad , \quad . \quad . \quad . \quad . \quad (2)$$

where $\alpha = \frac{L_2}{C_3} - \frac{L_3}{C_2}$, with similar equations for β and γ.

The cases when the expression (2) is a perfect square have special interest and form the subject matter of this Paper. This condition is satisfied if α, β or γ vanishes.

Suppose that $\beta = 0$, then $L_2C_2 = L_3C_3 = 1/g$ (say) and the branches 2 and 3 are tuned.

We now get $\omega^2 = \left(\frac{L_2}{C_1} + \frac{L_2}{C_3} + \frac{L_3}{C_1}\right) \div \Sigma(L_1L_2) = G$ (say). . . . (3)

or $= \left(\frac{L_2}{C_1} + \frac{L_3}{C_3} + \frac{L_1}{C_2}\right) \div \Sigma(L_1L_2) = G'$ (say) . . . . (4)

* A Paper read before Section G of the British Association.

These two equations are now seen to have a plain physical meaning, for the equations (3) and (4) may be transformed as follows :—

$$G = \left(\frac{1}{C_1} + \frac{1}{C_2+C_3}\right) \div \left(L_1 + \frac{L_2L_3}{L_2+L_3}\right) \quad . \quad . \quad . \quad . \quad (5)$$

$$G' = \frac{1}{L_2C_2} = \frac{1}{L_3C_3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

whence it appears that the resultant oscillation is compounded of (i.) the oscillation in the circuit made up of the branch 1 in series with the tuned parallel branches 2 and 3, and (ii.) the oscillation in the circuit formed by the two tuned branches 2 and 3.

It is interesting to note from the equation for G that two parallel tuned branches are equivalent to a single circuit containing the inductance and capacity formed by separately connecting the inductances and capacities of the branch circuits in parallel.

To obtain the conditions for only a single-frequency oscillation to exist in a combination of three branches as shown in Figs. 1, 2 and 3, we must put $A = 0$ in equation (2). Solving for α we get $\alpha = \beta + \gamma \pm 2\sqrt{\beta\gamma}$.

Suppose $L_1C_1 > \text{or} = L_2C_2 > \text{or} = L_3C_3$, then $\alpha > \text{or} = 0$, $\beta < \text{or} = 0$, and $\gamma > \text{or} = 0$. If α is real, then $\beta\gamma$ must be $> \text{or} = 0$. With the conditions stated this can only be the case if β or $\gamma = 0$. If $\beta = 0$, then $\alpha = \gamma$. We must thus have

$$\frac{L_3}{C_1} - \frac{L_1}{C_3} = 0, \text{ and } \frac{L_2}{C_3} - \frac{L_3}{C_2} = \frac{L_1}{C_2} - \frac{L_2}{C_1}.$$

From the last two equations it follows that $\alpha = \beta = \gamma = 0$. Similarly, if $\gamma = 0$, we can show that $\alpha = \beta = \gamma = 0$. Thus, it has been shown that for a single-frequency oscillation to be obtained we must have $L_1C_1 = L_2C_2 = L_3C_3$, or the three branches must be separately tuned to the same frequency.

In order to introduce the conception of "coupling coefficients" we shall consider the circuits from a different point of view.

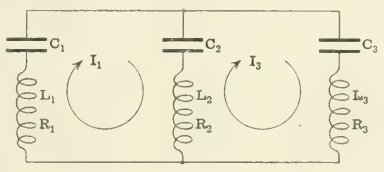


FIG. 4.

Let us suppose, as before, that the E.M.F. e is acting in the branch 1, and let us regard the branch 2 as being the common or coupling branch. If the mesh currents be I_1 and I_3 (Fig. 4) and $l_1 = L_1 + L_2$, $l_3 = L_3 + L_2$ and $C_1' = \frac{C_1C_2}{C_1+C_2}$, $C_3' = \frac{C_2C_3}{C_2+C_3}$, we have, by an extension of Ohm's law,

$$\left(l_1D + R_1 + R_2 + \frac{1}{C_1'D}\right) I_1 - \left(L_2D + R_2 + \frac{1}{C_2D}\right) I_3 = e \quad . \quad . \quad (7)$$

$$\left(l_3D + R_3 + R_2 + \frac{1}{C_3'D}\right) I_3 - \left(L_2D + R_2 + \frac{1}{C_2D}\right) I_1 = 0 \quad . \quad . \quad (8)$$

Neglecting the damping by putting $R_1 = R_2 = R_3 = 0$, the equation giving the frequencies of the oscillations produced is :—

$$\left(l_1D + \frac{1}{C_1'D}\right)\left(l_3D + \frac{1}{C_3'D}\right) - \left(L_2D + \frac{1}{C_2D}\right)^2 = 0, \quad . \quad (9)$$

where $D^2 = -\omega^2$; $\frac{\omega}{2\pi}$ being either oscillation frequency.

Thus.

$$\left(1 - \frac{L_2^2}{l_1l_3}\right)\omega^4 - \left(\frac{1}{l_1C_1'} + \frac{1}{l_3C_3'} - \frac{2L_2}{l_1l_3C_2}\right)\omega^2 + \frac{1}{l_1C_1'l_3C_3'}\left(1 - \frac{C_1'C_3'}{C_2^2}\right) = 0.$$

$$\frac{1}{\quad} \qquad \frac{1}{\quad}$$

$$k_m = \sqrt{\frac{L_2'}{\quad}} \text{ (the coefficient of magnetic coupling)} \quad . \quad . \quad . \quad (10)$$

$$\sqrt{C_1 C_2'} \quad . \quad . \quad . \quad (11)$$

$$2\pi \sqrt{\quad} \quad . \quad . \quad . \quad (12)$$

If the branches 1 and 3 are tuned, we have

$$\sqrt{1 - k_e} \qquad \sqrt{1 - k_e}$$

If λ_1 and λ_2 are the wave-lengths of the compound oscillation, and λ_0 the wave-length of the oscillation that would be produced in either side branch in series with the coupling branch (with the remaining branch removed),

$$\lambda_1 = \lambda_0 \sqrt{\frac{1 - k_m}{1 - k_e}}, \text{ and } \lambda_2 = \lambda_0 \sqrt{\frac{1 + k_m}{1 - k_e}} \quad . \quad . \quad . \quad (13)$$

In the experimental portion of this Paper two special cases I. and II. are considered in which the branches 1 and 3 are identical, with $C_1 = C = C_2$ and $L_1 = L = L_3$.

Case I.—In this case $L_2 = o$, the coupling being purely electrical.

From equations (13), putting $k_m = o$, we get

$$\lambda_2 = \lambda \sqrt{1 - k_e} \text{ and } \lambda_1 = \lambda_0 \sqrt{(1 - k_e)} \quad . \quad . \quad . \quad . \quad (14)$$

with $k_e = \frac{C}{C - C_2}$ and $\lambda_0 = 2\pi \sqrt{\left(L \frac{CC_2}{C - C_2}\right)}$

$$\therefore \lambda_1 = 2\pi \sqrt{\left(LC \frac{C}{2C - C_2}\right)} \text{ and } \lambda_2 = 2\pi \sqrt{LC} \quad . \quad . \quad . \quad (15)$$

The wave-length λ_2 will, therefore, be constant and independent of the value of C_2.

The equations (14) may also be obtained from the equations (3) and (4) by inserting the special values of the case under consideration, namely

$$C_1 = C = C_3 : L_1 = L = L_3 \text{ and } L_2 = o.$$

With these substitutions we get

$$= \left(\frac{2L \quad L}{C_2 \quad C}\right) \Big/ L \quad \text{or} \quad \frac{L}{L_2}.$$

$$= \frac{2C - C_2}{L \quad C} \quad \text{or} \quad \frac{1}{LC}$$

$$\therefore \lambda = \frac{2\pi}{\quad} \quad 2\pi \sqrt{\left(LC \frac{1}{2C - C_2}\right)} \text{ and } \lambda_2 = 2\pi \sqrt{LC}.$$

as already obtained in equations (15).

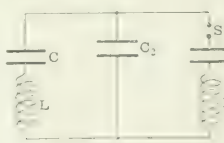


FIG. ...

From equations (13), putting $k_e = 0$, we get

$$\quad . \quad . \quad . \quad (16)$$

$$\sqrt{\left(\frac{\quad}{\quad}\right)} \quad . \quad . \quad . \quad (18)$$

These relations would hold although they did not allow for damping.

branch measured by a capacity-inductance circuit, containing a thermo-galvanometer loosely coupled to the inductance in series with [illegible]. For [illegible] were made of (1) the two wave-lengths λ_1 and λ_2 existing when all three branches were connected, and (2) the single wave-length λ_0 existing when one of the side branches was disconnected.

The values obtained are given in Table I. and Fig. 6.

Taking the measured values of λ_1, λ_2 and λ_0, the coupling coefficients k_e was determined from the test from the equations (14) which gave

$$\lambda \left(\frac{1 \quad 1}{\lambda - \lambda}\right)$$

For [illegible] were calculated from the equations (15) and (16) respectively. λ_1 [illegible] and the value of k_e

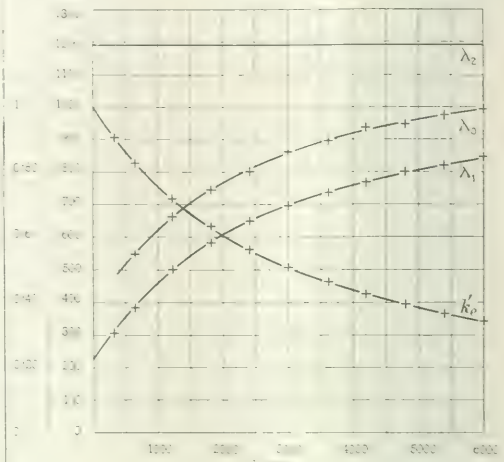


FIG. 6.

calculated from the known values of the capacities in the three circuits was also worked out from the relation

$$3{,}100$$

$$3{,}100 +$$

Table I.

C_2(cm.)	330	650	1,230	1,820	2,420	3,000	3,620	4,200	4,800	5,400	6,000
[illegible]	392	382	500	580	646	696	734	766	799	820	844
[illegible]	266	365	485	564	627	680	736	735	791	811	835
λ_2(m.)	1,190	1,190	1,190	1,190	1,190	1,190	1,190	1,190	1,190	1,190	1,190
λ_0(m.)	1,185	1,185	1,185	1,185	1,185	1,185	1,185	1,185	1,185	1,185	1,185
[illegible]	...	544	661	743	800	860	892	935	943	974	990
[illegible]	...	0·911	0·720	0·630	0·545	0·500	0·459	0·436	0·385	0·369	0·340
[illegible]	0·903	0·827	0·717	0·631	0·562	0·508	0·461	0·424	0·393	0·365	0·341

The above table corroborates the theory by showing the constancy of the one wave-length λ_2, and by exhibiting a very close [illegible] although the damping is neglected in the formulæ employed.

[illegible] gave the figure

Case II.—In order to check the theory further, it was applied to the case of pure magnetic coupling as shown in Fig. 7 with equal capacities, $C = 3{,}100$ cm. and inductances $L = 115{,}000$ cm. in the sides and an inductance aL in the middle. Various values of a were chosen, and the wave-lengths of the resulting oscillations observed [illegible] $L_1 = L_3 = L$ and $L_2 = aL$.

We thus obtain the equation—

$$\quad \quad \frac{1}{L} \quad \frac{1}{L}$$

whence

$$\frac{1}{\quad} \quad \frac{1}{L}$$

with [illegible] results

$$\lambda = 2\pi \sqrt{\quad} \text{ and } \lambda_2 = 2\pi \sqrt{LC}.$$

These values will be seen [illegible] would be obtained [illegible] Comparing the calculation with the test for three separate values of a we get the figures in Table II.

Table II.

a	[illegible]	Experiment.	[illegible]	Experiment.
0·436	1,620	1,580	1,185	1,170
1·00	2,050	2,050	1,185	1,210
2·87	3,090	2,910	1,185	1,230

A further comparison of the theory with the experimental results is obtained by putting in equations (16) the value of λ_0 determined from equations (17) and obtaining by a transformation of equations (16) a value of the coupling coefficient

$$k = \frac{\lambda_1^2 - \lambda^2}{2\lambda^2 + \lambda_1^2 - \lambda^2}$$

and comparing it with another value of the coupling coefficient obtained from equation (17) giving

$$k = \frac{L_1}{L_2}$$

The results obtained by putting in the numerical values are given in Table III. :—

Table III.

a	λ_0	k	k'
0·436	1,390	0·308	0·304
1·00	1,640	0·498	0·500
2·87	2,280	0·754	0·743

Another interesting case investigated was the one in which the three branches are separately tuned to have the same frequency, but with different values of the capacity and inductance in each. This corresponds to the relation $\alpha=\beta=\gamma=o$, for which values a single-frequency oscillation should be produced equal to the oscillation frequencyof each branch alone. This was confirmed by experiment.

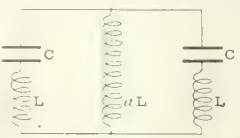


Fig. 7.

Besides this case, in which the two resultant frequencies are brought into coincidence, there are a number of possible values for the constants of the three branches that give rise to practically single-wave oscillations in one of the branches not containing the spark owing to the amplitude of one of the oscillations being very small.

For instance, in the case where $\alpha=1$ in Table II. it was found that in the middle branch the oscillation with the longer wave-length possessed about 10 times the energy of the one with the shorter, although their amplitudes were about equal in the side branches.

In conclusion, it is worthy of record that when working with tuned branches 1 and 3, the branch 2 could be brought into tune with these by listening to the sound of the spark situated in one of the branches 1 or 3. When the three branches were brought into tune by gradual alteration of one, the tone of the spark changed from a low buzzing note to a high hissing note, perhaps on account of the disappearance of beating oscillations.

RADIOTELEGRAPHIC INVESTIGATIONS.*

The war has had a very direct effect on radiotelegraphic investigations. About the beginning of August, 1914, private wireless telegraph stations throughout the Empire nearly all stopped collecting statistics, while naval and other Government stations stopped all merely scientific observing. The radiotelegraphic stations in Russia, Germany and neighbouring countries doubtless discontinued the filling up of our forms as soon as mobilisation began. A few stations in India, Australia, Canada, the West Indies and the United States are, however, still at work. In the last-named country about 30 [illegible]

The Committee's programme for the collection of statistics three [illegible] other countries, was planned to embrace one complete round of the seasons. The fact that the programme has been interrupted after only three months of work diminishes greatly the scientific value of such statistics as have been collected. It also implies considerable financial loss. A large batch of forms was distributed to our Navy in July; in clearing for action these Forms would probably be wasted. The German edition was distributed in June. The Russian edition also was probably distributed before the outbreak of war.

The extensive scheme of special observations projected for the occasion of the solar eclipse failed almost completely in the countries in which the eclipse was visible. A small amount of work was done in Norway and Sweden. All the necessary forms had been printed, and some had been circulated, before the war started. The financial loss to the Committee in this respect exceeds a hundred pounds.

The day-by-day statistics collected in the period April to July have been partially analysed. The conclusions drawn from these observations are described below. Apart from any scientific value they possess, they yield information which will guide the Committee, when the time comes, to further attacks on the problems concerned. A similar thought may be set down as consolation for the eclipse failure.

Analysis of Records of Strays.

Diurnal Variations.—The principal and most universal fact is that the strays heard in the dark hours are much more numerous and louder than those heard during daylight. If curves be drawn showing the mount of disturbance to telegraphic work from hour to hour, two types of curve stand out: One in which the changes from day to night and night to day conditions are somewhat abrupt, and another in which the changes are much more gradual. The former curves might be called "trough shaped," the latter "U shaped." The former type is met with at sea and on islands at a considerable distance from the mainland, the other on the mainland, especially in the tropics. The lowest point of the U or of the trough usually falls a little after midday, and the highest point of the convex part of the curve occurs a little after midnight, in nearly all stations north of the Equator. The only exception to this rule is found in some records from Lagos, Nigeria, where the curve showing the intensity of disturbance is lowest about seven in the morning and rises during the daylight hours. Unless local weather conditions are producing great disturbance, the change from night to day conditions and vice versa in stations north of the Equator lags behind the sunrise and the sunset. At some stations south of the Equator—*e.g.*, Cocos Island—the opposite rule seems to be usual. These regular and universal diurnal variations have an average magnitude which is represented on the arbitrary scale used in the forms by figures like 2 in the day and 5 at night in tropical latitudes, or 0·3 in the day and 3 at night in temperate latitudes. These figures are greatly affected by local meteorological conditions, which, in fact, frequently overwhelm all the statements set forth above.

Periods of Excessive Disturbance.—Occasionally the radiotelegraphic work at a station is rendered almost or quite impossible for a period by strays of vigour and number greatly exceeding the average. These occurrences are for brevity called "X storms," the term "X" being an alternative designation for "stray" or "atmospheric." When an X storm happens in the day and lasts more than an hour or two, it may completely alter the character of the curve of that day's disturbances, and even make the day portion of the curve higher than the night portion. An analysis of the records has shown that X storms occur within the same two or three days over very wide areas. Occasionally X storms are reported almost simultaneously at places several hundred miles apart, but more usually the X storms occurring at such distances are separated by several hours. Some of the European, American and Canadian X storms have been compared with the meteorological records and charts for the two continents. The comparison has shown very plainly that periods of severe strays coincide with periods of low barometer, high wind velocity, rapid change of temperature, great rainfall, and, especially, rapid barometer fluctuations. In low latitudes the barometer fluctuations during violent X storms can usually be followed on any ordinary instrument. The worst X storm in the European records was accompanied by the rapid movement of a low-pressure system in a north-easterly direction. In 24 hours the eye of the cyclone moved [illegible] another 24 hours into the Gulf of Bothnia. The worst X storm in the American records was also accompanied by the exceptionally rapid movement eastward from the Pacific of a cyclonic depression with steep pressure gradients. A report from a Californian station of the Marconi Wireless Telegraph Co. of America on this latter occasion states that the barometer was fluctuating between 29·44 in. and 29·52 in. very rapidly, the variations being accompanied by gusts of wind which attained the velocity of 70 miles per hour. The disturbance produced in the telephones by the strays amounted to a roar. On this occasion, between 1 p.m. and night, the strays rapidly diminished as the wind fell and the barometer rose. These meteorological conditions are precisely those that accompany or precede

* [illegible] Dr. W. H. [illegible] Prof. J. A. Fleming, C.B., W. G. Rhodes, H.M. [illegible] Capt. H. R. Sankey, Prof. [illegible] Shaw, Prof. S. P. Thompson and Prof. H. H. Turner.

thunderstorms and line squalls; and, in fact, the records of the Meteorological Offices, and of the observers reporting to the Committee, all lead to the conclusion that X storms are often associated with thunderstorms at places not very far distant. Sometimes all the symptoms of thunder weather, except thunder and lightning, may be present in a locality and a heavy X storm be recorded.

It is well known that the unstable atmospheric conditions bringing thunder weather,sometimes move at a relatively slow rate from place to place, and may have their movements traced by the ordinary methods of meteorology. The analysis of the radiotelegraphic records shows that such convective weather can be anticipated several days in advance. A report received from the wireless telegraph station of the Government of Australia, situated at Esperance, states that during the daytime rain is preceded in at least 80 per cent. of cases by intermittent disturbances.

This conclusion is borne out in other ways by some of the records forwarded to the Committee. There is evidence that north-west winds on our Atlantic coasts, especially in the winter, are associated with strong strays at Irish stations and at sea. The atmospheric convection produced by the land may be sufficient to account for this. It may be mentioned here as very significant that the months of the greatest X storms in the Mediterranean are shown by the recods to be September and October, the months of cyclonic weather.

As a whole the statistics show that there appear to be two kinds of X storm occurring in the daytime: (1) Those produced by convective conditions in the atmosphere within, perhaps, 100 miles of the station, which may be termed local X storms; (2) those originating at a distance. Regarding the first class, they may occur almost simultaneously over a whole continent, but this is only because convective conditions happen to be ruling all over that area. Stations not too far outside the boundary of such a region also receive many strays, but apparently their distance must be limited to within 200 miles of the disturbed regions. In general, we may conclude that the observation of strays in the daytime constitutes a method of feeling the fringe of a region of convective weather, and so anticipating thunder and rain a day or two in advance. Of course, this ability to prophesy the advent of thunder weather is well known, and is as old as wireless telegraphy itself; but hitherto it has been thought that the electric discharges at a great distance were responsible for the strays heard at the station attempting to prophesy. The present analysis indicates, rather, that at any rate in the daytime the strays are frequently due to very local discharges, often too weak to give noticeable lightning or thunder, but definitely indicative of an approaching period of instability in the atmosphere.

The second kind of X storm is not of strictly local origin, but is sometimes traceable in the stray observations made hourly at the Malta station of the Eastern Telegraph Company, and the Sierra Leone station of the African Direct Telegraph Company. There is evidence that on certain occasions the same cause is affecting both stations, though they are separated by 2,500 miles, mostly across mountain and desert.

As regards disturbances observed at night-time, these are also frequently very local and due to convective weather, but there is probably a greater proportion of non-local storms than appears in the day records. In this connection may be noted a report from Australian stations that the worst and most continuous type of disturbance (apart from local thunderstorms) occurs on calm nights when the sky is blue and starry.

As a contrast to the prevalence of strays during convective weather may be instanced the fact, reported by Lieut. E. R. Macpherson from Sierra Leone, that a very dry wind which blows periodically for several days on the west coast of Africa causes an almost complete cessation of strays immediately it starts, and allows of their resumption immediately it stops. On the other hand, the monsoon period on the same coast is one marked by great X storms.

Auroral Displays and Strays.—By the kindness of General Geo. P. Scriven, chief signal officer of the United States Army, the Committee have been able to obtain reports from officers in the wireless stations of Alaska concerning the presence or absence of any connection between auroral displays and disturbances due to natural electric waves or atmospheric discharges. At six stations special observations have been made duting the later months of the past winter. Various types of aurora were watched, but nearly all the observers reported that the appearance or disappearance of auroræ caused no unusual disturbances.

The 27 Day Period of Magnetic Variations.—Such of the radiotelegraphic records as were suitable for the purpose have been examined with a view to detecting a 27 day period in the cases: days with many strays, nights with many strays, nights with few strays. No trace of this period or of any nearly equal period has as yet been found, but the matter cannot be regarded as settled till more numerous and more continuous records are available.

EFFICIENCY OF LOADED TELEPHONE LINES.

At the request of the Austrian Telegraph and Telephone Department, E. E. Detritsch, a Vienna telephone engineer, has made extensive comparative tests regarding the relative efficiency of telephone lines using Pupin coils and those without these coils, as also lines using Krarup coils. The following points of general interest were given in a recent number of the "Telephone Engineer":—

1. *Efficiency of Ordinary Telephone Lines.*—The lines measured showed in general about the same strength of wire—namely, 5, 4, 3·5 and 2·5 mm. (13/64, 5/32, 9/64 and 3/32 in., or 0·26, 0·15, 0·14 and 0·09 in.). The damping coefficients or damping effects found for these wires are as follows:—

13/64 in. wire, bronze wire	$\beta = 0{\cdot}0019$
5/32 in. wire, bronze wire	$\beta = 0{\cdot}0028$
9/64 in. wire, bronze wire	$\beta = 0{\cdot}0035$
1/8 in. wire, bronze wire	$\beta = 0{\cdot}0044$
3/32 in. wire, bronze wire	$\beta = 0{\cdot}0100$
5/64 in. wire, bronze wire	$\beta = 0{\cdot}0132$
1/16 in. wire, bronze wire	$\beta = 0{\cdot}0167$

The rapid rise of the damping effect when passing from 1/8 in. wire to the 3/32 in. wire is due to the fact that the thinner bronze wire necessitated the use of another bronze mixture than that used in the heavier wire, which resulted in a corresponding decrease in the specific conductivity of the wire. One obtains a good picture of the efficiency of the various conductors when relating the damping effect to that of a 5 mm. (13/64 in.) wire. The specific damping effect is $\beta = 0{\cdot}002$. It has to be determined, therefore, what damping effect per kilometre (0·62 mile) of the wire used is equivalent to the standard of comparison of the 5 mm. (13/64 in.) bronze wire. The table is as follows: The damping effect of 1 km. (0·62 mile) bronze wire of

4·0 mm. (11/64 in.)	bronze wire is equivalent to			1·47 km. (0·93 mile)
3·5 mm. (9/64 in.)	,,	,,	,,	1·84 km. (1·34 mile)
3·0 mm. (1/8 in.)	,,	,,	,,	2·30 km. (1·42 mile)
2·5 mm. (3/32 in.)	,,	,,	,,	5·30 km. (3·28 mile)
2·0 mm. (5/64 in.)	,,	,,	,,	6·90 km. (4·37 mile)
1·5 mm. (1/16 in.)	,,	,,	,,	8·80 km. (5·45 mile)

of 5 mm. (13/64 in. standard bronze wire.

2. *Efficiency of Ordinary Cables.*—There are three types of cables that are used by the Austrian department, two for party lines and ordinary telephone service with 0·8 mm. (1/32 in.) copper conductors, and the other with 0·6 mm. (approximately 1/32 in.) copper conductors. The other type is a Krarup cable used for very important telephone service, such as between large cities and special government lines. Here 2 mm. (3/32 in.) copper conductors are used, wound with 0·3 mm. (1/64 in.) iron wire. This type f cable is also used when communicating between the Vienna and suburban exchanges—*i.e.*, trunk wire service. The specific damping effect for the three cables is as follows:—

Krarup cables with 2·0 mm. (3/32 in.) conductors $\beta = 0{\cdot}0140$
Telephone cables with 0·8 mm. (1/32 in.) conductors $\beta = 0{\cdot}0750$
Telephone cables with 0·6 mm. (1/32 in.) conductors $\beta = 0{\cdot}1160$

The efficiency is somewhat better when a little heavier iron wire is used for winding around the conductors. The damping effect decreases slightly and the characteristic increases, which is of advantage to telephone service. If no iron wire is used the damping effect increases for a 2 mm. (3/32 in.) copper wire to 0·0260 and the characteristic drops down to the very unfavourable value of $Z = 243\, e^{-35^{\circ} 40'i}$. Special attention is called to the great damping effect of the ordinary telephone cables. The damping effect of 10 km. (6·2 miles) cable of 1/32 in. conductors is equivalent to that of 500 km. (310 miles) of 13/64 in. bronze wire, and the effect of 6·2 miles of 0·6 mm. (1/32 in.) copper line is equivalent to 610 km. (378 miles) of standard bronze wire. On the other hand, the damping effect of the Krarup cable is very slight, 1 km. (0·62 mile) being equivalent to only 7·3 km. (4·5 miles) of 5 mm. (13/64 in.) bronze wire. This damping effect is, therefore, much closer to that of a 2 mm. (3/32 in.) wire. This is due to the fact that the material used for this smaller bronze wire is of greater strength than that for the heavier wire, and therefore of almost double the resistance as the copper wire in the Krarup cable.

3. *Efficiency of Pupin Lines.*—The tests made with the telephone lines equipped with Pupin coils showed results which corresponded exactly with the theoretical computations. With Pupin coils of 0·1 henry self-inductance and an effective resistance of 5 ohm, a frequency such that $\omega = 5{,}000$ is obtained, if the coils are used at distances of 6·2 miles. The damping effects under these conditions were as follows:—

11/64 in. bronze wire	$\beta = 0{\cdot}0017$
9/64 in. bronze wire	$\beta = 0{\cdot}0020$
1/8 in. bronze wire	$\beta = 0{\cdot}0024$
3/32 in. bronze wire	$\beta = 0{\cdot}0048$

When compared to the damping effect of [illegible] 13/64 in.) bronze, the damping effect of Pupinised telephone lines is as follows:

11/64 in. bronze wire corresponds to the [illegible] 0·52 mile of 13/64 in. wire.

9/64 in. bronze wire corresponds to the [illegible] 0·62 mile of 13/64 in. wire.

1/8 in. bronze wire corresponds to the damping effect of 0·77 mile of 13/64 in. wire.

3/32 in. bronze wire corresponds to the damping effect of 1·55 mile of 3/64 in. wire.

It is, therefore, feasible to substitute telephone lines of 13/64 in. bronze wire up to lengths of 434 miles [illegible] wire, and for lengths of lines beyond 434 miles bronze wire of 11/64 in. thickness, provided Pupin coils are used.

Pupin Cables.—The specific damping effect of the Pupin cables in service is lower by almost half than that of Krarup cables having the same thickness copper conductors. The average damping effect of a Pupin cable is $\beta=0{\cdot}0068$, and 1 km. (0·62 mile) of such a cable has no greater damping effect than 3·5 km. (2·17 mile) of bronze wire of 5 mm. (13/64 in.) thickness.

Efficiency of Complex Lines.—In telephone lines made up of various types of lines the efficiency is always lowered by reflection losses. The magnitude of these losses stands in a certain definite relation to the difference in magnitude of the characteristics of the types of lines used in the telephone circuit. If these characteristics of the different types of lines are the same, then there are practically no reflection losses. For example, lines made up of 3 mm. and 4 mm. wire directly connected to a line of 5 mm. wire give no losses. On the other hand, to connect 2 mm. (3/32 in.) wire with another line of 5 mm. (13/64 in.) wire is dangerous, as the characteristic of the 3/32 in. line lies very near to 1,000, and is, therefore, much higher than that of the thicker wire line. The greatest losses are observed where lines with greatly varying characteristics are connected, as the line Triest–Zara, where long stretches have Krarup gutta-percha cables with a characteristic of 300 connected to 5 mm. (13/64 in.) wires with a characteristic of 600, the losses being 0·35220 at $\omega=5{,}000$. Like great losses are noticed on the line Vienna-Bielitz, where Pupin loaded wires with a characteristic of 1,400 are connected to Krarup cables with a characteristic of 400, the losses being 0·21525 with $\omega=5{,}000$. Even when connecting Pupin cables direct to telephone wires the reflection losses are so great that the advantages of these cables through their low damping effect are lost again. These losses are not so great when Krarup cables are connected to heavy uncovered telephone wires. No losses at all are noticed when open wires are connected to the ordinary telephone cables, which is to be expected, since the characteristic of the copper conductors in the cable of 0·8 mm. (1/32 in.) diameter have a characteristic of 590, which is about the same as that of heavier uncovered wires. It would seem from the observations that Krarup cables or ordinary telephone cables can be connected to uncovered ordinary telephone wires as described, without disturbance of the various electric factors. On the other hand, connection of Pupin loaded telephone lines to Krarup cables or of Pupin cables to telephone lines must be avoided.

General Principles for Pupinisation of Lines.—The reflection losses that occur when Krarup cables are connected to pupinised telephone lines are so great that they must be watched in the case of lines whose total damping effect is $\beta_1=1$. With increasing length of the pupinised line this fact becomes less noticeable, as the losses are distributed over a greater number of miles. The increase of efficiency through the Pupin coils would then be the greater factor.

Pupinisation of uncovered telephone lines is only advisable for long lines whose damping effect (β_1) without Pupin coils is at least 2 to 2·5. In this case the gain would be from $\beta_1=1{\cdot}0$. Pupin lines should always be used for direct long-distance lines without intermediate stations—*i.e.*, between large cities having direct telephone connection. The connection of cables of low characteristic within pupinised lines should be avoided and the line should be as uniform in character as regards thickness and material of wires as possible.

It was finally attempted to eliminate the bad effects in reflection losses noticed when connecting pupinised uncovered lines to Krarup cables by various means. It was found possible to load cables having fairly heavy conductors with self-inductances in such a way that they were given a characteristic which made them suitable for connection to Pupin lines as well as to ordinary lines. The coils need not be built in at special points either, although a certain systematic construction is advisable. There are no objections to loading Krarup cables with Pupin coils. The Krarup cables have an artificially increased self-inductance, and it would be sufficient to insert every 3 to 3·5 miles a Pupin coil of 0·2 [illegible] inductance in order to raise the characteristic of the cable from 300 to 500 or 600 and decrease the damping effect from 3 [illegible] 0·0050. The cost of pupinisation would be about one-third of the costs of copper conductors used in cables without the iron winding.

A NOTABLE ELECTRIC WINDER.

Summary. Reference is made to the influence of drum profile on the performance of a winder, and diagrams of a number of winders are given. The new 12-ton winder at the Cwm Colliery, belonging to the Great Western Colliery Co., is described in detail.

As long ago as 1908, Mr. H. Bramwell directed attention to the question of the influence of drum profile on the performance obtained,* and described an ingenious type of drum which he had designed for the electric winder at the Maritime Pit,

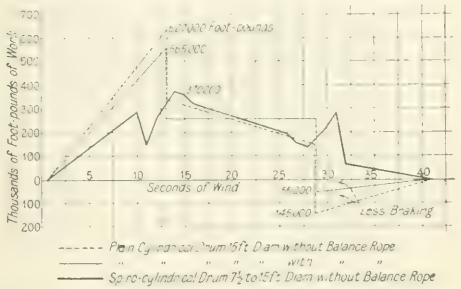


Fig. 1.—Showing Influence of Drum Profile on Performance.

belonging to the Great Western Colliery Co. This winder, it will be remembered, was designed for an output of 175 tons per hour from a depth of 1,110 ft., and the diagrams (Fig. 1) were given by Mr. Bramwell for three different types of winder,

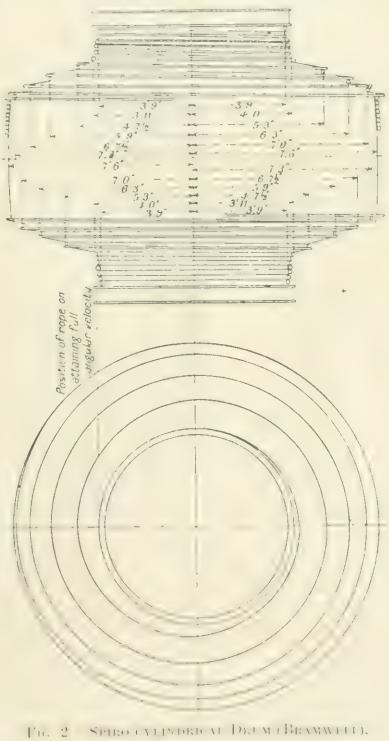


Fig. 2.—Spiro-cylindrical Drum (Bramwell).

all intended for the same duty. The improved performance of the winder having the spiro-cylindrical drum is evident from the diagrams. Prior to 1908 spiro-cylindrical drums were used, but as far as we are aware Mr. Bramwell was the first to suggest

* "Proceedings" South Wales Inst. of Engineers, Vol. XXVI.

that the torque-time diagram could be greatly improved by coiling the cord at a varying rate up the cone, thus increasing the diameter, at first rapidly, and afterwards more slowly. A diagram of the system used is given in Fig. 2, and of the 26½ coils, three are dead on the small end of the drum, four are wound on the part varying from 7½ ft. to 8 ft. in diameter, four are wound

From the general arrangement drawings (Fig. 6), it will be seen that the drum is of spiro-cylindrical form, 12 ft. to 18 ft. in diameter. An unusual and interesting feature of the drum is that the small diameter is at the centre. This diabolo arrangement of drum was adopted on account of the considerable distance between the pithead sheaves. With the

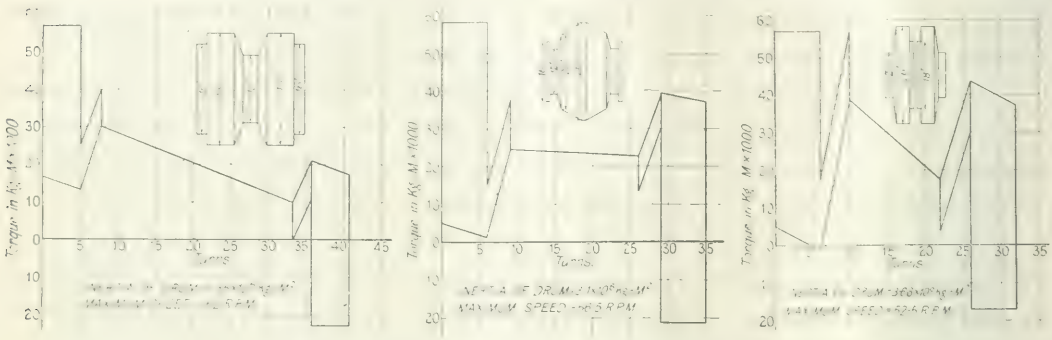


Fig. 3. Torque-time Diagrams of Winders for the Same Duty.

on the conical part varying from 8 ft. to 15 ft. in diameter, and the remainder are wound on the cylindrical part. More recently* Mr. A. E. du Pasquier, in an informative Paper on "Electric Winding Engines," discussed the same question. Of the many examples which he gave, the torque diagrams of a number of 6-ton winders, all calculated for outputs of 360 tons per hour from 2,250 ft., are of particular interest, as they illustrate in a striking manner the effect of comparatively small changes in the conditions or winding cycle. The diagrams referred to are reproduced in Fig. 3. In connection with this example, Mr. du Pasquier stated that a 12-ton lift was being carefully considered, and that if adopted the winding proposition would be greatly improved.

A 12-ton lift was ultimately decided upon, and it is the purpose of this article to describe the mechanical and electrical details of the winder. The machine is being erected at the Cwm Colliery (Great Western Colliery Co.), to the designs of Mr. Bramwell. Messrs. Fraser & Chalmers, of Erith, are the makers of the whole of the mechanical parts of the winder, and the entire electric equipment is being supplied by the British Westinghouse Electric & Mfg. Co., of Manchester. Torque-turn and horse-power time diagrams are given in Figs. 4 and 5. The chief particulars of the machine are summarised below :—

Depth of shaft	2,250 ft.
Cycle—	
Duration of cycle	120 secs.
Acceleration period	21 secs.
Retardation period	21 secs.
Duration of rest	12 secs.
Maximum speed	1,050 ft. per min.
Maximum output	28·6 tons per min.
Weight of rope	12·28 tons
Number of ropes	2
Number of layers	4
Weight of cage	6·36 tons
Weight of tub	2 tons
Weight of load	5·6 tons per tub, 12 tons per load
Drum—	
Speed of drum	26·7 r.p.m.
Diameter of drum	12 ft. to 18 ft.

* Trans. West. Soc. of Engineers, Vol. XXVIII.

ordinary arrangement of drum this centre-to-centre distance would have necessitated either great overall width or two separate drums, and this would have resulted in a considerable

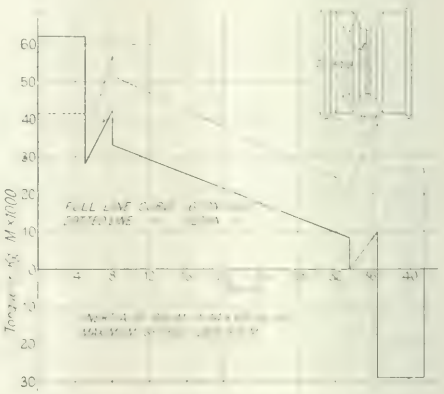


Fig. 4. Torque-turn Diagram for 12-ton Winder.

increase of inertia and higher initial cost. Another feature of interest is the lapping of the rope on itself on the cylindrical

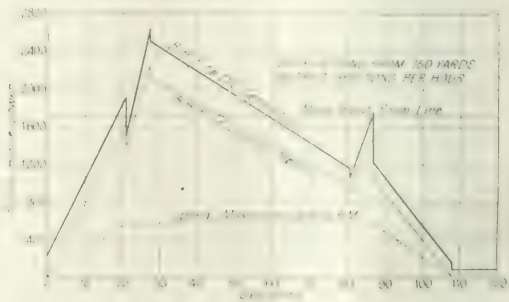


Fig. 5. H.P. Time Diagram for 12-ton Winder.

part of the drum. Without such overlapping it would have been necessary to use a drum of 50 ft. in diameter, and of more

than 100 tons in weight. Although [illegible] rope is viewed with suspicion by many colliery engineers, it is, nevertheless, common practice under the [illegible] conditions in South Africa and in America, and in the present instance a very good case has been made out in favour of [illegible]. Valuable information on the coiling of winding ropes on drums was published by Mr. Bramwell about a year ago.*

When overlapping is used the rope must be wound up to a nominal (R.M.S.) rating of 900 B.H.P. at 28·6 revs. per min. From Figs. 1 and 5 it will be seen that the design of the drum is such that the load is so very well equalised that under ordinary conditions the two motors will not be required to exert a greater output than about 2,700 B.H.P., but the motors are designed to be capable of giving well over 100 per cent. overload if necessary. The motors are controlled on the equalised Ward-Leonard system.

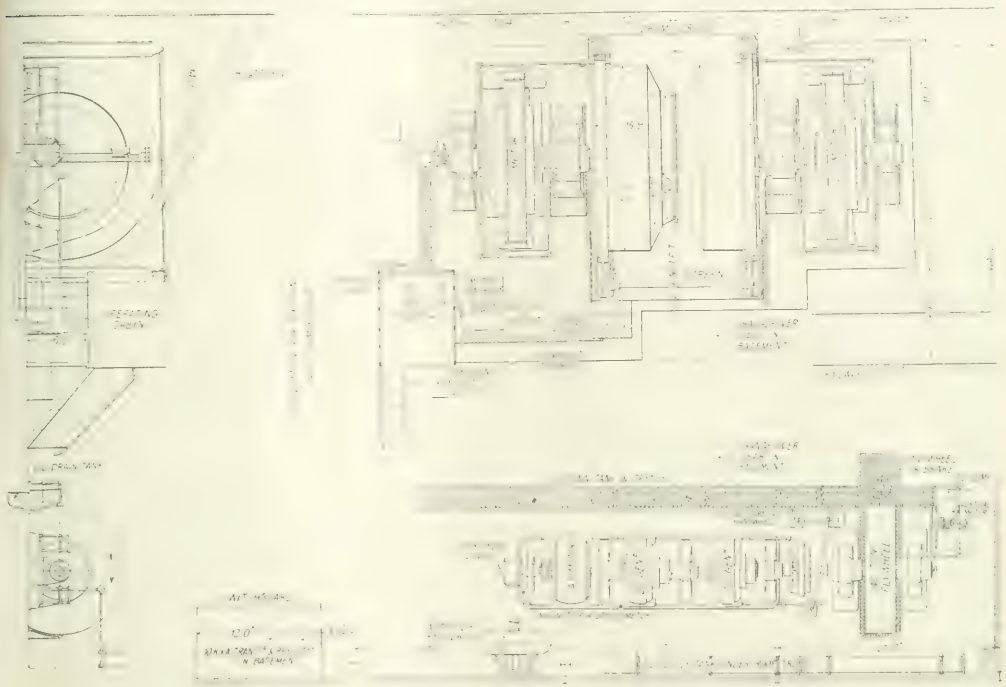


FIG. 6.—ARRANGEMENT OF 12-TON WINDER AND LOAD EQUALISER.

re-coil on the first layer by means of a filling-in strip, and in the case of a grooved barrel the several sections depicted in Fig. 7 result. From this diagram it will be noticed that the point E is at the same place in the circumference on each coil right across the face of the drum. The wear on the rope will, therefore, occur at fixed intervals, and the position of this series of points can be changed from time to time by paying out a length of rope, less than one coil, from the dead end. To enable this to be done there is a reel which, although normally clamped to the drum, may be rotated relatively to the drum, so that by paying out one-third of a coil on the first occasion and a second one-third on a subsequent occasion the wear is distributed over three series of points throughout the length of the rope. The position of this reel is shown in Fig. 9. From this drawing it will be seen that there are three dead coils in a deep groove at the centre of the drum, [illegible] on the part 12 ft. to 13 ft. in diameter, and [illegible] coils on the scroll. The cylindrical portion of the drum carries 20 coils in the first layer, and the remaining length of rope is coiled on the second layer. The brake drums are 19 ft. in diameter and 13½ in. wide on the face. The drum shaft, 2 ft. in diameter between the bearings, is of Siemens-Martin steel, and is 26 ft. 6 in. long over all. The half couplings are forged solid with the shaft, and the journals are 20 in. in diameter and 46 in. in length.

The drum is driven by two interpole [illegible] one at each end of the shaft, as shown in Fig. 6. [illegible]

* "Proceedings South Wales Inst. of [illegible]," Vol. XXX.

The motor-generator flywheel set consists of an 1,800 H.P. slip-ring induction motor coupled to two 750 kw. (R.M.S. rating) 550-volt continuous-current dynamos and a 40-ton flywheel. The set runs normally at 485 revs. per min., and the speed is varied by means of a liquid type automatic slip

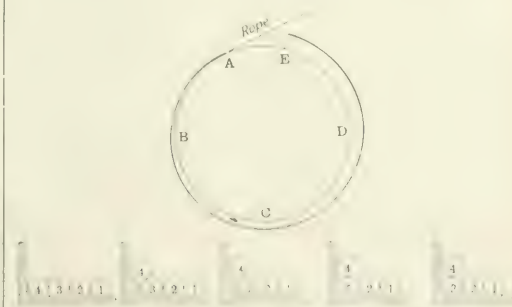


FIG. 7.—FILLING-IN STRIP FOR REEL ON ROPE TO GIVE SECOND LAYER.

regulator, so as to enable the flywheel to equalise the demand for power from the mains. This regulator is operated by a motor magnet which is energised from the line through the medium of series transformers. The induction motor has six

poles, and is designed for a 2,200-volt three-phase 25-cycle supply. The generators have interpoles and compensating windings. They are sufficiently large to supply the winder motors under all conditions of loading. The flywheel is of cast steel and is 12 ft. 6 in. in diameter. It is mounted at the end of the shaft, and may be readily disconnected so as to

Leonard set are arranged for both ring and flow lubrication, the oil for the latter being stored in an overhead tank of capacity sufficient to supply oil for a period of one hour after the oil pumps are stopped. There are two oil pumps, one motor-driven and the other chain-driven from the shaft of the flywheel set.

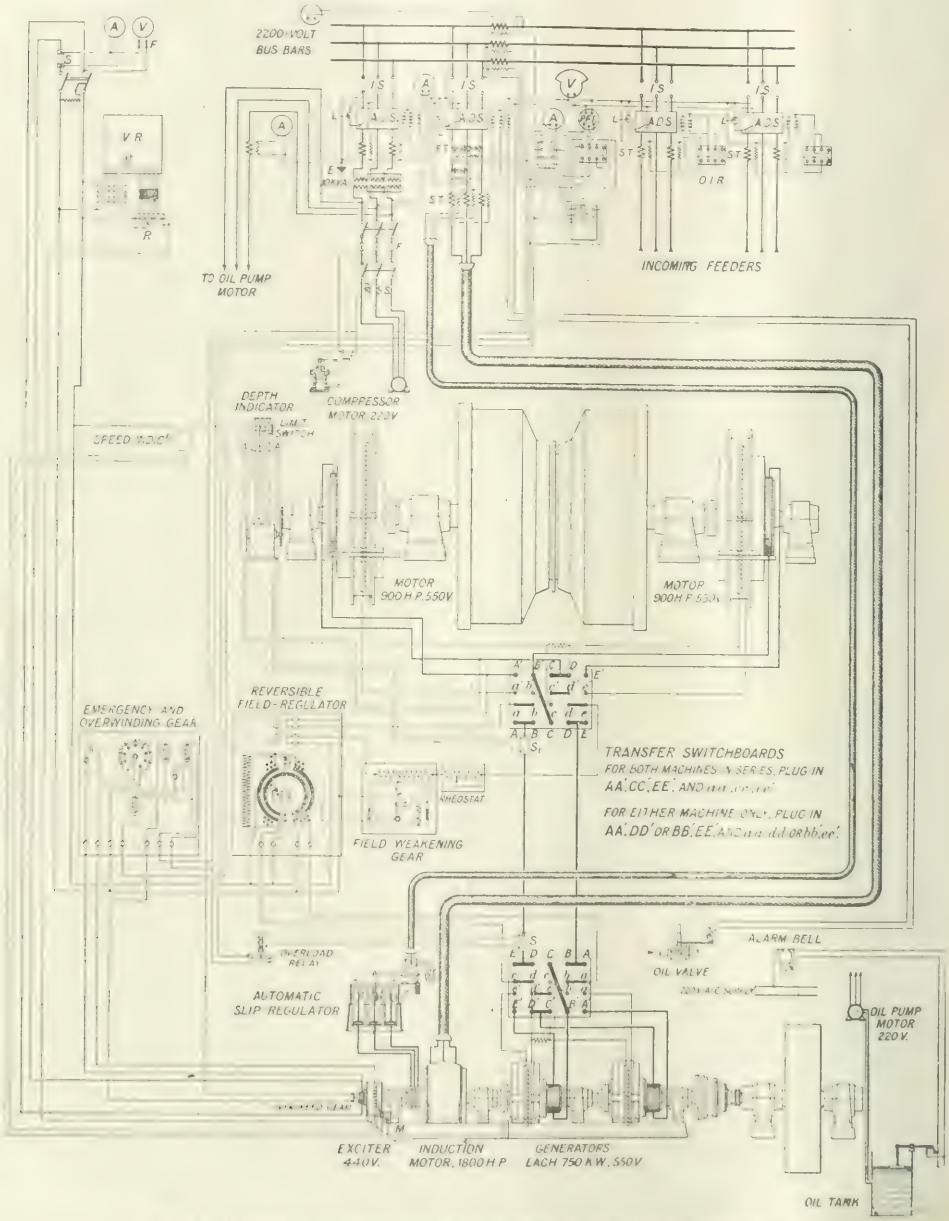


Fig. 8.—Diagram of Connections of Plant for Electric Winder and Load Equalizer.

From the diagram of connections (Fig. 8) it will be seen that a set of disconnecting links is arranged so that either winding motor or either Ward Leonard generator can be cut out of circuit if desired, allowing the winder to be operated at a reduced output. The depth indicator, which is of the vertical

type, consists of two vertical screws driven from the drum shaft by gearing. Each screw is furnished with a nut and pointer to indicate clearly the position of the [illegible]. An over-winder arranged so as to operate the brakes and cut off the supply to the motors at a predetermined point in the wind is fitted. In addition, an automatic accelerating and retarding device is provided, which limits during starting the displacement of the driver's control lever and automatically returns it to the "off" position towards the end of the wind. As the speed of the winder motors, when controlled on the Ward-Leonard system, is determined by the position of the driver's control lever, acceleration beyond a predetermined rate is thereby prevented, the driver being able to move his control lever more and more as the wind progresses until full speed is attained.

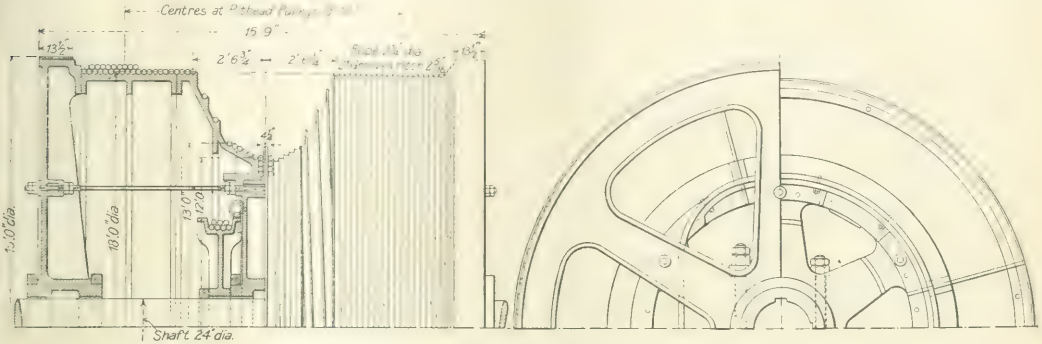


FIG. 9.—CYLINDRO-CONICAL GROOVED DRUM AND OVERLAPPING ROPES. 850 YARDS, 2¼IN. ROPE.

A small air cylinder fitted with a plunger is so arranged that, should the air pressure drop below 60 lb. or fail altogether, hereby partly or fully applying the brakes, the plunger will also operate a special catch on the over-winding attachment, which will fully apply the brakes and cut off the current supply.

To provide a means of automatically bringing the winder to rest in case of emergency, a Westinghouse emergency and over-winding gear is provided. It is arranged to operate the emergency brake in the event of over winding, or of failure of the supply voltage, or of overload on the winder motors. The gear may also be operated by the driver's emergency lever from the control platform. The arrangement includes a rheostat, which is normally short-circuited, and a weighted arm held up by a trigger. In the event of an overload on the winder motors the trigger is released by a relay-operated solenoid, or by a mechanical attachment from the depth indicator, or by means of the driver's emergency lever. On this device being tripped due to any of the above-mentioned causes, the weighted lever drops slowly against the retarding action of a dashpot and operates the rheostat so as gradually reducing the generator voltage practically to zero, and finally open-circuiting the exciter circuit, and so cutting off the supply of power to the winder motors. At the same time as the weighted lever drops the emergency brake gear is also released by an attachment to the valve of the air-brake engine. A limit switch is fitted to the depth indicator so as to open on overwind, and thus operate the safety gear. The over-speed attachment, shown in Fig. 8, is simply a centrifugal switch mounted on the shaft of the motor-generator flywheel set, which opens the main circuit-breaker when a certain speed is exceeded.

SPACE DISTRIBUTION OF FLUX DENSITY.*

BY ALFRED STILL.

Summary.—In this article diagrams drawn according to the plan proposed by Lehmann are given, and the author describes a simple method, sufficiently accurate for practical purposes, of predetermining the variation of the flux over the surface of an armature.

It is not an easy matter to predetermine the distribution of the flux in the air-gap of a dynamo or alternator, but none the less the manner in which the flux density will vary over the armature surface is frequently an important factor in design. An attempt will be made in this article to outline a practical method which the author has found to give very satisfactory results. Open-circuit conditions will alone be considered; but if these can be correctly predetermined, it is an easy matter to take into account the effect of the armature currents, and so obtain the flux distribution corresponding to any desired condition of loading.†

Although the effects of tooth saturation in slotted armature core be of great importance, especially in continuous-current generators where the tooth densities sometimes attain very high values, these effects will not be considered here. The length of air-gap will be considered as that of the *equivalent* gap, or, in other words, the actual toothed armature will be replaced by an imaginary smooth-core armature of the proper diameter to insure that the reluctance of the air-gap per unit area at any point on the periphery shall be the same as the average reluctance per unit area taken over the slot pitch.

In Figs. 1 and 2 an attempt has been made to represent the actual distribution of flux lines (1) for the condition of one pole acting alone without interference from neighbouring poles, and (2) for the practical condition of neighbouring poles of equal strength and opposite polarity. The machine to which these diagrams apply is a continuous-current dynamo of pole pitch 37 cm., pole arc 27 cm., and equivalent air-gap of 0·8 cm. at centre of pole face. The air-gap is of uniform length except near the pole tips, where it is slightly increased, as indicated on the drawings. With a little practice, unlimited patience, and ample time in which to perform the work, diagrams of flux distribution such as those of Figs. 1 and 2 can be drawn, and they will indicate accurately the actual arrangement of the flux lines. The method is one of trial and gradual elimination of errors, based on the well-known principle that the flux lines will take such a distribution that the total permeance is a maximum, or, in other words, that the maximum flux will occur with a given M.M.F.

Lehmann's Method of Plotting Flux Distribution.—Probably one of the most practical and at the same time most accurate methods of procedure is that proposed by Dr. Lehmann* and followed in preparing the flux diagrams (*see* Figs. 1, 2, 4 and 5). A section perpendicular to the shaft through the pole shoe and armature is considered, and all flux lines in the air-gap are supposed to lie in planes parallel to this section. Equipotential lines are drawn in directions which seem reasonable to the draughtsman, and tubes of flux, *all having the same permeance*, are then drawn with their boundary lines perpendicular at all points to the equipotential lines. At the first trial it will generally be found that these conditions cannot be fulfilled, but [illegible]

* From the "Electrical World."

† See "An Air-Gap Flux Distribution Diagram [illegible]," by Alfred Still, "Journal" of the Franklin Institute, January, 1915.

* "Graphische Methode zur Bestimmung der Kraftlinienfelder in der Luft," "Electrotechnische Zeitschrift," Vol. XXX. (1909), p. 995.

ance is 0·25 because it consists of four portions in series, each one of making each section of the individual tube of induction exactly as wide as it is long, the permeance of every one of the component areas in the diagram is always unity, and any complete tube, such as EFGH, has the same permeance (in this example 0·25) as every other tube. The computation of the total permeance between the pole shoe and armature over any given area is thus rendered exceedingly simple. Although the armature surface is represented as a straight line in all the figures illustrating this article, the actual curvature of the armature may be taken into account if preferred; but the error introduced by substituting the developed armature surface for the actual circle is generally negligible.

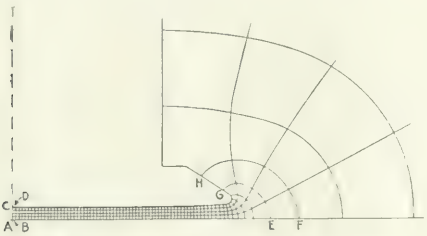


FIG. 1.—FLUX LINES FROM ONE POLE OF DYNAMO.

In Fig. 2 the flux lines have been drawn to ascertain the effect of the neighbouring pole in altering the distribution over the armature surface in the interpolar space. The perpendicular NN′ has been erected at the geometric neutral point, and may be considered as the surface of an iron plate forming a continuation of the armature surface AN. Thus ANN′ will be an equipotential surface between which and the polar surface the intermediate equipotential surfaces must lie.

It may be mentioned that in Figs. 1 and 2, and also in the other flux-line diagrams, the pole core under the windings cannot properly be considered as being at the same magnetic potential as the pole shoe, relatively to the armature. The proper correction can easily be introduced in calculating the flux in each tube of induction; but

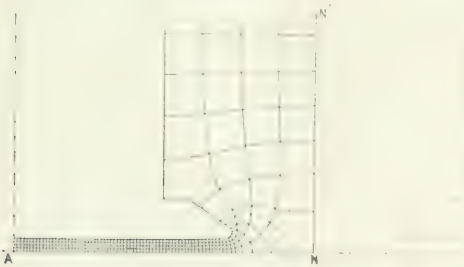


FIG. 2.—ACTUAL AIR-GAP FLUX DISTRIBUTION (DYNAMO).

since the present investigation is confined to the flux entering the armature from the pole shoe, it will not be necessary to make this correction.

The flux density at all points on the armature periphery is easily [illegible] when the flux lines have been drawn. Thus, since each tube of induction incloses the same number of magnetic lines, exactly the same amount of flux will enter the armature in the space EF [illegible] the space AE. If B_E is the flux density in the tube CDAB at the centre of the pole face, the average density over the space EF will be

$$B_E \cdot \frac{EF}{AE+EF}$$

[illegible] It will be seen that the dotted curve, giving actual distribution of flux for the case of Fig. 2, does not differ from the full line curve [illegible] except [illegible] the [illegible] pole [illegible] the [illegible] pole [illegible] approximate. The [illegible] the flux to diminish rapidly [illegible] the [illegible] the point N.

where its direction reverses. This is what one would expect to find because, although the magnetic action of any one pole considered alone will extend far beyond each pole tip, this action will not be [illegible] beyond the [illegible] on account of the shading effect of the neighbouring poles. In order to ascertain how far the demagnetising effect of neighbouring poles is likely to extend when the air-gap is not constant but increases appreciably in length as the distance from the centre of the pole increases, the case of a salient pole alternator has been considered. The flux lines and equipotential surfaces for an alternator with shaped poles are shown in Figs. 4 and

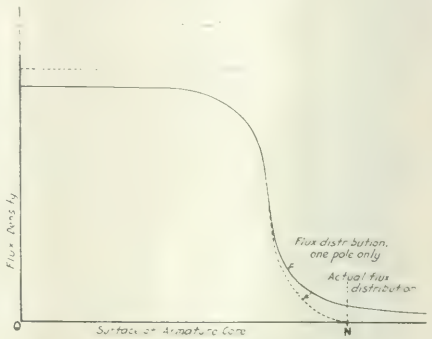


FIG. 3.—FLUX DENSITY OVER ARMATURE SURFACE.

5. The object of shaping the poles by gradually increasing the air-gap from the centre outward is, of course, to obtain over the pole pitch a distribution of flux which shall approximate to a sine curve. The data of the machine under consideration are as follows:—

Pole pitch=22 cm.; pole arc=14·3 cm.; equivalent air-gap at centre of pole face=1 cm. and air-gap at other points on armature

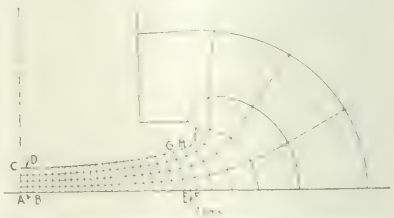


FIG. 4.—FLUX LINES FROM ONE POLE OF ALTERNATOR.

surface=1/cos θ, where θ is the angle (in electrical degrees) between centre of the pole and the point considered.

In Fig. 6 the curve marked "permeance" has been plotted from Fig. 4. Its shape indicates the flux distribution over the armature surface on the assumption that the effect of neighbouring poles is negligible. The M.M.F. between pole shoe and armature core being

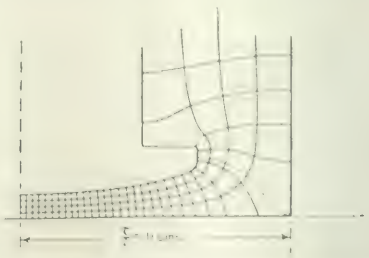


FIG. 5.—ACTUAL AIR GAP FLUX DISTRIBUTION (ALTERNATOR

[illegible] at all points on the armature surface, it is evident that the curve of flux distribution will exactly represent the variation of [illegible] per unit area of the armature surface. Thus the permeance per square centimetre at the point 7 cm. from centre of pole is the permeance of the tube GHEF in Fig. 4 divided by the area

of the [illegible] DE. The permeance [illegible] the [illegible] of the tube DAD [illegible] of path measured [illegible]. The area of the [illegible] and the permeance per square centimetre [illegible]

$$P_r = 0{\cdot}25/0{\cdot}50 = 0{\cdot}5.$$

The dotted curve marked "flux" in Fig. 6 has been plotted from Fig. 5, and shows the effect of the neighbouring pole in reducing the air-gap flux and causing it to pass through zero value at a point exactly half-way between the poles. A comparison of the full line and dotted flux curves shows that, even with the greatly increased air-gap, the influence of the neighbouring poles is not appreciable except in the uncovered spaces between the pole tips. The vertical dotted line in Fig. 6 shows the limit of the pole arc.

In order to find a scale for the flux curve it is necessary to know either the total flux entering the armature in the space of a pole

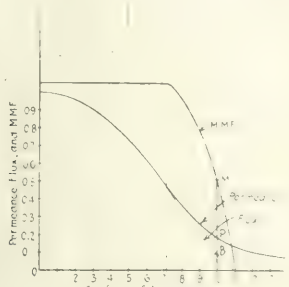


Fig. 6.—Method of Obtaining M.M.F. Curve from Flux Curves.

pitch or the M.M.F. between pole shoe and armature. If the resultant M.M.F. tending to send flux from the pole to any point on the armature is known, the flux density can be calculated because B=flux per square centimetre=(M.M.F.)×permeance per square centimetre.

Thus, if the M.M.F. necessary to overcome air-gap reluctance at centre of the pole is known, the curve of resultant M.M.F. at all points on the armature can be plotted. This has been done in Fig. 6, where the ordinate of the M.M.F. curve at any point, such as 10, is simply 10—M=(10—B)(10—P), where the ordinate 10—B of the flux curve must be expressed in gausses.

Short-Cut Method of Predetermining Flux Distribution.—Although the method that has been described gives excellent results in the hands of an experienced designer who can afford the time required to map out the actual paths of the flux lines, it is not suitable for general use in actual designing work. By adopting a simple construction which assumes a certain flux distribution and avoids the

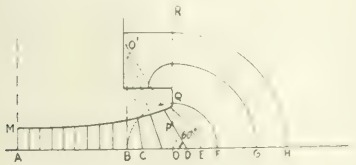


Fig. 7.—Approximate Flux Lines.

drawing of equipotential lines, results of sufficient accuracy for practical purposes can very quickly be obtained. This construction is indicated in Fig. 7. A section through one-half of the pole shoe, showing the air-gap in its proper proportion, is drawn to a sufficiently large scale, preferably with the "developed" armature surface, because the construction is a little simpler if radial lines may be shown as perpendiculars erected on the horizontal datum line representing the armature surface. The distance AM is the equivalent air-gap, as calculated for the centre of the pole face. Draw the perpendicular OR tangent to the pole tip, and, through the first point of tangency Q, draw the semicircle BQF with its centre at O. Draw QO at the point P and draw PD at an angle of 60 degrees. At D erect DP to O′ where it meets the perpendicular erected on AD at the point B. Flux lines of which the length and direction will be approximately correct can now be drawn. All lines from points on the armature surface lying between A and B will be considered perpendicular to the armature surface, *i.e.*, verticals erected on the datum line. Between the points B and D the lines will be considered straight, but with a slope determined by the position of the point O′ through which they will pass if produced beyond the pole face. From the point F the equivalent flux line will be the arc of the circle described through the point Q with the radius OQ, and lines from points between D and F must be put in by the eye so that their curvature shall be something between the circle through F and the straight line through D. One of these intermediate lines has been drawn from the point E. Over the region beyond F all flux lines will be drawn as circles described from the centre O and continued beyond the vertical OR until they meet the pole in a direction normal to the surface of the iron. Thus the line from the point G is completed by an arc of circle with its centre at the junction of the line OR and the flat surface of the polar projection, while the flux line from H is continued as a straight line (the shortest distance) until it meets the pole perpendicularly to the surface.

Any desired number of lines can very quickly be drawn in this manner, and they may be thought of as the centre lines of "equivalent" tubes of flux of uniform cross-section over their entire length. If, now, the length of any one of these imaginary flux lines be measured in centimetres, the reciprocal of this length

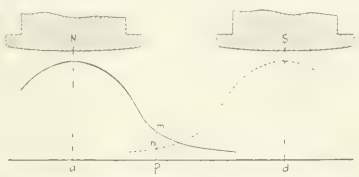


Fig. 8.—Effect of Neighbouring Pole in Modifying Flux Distribution.

will be the permeance per square centimetre between pole shoe and armature at the point considered. It is, therefore, an easy matter to plot a permeance curve similar to the one shown in Fig. 6. This curve, which represents the permeance per square centimetre of armature surface between pole and armature, can evidently be thought of as a flux-distribution curve on the assumption that one pole acts alone without interference from neighbouring poles.

In regard to the actual flux distribution for no-load conditions, it may be argued that if two neighbouring poles each acting alone would produce a flux distribution as shown respectively by the full line and dotted curves of Fig. 8, then the flux at any point p will be $pm-pn$. This method of plotting the resulting flux distribution curve should give satisfactory results in the space between pole tips, but it does not provide for the gradual change in the flux distribution near the pole tips where the shading effect of the masses of iron becomes important. For the practical designer the writer recommends the approximation indicated in Fig. 9 where P is the permeance

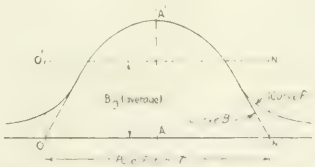


Fig. 9. Approximate Correction for Effect of Poles.

curve previously obtained. The flux curve is derived therefrom by drawing tangential straight lines through the neutral points (half way between centres of poles). In this manner the curve OA′N is obtained, representing the flux distribution on open circuit. This curve has yet to be calibrated, because the value of its ordinates cannot be determined unless either the M.M.F. or the total flux per pole is known. In designing a machine, the total flux per pole will be known at this stage of the work, and the unknown factor will be the ampere turns on the poles necessary to produce this flux. Measure the area of the curve OA′N and construct the rectangle OO′N′N of exactly the same area. The height of this rectangle will be a measure of the average density over the pole pitch. This is known to be $B_g = \frac{\phi}{\tau \times L_g}$, where ϕ = total flux per pole in the air gap; τ = pole pitch in centimetres; and L_g = gross length of armature in centimetres. In this manner a scale is provided for the flux curve OA′N, which should preferably be replotted. The curve

of resultant M.M.F. can now be derived as explained in connection with Fig. 6.

Since the permeance curve as obtained by either of the methods here explained does not take into account the reluctance of the armature teeth, or indeed the reluctance of any part of the magnetic circuit other than the air-gap, the actual ampere turns necessary to produce the required flux will be greater than the amount indicated by the maximum ordinate of the M.M.F. curve of Fig. 6. The fact that the reluctance of the teeth at different points under the pole face is dependent upon the flux distribution tends to complicate the problem; but since this matter has been dealt with elsewhere by the present writer, it will not be discussed further in this article. The correction for tooth saturation is of importance in continuous-current machines; but it is usually unnecessary in alternator design because the higher frequencies prohibit the use of high flux densities in the teeth.

Advantages of the Outlined Method.—The writer believes that the method outlined above will enable the designer to obtain, with a minimum of work, flux-distribution curves which should be of great value to him in predetermining the characteristics of dynamo-electric machines. It is true that fairly satisfactory results can be obtained without the aid of flux curves when the design departs but slightly from a type of which the performance is known. The chief advantage of a method of design which involves the plotting of flux distribution curves lies in the fact that new machines, departing radically from existing models, can be correctly designed without using test data or empirical formulas of limited application.

APPARATUS FOR PROTECTING ELECTRICAL MACHINERY AGAINST ABNORMAL ELECTRICAL CONDITIONS.*

BY C. C. GARRARD.

(*Continued from p.* 807.)

Summary.—The author deals first with the conditions which give rise to abnormal electrical conditions of a transient type, such as those due to switching, arcs and sparks. Methods of suppressing arcs to earth are described. The author then passes on to pressure rises between the turns of electrical windings, and those due to causes exterior to the system, such as lightning. Various protective devices are described, such as water jet earthing resistances, the Moscicki and other condensers, Giles' valve and the more ordinary lightning arresters. In conclusion the question of earth plates is considered.

THE ELECTROLYTIC LIGHTNING ARRESTER.

The electrolytic lightning arrester depends for its action upon the well-known fact that an aluminium anode, in common with a number of other metals, in certain solutions covers itself with a thin insulating film which prevents the passage of any appreciable quantity of electricity from the electrode to the solution unless a particular critical voltage is exceeded. If, say, an iron cathode be used and an alternating voltage be applied to the terminals of the cell, a uni-directional current will pass, and upon this principle the electrolytic rectifier is constructed. If both electrodes be made of aluminium then very little current passes at all until the critical voltage is exceeded. The first suggestion to use this physical fact as a basis for a lightning arrester was made by Ferranti in his British patent 25,426 of 1901, and the reader is referred to THE ELECTRICIAN, Vol. LVIII., p. 858, for a description of the apparatus then made. Uncertainty still exists as to the precise nature of the high resistance film which forms on the aluminium (compare article on "Electrolytic Valve Cells," in [illegible], May 3, 1907).

The breakdown voltage of the film depends in a large degree upon the nature of the electrolyte, and considerable research work has been carried out to find which solution gives the highest possible value. The curve in Fig. 34 contains the results obtained with a saturated solution of potassium bichromate and sodium phosphate. It will be seen that the critical [illegible] is reached with an enormous number of minute sparks, showing where the insulating film is breaking down and allowing the current to pass. On lowering the voltage below the critical value the current is reduced again to its small value. In modern electrolytic arresters this critical voltage is as high as 350 volts (effective).

Now, it is obvious that a battery of cells having this characteristic must be an excellent arrangement for dealing with pressure rises above the normal voltage. If sufficient cells in series be used, so that the normal voltage is just below the critical voltage, any pressure rise will cause a large current to flow through the arrester and relieve the line. Directly the

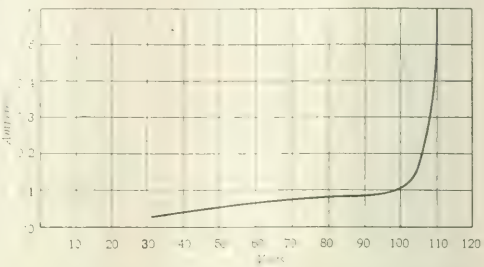


FIG. 34.—CURVE ILLUSTRATING VALVE ACTION OF ELECTROLYTIC LIGHTNING ARRESTER. (Nearly saturated solution of $K_2Cr_2O_7$ and sodium phosphate, two aluminium electrodes dipping into solution about 2 in.)

voltage falls to the normal value the cells build up again in resistance, and prevent any current flowing from the machines. A battery of aluminium cells connected from each line to earth, therefore, should form a very efficient lightning arrester. Unfortunately as yet, however, such an arrangement can only be used on continuous-current circuits, and for such the aluminium arrester forms, there is no doubt, the most perfect protective device known. On alternating-current circuits, however, the direct connection of the cells to the line cannot be made. This is by reason of the following: If we consider the

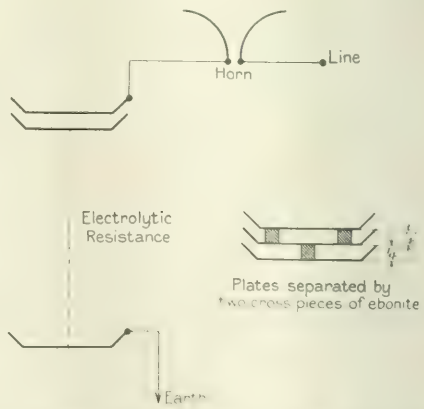


FIG. 35.—PRINCIPLE OF CONSTRUCTION OF HIGH VOLTAGE ALUMINIUM LIGHTNING ARRESTERS.

thin insulating film on the surface of the aluminium as the dielectric of a condenser, the plates of the same being the electrode and the solution, it is obvious that it must have a considerable electrostatic capacity, and with an alternating impressed E.M.F. a certain amount of capacity current will pass. This current, in its passage through the electrolyte, heats the same with consequent disintegration of the film. In fact, it has not yet been possible to construct a practical elec-

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trolytic arrester which can be connected to an alternating-current circuit, without having a spark-gap inserted in series with it. Unfortunately, this spark-gap detracts considerably from the value of the apparatus, principally because of the fact that it becomes necessary to charge the cells daily. This will be considered later.

Construction of Aluminium Lightning Arresters.—The method of construction of high-voltage aluminium arresters is shown in Fig. 35. The cells consist of aluminium trays stacked one above the other. By this means a large number can be got into a small space. The electrolyte is

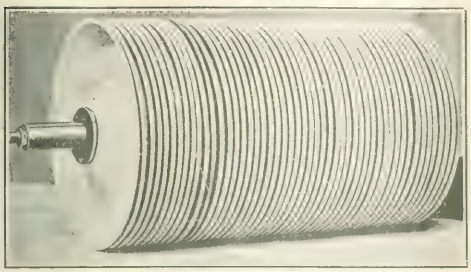


Fig. 36.—Battery of Dished Aluminium Electrolytic Lightning Arrester.

poured into the top tray, and overflows into all the others. The stack is placed in an outer insulating vessel. A small quantity of transformer oil is placed on top of the electrolyte in each tray to prevent evaporation. An illustration of an actual set of trays is given in Fig. 36 (*see* Peck, I.E.E. "Journal," Vol. XL., 1908, p. 498). In Fig. 37 an outline drawing of a complete set for a three-phase line, also taken from Peck's Paper, is given.

The Charging of Alternating-Current Aluminium Lightning Arresters.—The insulating film on the surface of the aluminium

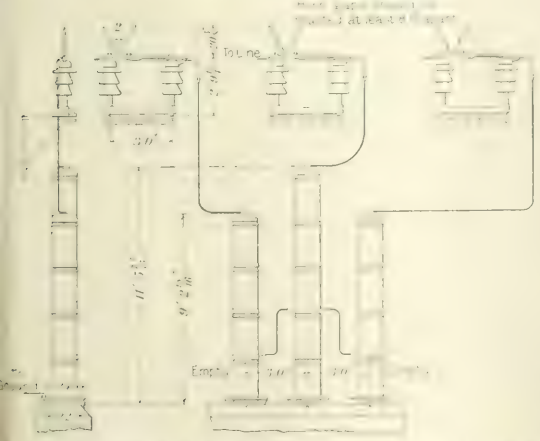


Fig. 37.—Outline of Electrolytic Lightning Arrester for 33,000 to 66,000-volt Three-phase Line.

electrode, if left to itself, slowly disintegrates and disappears. If a lightning discharge were now to jump across the horn-gap the cells would offer no resistance, and practically a short-circuit would occur. In order to keep the film in condition it is necessary to charge the cells once a day, and this is done by momentarily connecting them directly to the line by bridging the horn-gap. In the first aluminium arresters the charging was done in this fashion. Unfortunately, however, difficulties were encountered partly in the form of surges, which were set up at the instant of charging which caused insulation failures, and partly due to the fact that the large rush of current at the instant of charging damaged the arrester itself. To get over this, charging resistances were resorted to. An auxiliary horn-gap is used in series with the charging resistance, and this gap is the one bridged instead of the main gap, the charging current being limited by the resistance. It is obvious that this added complication detracts considerably from the original simplicity of the aluminium arrester. Fig. 38 illustrates the horn-gap arrangements belonging to a modern arrester and embodying these features. It will be seen that the auxiliary gap in series with the charging resistance is situated above the main gap. This offers a selective path for light discharges which pass both through the charging resistance and the aluminium cells to earth. Heavy strokes pass directly across the main gap, and the current is limited only by the valve action of the electrolytic cells. The arc rises from the lower horns to the upper ones, and on striking the latter the ohmic value of the charging

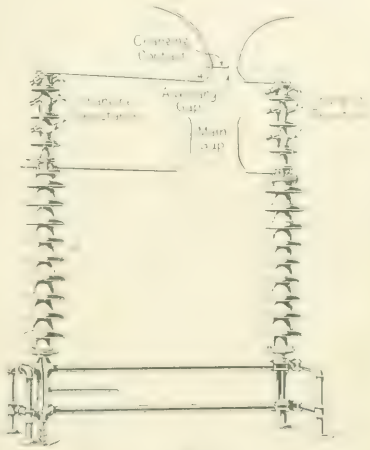


Fig. 38.—Horn Gaps for 150,000-volt Aluminium Lightning Arrester. (General Electric Co.)

resistance comes into action in still further limiting the flow of current and assisting in the suppression of the arc. It will thus be seen that there is much less danger of large current arcs being suddenly broken at the horn-gap, and the danger of voltage rises due to the action of the arrester itself lessened. The charging contact will be seen fixed to the left one of the upper pair of horns. Contact is made for charging by rotating the whole of the left-hand column of insulators by means of the handle seen in the lower part of the drawing. The charging usually only requires about 10 seconds.

Value of Charging Resistance for Aluminium Arresters.—At first sight it would seem desirable to use as large a charging resistance as possible. If too large a resistance be used, however, the cells will not acquire a thickness of film corresponding to the line voltage. Fortunately, the natural relations in the circuit are helpful, as the aluminium cells are condensers, so that the voltage across them will be at right angles to the difference of potential across the series resistance. Usually the series resistance is chosen to limit the charging current to 10 amperes. The charging current at 60 periods per second of the standard General Electric Co.'s arresters when fully charged is 0·1 amperes (see E. E. F. Creighton, "General Electric Review," Vol. XVI., April, 1913, p. 251). Assuming a 10,000-volt arrester this would have a charging resistance of 1,000 ohms. The dropped across the charging resistance at 0·1 amperes

is 400 volts. The clock diagram in Fig. 39 gives the result that the drop across the condenser under these conditions is 9,992 volts.

It will be seen, therefore, that with this resistance the cells acquire practically a film corresponding to the full line voltage.

The question may now be considered whether the sudden charging of the condenser through this resistance will set up surges. If no sparking nor arcing occur at the charging contact these surges cannot take place. This follows from the fact that if the charging resistance be above twice the surge impedance of the line (*i.e.*, above about 800 ohms), the charging current will be an aperiodic one, *i.e.*, will not oscillate at all. The surge impedance (*see* p. 352) is equal to $\sqrt{\frac{L}{C}}$ where L = self-induction per mile of the line, and C equals capacity per mile of the line. Since the resistance chosen on a 10,000 volt line is 1,000 ohms, it will be seen that this is well above twice the value of the usual surge impedance of any overhead line. As, under these circumstances, even a single reversal of the charging current is not possible, it is very evident that dangerous oscillations cannot occur. This is, however, only true provided no sparking nor arcing takes place at the charging contact. If such sparking or arcing takes place the arrangement may function as an arcing ground which (as has been shown on p. 423) may cause damage by localised pressure rises even when the arcing takes place through large resistances. For this reason modern arresters are best arranged with spring clips on the charging horn, so that the charging may take place without arcing.

It is true that Creighton (in article above referred to) claims that the aluminium arrester, even when charged through an arc, cannot act as an arcing ground. This argument is based

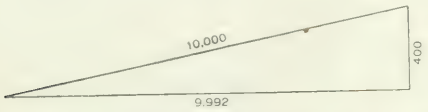


Fig. 39. Diagram illustrating charging voltage of Aluminium Lightning Arrester. (Not to scale.)

upon the fact that the electrochemical reactions due to the passage of current through the arrester absorb energy, exactly similarly to the absorption of energy due to passage of a current through a resistance. In fact, this electrochemical energy absorption can be represented by a resistance and will have the same effect in suppressing oscillations. Calculations on this basis give an equivalent resistance per cell of 100 to 370 ohms. A battery of cells, therefore, will always have, according to Creighton, sufficient equivalent resistance to prevent its acting as an arcing ground. While this argument of Creighton's is doubtless correct if oscillations of the entire circuit are considered, it would yet appear that localised pressure rises might still arise as Berg's experiments distinctly showed the possibility of these with arcing grounds even through very high resistances. Moreover, if the films are all dissolved, at the instant of charging the equivalent resistance is doubtless very much less than normal. The only safe arrangement is not to charge through any arc or spark, but to make a good mechanical

state that according to American experience, if the charging be

Upkeep of Aluminium Lightning Arresters.—It is clear

deterioration of the electrolyte, due, among other causes, to the

(*To be continued.*)

THE SIEMENS-SCHUCKERT QUICK REGULATOR.*

BY G. E. GRAY.

The Siemens-Schuckert quick regulator is composed of three magnetic systems, called respectively the voltage relay, the trembling relay and the intermediate relay. In Fig. 1 the voltage relay is shown connected through a considerable resistance to the terminals at which the voltage is to be kept constant, and is intended to utilise the variations of voltage in the network for the regulation of the machine supplying the current. It is joined with the trembling relay, which is connected through a large resistance to the terminals of the exciting machine. Its armature carries the contact *b*, which, owing to the action of the spring *f*, is normally pressed against the fixed contact *c*. The coil of the intermediate relay, which is connected through a series resistance to the terminals carrying the exciter voltage is short-circuited through the contacts *b* and *c*. The intermediate relay with its contacts *e* and *h* short-circuits the series resistance of the exciter machine, through which the latter is regulated. The main regulator of the generator is short-circuited. Let us suppose the voltage relay coils excited: then the spring *f* will cause contact to be made between *b* and *c* at a given voltage. The coil of the intermediate relay is, therefore, short-circuited and this also has the effect of short-circuiting the shunt regulator of the exciting machine. The exciter, therefore, becomes magnetised, and tries to reach the maximum voltage in the shortest possible time. At some

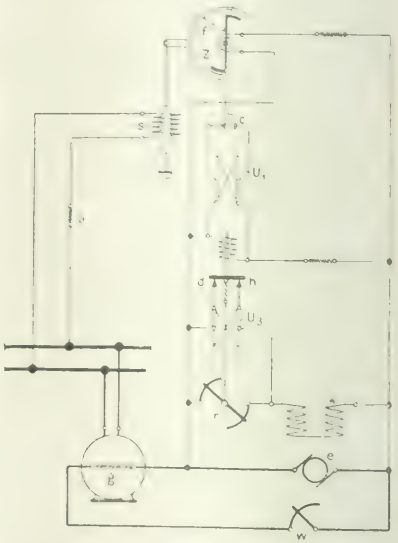


Fig. 1.—Diagram of Connections for the Siemens-Schuckert Quick Regulator.

particular instant the magnetic pull in the trembling relay, caused by the exciter voltage, becomes equal to the power of the spring. If the voltage rises yet a little more, the magnetic pull overcomes the power of the spring, the armature turns to the right and the contacts *b* and *c* are separated. Now the current flows through the coil of the intermediate relay, so that the contacts *d* and *h* are separated and the series resistance regulates the exciter. The voltage of the exciter falls off [illegible]. With it the magnetic pull of the trembling relay [illegible] the pressure of the spring [illegible] the contacts *b* and *c* [illegible]. The exciter voltage rises till the pressure of the spring is again overcome and the regulating series resistance is again inserted. This process is shown graphically in [illegible] resistance is short-circuited. The current from the exciter rises

magnetic pull. At 80 per cent. of the pull [illegible] the contacts b and c are separated and the shunt regulating [illegible] is inserted. The voltage falls according to curve 6, passes through the value at which the magnetic pull balances the spring, and at 70 per cent. the contacts come together again, so that the resistance in the exciter circuit is again zero. Now the voltage rises according to curve 5 and the process is repeated. If the resistance is short-circuited, the voltage rises; if it is in series, it falls. Therefore, there results a curve for the voltage, which resembles the [illegible] curve. Any particular tension of the spring corresponds to a given mean value of the voltage; in practice it will sway between values slightly above and slightly below this mean. If the main generator is loaded, its voltage falls, and this affects the pull of the voltage relay. Thus the mechanism comes into action, and though the magnets of the main generator are connected to the fluctuating voltage given by the exciter, these fluctuations are not reflected in the working of the generator owing to its strong damping action.

The construction of the apparatus is shown in Fig. 3. It will be seen that the U-shaped yoke j can be rotated about the axis k; this axis also carries the T-shaped armature of the trembling relay. Both are magnetised by the fixed coil z. The lines of force from the cylindrical shaft of the T-shaped armature pass symmetrically on both sides through the U-shaped yoke. The magnetic pull between j and a, which exerts only radial forces, endeavours to turn the armature to the right. This is opposed by the two springs f, which cause the spring contact b to press against the fixed contact c. As the core of the voltage relay sinks, the U-yoke of the trembling relay turns to the left. Seeing that the contact b touches c, the armature remains in the same position, so that the spring f is bent and the lever arm through which the spring acts on the armature is lengthened. The torque is thus increased and is approximately proportional to the square of the angle of torsion. Small set-screws are added so as to compensate for any deviation from the quadratic law,

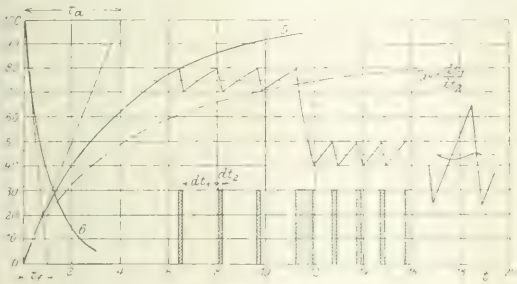


Fig. 2.—Magnetising Curves.

and a dashpot tends to check any irregularities in motion. Each regulator has double the requisite number of trembling relays as a precautionary measure. A multipole switch can be used to change from the one set to the other, so as to allow the inspection and cleaning of the contacts. By the use of two two-pole switches the polarity of the main contacts and that of the contacts of the trembling relay can be altered, and this contributes to even wear. There is also an adjustment by which the apparatus can be suited to a change in the main constant voltage; thus the voltage can be kept constant at any point on a range of 8 per cent.

This quick regulator gave such good results that its application has been somewhat extended. It has therefore been used in connection with buffer batteries in rolling mills, and also on railway work and lifts. The arrangement is such that there is a synchronous [illegible] machine so coupled to a direct-current machine that the latter either charges a battery or takes current from it as a motor, according to the amount of power taken from the network. The introduction of the buffer effect is either brought about directly by the direct-current machine or by some auxiliary unit. Naturally, it is not possible in such a case to use the ordinary quick regulator as used for voltage regulation. It must be [illegible] regulator to keep the current or power constant. It is simplest to design it for a constant output of [illegible] appeared at the [illegible] must, therefore, be added, and this consists of two coils, the one [illegible] coil is dragged downwards and the other upwards. On each of the [illegible] from the network. The connections are such that in the one coil the [illegible] directions. The two coils [illegible] therefore, the resultant pull is the difference of the forces on the two cores. The author proceeds to explain how the various quantities in question can be determined to suit a particular case and this is conveniently done by a kind of Wheatstone bridge arrangement. To take, however, a practical case, let us suppose that we have to deal with a rolling mill which takes current from a transmission line which is fed through rotaries. We have to consider flywheel effects; then the output, reckoned in the form of direct current acts on the voltage relay of the quick regulator; this affects the field of a direct-current machine, connected to one of the flywheels, so that the load is thrown on the flywheel when the output to the rolling mill is more than sufficient; conversely, the load is removed from the flywheel when the demand in the mill increases. In this case a special relay is constructed, which measures the direct-current output in the way used in polyphase instruments.

The quick regulator has a special importance in the paper factory. Formerly the paper machines were driven solely by steam engines; in new installations electricity is the sole motive power. The same machine ought to be able to make papers of different kinds; therefore, a great difference in speed is necessary, sometimes varying in the ratio of 1 to 20. The Ward-Leonard system is mostly used, by which a variable voltage is led to the motor. At high speeds no

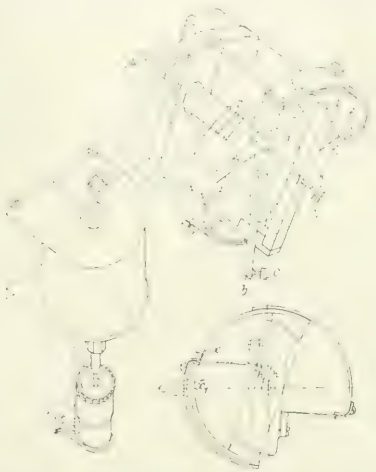


Fig. 3.—Construction of the Siemens-Schuckert Quick Regulator.

special regulation is required seeing that the direct-current motor is nearly constant in speed. At low speeds the ratio of ohmic resistance to the voltage at the motor terminals is of importance with regard to changes of load, so that it is impossible to work without regulating devices. With the help of the quick regulator it is possible to keep the speed steady to within 1 per cent.; this success is vouched for by the fact that the two biggest paper drives in the world, at Halsta, in Sweden, which have 140 kw. machines, were fitted out with quick regulators. The regulation is effected in the following way: The voltage of a tachometer-dynamo, connected to the paper machine, acts on the voltage relay; this voltage is always strictly proportional to the speed. The field of the starting machine is affected by the intermediate relay, and so a periodically varying voltage is impressed on the motor. The tachometer-dynamo acts on the quick regulator, and this smooths out all variations of speed.

Some people object that this quick regulator is in action unnecessarily all the time, whether the load is varying or not. If we reckon on an average vibration of 250 a minute, we see that there will be about a million vibrations in three hours. This seems unnecessary in installations in which there are relatively infrequent variations of load; the quick regulator mainly justifies its existence in places where there are heavy, frequent and sudden changes. An improved type has, therefore, been designed for such cases; this [illegible] portions, viz., the relay and the apparatus for moving the brushes. The motor moving the brushes is driven through an arrangement which depends on the voltage relay, so designed that the whole range [illegible] tact of the relay before the constant voltage is reached and stops the regulating process in good time.

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ELECTRIC WINDERS.

Readers of The Electrician will remember that little more than 10 years ago discussions centering round possibilities of the future development of the electric winder as a practical machine were for the most part hostile in tone and condemnatory in character. In some quarters the view was held that, so far as winding was concerned, electricity could never compete with steam either as regards economy or reliability. From the point of view of first cost it was urged that the steam winder had the advantage. At the time mentioned many engineers were inclined to ridicule the small winders that had been installed. The machines were contemptuously called toy winders, and the opinion was expressed that the duty which these winders performed was "playing at winding."

[illegible] collieries [illegible] country is run on sounder commercial lines than that of winning coal, and in our opinion mine managers and engineers can be trusted to give proper consideration to the commercial side of their business. Such business, we take it, consists in getting a maximum return on the capital invested and in making the most of the [illegible]. A mine manager [illegible] a man of many and varied attainments. [illegible] years he has had to develop the electrical side of his training, and, largely through no fault of his own, he has had to make himself conversant with modern electric generating station practice. With a few notable exceptions, it has been necessary to put down power stations at the collieries; but as experience is gained in the supply of power in bulk the small generating stations which have sprung up on every side, as the result of bad engineering and waste [illegible] in collieries, at times

and in works, in cities, towns and hamlets alike, will disappear with incalculable gain to the community and to the individual.

The installation of more than half a million horse-power of electric winders supports the view that the electrically-driven winder is in many cases superior to the modern steam winder, and shows that under normal conditions the former is a formidable rival of the latter. No doubt much of the success is due to the fact that the manufacture of the mechanical parts has been entrusted to those best fitted for the task—namely, to the firms having intimate knowledge of the design, construction and operation of steam winders.. The "toy" winders have been displaced by machines taking upwards of 10,000 H.P. on the peak, and winding loads of 8 tons from depths of close upon a mile at speeds approaching 40 miles per hour.

Before any reliance can be placed on the figures brought forward in support of either of the two methods of winding, comparisons must be made between machines of the same capacity and of, approximately, the same age. Furthermore, the conclusions will have to be based on all-year performance. Figures giving the actual cost of winding and waiting are indispensable. We attach little importance to the results of short-time tests either of motors or of steam engines. The cost of winding under test conditions is only of academic interest. Business people prepare balance-sheets giving the results of yearly or half-yearly trading, and no sane man of business would predict his balance-sheet from the result of an hour's trading at the commencement of the year.

We have no patience with those who hold that small coal is of little value. Every British thermal unit in every pound of coal has a certain cash value, in so far as it can be converted into a definite amount of work, and the fact that we have insufficient skill to devise appliances, or that we lack the foresight to use existing appliances for effecting the conversion, does not affect the argument. Recognition of the monetary value of small coal puts the matter on an entirely different footing, and were the electric winder a less efficient machine than it is known to be it would still receive the serious consideration of colliery engineers. It is probable that the monetary value of small coal has done more than anything else to expedite the electrification of collieries, for it was not until this was recognised that attention was directed to the appalling waste of small coal, and steps were taken to minimise the waste. In recent discussions on the subject the value of small coal has been quoted at 7s. 6d. to 10s. per ton, and nowadays every effort is made to minimise the coal consumed at the colliery. This necessitates electrification.

No hard and fast rules can be laid down as to the system of winding to be adopted in a given case. Although each of the principal systems can be arranged for load equalisation, it is desirable to regard the load equaliser as a temporary expedient. In course of time, as power [illegible] increase in size, the restrictions imposed by the supply authority with regard to peak loads will be less severe than at present, and will eventually be entirely removed. As an example of this may be given the supply to the mines of the Witwatersrand District of the Transvaal. Notwithstanding the fact that in the Central Mining Rand Mines Group there is in operation some 60,000 H.P. of electric winding plant, there is not a single example of an equalised drive. Some of the power companies at home are sufficiently developed to deal direct with rapidly-varying loads running up to 1,700 H.P. on the peak. The establishment of waste heat stations at the collieries by the supply companies will not only hasten the removal of irksome restrictions, but will be to the mutual advantage of the mine owner and the supply authority.

In the many cases where load equalising plant has to be provided it is, as a rule, unnecessary to instal a flywheel of sufficient capacity completely to equalise the load. Partial equalisation of the load lessens the initial cost of the equipment and reduces the continuous losses. On another page of our present issue will be found a description of a 12-ton winder constructed to the designs of Mr. HUGH BRAMWELL, of the Great Western Colliery Co. In the preparation of this article we have endeavoured to bring into prominence the influence of drum-profile on the performance of a winder. The subject is of much importance, and is one to which many engineers, and Mr. BRAMWELL in particular, have given a great deal of attention. Other interesting features of the new Great Western winder are the diabolo-shaped drum and the overlapping ropes.

REVIEWS.

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Steam Power. By W. E. DALBY, F.R.S. (London: Arnold, 1915.) 1st edition. Pp. xvi. + 760. 21s. net.

Much of a reviewer's work is made uninteresting by the fact that many of the books he has to review are barren, and from an intellectual standpoint, at least, the greater part of his work is unprofitable. Once in a while a great book has to be reviewed.

Those who are familiar with the work of Prof. Dalby will expect to find originality in his latest book, and they will not be disappointed. As regards method and matter, "Steam Power" is a strikingly original book. The treatment is scholarly, the several sections of the subject are well balanced, and the author has shown rare judgment in his selection of data.

The first chapter of the book is preliminary, and is arranged to aid a student who is at work in a steam laboratory. A steam plant is described, the measurement of its power is discussed, the laws of thermodynamics which condition its thermal efficiency are stated, and then, leaving objective realities, the heat stream flowing through the plant is imagined in a series of temperature falls. In the course of the chapter the heat-carrying media are analysed into three interacting circuits—namely, the heating circuit, the motive power circuit and the cooling circuit. A general perspective of the actions of the plant is presented at the outset, and afterwards as each element is studied in detail the true relation of each part to the whole is kept in view.

After the first, the chapters may be grouped in three divisions. The heat-flow through the plant is considered in detail in the first division, consisting of Chapters II. to VI. In these chapters, attention is concentrated on the heating and cooling circuits. The principles of thermodynamics are developed so

and the reader is led up to the calculation of the properties of steam from Callendar's characteristic equation. The principles are used to establish the Rankine ideal standard of performance, and the actual performance of a steam engine is compared with this ideal standard. Special consideration is given to the interaction of the three circuits, and the results of the heat energy flow through a plant are shown graphically. An account is included of the researches of Callendar and Nicolson on the condensation of steam in the engine cylinder, and the laboratory method described for the determination of the whereabouts of the missing quantity is based on these investigations.

In no book will the reader find more information on the dynamics of the steam engine than in "Dalby." The subject is dealt with in the group of chapters forming the second division. The matter in the chapters on governors, flywheels, engine balancing and valve-gear mechanisms is well-found. We venture to think that the sections devoted to the science of the locomotive will make a strong appeal to a wide circle of readers.

The last two chapters fall in the third division, which is reserved for the special consideration of steam turbines. As a preliminary to the actual study of the turbine, the flow of steam is separately considered, and the main results are given of important contributions to the theory of the flow of steam through nozzles. In the last chapter the general principles involved in the action of a steam turbine are developed.

Judged by their works, many authors and publishers attach no importance to the quality and accuracy of book illustrations. This does not apply to the book under review, and author and publisher are to be complimented on the uniform excellence of the 260 drawings which accompany the text. It will not be the fault of the author if any student of the steam engine who buys this book fails to obtain full value for his money.

Dielectric Phenomena in High Voltage Engineering. By F. W. Peek, Jun. [illegible]. New York: McGraw-Hill Co., Incorporated. Pp. xvi + 265. 12 in. × 8½ in.

In this book of 11 chapters the properties are given of gaseous, liquid and solid insulations, and methods of utilising these properties to the best advantage in the problems of high-voltage engineering are fully described. Such problems require a knowledge, not only of the laws and mechanism of breakdown of dielectrics as determined by experiment, but also a simple working knowledge of the dielectric circuit. The author deals with these in a very lucid manner. Methods that have proved useful in designing apparatus, transmission lines, insulators and bushings are discussed and illustrated by practical application. The 14 cases worked out will be invaluable to the busy engineer, and the student will benefit by considering the cases in which he is interested. By so doing he will be able to memorise a number of important facts.

A good deal of space is devoted to the consideration of such subjects as the manner of making extensive engineering investigations and of reducing data, the measurement of high voltages, the effects of impulse and high-frequency voltages, methods of drawing dielectric fields, outline of modern theory and various dielectric phenomena. The five chapters dealing with visual corona, spark-over, corona loss, corona and spark-over in oil and liquid insulations and practical corona calculation for transmission lines are particularly well written. In all cases where [illegible] and discussions of dielectric phenomena are given these are accompanied by experimental data.

The [illegible] researches were made possible by facilities afforded by the consulting engineering department of the General Electric Co. of America. We admire the generosity of this firm in affording such facilities and in granting the author permission to publish such a large amount of valuable [illegible] material. The book is in every way a worthy addition to the excellent series of books published by the McGraw-Hill Co., and is a credit to the author, whose native [illegible] has enabled him to produce connected with high-voltage engineering.

FOUR YEARS' OPERATING EXPERIENCE ON A HIGH-TENSION TRANSMISSION LINE.*

BY A. BANG.

[illegible]. The Pennsylvania Water & Power Company, since it started operation of its hydro-electric plant at Holtwood, Pennsylvania, has kept a careful record of the operating costs. In the following Paper these costs are given for the four years 1911-1914, since the high-tension transmission line, Holtwood to Baltimore, is concerned. The record deals essentially with certain observations made on lightning flash-overs, deterioration of insulators, sleet on cables, and the various means adopted to prevent disturbances to operation from these causes.

The transmission line for which the operating record is given herein is the line which transmits energy at 70,000 volts from the Pennsylvania Water & Power Company's hydro-electric plant on the Susquehanna River at Holtwood, to the same company's terminal station at Baltimore, Md., where the current is stepped down for distribution purposes. Practically all the load consists of synchronous machinery, such as synchronous converters, frequency changers, &c.

This line is about 40 miles long, and consists now of two rows of steel towers, each capable of carrying two independent three-wire circuits. The first of these tower lines (No. 12) was built in 1910,

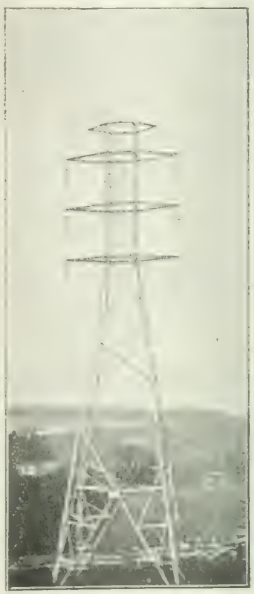


Fig. 1. Suspension Tower on Line 12.

with both circuits installed; the second (No. 56) in the summer of 1914. On this latter at present only one circuit is installed (circuit No. 6).

Towers. The towers are galvanised steel towers, designed for six power cables and two ground cables for the old line only one ground cable; they are spaced about 10 to a mile and the cables on the new line are anchored at every fifth tower at least.

The height of the tower is 44 ft. from ground to the lower cross-arm. The distance between the cross arms is 9 ft., against 7 ft. on the older tower line, and the ground wires are located 12 ft. above the upper cross arm. Figs. 1 and 2 are views of the towers, which show how on line No. 12 the power cables for each circuit were located all three in a vertical line one above the other, but the cables on the new line have been staggered to prevent trouble from sleet.

Conductors. The conductors are 500,000 c.m. mil. 19-strand aluminum cable. The ground wires consist of [illegible] in. galvanised seven-strand steel cable.

Calculated load. Maximum load on the cables is assumed to occur at a temperature of 25° C., wind pressure of 15 lb. per

* Abstract of a Paper read before the American Institute of Electrical Engineers.

square inch on wires covered with [illegible]. During these load conditions the tension in the cables approaches the elastic limit. The stringing tension at +25°C., was 500 lb. for the power cables and 950 lb. for the ground cables.

Insulators.—The insulators are of the [illegible] type, 10 in. in diameter (*see* Figs. 3 and 4). The units selected for the newer line have the following electrical characteristics:—

Individual dry flash-over voltage	[illegible]
Individual puncture voltage	=140,000 to 150,000 volts.
Units used for line have [illegible]	[illegible]
And puncture	=100,000 to 107,000 volts.

Eight units to the string are used on anchor towers and seven on suspension towers. Seven units correspond [illegible] dry flash-over

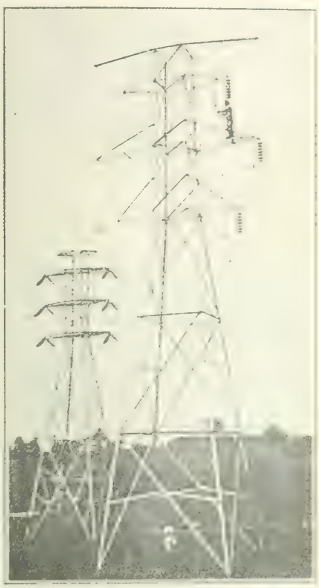


Fig. 2.—Suspension Tower on Line 5a, and [illegible] Background Strain Tower of Line 12.

voltage of 378,000 volts. The new tower line is built parallel to line No. 12, distance between lines being only 50 ft. on centres. The standard span is 500 ft.

Electrical Data.

Frequency	=25 cycles.
Normal line voltage between phases	=60,000 to 70,000 volts.
Ohmic resistance of one wire	=12·1 ohms (12°C.)
Ohmic reactance at 25 cycles is	=13·1 ohms.
Impedance at 25 cycles is	=17·9 ohms.
Losses in three lines at 200 amperes	5,800 kw., or 10 per cent.
Capacity current	3·5 amperes per wire.

Operating Record.

Below is given a tabulation of all the disturbances to normal operation of the system originating in the transmission lines, together with the cause of the trouble and the year it occurred. These disturbances have further been divided into three groups, depending on their seriousness—*i.e.*, total interruptions (T.I.), where all the load was lost, though generally not more than for a few minutes; partial interruptions (P.I.) where a percentage of the load was momentarily lost; and, finally, mere voltage or frequency disturbances (V.D.), where no load whatever was lost. These disturbances have been recorded whenever the voltage changed suddenly 5 per cent. or more.

It will be seen that the overwhelming cause of trouble is lightning. Though the lines are protected at both ends with aluminium lightning arresters, which duly discharge during storms, lightning discharges or surges will nevertheless give rise to "flash-overs" on the line, which, once established, are maintained by the power from the generators. Such flash-overs practically always start at the towers where the clearance distances to ground (*i.e.*, towers) are the smallest.

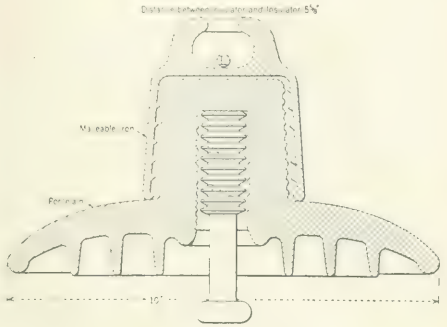


Fig. 3.—Insulators used on Circuits 1 and 2.

The path of the flash-over may vary. Thus, when circuits Nos. 1 and 2 originally went into service, the suspension towers were equipped with five units to the string and strain towers with six units. With this arrangement it was always found that the flash-over would occur upwards from the conductor *alongside* the string of insulators.

Fig. 5 shows a typical string of insulators, damaged by such an arc. It can be seen how the three lower insulators are completely broken to pieces, probably mainly due to the heat generated by the

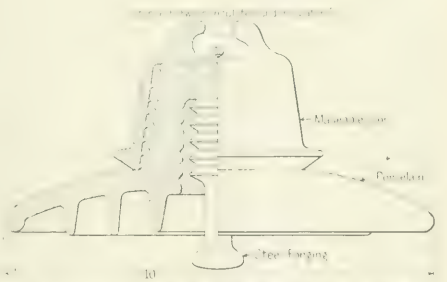


Fig. 4.—Insulators used on Circuits 5 and 6.

arc; the bottom bolt shows a deep burn. It can also be seen from the marks on the string how the arc in this string, instead of travelling all the way from conductor to the tower in one unbroken arc, has broken into small individual arcs, each encircling one insulator. That happens frequently, though not always.

Not only the insulators but also the cable is liable to be damaged by lightning arcs. If the arc stayed at one place it would quickly burn the cable through. Fortunately, the arc is generally on the move. As a rule it is blown away from the power house, due to its own magnetic action. In a few seconds the arc may travel 5 ft. to 30 ft.

The plan was tried in 1912 of increasing the number of discs of a suspension string to seven and of a dead-end tower to eight, on two particular stretches where the lightning had been especially severe. This proved successful in so far that only one lightning stroke occurred on these stretches in 1912 against 22 in 1911. Before the lightning season of 1913 one whole

Table I—*Operating Record for Holtwood–Baltimore Transmission Line, January 1, 1911, to December 31, 1914.*

Cause.	1911.			1912.			1913.			1914.			Total for four years.		
	T.I.	P.I.	V.D.	T.I.	P.I.	V.D.	T.I.	P.I.	V.D.	T.I.	P.I.	V.D.	T.I.	P.I.	V.D.
Lightning	23	...	10	3	19	4	3	17	11	1	6	7	30	42	32
Defective insulators	...	...	...	...	...	...	1	...	...	1	1	1	1	1	1
Sleet on cable	...	...	...	...	...	...	...	...	...	2	2	...	2	2	...
Birds on line	1	...	...	...	...	...	1	...	2	1	3	2	3	3	4
Wires blowing together	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1

circuit (No. 1) was, therefore, equipped in this way with seven suspension and eight strain units. The result was that in 1913 there were 27 lightning strokes on circuit No. 1, 20 on No. 2 and 6 unknown on which circuit.

In other words, the circuit with the many insulators showed the larger number of lightning strokes. Evidence from inspection of the line showed, however, that whenever the flash-over took place on a suspension tower the lightning arc on No. 2 circuit would, as usual, rise upwards along the insulator strings to the cross-arm above, while on No. 1 circuit the arc would in every case go just the opposite way to the cross-arm below. This was naturally due to the fact that this clearance distance for the two upper conductors was materially decreased (from about 36 in. to 24 in.) by adding two more units to the string. For the bottom conductor, where the clearance distance still remained ample, the number of flash-overs was greatly reduced. With this change in the location of the arc it did not have nearly the same chance for damaging the insulators by heat, as it did not pass alongside them but away from them. Thus, in 1913 it was necessary to remove 210 insulators from circuit No. 2, due to lightning damage, and only three from No. 1 circuit. Another advantage gained was that it proved to be easier to extinguish the arcs on No. 1 circuit, and that it could be done with much less loss of the synchronous load connected to the system (on account of the preponderance of two-wire short-circuits compared with three-wire short-circuits). The following year one more unit was added to No. 2 circuit suspension towers and two more to the strain towers, and this is the way it is at present.

Far more important from a maintenance point of view is the continuous *deterioration* of the porcelain in the insulators.

In 1913 the Pennsylvania Water & Power Co. began investigating this by means of megger tests between the pin and cap. The result



Fig. 5.—Part of Interruption of No. 12 in 1913. Suspension Type Insulator, removed from Bottom Phase of Circuit No. 2.

was rather surprising. While the majority of insulators, when the weather was dry enough to permit of any testing, naturally would read infinity, many were found which would read below 10 megohms and some below ½ megohm or lower. On none of them could any external damage be seen. A complete test of circuits Nos. 1 and 2 in the winter 1913-14 showed that out of about 22,400 units, 1,621, or 7·3 per cent., were found to have deteriorated, giving below 500 megohms. By the autumn of 1914 an additional number of about 1,020, or 4·7 per cent., had gone bad. All told, four years' operation [illegible] 11·7 per cent. bad units. It seems as though this deterioration [illegible] a rapidly increasing rate year after year.

Table II. [illegible]

			Per cent.		Units	
[illegible]	[illegible]	[illegible]	17·3	[illegible]	1,0	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	485	[illegible]
[illegible]	[illegible]	[illegible]	17·1	[illegible]	9·0	[illegible]

seen that the two circuits have practically the same number of bad units, but the strain towers on both circuits show a very much larger percentage (17·1 per cent.) of damaged units than the suspension units (7·6 per cent.), indicating that the horizontal strain units are very much more exposed to this trouble than the vertical suspension units.

A number of other tabulations has also been made up to see if there were any difference between insulators from the top, middle and bottom phases, or between the various units in a string. Only slight differences could be found, excepting between the different insulators in a suspension string. Taking only the five first insulators in the string, which have been in service from the beginning of operation, we find that the top unit—*i.e.*, the one nearest to the cross-arm—is the one most subject to damage. (*See* Table III.)

Table III.—*Suspension Insulators Nos.* 1-5 *Deteriorated* 1911-1914.

Unit No.	1	2	3	4	5
Circuits Nos. 1 & 2	210	120	142	169	146

After a number of these units were removed from the line, a series of tests was made in an attempt to determine the cause of this trouble. The tests were as follows:—

First.—230 units with megger readings from 0·01 to 500 megohms were given a high-potential test (25 cycles). All of these units punctured before flash-over voltage, the puncture voltage varying widely, increasing in a general way, however, with an increased



Fig. 6.—Insulator String Punctured on Line.



Fig. 7.—Insulator String Punctured by Test.

megger reading. The puncture takes place inside through the porcelain hidden between the pin and the cap, generally on the side and very often close to the rim of the cap.

Second.—While these tests were going on, a puncture of each and every one of a string of five insulators occurred one day on the line during actual operation. No lightning was reported, the weather was clear and no switching was done at the time of the disturbance. Fig. 6 shows this string. It can be seen that holes as large as a finger tip are burned through the porcelain and the cap, all on the side of the insulator, thus forming a short path between the pins and caps; no evidence of any simultaneous flash-over could be seen. It was a case of [illegible] puncture.

It was naturally thought that this was a case of deteriorated porcelain, which could have been caught in time to prevent failure. [illegible] megger readings [illegible] taken of these insulators some time beforehand. To prove this, five units removed from the line because [illegible] megger readings were connected in a string and high voltage was built up on them [illegible] testing transformer, where the [illegible] current [illegible] was small but from a 70,000 volt, 10,000 kw. transformer, with a 10,000 kw. generator behind it. The current was limited to about 250 amperes by a resistance.

The result of the test [illegible] Fig. 7 when the voltage reached about 70,000 volts. The insulators punctured, burning porcelain and arcs being, as is [illegible], shot out from the side of first one, then of

another insulator, leaving holes of just the same nature as found in the insulator string punctured on the line.

Third.—To discover the nature of this insulator deterioration the tests were made on 24 insulators discarded from the line because of low megger readings. The pin, cap and cement were dissolved in a diluted solution of nitric and hydrochloric acid, so as to give an unobstructed view of the surface of the porcelain, normally hidden by the pin and cap. Of these insulators seven showed clearly a tiny crack in the porcelain at the bottom of the head, which was totally invisible as long as the cap covered it; three showed similar cracks across the head; 13 did not show any cracks; and one was destroyed during the test.

Megger tests on those cracked showed that the low resistance was located right in the crack, and the most natural explanation of the reason for the low megger reading on these insulators would, therefore, seem to be moisture which has penetrated through the cement into this crack. To explain the crack itself, it has been suggested that this may have been caused by high internal stresses set up by uneven temperatures and expansion of the various parts. A. O. Austin has also suggested that crystalline growth in the cement may cause expansion of this, with consequent heavy stresses in the porcelain.*

None of these explanations would seem to hold good for the insulators where no cracks could be found. On these insulators it was possible, however, by means of the megger, to trace areas of low resistance on the outside of the insulator head. It seems evident, therefore, that the acid used in dissolving the pin and cap had penetrated the unglazed body of porcelain between the pin and cap in spots, thus making it more or less conductive. But wherever acid can penetrate porcelain, it is natural to suspect that plain water can do the same. It is, therefore, believed that the failure of these insulators is due to *porous material or lack of vitrification in the burning*, which has gradually allowed moisture to be absorbed by the porcelain in the same way as moisture penetrated through the cracks in the cracked insulator.

Fourth.—When it was first discovered that a large percentage of the low megger readings was due to cracks in the porcelain it was naturally feared that these insulators had lost a great part of their mechanical strength. However, 25 picked out at random were found to have an ultimate strength of between 6,500 lb. and 10,700 lb., with an average of 8,100 lb., which is approximately the same as that of good insulators, when the cement has set thoroughly.

Fifth.—Hot and Cold Water Test.—When bids were requested for insulators for the new transmission line a series of tests was made on insulators submitted by different manufacturers, particularly with a view to finding the type of insulator that would seem to be least subject to depreciation. Working on the theory that the depreciation was at least partly due to high internal stresses, set up by temperature changes, the insulators were subjected to alternate immersions in hot and cold water of five minutes each. After each temperature change the insulator was tested with a megger and discarded if it gave a reading less than "infinity." If an insulator endured the treatment without change in resistance it received in all 10 temperature changes. Table IV. shows the result for six different types of insulators, designated A to F.

The insulators which had not been damaged by the hot and cold water test, so far as could be determined by the megger, were now subjected to high potential, with the results as shown in Table V.

These tabulations show that type E insulators withstood the tests the best, as none of them failed, while types C and D suffered the most, for, among 38 insulators treated, only one withstood the flash-over voltage afterwards.

The insulators which had already shown up poorly on the megger test were also given a high-potential test. They all punctured at voltages varying from 18,000 to 24,000 volts. The megger reading before test varied from 0·4 to 9 megohms. The cap and pin were also dissolved on two of the damaged insulators of types D and F. Both showed tiny cracks at the bottom of the head.

South Improvement of the Insulators.—Working on the other hand, on the theory that, at least in part, this insulator trouble was due to absorption of moisture without accompanying cracks, the plan was tried of drying out some of the insulators removed from the line, under high vacuum (about 27 in.), and at temperatures varying from 50° C. to 90° C. The drying out lasted from 10 to 20 days, and megger readings were taken every few days. The following observations were made :—

A. After only a few hours' treatment, the insulation resistance decreases materially, probably because water is a better conductor when hot than when cold. After 24 hours' treatment a material increase is, however, always found, and this continues steadily until

* See THE ELECTRICIAN for July 30, 1915, p. 160.

Table IV.

Type.	Weight per unit.	No. of insulators. Tested.	Failed.	No. of single temperature changes withstood by insulators.	No. of insulators that failed when transferred from Cold to hot.	Hot to cold.
A	8·5 lb.	19	6	141	3	2
B	9 ,,	19	12	104	5	7
C	10 ,,	19	12	88	4	8
D	9·5 ,,	19	16	67	1	15
E	11 ,,	6	0	60	...	...
F	11 ,,	6	2	40	2	...

Table V.

Type.	Total No. insulators tested.	No. units which withstood flash-over.	No. of units and puncture voltage.
A	13	6 (92 kv.)	7 (43 to 91 kv.)
B	7	3 (96 kv.)	4 (50 to 95 kv.)
C	7	1 (90 kv.)	6 (27 to 87 kv.)
D	3	0	3 (38 to 70 kv.)
E	6	6 (98 kv.)	...
F	4	4 (85 kv.)	...

many of them reach the infinity mark, even when hot. All of them, without exception, will record infinity, when tested cold after two days' treatment.

After drying out, the insulators were given a high-potential test with 25 cycles.

B. *The result was that out of a total of 37 insulators tested, 12 withstood a heavy flash-over test for ½ minute.* The rest of them punctured at voltages varying from 30,000 to 90,000 volts. As the megger readings on some of the insulators that withstood the flash-over were as low as 1 to 2 megohms before drying out, there cannot be any doubt but that they would have punctured at low voltages if they had not been treated.

C. The insulators which dried out the quickest punctured at the lowest voltages. These presumably were the cracked insulators. On the other hand, the insulators that withstood the high voltage generally increased very slowly in insulation. These perhaps were insulators which would not have shown cracks under the cap.

D. Four of the successfully dried out insulators have since that time—*i.e.*, four months—been exposed to the weather, hanging in a vertical position. They still read infinity. It is believed that if means could be found to prevent moisture from re-entering such insulators, it would be perfectly safe to put them out on the line again.

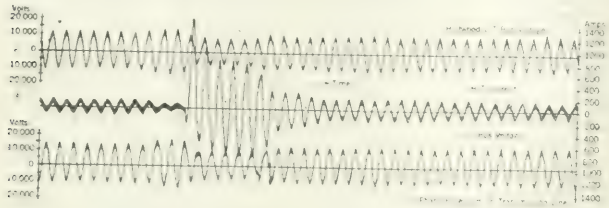
It has often been suggested that the deterioration of insulators was due to electrical causes, such as switching, surges, arcing ground, high-frequency discharges, &c. As an indication that this is not the case, an insulator record from a 70,000-volt transmission line between Holtwood and Lancaster, 13 miles long, may be of interest. This line consists of two identical circuits on the same tower line. While the two circuits were built at the same time, it has been customary to use only one of them, while the other one was kept as a spare. At the end of the test one of the circuits had been under voltage 481 days, the other one only 91 days. Still they showed very nearly the same percentage of damaged units—*i.e.*, 8·9 against 8 per cent. On the whole, the insulator record given above, and the experiments made, all tend to show that the deterioration of the type of insulator in question is not due to electrical but rather to mechanical and ceramic causes.

Sleet.—It is now well understood that the most common cause of sleet trouble is the fact that when, with the arrival of milder weather, the sleet starts falling off the wires, it will often fall off one full span or several spans at one time but still remain on other spans. Such conditions result in unequal loading and therefore also extremely unequal sag for the different spans. If the wires of different phases, therefore, as on circuits Nos. 1 and 2, are in the same vertical plane, they are liable to come in touch with each other and produce short-circuits. The few disturbances recorded as caused by sleet on the Baltimore transmission line have all been of this nature.

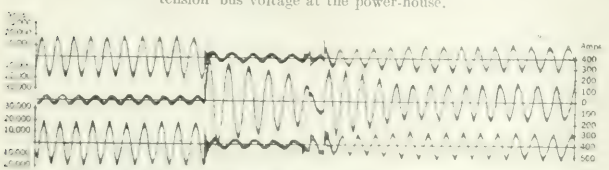
In building the new line to Baltimore it has been attempted to prevent or minimise this trouble by having the middle cross-arm extend farther out (about 2 ft. to 3 ft.) than the top and bottom one; a larger number of strain towers has also been used, so as to avoid having more than five suspension spans between two dead-end towers. It may be of interest to note that during a recent sleet storm where both the old circuits, Nos. 1 and 2, were short-circuited, due to sleet, the new one, No. 6, stood up without a single short-circuit.

There is, however, another method of preventing sleet trouble,

which the Pennsylvania Water & Power Company has lately adopted. The principle of this method is simply to keep the conductors so hot that no sleet whatever can be formed on them. The heat is produced by circulating electric current through the wires. Test and experience show that for a 300,000 c.m. mil, 3-conductor cable, about 250 to 300 amperes is enough to keep the heat generated in the cables; often even less current will do it. On the other hand, if ice already deposited on the wires is to be melted off, considerably more current is necessary. The present arrangement, when a sleet storm is reported and the load is at its lightest, is to leave only one circuit (No. 6) in service, which carries all the load, while the two others are connected in series, short-circuited at one end, and current is sent through them from two generators and two transformers.



(A) The middle wave represents the high-tension current, the others the low-tension 'bus voltage at the power-house.



(B) The middle wave represents the high-tension current at the sub-station, the two outer ones the low-tension 'bus voltage at the sub-station.

FIG. 8.—OSCILLOGRAMS SHOWING ACTION OF ARC EXTINGUISHING FUSE. (A) AT POWER HOUSE AND (B) AT SUB-STATION.

If the load is heavier, all three circuits will be put in service, and if the current is not judged to be sufficient to prevent sleet, an arrangement is adopted by means of which wattless current is brought to circulate over the wires while they at the same time carry the load. This object is obtained by dividing the generators at the power house into three groups, each of which through its respective transformers is connected with one transmission circuit. The three circuits are paralleled at the sub-station end. The field circuit is kept open on the generators of one of these groups, while the others are over-excited. Consequently the generators with the open field will draw their excitation from the alternating current side, but the current will first have to pass the transmission line. An increase of from 40 to 200 per cent. in total current for the three lines, depending on the load conditions, can be secured this way.

Buzzards.—The birds troubling this line are turkey buzzards. These birds often choose the towers as a resting place, and here they are liable to ground the line to the tower through their own bodies. There is especial danger if they sit on the cross-arm right below the live wire. A buzzard grounded in this way is always killed, and will often fall down without even causing a voltage disturbance, but frequently it will give an intermittent ground which may even develop into a permanent one.

Wires Blowing Together.—The one voltage disturbance recorded is due to the contact which represents a case where the ground wire swung into one of the lower cables at a place on a curved tower, where the clearance distance was abnormally small.

PROTECTIVE DEVICES.

In order to maintain continuous operation when sleet or ice storms cause one or more of the above causes, one or the first several distinct protective devices have been adopted.

1. *Interlocking Line Relays.*—Trouble from defective insulation, such as that caused by the wind throwing a branch or other object across two wires, or a wire to ground or short-circuit may persist on the line until the voltage is reduced at the power house sufficiently even to melt on a permanent fault that does not permit restoration of voltage until repairs are made. The natural method to safeguard operation against such troubles is, therefore, to cut the damaged line out, and the earlier the better. This means, as a general scheme, automatic operation of switches.

The system in use consists simply of overload relays at the power house connected in series with the three current transformers and also one relay in the ground connection for the neutral of each transformer bank. At the sub-station, reverse-current relays take the place of the over-load relays at the power-house. All these relays are themselves made as instantaneous in their action as possible, but are used in connection with definite time limit relays, so that a momentary short-circuit will not produce action. To prevent all three lines from going out by relay action, in case there should be a short-circuit on all the lines at the same time, the trip circuits are interlocked.

This system has not always been entirely successful. Difficulties were especially encountered in giving the various relays a suitable current and time setting, and due to the complication in wiring introduced, since low-tension automatic switching was adopted. Since June, 1914, when various changes were made, especially on the reverse-current relays, so that they would be more sensitive, the record shows seven entirely successful actions out of a total of nine times when the conditions were such that they could act correctly.

It may be asked why the same interlocking relay arrangement is not sufficient as lightning protection. The reason is the simple fact that lightning flash-overs very often will occur on both circuits Nos. 1 and 2 at the same time. (It still remains to be seen whether they will occur on all three circuits at the same time.) When both circuits are in trouble at the same time, the clearing of both means, of course, a total interruption.

Though the lightning short-circuits were so severe that it was necessary to clear the circuits, the insulators and cables were never so badly damaged that it was impossible to come right back with the voltage right after the interruption. This indicated clearly that if only some means could be found to extinguish the power arcs, an interruption might be avoided.

The first scheme tried with this end in view was based on the idea of clearing one line completely, while the other one, even if in trouble, was supposed to maintain some kind of synchronism with the customers' load; then the first circuit would be put right back again and the second line cleared, &c. The system was actuated by overload relays at Holtwood, and their action was transmitted by means of overhead wires to other relays at the sub-station, so as to get synchronous action of the oil switches. This system proved a failure mainly because it was found that certain atmospheric conditions of no danger to the high-tension transmission lines, would produce disturbances through the overhead relay wires and thus unnecessarily

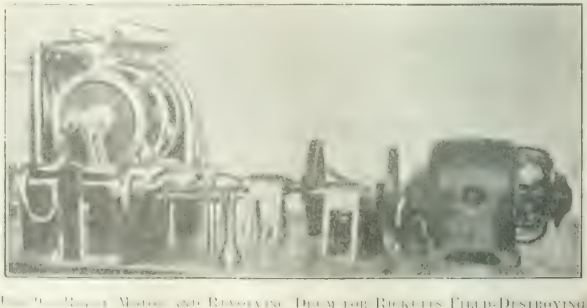


FIG. 9.—POWER MOTOR AND RECEIVING DRUM FOR ROCKETS FIRED DESTROYING WIRE RECEIVING DEVICE.

2. *Interlocking Fuse Relays.*—Trouble from defective insulation, such as that caused by the wind throwing a branch or other object across two wires, or a wire to ground or short-circuit may persist on the line until the voltage is reduced at the power house sufficiently even to melt on a permanent fault that does not permit restoration of voltage until repairs are made. The natural method to safeguard operation against such troubles is, therefore, to cut the damaged line out, and the earlier the better. This means, as a general scheme, automatic operation of switches.

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proper wires automatically. Seldom more [illegible] will pass from the time the lightning arc is established until the switch is closed.

An important point for successful [illegible] is that they be timed correctly. If this time is too short the arc may be re-established, and if too long, it is very difficult for the [illegible] to remain in synchronism. Cycle recorders are installed between the fuse banks, so that an actual record of the time it takes a fuse to blow, during a lightning storm, always can be found afterwards. Fig. 8 shows two oscillograms which illustrate the action, the upper one being taken at the power-station, and the lower one at the sub-station. On both oscillograms the two outer curves represent the low-tension bus voltage, while the middle wave represents the high-tension line current. The fuses are now only put in service when a lightning storm is reported, so as not to act on low-tension short-circuits on the other occasions when they are of no use. When only a ground or two-wire short-circuit occurs this device saves all or practically all the synchronous load, and on three-phase short-circuits generally about 50 per cent. of the load can be saved. By keeping the voltage on the line all the time it makes it also possible to restore lost load more quickly than otherwise would be the case.

Another lightning protective device in use has been invented by Mr. F. E. Ricketts, of Baltimore. The principle is simply that whenever a short circuit occurs on the line, the field of all the generators will for a moment be destroyed, so as to allow the arc on the line to be extinguished on account of lack of voltage, and then immediately after be built up again so as to force the synchronous load into step again before the synchronous converters, frequency changers, &c., have come to a stop.

In order to give the Nicholson arc extinguisher and the interlocking relay arrangement the first chance to clear the trouble, the relays are used in connection with a definite time element, at present set for four seconds. When these four seconds are up, a clutch for a small motor, which is running continually, will be thrown in contact and start a drum rotating. On this drum contacts are arranged so that all the field circuit-breakers will be opened simultaneously, at the same time short-circuiting the field windings across their respective discharge resistances. Meanwhile the drum continues to revolve and will, after a predetermined time (originally 5 seconds, now 1½ seconds), close other contacts which have the effect of slamming all the circuit-breakers in again. The drum continues to rotate until it has made one complete revolution, after which time it is disengaged from the motor and the whole equipment ready for another operation. The apparatus is shown in Fig. 9. The record for this device shows for 1913 and 1914 [illegible] lightning operations and four failures.

Comparing this device with the Nicholson arc-extinguisher, it must be said that the fuse arrangement has been given preference and first chance for acting, mainly on account of its quickness of action, which saves the line from too severe damage, and also on account of the excellent results it has produced in case of the lesser lightning disturbances like grounds and two-wire short-circuits. The field-destroying device treats all lightning disturbances as equally severe and produces the same disturbance on practically all of them, but seems, on the other hand, to have the great advantage of extinguishing the arcs with more certainty.

Difficulties with this device are mainly due to the difficulty of keeping the generators synchronised when the field is lost.

[illegible]

It has been shown that while [illegible] of disturbances, these have been very materially reduced both in number and in severity, year for year, by the use of special protective devices. As to [illegible] during such storms, which it is believed will prevent trouble from this cause. The approaching danger from deterioration of the insulators has been discovered at an early stage, and rigid and repeated elimination tests of bad insulators, with megger, have been adopted as part of the maintenance routine, so that it is felt that *operation* will have but little to fear from this source.

BOOKS RECEIVED.

[illegible]

"Proceedings" of the Koninklijke Akademie van Wetenschappen te Amsterdam. Amsterdam: Deel [illegible] XVIII.

Land Measurement. Over-sea Work, 1914. [illegible] Professional Research. By L. A. Bauer and [illegible] Washington: Carnegie Institution of Washington. Pp. [illegible].

CORRESPONDENCE.

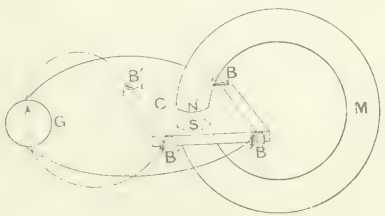
THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Many who have read Mr. Hering's letters on the alleged erroneous statement by Maxwell concerning the laws of induction must have felt that Mr. Hering has not proved his case.

The explanation appears to be that, in moving his sliders from BB to B′B′, Mr. Hering has really produced a new circuit which is quite different from the original one. He has, therefore, not dealt throughout the experiment with a circuit as premised by Maxwell, but with a multitude of circuits, connecting them up and disconnecting them again with each minute movement of the sliders. This may not seem quite clear where a solid block of copper is used, but if we replace it by Mr. Hering's series of insulated bars, and move the sliders along the bar ends, then it at once becomes obvious that we are dealing with a new circuit each time that the sliders leave one bar and touch another.

There is nothing in Maxwell's law to make one think that an E.M.F. should be generated by this kind of action. Suppose that we magnetise a closed iron ring and then build a con-



ducting circuit round it, no E.M.F. will be generated in it according to Maxwell's law, at any rate in the opinion of most people, although Mr. Hering appears to expect that an E.M.F. would be generated under such conditions if the law is universally true.

We may, of course, alter or vary the connections in many electrical experiments without appreciably affecting the result, provided that we do not alter the intrinsic parts of the circuit. If we do that we may expect to find variations in the results. To prove his case, Mr. Hering must connect up his electric circuit and link it with a magnetic flux in the manner premised by conventional text-books, and, having done so, he must refrain from making any further alterations to the electric circuit.

If he can then vary the magnetic flux without producing an E.M.F. in the electric circuit he may claim to have upset Maxwell's law and to have discovered a new and very important phenomenon in Nature.—I am, &c.,

North Shields, Sept. 18. C. TURNBULL.

SCIENTIFIC COASTING IN ELECTRIC TRACTION.

During the early part of the year 1913 the San Francisco-Oakland Terminal Railways installed for trial use 30 Recording recorders, enough to equip completely all cars on the West Eighth Street line at Oakland. The Electric Railway Journal gives an account of the results obtained, which show what a wonderful saving in energy can be effected by giving attention to coasting.

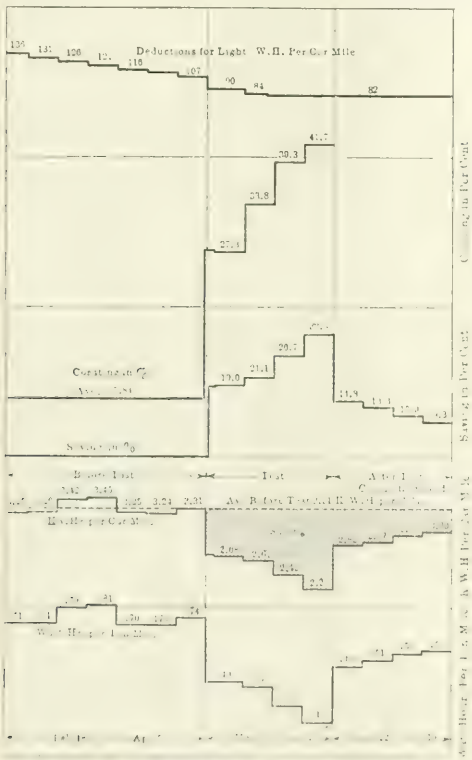
For seven weeks before the trial weekly records were made of total [illegible] hours of labour due to propulsion alone (voltage lighting, hours and number of heating unit being known), total car-miles, total car-miles of coasting clock cars alone and total passengers. Similar records were made weekly during the four weeks' test period from May 24 to June 21, and for four weeks following the test period. The three sets of observations gave their significant results. Before the recorders were installed the energy consumption per car-mile averaged 3·31 kw hour, or 174 watt hours per ton-mile. [illegible] 7·84 per cent., although it may

be added that the coasting average for the system as a whole was about 15 per cent.

With the inauguration of the coasting clocks and instruction service on the cars the percentage of coasting rose to 27·60 per cent., and for the week ending the test the coasting was 41·70 per cent. The result is reflected in the averages of 35·34 per cent. coasting, 2·5 kw.-hours per car-mile and 131 watt-hours per ton-mile shown in the accompanying graph, the whole meaning a saving of 24·5 per cent. in energy.

The need for the continued and systematic use of recorders was quickly demonstrated in the period after the coasting recorders had been removed. During these four weeks the energy requirements rose from 118 watt-hours per ton-mile to 157 watt-hours, so that for the last week of the period the energy saving over the original conditions was but 9·3 per cent. This is also shown in the diagram.

Appreciable savings in brake-shoe wear were also made on the same line. Thus between April 13 and May 6, 1913, before the use of coasting clocks, five cars averaged 22·4 lb. wear per 1,000 miles; whereas four cars of the same type and in the same service, but



Curve Sheet from Log Sheet showing Energy Saved by Coasting Tests.

equipped with coasting recorders, averaged only 13·5 lb. wear per 1,000 miles between June 11 and June 22, 1913—a saving of 39·7 per cent. The money value of the brake-shoe saving worked out at over £1,000 a year.

As the result of these tests, the company placed an order for 350 coasting recorders, enough to cover all the city and high-speed [illegible]. All cars were so equipped by May 31, 1914.

The coasting tape records as taken from the clock show in order the number of the car, which is also that of the clock; the coasting [illegible] to read, and the number of the motorman, an "E" being added to indicate an extra. Any delays exceeding three minutes are taken into account in calculating the percentage of coasting [illegible]. The records are turned in daily to the district and division [illegible] for inspection, and they in turn forward them to the [illegible] department. Monthly lists are made up to show what percentage of cars are reading certain coasting records. Other [illegible] are worked up into graphs which compare the various districts. Another set of graphs shows the coasting percentages and the average number of passengers carried per diem plotted against watt-hours per ton-mile and kilowatt-hours per car-mile.

Men whose coasting records are low are placed in the charge of a coasting instructor, who devotes an entire day to the delinquent. Generally speaking, about 90 per cent. of the men have been thoroughly educated to the meaning of efficient coasting. Should a man prove incorrigible after repeated instruction, but be satisfactory otherwise, he is disciplined by being placed on the extra list or treated as a recruit motorman. So far it has not been necessary to discharge one man because of poor coasting alone. Some 400 motormen are kept up to high coasting pitch with the aid of but one instructor. At first two coasting teachers were constantly engaged.

A large number of men had the impression that the best coasting records were to be obtained by allowing the car speed to die down and then jerking the controller handle over for a short spurt, and so on repeatedly. Of course, this mode of operation is disagreeable to passengers, and it does not produce the best coasting records. The men are taught that the best results are secured by accelerating and braking to maintain a uniform rate of speed, and by anticipating stops so that the car will do part of the braking.

Reference has already been made to the subdivision of coasting records by lines and classes of men. To afford a still fairer basis of comparison, the coasting instructor began about April 1, 1915, to work up a standard for each line, instead of determining standards from the work of all men. Should a time-table be changed, the instructor rides all over the line again to establish a new standard if that appears necessary.

Although the company has maintained careful analyses of accidents by divisions, it did not begin until recently to check against the coasting records those accidents, like collisions and thrown passengers, which might be promoted by a too eager desire to coast. As yet there is no evidence to show that increased coasting has added to the number of accidents. It has been observed, however, that, following the semi-annual selection of runs, accidents tend to go up until the men who have changed are accustomed to new conditions.

Clock troubles are recorded on a defect sheet devised by the Railway Improvement Company. During the first four months of 1915 the average number of troubles per car per month were 0·248, 0·231, 0·254 and 0·198. This shows how most of the troubles are now guarded against.

The publication of the results of a three-day test when a low-coasting and a high-coasting motorman were checked by means of watt-hour meters demonstrated conclusively that the man who did the most coasting was using the least energy, and that low coasters consume power to the value of 4s. to 8s. a day more than high coasters, even when energy is figured at but 0·6d. per kilowatt-hour. The man coasting 42·9 per cent. of the time only consumes an average of 495 kw.-hours, as compared with the man coasting 29·1 per cent., consuming an average of 610 kw.-hours, making a difference of 115 kw.-hours in favour of the man with the high-coasting record.

Electric Surges.—Mr. L. Blinder publishes in the "Elektrotechnische Zeitschrift" some investigations into the shape of the crest of a surge. The main point in dispute between him and others is as to the steepness of this crest. He measures the voltage between different points on the same conductor; this measurement of voltage is carried out in two ways, the first uses a spark gap through which the radiation from radium or ultra-violet light passes, and the second employs a condenser, the charging currents of which are measured by a hot wire. Both methods agree in their results. The surge on closing a switch was examined. It was found that the voltage between two points, 1 metre apart, amounted to 12 per cent. of the height of the wave, and between points, 20 metres apart, amounted to 70 per cent. of the height of the wave. The crest of the surge does not, therefore, seem to rise as steeply as is commonly supposed. These values were obtained on closing a circuit, similar to that which commonly occurs in high-tension work, i.e. with pressures above 3,000 volts. In this case there are sparks before the contacts are closed. Surges due to various kinds of arcing phenomena were examined, but the results were similar in all cases. Thus there is the case of a surge due to the closing of a high tension direct-current circuit, or to the closing of an alternate current circuit very rapidly, as, for instance, with an oil switch. There is also the case of a succession of surges on alternate current, where the surges follow the frequency of the current. But the author finds no essential difference between these types of surge.

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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THE EXCHANGE SYSTEM FOR BATTERY VEHICLES.

At the Convention of the I.M.E.A. held in London in 1913, when the subject of commercial electric vehicles was actively revived in this country, a Paper was read which recorded the developments in recent years, more particularly in America, of battery-propelled cars. In the discussion on this Paper attention was called to the possibility of inaugurating a system whereby vehicle users would be supplied with facilities for exchanging discharged for charged batteries as and when required. We now gather that a scheme which makes this exchange possible has been in operation for a period of at least two years in the United States in the district served by the Hartford Electric Light Co., Connecticut. In the initial stages the user of the electric vehicle is saved from 20 to 25 per cent. of the capital outlay, because he purchases the machine minus the battery. Then again he is relieved of the worry and cost of battery maintenance and repair, although, of course, he pays for these indirectly in the charges upon which the battery exchange facilities, of which he takes advantage, are based. The problem of garaging is also considerably simplified. The vehicle user can, if he so wishes, pay the electricity undertaking which supplies him with batteries for the garaging, washing, oiling, greasing and the making of minor adjustments to his vehicle. On the other hand, if he has the space at his disposal, he can house the vehicle or vehicles himself. The latter is the more likely thing for him to do, because any weatherproof building or outhouse will serve to store the vehicle, seeing that it is not necessary to make any provision for the protection of charging apparatus.

This scheme appears to have been put into operation by the battery makers and the central station engineers getting together and agreeing upon a schedule of charges which will be mutually satisfactory to themselves and to the vehicle user. This schedule has been drawn up to give certain monthly prices which the vehicle user is charged for the various capacities of wagons which he has in service. The monthly charge for garaging and for battery service and inspection is a definite sum for each type of vehicle. In addition to this, there is a mileage rate, which is graduated so as to fall from the 500-mile to the over-1,000-mile limit. The general basis of these charges was published in the August issue of our monthly supplement "Electric Vehicle Progress," and the figures, which were taken from the "Electrical World," were converted as nearly as possible to English numbers. We realise that they relate exclusively to American conditions, but we also feel that they may serve as a useful guide either to the Electric Vehicle Committee or to any other body which may be able in the near future to place this system of battery exchange upon a commercial basis.

A number of vehicles which are in operation in this country at the present time are within easy range of charging facilities which are provided by their owners. In certain cases the practice of boosting is resorted to in order to increase daily mileage over that which is available on one charge of the battery. These vehicles, which usually exist in fleets of anything from six machines upwards, hardly come within the scope of the battery exchange system. This latter is principally intended to encourage the use of the electric vehicle in those trades and industries which require only from one to, say, four machines. This class of vehicle user is neither anxious, nor, in fact, should he be encouraged, to incur heavy outlay upon batteries and battery-charging equipment. The particular problem which this class of transportation represents can undoubtedly be solved by the application of some such method as the battery exchange system as it is now in vogue in certain American cities. For the time being, it is too much to hope that the central station interests in this country can co-operate sufficiently strongly to obtain the necessary financial support for putting into operation some such system on a scale which will bring into service a score or more of electric commercial vehicles in each of the principal towns in this country which are served by a public electricity supply.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Sept. 13, 1915, *to* Sept. 18, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]

LONDON.—*U.S.A.:* Elec. machinery, £1,731; carbon candles, £500; telephone [illegible] pkgs. *Switzerland:* Elec. machinery, £14; unenumerated, £639. *Holland:* Elec. lamps, £459—13 pkgs.; elec. machinery, £55; elec. copper wire, 28 pkgs. *France:* Elec. lamps, £12—22 pkgs. *Denmark:* Unenumerated, £20. *Italy:* Elec. carbons, 8 pkgs. *Spain:* Elec. carbons, 298 pkgs.; insulators, 14 pkgs. *Sweden:* Elec. lamps, £76 *N. Atlantic:* Quantity submarine telegraph cable. *Canada:* Unenumerated, £490.

MANCHESTER.—*Holland:* Elec. lamps, 9 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Wire and cable, £1,262; elec. machinery, £98; unenumerated, £326. *Melbourne:* Wire and cable, £47; unenumerated, £1,451. *Sydney:* Elec. machinery, £133; telegraph material, £78; unenumerated, £1,324. *Wellington:* Elec. machinery, £11; unenumerated, £1,497. *Brisbane:* Unenumerated, £21. *Christchurch:* Wire and cable, £1,192; unenumerated, £134. *Dunedin:* Wire and cable, £537; unenumerated, £34. *Hobart:* Wire and cable, £580; unenumerated, £23. *Lyttleton:* Unenumerated, £48. *Napier:* Unenumerated, £41. *Adelaide:* Unenumerated, £286 *Fremantle:* Elec. machinery, £50; wire and cable, £116.

AFRICA.—*Durban:* Wire and cable, £1,537; elec. machinery, £691; unenumerated, £2,259. *Port Elizabeth:* Wire and cable, £183; telegraph material, £173; unenumerated, £640. *Cape Town:* Elec. machinery, £92; wire and cable, £787; unenumerated, £960. *East London:* Wire and cable, £139; telegraph material, £316; unenumerated, £21. *Beira:* Unenumerated, £83. *Secoondee:* Unenumerated, £33.

EGYPT.—*Alexandria:* Unenumerated, £313.

ADEN.—Unenumerated, £168.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Elec. machinery, £61; unenumerated, £1,986. *Monte Video:* Elec. machinery, £72. *Tampico:* Telegraph material, £10.

JAPAN.—*Kobe:* Elec. machinery, £62.

CHINA.—*Hankow:* Unenumerated, £51. *Shanghai:* Telegraph material, £50; unenumerated, £35. *Hong Kong:* Wire and cable, £582; unenumerated, £20. *Peking:* Unenumerated, £195.

U.S.A.—*New York:* Unenumerated, £679.

DOMINICA.—Unenumerated, £38.

[illegible] £2,175; elec. machinery, £38; unenumerated, £983. *Calcutta:* Unenumerated, £335. *Madras:* Wire and cable, £185; telegraph material, £17; unenumerated, £315. *Ceylon:* Wire and cable, £22; unenumerated, £134. *Singapore:* Elec. machinery, £99; unenumerated, £159. *Penang:* Unenumerated, £291. *Bankok:* Unenumerated, £625. *Karachi:* Unenumerated, £598. *Port Swetenham:* Unenumerated, £13.

WEST INDIES.—*Demerara:* Unenumerated, £12. *Trinidad:* Telegraph material, £15; unenumerated, £12.

FRANCE.—*Dieppe:* Unenumerated, £44. *Paris:* Elec. machinery, £118; wire and cable, £163; telegraph material, £250; unenumerated, £997. *Boulogne:* Unenumerated, [illegible]

MALTA.—Unenumerated, £89.

PORTUGAL.—*Lisbon:* Telegraph material, £17; wire and cable, £2,740; unenumerated, £410.

HOLLAND.—*Amsterdam:* Unenumerated, £540.

RUSSIA.—*Archangel:* Unenumerated, £448. *Petrograd:* Elec. machinery, £162; unenumerated, £1,321.

GIBRALTAR.—Telegraph material, £33; unenumerated, £288.

SOLOMON ISLANDS.—Unenumerated, £15.

FOREIGN GOODS (duty paid and free).

[illegible] merated, £119. *Christchurch:* Unenumerated, £40. *Buenos Ayres:* Unenumerated, £322. *Petrograd:* Elec. fans, £227. *Port Elizabeth:* Unenumerated, £406.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Alien Enemy Patents.

[illegible] was stated that, according to the patentee's plan, the hammer was sus- [illegible] weakened the stroke and diminished the power for lifting the tongue. [illegible] prevent the circuit being closed prematurely, and contact for the next [illegible]

[illegible] patentee had been interned in Scotland, and the licensees were in the difficulty that, while holding an exclusive licence from Mr. Herrde, they [illegible] that their contract gave them power to manufacture — under a certain clause the patentee had hitherto supplied all the electric fittings—and, furthermore, they were troubled as to whether any question could be raised as to trading with the enemy.

The Controller (Mr. TEMPLE FRANKS), examining the licence, said it appeared that the patentee granted the firm power to sell, use and exercise the patent rights of the invention, and there was a further clause which referred to "manufacturing, selling and disposing of bells." That looked as though the right to manufacture was given in terms, but a later clause bound Messrs. Warner & Sons to place with the patentee orders for electric fittings to the amount of a certain sum per annum. That was wholly inconsistent with the right which seemed already to have been [illegible] to manufacture. When a licence to manufacture was given and taken away in the next 10 lines he owned he did not clearly understand what was intended. The licensee was to be entitled to the sole right to manufacture in the event of the death, retirement or bankruptcy of the patentee, or in default of keeping the patents and inventions in full force and effect. The licensees had paid patent renewal fees in the patentee's default, and they said that he had broken his agreement. The Controller added that he must take the view that under the contract applicants had power to manufacture. Another question was raised. They could do nothing without the tools, drawings and patents for electric fittings, which were at Herrde's office, and these the landlord had seized for rent. He also said he had made advances to the patentee in respect of working.

Mr. ROBERT WARNER, managing director of the applicants, gave evidence, and said they had made their appliance the latest and most perfect thing out. Substantially, it consisted of a cast-iron box, with an electric mechanism, which could be fitted inside any bell. It was equally effective with very heavy bells. It might be a little expensive, but the point was it was practicable, and they had sold a considerable number. They desired now to manufacture for themselves, except perhaps the switch, which was a complicated part of the installation; that they could get some competent engineer to undertake.

The CONTROLLER: As far as the agreement is concerned, I think you may commence to manufacture to-morrow; but you cannot, I recognise, manufacture without tools. The landlord may have a lien on them, and I advise you to take legal opinion on your position there. It is possible after what you have said, and what you have paid, that you may have a prior lien. No question of trading with an enemy arises. As to agreements with alien enemies, generally speaking the operations are suspended during the war. You cannot receive anything from him or pay him any money. He thought the applicants need anticipate no hostility from Mr. Herrde when they came to make their arrangement hereafter. A letter from him suggested he was agreeable to amicable settlement.

Premature Electric Supply Connection.

At Birmingham Petty Sessions Court No. 2) last week, Lewis Chapman, the occupier and licensee of the Aston Theatre Royal, was summoned for not giving notice in writing to the inspector of electrical fittings of a desire to instal temporary lighting; also for using a temporary electric lighting installation without inspection, and permission in writing to use same from the inspector of electrical fittings. There were further summonses against Chapman, Harry H. Carrad and Thomas P. Bird, to show cause why their recognisances should not be forfeited.

Mr. HILL (for the prosecution) said the proceedings were a sequel to a fire at the theatre on Sept. 7. Fortunately little damage was caused, but had it not been for the effective manner in which the sprinklers at the theatre worked, serious consequences might have resulted. It was most necessary for the safety of patrons of theatres that the regulations should be observed, and he thought if they were observed no untoward incident would ever occur.

Mr. COHEN (for the defence) admitted a technical offence in each case, and explained that both Mr. Bird and Mr. Carrad were not nominal sureties, but they were in the habit of frequently visiting the theatre in order to see if the regulations were being carried out. They had done all that was possible for sureties to do. Mr. Chapman desired to state he was very sorry for what had occurred. The electrician who put up the installation had no idea he was infringing the regulations. Nothing of [illegible] would occur in the theatre again.

Mr. [illegible] was fined £[illegible] on the first two summonses, but the case against the sureties was dismissed.

PARLIAMENTARY INTELLIGENCE.

NEW TAXES.

[illegible] House of Commons on Tuesday the Chancellor of the Exchequer (Mr. Reg. McKenna) made his Budget statement, and among the proposed [illegible] the following:

[illegible] the charge will be 9d. for [illegible] and 2d. halfpenny, [illegible] will be 2s. 6d. per 100 words at [illegible] with 8d. for each additional [illegible] 2d. respectively.

[illegible] proposed to raise the rate to £20 (instead of £17) per [illegible] for first line and £17 (£14 for second and subsequent connections

in London, and £12 and £10 instead of £10 and £8 10s. in the provinces for two party lines £7. 10s. (£6. and four party lines £5. (£4.) existing flat rate subscribers only. Trunk service will be 1d. for 25 miles instead of 3d.), for 50 miles 8d. (6d.), 75 miles 1s. (9d.), 100 miles 1s. 4d. (1s.) and 8d. (6d.) for every additional 40 miles. The few existing trunk fees at 1d. and 2d. will be made 2d. and 3d. respectively. The call fee in London will be 3d. (2d.) in addition to the trunk fee, and the local call in the provinces 2d. (1d.) in addition to any junction fee.

Postal Rates.—The present ½d. postal rate has been abolished, and the letter rate has been increased to 1d. per oz., with 1d. for second ounce and ½d. for every additional 2 oz. Registered newspapers will be charged 1d. instead of ½d. The parcel post rates have been increased by 1d. per lb.

Import Duties.—On imported motor cars and motor cycles, clocks, watches, cinema films and plate glass [illegible] duty of 33⅓ per cent. has been imposed.

Motor spirit duty has been increased by 3d. per gallon.

EDUCATIONAL NOTES.

University of London, King's College.—The faculty of engineering provides complete courses of study extending over a period of four years in civil, mechanical and electrical engineering, for the engineering degree of the University of London and for the diploma and certificate of the College. The four years' course provides, in addition to academic training, opportunity for practical training in works. The next term begins on Wednesday, Oct. 6, and full particulars may be obtained from the Dean or the Secretary, King's College, Strand, W.C.

University of Edinburgh.—The University provides courses in civil, mechanical and electrical engineering, qualifying for the degree of B.Sc. in engineering and extending over three years. The next session will open on Oct. 17. A preliminary or entrance examination is held this month. Full particulars from the Matriculation Office.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

Manchester Municipal School of Technology.—The 1915 session will open on Oct. 5, and matriculation and entrance examinations will be held in July and September. Complete courses of instruction are provided in mechanical, electrical and sanitary engineering, chemical and textile industries, architecture, &c. Prospectuses, giving complete particulars of the courses leading to the Manchester University degrees in the faculty of technology can be obtained free on application.

Part-time courses in mechanical and electrical engineering, chemistry, architecture, &c., are provided for evening students and others whose ordinary employment occupies the greater part of their time. These include apprentices' day and evening courses, as well as full-time and part-time day classes for advanced study and research. The ordinary evening course extends over five years, and leads to the associateship of the School of Technology. There are special classes in wireless telegraphy, which extend over years. The numerous and extensive laboratories and workshops are equipped with modern machinery, tools, &c.

Heriot Watt College, Edinburgh.—This college provides theoretical and practical training for mechanical, electrical and mining engineers, chemists, &c. The diploma course in engineering lasts for three years, and arrangements exist for shortened apprenticeships with local mechanical and electrical engineering firms. The course in mining extends over three years, and is recognised by the Home Office as equivalent to two of the five years' underground training required of candidates for the colliery manager's certificate. The training in mining is also recognised by the University of London for the purposes of the B.Sc. (Lond.) degree in mining. There are complete courses of instruction, extending over four years, for those who are studying for the fellowship of the Institute of Chemistry. Particulars of courses, fees, &c., from the clerk (Mr. R. Macnaughton, S.S.C.), Heriot Trust Office, Edinburgh.

Northampton Polytechnic Institute.—The session 1915-16 will commence on October 4 next. In the engineering day college there are full-day courses in the theory and practice of civil, mechanical and electrical engineering.

The courses in civil and mechanical engineering include specialisation in automobile and aeronautical engineering, and those in electrical engineering include specialisation in radio-telegraphy. These courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. Eng. of the University of London. The entrance examination will take place on Sept. 28 and 29.

In technical optics there are full and part-time courses in all branches, and instruction is given in specially equipped laboratories and lecture rooms. Full particulars as to fees, dates, &c., and all [illegible] respecting the work of the Institute, can be obtained at the Institute or on application to the principal, Dr. R. Mullineux Walmsley, St. John-street, London, E.C.

We have received a copy of "Announcements" for the session 1915-16, from which we learn that there are day and evening courses in engineering (Civil, Mechanical and Electrical), in technical optics, in artistic crafts and in horology. The engineering courses include sub-sections in automobile work, aeronautics and radio-telegraphy. In addition there are evening courses in electro-chemistry, metallurgy and domestic economy. The day classes commence on Oct. 4, and those of the evening courses on the 27th inst. Enrolments for the latter have commenced.

Notwithstanding the disturbance caused by the war the equipment of the various departments was extended during the session 1914-15 in several directions. In the mechanical engineering department the testing equipment was increased by the addition of a Heenan & Froude dynamometer, and the prime mover equipment by a semi-Diesel engine. In the electrical engineering department various transformers and motors of special types were added, and a Tirrell regulator and a mercury arc rectifier were installed. The instrument equipment was also extended, and in the technical optics and other departments a fair amount was also spent on extensions during the past session. The programme of work for the new session has necessarily been given very careful consideration by the Governing Body, and, speaking generally, it has been decided to continue to announce the various regular classes which have been announced in previous sessions. The courses in the engineering day college are to be continued, but the second and third year courses which ordinarily extend from September to Easter are, in 1915-16, to commence in January, and to be continued until July. This will enable the students to work up to Christmas in the munitions workshop which has been fully employed in making gauges and parts of armaments during the whole of the summer vacation. In the evening classes in engineering it has been found impossible to arrange for special series of advanced lectures which have been features of recent sessions, as the possible lecturers who have been approached are all fully engaged in work connected with the war. The only new class, therefore, is a "Glass Workers" evening course which is being jointly undertaken by the technical optics and the technical chemistry departments. The class is urgently required at the present time owing to the disturbance in this particular trade caused by the war. The special classes for Post Office workmen and boy messengers, started two years ago, are being continued, as are also the classes in submarine cable work for the employees of the various cable companies who have their headquarters in London. The elementary and advanced classes in radio-telegraphy are also being announced. In all the departments the programmes of the various classes have been brought up to date, and full particulars of classes, fees, &c., are set out in "Announcements."

Battersea Polytechnic, London, S.W.—At this Polytechnic there are day courses which prepare for the B.Sc. (Eng.) of London University and for the Polytechnic diploma, and also evening courses in d.c. and a.c. work, electrical design, generation and transmission, electric lighting, &c. Full particulars may be obtained from the Secretary.

Merchant Venturers' Technical College.—The 1915-16 Calendar of this College, in which the faculty of engineering of the University of Bristol is provided and maintained, gives full particulars of the courses of instruction, fees, &c.

There are complete courses of instruction in civil, mechanical, electrical and automobile engineering, leading to the B.Sc. degree in engineering. There are also evening classes in each branch of engineering which qualify for a certificate. There are well equipped laboratories and facilities are given for practical work and research. Prof. David Robertson, D.Sc., M.I.E.E., is head of the electrical engineering department, and he is assisted by a competent staff of lecturers and demonstrators. There are evening classes in electric wiring, telegraphy, telephony, &c.

BUSINESS NOTICES.

The partnership between Herbt. E. How, Chas. L. Arnold and Chas. R. Belling (trading as Belling & Co.), specialists in electric heating, Derby-road, Edmonton, has been dissolved. Debts by Mr. C. R. Belling, who continues as Belling & Co. at the same address.

On and after the 29th inst. the address of the Fuller Electrical & Mfg. Co. will be Canada House, Kingsway, London, W.C. Telegrams: Fullinge London. Telephone No.: Holborn 1411.

Mr. Arthur James, who until recently was outside representative for the Record Electrical Co. (Ltd.) for Lancashire and Yorkshire, has resigned the board of directors of the company, and has transferred his activities to Scotland to further develop the business in that area.

Plant Wanted.—Messrs. Fisher & Co. (Ltd.), Kettlebrook Mills, Tamworth, advertise that they require a 200 c.c. high-speed two-cylinder vertical engine suitable for driving a pedal machine.

Patent Development.—The Submarine Wireless Co., 61, Broadway, New York, advertise that it is desirous of making arrangements for the manufacture and commercial development of patent No. 25,207 1913 relating to "Submarine signal receiving apparatus."

ELECTRICITY SUPPLY.

EXTENSIONS.

Aldershot.—The Finance Committee have arranged to take up a loan of £6,194 at 4 per cent. for extensions of the electric supply undertaking.

Ilford.—The Electricity Committee recommends application to the L.G. Board for sanction to borrow £870 for erecting an engine room at the refuse destructor.

Sheffield.—The L.G. Board have sanctioned the borrowing of £10,500 for the installation of electric plant.

Owing to the heavy demand for power supply for war work it is necessary that additional machinery should be purchased for the electric supply department at an estimated cost of £100,000, and the Ministry of Munitions has given an assurance that the Corporation will be indemnified against any loss. The Finance Committee has approved of the proposed expenditure, and of the plant being ordered forthwith.

A special sub-committee has been appointed with power to take any steps that may be necessary to expedite the completion of the buildings at Neepsend power station, and to purchase any necessary plant, so as to enable the extension to be completed without avoidable delay.

Mains are to be extended in various parts of the City at a cost of £15,424, including £13,000 on a new e.h.t. feeder from the Neepsend power house to Brightside-lane. The Finance Consultative Committee has approved supplementary estimate of £20,000 for expenditure on mains extensions for the year ended March 25 last. This sum is part of £75,000 for which a formal sanction of the L.G. Board was granted in September, 1914.

Walsall.—The Council have authorised the extension of the electric supply mains to the works of Messrs. Beebee & Beebee, who are engaged on war work.

Wigan.—An inquiry was held here on Tuesday into the application of the Corporation for sanction to borrow £6,700 for extensions of the electric supply undertaking.

GENERAL

Aberdeen.—The Electricity Committees have approved the accounts of the department for the past year and they again recommend an all-round increase in the charges for electric current by 15 per cent.

On March 2 a packed meeting of citizens met on the report, but by 20 votes to 10 it was decided that the charge for current for lighting (including public lighting) be increased by 10 per cent. and the charge for power (including heating and lighting) by 25 per cent.

Accrington.—In view of the desire for economy, the question of discontinuing showrooms of the electricity department has been referred to a sub-committee.

Battersea (London).—The Electricity Committee recommends that 10 per cent. be added to consumers' accounts as from the date of the next meter readings.

Brighton.—In consequence of the diminished revenue owing to lighting restrictions and the increased price of coal, the charges for electric current to all classes of consumers have been increased.

The engineer and manager (Mr. John Christie), reporting on the first quarter's working of the current financial year, states that there is every possibility of a serious deficit on the year, due chiefly to the high price paid for coal—£8,000 more than if last year's already high price had still obtained. It was probable that the cost would be still further increased, and in order to reduce an estimated deficit of £5,150, he saw no alternative but to still further increase the price. The committee, therefore, resolved to increase the special tariff for arc lamps, advertising signs, cookers and basement lights from 3½d. to 4d. per unit; the charge to customers on the maximum demand system on existing agreements are increased from 6d. and 3d. to 7d. and 3d. per unit; the flat rate of 4½d. per unit for shops, private houses and other premises being increased to 5d. per unit, and the flat rate of 3½d. per unit for hotels, public-houses, clubs, cinematograph theatres and large shops taking a minimum of 1,000 units per annum to 4d. per unit, while the charge to hotels, public-houses and parties having more than 20,000 units per annum has been increased by ½d. per unit, and the charge to theatres and other premises using 20,000 units per annum by 1d. on the 3d. rate. The charge of 4d. per unit for electricity supplied outside the borough has been increased to 5d. per unit, and the charge for electricity supplied to the Corporation for Municipal purposes by 1d. per unit. The flat rate of 1·1d. per unit for electricity supplied for power has been advanced to 1·25d. per unit, and the charge for electricity supplied to the tramways from 1·3d. to 1·45d. per unit, but no alteration has been made in the charge for street lighting, viz., 2d. per unit. The charge to Hove Corporation for electricity supplied to Montpelier has been increased from 3d. and 2d. per unit to 3d. and 2½d. per unit.

The proposed increases will yield an additional revenue of approximately £14,000. Mr. Christie stated that should the average price of coal not be reduced below 30s. a ton, and should there be an increased demand for power after the war, there will be a small surplus.

Bulk Supply Order.—The Board of Trade have recently issued an order authorising the County of London Electric Supply Co. to supply electric current in bulk to the South Metropolitan Electric Tramways & Lighting Co.

Ebbw Vale.—Great credit is due to the engineer and staff of the Ebbw Vale Steel & Iron Co. for the prompt manner in which the position arising out of the disastrous fire which occurred on Aug. 1 was dealt with.

At the outset attention was given to the plant supplying the town lighting, and this was restored in 30 hours, and then the other departments were dealt with. The steel works and the sheet mills had closed down for the Bank Holiday week, but the collieries were only taking two days. It is looked upon as a feat on the part of those responsible that they were able to overcome all obstacles so that work could be resumed at the steel works and the collieries in a week, and the sheet mills the following Wednesday week, when the whole of the works were again in full swing. Temporary electrical apparatus and switchboards were erected, and temporary roofs of tarpaulin were erected over the station buildings. In all eight engines for power and lighting and four blowing engines for the blast furnaces, together with the turbo-machinery for the colliery, were dealt with. The work of fitting permanent machinery is well in hand.

Harrogate.—Last week the Corporation were recommended by the Lighting Committee to transfer the payment of accounts of the electric lighting undertaking from the Borough Treasurer's department to the electricity department, but the Finance Committee thought it inadvisable to alter the existing arrangements.

Councillor LOFTHOUSE, chairman of the Lighting Committee, said the electricity department wanted to take advantage of all the latest advantages in connection with the use of electricity, and they asked that, in order to get into touch with customers, that they should pay their accounts at the electricity department. He thought it would be of advantage to the development of the undertaking, and the increase of consumption of current in the daytime for cooking and heating, thus bringing down the price of current for lighting.

After discussion it was decided by 13 votes to 10 to make no change.

Keighley.—At the Council meeting last week Ald. Midgley raised a question as to laying an electric supply cable in a different direction from that authorised by the Council.

He said the Electricity Committee were constantly doing work without the knowledge or sanction of the Council, and he protested against the way in which the electricity department was spending money at a time when they were all urged to exercise economy. He moved the reference back of recommendations for the supply and fixing of a 40-ton crane at the electricity works at £783, and also for the supply and fixing of a patent pressure chamber centrifugal pump at £350.

In reply, Mr. WHITEHEAD said the item as to the crane had already been passed and gone on with.

The MAYOR explained that sanction had been given for the erection of a crane at £400. The present recommendation applied to a larger crane, costing a larger amount.

The amendment was however carried.

Lowestoft.—The Electric Lighting Committee has reported that there will be a deficiency on the undertaking for the current year.

In an ordinary year the Council pays to the electricity undertaking for public lighting £2,550. The Council have now agreed to pay the undertaking a sum equal to the sinking fund and interest (£850) and a further sum of £1,500 towards the deficiency.

The general manager (Mr. G. A. Bruce) reported last week on an application from Messrs. Maconochie Bros. for a supply of current for power and light for their new factory near Waveney Drive, and the Committee recommended that supply be given on the Council's usual standard charges; Messrs. Maconochie to pay 5 per cent. on the capital outlay required to supply the factory, and to enter into an agreement for a term of years equal to the term of repayment allowed by the L.G. Board for any loan which may be necessary.

The chairman (Mr. C. Y. FRY), referring to the application for power and light from Messrs. Maconochie, said the Committee had recommended what they considered equitable terms, but that was, of course, subject to the necessary consents, concerning which he thought there would be no difficulty. The prospective capital outlay was £2,500.

The report was agreed to.

Newport (Mon.).—The Town Clerk and Borough Electrical Engineer are to approach the L.G. Board with a view to obtaining their preliminary approval of the proposed acquisition of a site, and the Treasury approval of the raising of the loan for a sub-station for the Pillgwenlly area, where the demands for supply are constantly increasing. In the meantime the Town Clerk is to negotiate for obtaining a lease of a site of about 500 sq. yds., with an option of purchase, say, in five years.

Newquay.—A public meeting was held last week to protest against the proposal to increase the maximum price of electric current by 2d. per unit.

The Newquay Electric Light & Power Co. has decided to increase the price to 7d. per unit, and consumers have been notified of this as well as of the application to the Board of Trade to authorise an increase of the maximum rate from 6d. to 8d. per unit.

At the meeting consumers were asked to petition against the proposed increase, and to ask the Board of Trade to hold a local inquiry.

Nuneaton.—A Lea recorder is to be installed in connection with the proposed new turbine. A grant of £5 per month is to be made to the acting electrical engineer.

Pembroke (co. Dublin).—It was reported to the Council last week that Diesel engine No. 1 had been out of action for the past two months, and that there was no prospect of putting it into beneficial use for the coming winter.

Negotiations are in progress with the [illegible] to the Council's claim against them, and it was decided to obtain expert opinion on the condition and construction of the engine.

Peterborough.—The City Council were recently recommended to increase the charge for electric current by ¼d. per unit.

The Mayor said they were now paying 21s. 1½d. per ton for coal similar to and no better than that for which they paid 8s. 7d. per ton in 1907. Over 30 towns had increased their charges, some of them for both power and light.

The matter was, however, referred back.

Provisional Order Transfer.—Surbiton Urban Council give notice of intention to transfer to Callender's Cable and Construction Co. (Ltd.) their powers, liabilities, &c., under their 1891 and 1905 electric Lighting Orders. The transfer is to be made in perpetuity subject to the right of the Council to repurchase the undertaking at the end of 42 years, or any subsequent 10 years.

The pecuniary consideration is £55,244. 14s. 6d., payable at the option of the company in one sum, or in instalments at dates set out in the draft deed of transfer. Copies of the deed of transfer can be obtained at the District Council Offices, 17, Ewell-road, Surbiton (price 6d.). Any representations against the proposed transfer must be sent to the Board of Trade, 7, Whitehall-gardens, London, S.W., before Oct. 11.

Southend-on-Sea.—Arrangements are to be made for reducing the amount of current supplied through prepayment meters for each 1s. inserted, so that the charge shall work out at the rate of 6d. per unit.

The Electrical Committee recommends the Council to authorise the electrical engineer (Mr. R. Birkett) to purchase lathes and drills for use at the works for the manufacture of munitions at a cost of £388.

Tynemouth.—Having regard to the fact that the Newcastle Electric Supply Co. consider that it will probably be necessary to run the steam plant at the Corporation electricity works during the coming winter, the Electricity Committee has invited tenders for the supply of 1,000 tons of coal.

The Committee proposes to reduce the rent of outside lamps by 50 per cent. A similar reduction is proposed to be made in cases where a charge is imposed for wiring which has been provided by the department.

LIGHTING & POWER NOTES.

Aldershot.—The street arc lamps are to be extinguished at 9 o'clock each evening in future.

Last week letters were read from Farnham Urban Council in reference to the Hale Electricity Supply, and the clerk was instructed to reply that the Lighting Committee, under present conditions, cannot undertake to supply electricity outside Aldershot, but would be prepared to receive applications when the new plant is completed.

Great Saving by Electric Pumping.—A saving of £500 a month has been effected in the coal bill of the Thomas Iron Co. by the installation of electric pumps in place of steam ones in the Richard mine at Wharton, N.J.

Formerly reciprocating pumps at depths of 1,000 ft. and 800 ft. raised the water to plunger pumps at 700 ft., which raised it to the surface. The steam pipes to all of these were over 2,000 ft. long. They are now replaced by four 300 gallon per minute Cameron centrifugal pumps, delivering at a pressure of 174 lb. per square inch and 1,750 revs. per min., and placed two at a depth of 500 ft. and two at 800 ft. The motors are 50 h.p., three-phase, 60-cycle, 550-volt, 1,800-revs. per min. Fairbank-Morse induction motors. A good deal of energy [illegible] the steam pumps used to have to raise their own condensed water. As there is now none of this, the water delivered is also considerably [illegible] and can be used for cooling an air compressor.

Infirmary Lighting.—At the meeting of the Islington (London) Guardians last week the Electric Lighting Committee reported on the electric lighting of the infirmary.

It was stated that the cost of overhauling the existing storage battery and plant would be about £700. The cost of [illegible] the present installation to admit of supply from the Borough Council would be about £500. The expense of providing light at the present [illegible] something under 1½d. per unit. As the committee were [illegible] to the course to adopt, the matter was referred back to them for consideration.

Mr. Aspinwall, chairman of the Committee, moved that the Board agree to the cost of the present installation being [illegible] a supply of electricity from the Borough Council at a cost of £400, and at a flat rate of 2d. per unit.

After a discussion the motion was carried by 15 votes to 3.

Village Lighting.—The public electric lighting of Stewartstown (Co. Tyrone) was inaugurated on the 7th inst. There are 17 50 c.p. lamps.

A Committee has been appointed at Draperstown to inquire into and report as to the cost of public electric lighting.

TRACTION NOTES.

Edgware and Hampstead Railway.—The London Electric Railway Co. have applied to the Board of Trade for an order under the Special Acts (Extension of Time) Act, 1915, to extend to Aug. 7, 1916, the time limited by the Edgware and Hampstead Railway Act, 1912, for the exercise of the powers for the compulsory purchase of lands and easements authorised by the Act.

Glasgow.—Last week the receipts of the tramways department totalled over £23,000, the highest in the history of the department. There are now about 800 women employed on the cars as conductors.

Lowestoft.—At the Council meeting last week the Tramways Committee reported receipts from Oct. 1 last to Aug. 31 of £3,415, compared with £10,318 at Aug. 31, 1914.

The Borough Accountant reported that the estimated loss on the tramways undertaking for the year ending Sept. 30 was £2,700, and suggested that £1,000 of this be provided for in the borough rate. The re-laying of the track at the south end cost £485, and the Committee recommended that that amount be also charged against the general district rate.

Mr. Spashett remarked that it was very singular, and he could not explain it, that the takings during August, although the tramcars ceased running two hours earlier, exceeded those of July by £200. He thought they might congratulate themselves that the loss was not greater, for the loss on the Yarmouth tramways was £4,500.

The report and recommendations were then agreed to.

Manchester.—The report of the Board of Trade inspector (Lieut.-Col. von Donop, R.E.) on his inquiry into the circumstances of the tramcar accident at the junction of Alexandra-road South and Wilbraham-road on Sept. 3 has been issued.

Colonel Von Donop states that the night on which the accident occurred was reported to have been a very dark one and slightly misty. The lighting of the road, in conformity with the restricted lighting order, was less than it would have been in normal times. Everything pointed to the overturning of the car being entirely due to excessive speed round the curve. As a speed of 16 miles an hour is authorised along Alexandra-road South it might be safely concluded that the car was running at that speed. Therefore, if the speed were not checked before the curve was reached the car would probably overturn on reaching the curve. In regard to the lighting of the road, Colonel Von Donop does not think that any objection would be raised by the military authorities if a change in the lighting arrangement were made, and the tramway authorities had undertaken to ascertain whether this could be done. If not, some other arrangement should be made for marking more definitely by night the position of the curve. In transmitting the report to the General Manager of the tramways department the Board of Trade state that they will be glad to learn what steps have been taken for marking at night the position of the curve at the scene of the accident.

Southend-on-Sea.—In view of the difficulty of collecting tram fares during the regulations as to the diminution of light, bull's-eye lamps are to be purchased for conductors, at a cost of 2s. 6d. each.

Women Tramcar Conductors.—Manchester Tramways Committee have decided to engage 12 women tramcar conductors. The general manager (Mr. J. M. McElroy) is to prepare a full report on the matter.

At Glasgow there are about 800 women and about the same number of men conductors; Sheffield has 262 women and 300 men; Newcastle 153 women and 256 men; and nearly half the Preston guards are women.

At Salford, where there are 70 women conductors, the general manager of the Corporation tramways (Mr. G. W. Holford) states that the women were taken over [illegible] the ordinary duties of conductors, except that so far they had not been called upon to take up duty on the early workmen's cars. They carried out their duties very efficiently, and one duty—the collection of fares—they found that the women guards performed better if anything than men.

Mr. J. B. Hamilton, commercial manager of the trading concerns of the Leeds City Council, is of opinion that there is at present no need to substitute women for men as conductors at Leeds. Some months ago the Corporation offered 300 eligible men to the Leeds Munitions Committee, but [illegible] had yet been called upon, nor had [illegible] the 165 men registered at the Leeds Labour Exchange for war work been taken on.

EMPIRE NOTES.

Australasia.—The whole trend of modern Commonwealth legislation is in the direction of encouraging the development of local manufacturing industries.

[illegible] a bounty on [illegible] the Australian manufacturer and to induce people not only to produce the raw material, but to have it made

manufactured and then re-purchased by Australians. The number of [illegible] the last 10 years, and there are now over 15,500, of which 1,814 are in connection with metal works, machinery, &c., and 426 in connection with heat, light and power. The term "factory" is applied to any workshop or mill where four or more persons are employed or power used. The chief motive power is steam, but the principal towns possess electric power stations, owned either by the Government or by the public bodies or private companies, and from these many factories find it convenient to derive their motive power. The total horse-power of the engines used in the factories has been given as 442,154. Of this total, steam represents 313,085 H.P.; electricity, 72,250; oil, 8,142; and gas, 48,677. During the past five years the number of establishments using mechanical power has increased over 35¼ per cent., the actual horse-power of the engines used increasing by over 82 per cent. during the same period. The total increase in the number of hands employed from 1908 to 1913 was 79,607. The greatest increases were recorded in the metal and machinery works and the clothing and textile factories.

A factory has been established at Box Hill, about 10 miles from Melbourne, for the manufacture of porcelain insulators. A remarkable deposit of clay was discovered in the district some time ago, and the Commonwealth Art Pottery & Insulator Co. acquired the property, and has since worked the clay, mostly in the production of insulators. There are six filter presses, producing about 10 tons of plastic clay per day; the two pug mills treat a similar quantity; three stamping machines have each a capacity of 3,000 insulators per day; the 13 lathes have an average capacity of 500 per day; the four kilns have an average capacity of 9,000, and the average stock in process of manufacture is 45,000. It is stated to be practically the only deposit of clay in the State which has so far turned out any considerable quantity of insulators suitable for electrical purposes.

A six days' exhibition of samples of German and Austrian goods was opened at the Sydney Chamber of Commerce on July 19. Amongst the goods shown were chinaware, glassware, earthenware, chemicals, tools and gas and electrical appliances. It was proposed to hold during the present month a further exhibition at the Chamber illustrative of the goods made in Australia and other parts of the British Empire, as well as of manufactures of allied countries.

The "Commonwealth Engineer" says Balaklava (S. Australia) ratepayers have approved of a proposal that the municipality establish electricity supply works.

Mackay (Queensland) Council has under consideration offers received for establishing electricity supply works for the town.

The proposal of Devonport (N.Z.) Electricity Supply Corpn. to light the streets of Devonport electrically has been considered by the Council. The company offer to instal 167 lamps of 100 c.p., 10 of 300 c.p., 6 of 1,000 c.p. and 3 of 2,000 c.p. The charges payable by the Council for [illegible] cent. if 8,000 c.p. be taken as a first instalment of a lighting scheme. The matter was referred to the Works Committee, with instructions to select two areas in which gas and electric demonstrations could be carried out over a period of three months. The Council accepted the offer of the Electricity Supply Corpn. to supply electric power for operating a stone crusher.

Kyneton (Victoria) Council propose to instal electric lighting plant, and have invited offers from consulting engineers to act for them.

Lyttelton (N.Z.) Council has approved of the principle of lighting the borough electrically, and a poll of ratepayers is to be taken on the question.

The Manilla (N.S.W.) electric lighting plant was switched on in July. The charges for current are 8d. per unit for lighting and 4d. for power. Distribution is on the three-wire system, 480 volts across outers.

The Eyre (Queensland) electric supply scheme is nearing completion. Supply is given on the three wire system at 220 and 440 volts.

Walgett (N.S.W.) Council has decided to submit the question of installing an electric supply scheme to a plebiscite of ratepayers.

Wickham (N.S.W.) municipality recently invited tenders for lighting the town by means of gas or electricity.

In his report on a proposal to utilise the water supply system of Grafton and South Grafton in connection with a hydro-electric power scheme, [illegible] a new gravitational water supply for the two municipalities has recently been provided from the Nymboida river, whence water is taken by means of a tunnel ½ mile long and a 22 mile pipe line. There is a fall of 200 ft. in the first mile or two on the Grafton side of the tunnel, and by leading a new power pipe line for this distance it is estimated that, without any [illegible] proximate cost of the hydro-electric installation and transmission line [illegible]

The report of the city electrical engineer (Mr. M. C. Henderson) on the Dunedin (N.Z.) municipal electricity undertaking (which takes its power [illegible]

[illegible]

£43,002 (£45,486), gross profit was £34,422 (£32,782), and net profit £5,255 (£4,050). Passengers carried were 14,699,011 (14,779,703), car-miles run 1,304,431 (1,315,182), and units used 1,880,441 (2,032,443).

Current from the N.Z. Government's Lake Coleridge hydro-electric plant is now being used extensively over the countryside of Canterbury. At Tai Tapu, 12 miles from Christchurch, the butter factory is changing over to electric drive, and undertaking the distribution of current to residences in the district. A large flour mill is to be erected at Lincoln, to be operated by electricity, and the Lincoln Agricultural College is to be supplied also. Negotiations are in progress to supply current to Oxford, Hororata and Cust. The Government, however, are not securing an altogether uninterrupted supply in Canterbury, in spite of their dual transmission lines. It appears that the spare line has not yet been in use, and 15 insulators have had to be replaced, probably having been wilfully damaged. It is now proposed to instal an extra set of lightning arresters, to maintain the spare line under pressure, to invoke the aid of local schoolmasters in stopping stone throwing and shooting at the 28 lb. insulators, to earth the neutral with a view to the prompt detection and elimination of faulty insulators and to employ efficient repair gangs.

Katoomba (N.S.W.), where electric lighting plant was switched on in July, is the first town in the Blue Mountains to be lighted electrically. The works are owned by the Katoomba Electric Supply Co., and the municipality will have the option of taking over the undertaking at the end of 10 years. The system is three phase, the generators being star wound, giving 415 volts at 50 periods between phases and 240 volts between any phase and the neutral point, the latter being earthed at the generating station. For supplying Leura and consumers in the distant part of the municipality current is stepped up to 3,300 volts, and subsequently reduced to 240 volts, at which pressure it is supplied to consumers. The overhead system of mains has been adopted, with bare copper conductors. Street lamps number 160, lighting about 13 miles of streets. Of these seven are of 2,000 c.p. and the remainder of 100 c.p. and 50 c.p. The lamps in some streets are suspended across the centre of the road, the remainder being on iron brackets fastened to poles. At the generating station a Babcock & Wilcox water-tube boiler, two Parsons steam turbo-alternators (200 kw. and 130 kw. respectively) and a turbo d.c. generator of 20 kw. capacity are in use. There are also at the station a storage battery of 135 cells with a capacity of 700 ampere-hours, a booster and a reversible motor.

The Queensland Minister for Railways states that 14 railway stations are supplied with electric light by the Brisbane Tramways Co. The total cost was £2,980, but that price included cost of the current for Roma-street, workshops, printing office, electric cranes, &c. The Commissioner's Roma-street scheme provided for an electric plant that would provide the necessary motive power and light up all the stations within a 10-mile radius of the G.P.O.

Electric Power in Oil Fields.—In the report of the Kern River Oilfields of California, Ltd., it is stated that, with the exception of [illegible] and a water supply well, which are pumped by means of [illegible] the whole of the [illegible] section 33 Kern River field [illegible] have now been connected to electricity. Owing to the extension of the electric system it has been possible to reduce further the number of boilers in use and to consolidate the steam [illegible] boiler house, with a consequent further reduction in the [illegible] employed.

Electric Traction in South Africa.—In the annual report of the general manager of the South African Railways & Harbours (Mr. W. W. Hoy) it is stated that the Administration had in contemplation the electrification of certain sections of the railway, and a decision had been arrived at to obtain the services of an eminent consulting engineer to study the local problems and conditions on the spot, and thereafter submit a comprehensive report. Unfortunately, the condition of affairs in Europe and in South Africa necessitated a postponement of the proposals, but the matter is one which should receive early attention after the cessation of hostilities.

South Africa.—The turbo-generators at the Pietermaritzburg [illegible] power station, which have now been working for some 16 months, have enabled a greatly increased demand for current to be dealt with, and also effected considerable economy in cost of generation. [illegible] increasing demand. The question of putting down additional plant will shortly have to be considered.

FOREIGN NOTES.

Argentina.—[illegible] have ordered in Europe [illegible] fixed cranes of [illegible] and 30 [illegible]

[illegible] hitherto been mainly supplied by Germany, the United States and Italy. Catalogues received from the Continent of Europe and from the United States are without exception printed in Spanish, while those from the United Kingdom are [illegible] French, with prices, weights and [illegible] Mr. Spencer Dimond thinks the present moment offers a unique opportunity for British trade,

but that there is going to be keen competition between the United Kingdom and the United States, and that the latter will try to win on the question of price, and he recommends that the lowest prices possible should be quoted to secure customers. Imports of machinery at Rosario in 1914 included 83,844 tons from Germany (compared with 135,853 in 1913), 16,778 (against 82,408) from the United Kingdom, and 27,652 (57,890) from the United States.

The "Review of the River Plate" says that the loan held at Mar del Plata is likely to be cut off, because of the inability of the municipality to pay the amount owing by them to the electricity supply company. The debt is said to amount to $124,000 (£24,800).

The Castelli electric power station, erected under Senor Antinori's concession, was opened recently.

Hamburg.—It is reported that, notwithstanding the great increase in the use of electric current for domestic and household purposes, owing to the scarcity of petroleum, the receipts of the Hamburg Electricity Works diminished during the past year from £580,000 to £400,000.

Japan.—The British Consul at Shimonoseki says, generally speaking, the present time is not a favourable one for British exporters to ship direct to Moji, the principal port of the consular district of Shimonoseki.

An exception, however, must be made in regard to machinery, for which there should be good prospects in view of the cessation of German activities. The district includes many towns of considerable manufacturing importance, and the rapid extension of electrical enterprise throughout the country implies a steady demand for electrical plant and machinery. Approximately 70 per cent. of the constructional steel and other metal work for building, imported into Moji, has been of German origin; the total imports of these materials in 1913 amounted to £81,439 and in 1914 to £14,931. Business cannot be done by correspondence; to obtain a footing it is essential to appoint local representatives with full powers as to offering trade discounts and other inducements to prospective customers.

Italy.—The following are extracts from British consular officers reports on the prospects of British trade with Italy:—

Germany has hitherto supplied to Piedmont four-fifths of the machine tools imported, and it is estimated that £400,000 worth of business per annum could be done in this line. Special attention is drawn to the trade in electrical machinery and appliances, the market for which has been entirely in German hands. This class of goods includes equipment for electric tramways, dynamos, transformers, accumulators, controllers, insulators, starting switches, speed regulators, safety fuses, lightning conductors, electric lamps, &c. Other machinery for which there is a demand includes Diesel engines, light locomotives for steam tramways, accessories for steam engines, &c.

Belting would also probably find a market here. The kinds most in demand are leather bordered and triple braided, raw hide for dynamos and camel hair. Local buyers prefer to buy belting by measure. Scientific and mathematical instruments have hitherto come from Germany.

Machinery imported into Rome in 1913 from Germany was valued at £13,923 and from the United Kingdom £1,303.

The Vice-Consul at Taranto says there is little inducement for United Kingdom firms to open up direct relations with dealers in that district, and that it is better to deal through large firms established at the important industrial centres. Having secured such a connection, circulars might be sent to small buyers in such places as Taranto, informing them where British-made goods can be obtained and adding some description in Italian, with prices in Italian currency and weights and measures in the metric system. Among articles which might find a ready sale are electric light fittings and accessories, stoves and heating apparatus (gas and electric) and tools.

The goods imported into Palermo in 1913 included the following: Metal manufacturers from United Kingdom £5,561 and from Germany: £22,373; machinery and apparatus £8,566 and £21,592 respectively scientific instruments, £389 and £8,409; electric wires and cables, £143 and £2,668. Many goods are purchased from the north of Italy, so that the above figures do not represent the total demand.

United States.—*Exports.*—A table showing the domestic exports from the United States in 1915 compiled by the New York "Commercial and Financial Chronicle" gives the total value as $2,716,200,000, compared with $2,329,700,000 in 1914.

These included copper (pigs, &c.), $96,200,000 (against $144,900,000); automobiles, $68,100,000 ($33,200,000); [illegible] $21,200,000 ($400,000); brass manufactures, $20,500,000 ($7,500,000); electrical goods, $19,800,000 ($25,100,000).

MISCELLANEOUS NOTES.

Electro-Harmonic Society.—The programme of the forthcoming season has now been arranged, and consists of [illegible] four being smokers and two ladies' nights. All will be held at the King's Hall of the Holborn Restaurant. The first will be a smoking concert on Friday, Oct. 8.

Munitions Cases.—Before the Metropolitan Munitions Tribunal last week the Electrical Apparatus Company complained that Messrs. Cater & Gorringe had employed one of their men without a certificate. Respondents pointed out that the man came from a Labour Exchange with the green card, showing that he was disengaged.

Mr. WALLACE said that on an undertaking being given by respondents to dismiss the man the fine would be £5. The undertaking was given.

At the meeting of the Birmingham and District Munitions Tribunal last week the Electric & Ordnance Accessories Co. were fined 60s. for employing two girls who left the Acme Screw Co. without certificates and obtained employment with them through the Labour Exchange.

For the company it was explained that as the girls came to them through the Labour Exchange they thought they were justified in employing them.

The chairman (Mr. E. Moon, C.B., K.C.) remarked that most of the cases that had arisen were cases under sec. 7 of the Act. It did not appear to be properly appreciated that when an employé came and asked for employment an employer must satisfy himself that the employé had not been employed on munition work within six weeks of that day, and it was not enough to ask the workman himself whether he had been engaged on munitions. What the employer had to do was to say, "Where are you employed?" If it happened to be a firm in the same town then the employer could get through to the firm named on the telephone and quickly ascertain the facts. In future cases he should not accept as an excuse that a workman himself was asked whether he was employed on munitions and said no. The employer must take further steps to ascertain where the workman was employed. In future cases the penalties would be very much more severe. The Chairman added that the Electric & Ordnance Co. were not entitled to retain the services of the girls. If a person who had been fined under these circumstances continued to retain the workpeople in his employ he would have to answer for it again.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during August, 1915, and (*b*) the aggregate figures from Jan. 1 to Aug. 31, with the increases or decreases compared with corresponding periods of 1914:—

Electrical machinery, (*a*) £98,039 (including generators and motors other than for aeroplanes, motor cars and cycles, £20,987, and electrical machinery unenumerated, £77,052 (increase £48,359), (*b*) £1,120,491 (including generators and motors other than for aeroplanes, motor cars and cycles, £187,006, and electrical machinery unenumerated, £933,485) (increase £78,052); telegraph and telephone cables, submarine (*a*) £131 (increase £115), (*b*) £131 (decrease £442); other than submarine, (*a*) £3,826 (increase £1,746), (*b*) £20,727 (decrease £24,107); telegraph and telephone apparatus, (*a*) £6,762 (increase £3,402), (*b*) £49,515 (decrease £100,358); other electrical wires and cables, rubber insulated, (*a*) £7,648 (increase £4,222), (*b*) £64,513 (decrease £157,966); with other insulations, (*a*) £10,957 (increase £9,185), (*b*) £31,825 (decrease £26,662); carbons, (*a*) £23,362 (increase £20,912), (*b*) £95,588 (decrease £4,398); glow lamps, (*a*) £10,974 (increase £4,243), (*b*) £90,969 (decrease £7,221); arc lamps and electric searchlights, (*a*) £40 (decrease £5), (*b*) £1,626 (decrease £872); parts of arc lamps and searchlights (other than carbons), (*a*) £6,307 (decrease £293), (*b*) £60,046 (decrease £2,542); primary and secondary batteries, (*a*) £15,922 (increase £13,187), (*b*) £83,809 (increase £21,363); meters and measuring instruments,* (*a*) £786, (*b*) £19,101; switchboards,* (*a*) £1,074, (*b*) £5,089; electrical goods and apparatus unenumerated, (*a*) £17,514, (*b*) £135,820. Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £105,303 (increase £67,852), (*b*) £658,759 (decrease £322,683).

Exports.—The exports of electrical machinery, material, &c., (*a*) during August, 1915, and (*b*) from Jan. 1 to Aug. 31, with the increase or decrease compared with the corresponding periods of 1914, were as follows:—

Electrical machinery, (*a*) £87,481 (including railway and tramway motors, £6,673, generators and motors other than aeroplanes, motor cars and cycles £35,845 and electrical machinery unenumerated £44,959) (decrease £16,020), (*b*) £914,554 (including railway and tramway motors £93,111, generators and motors other than for aeroplanes, motor cars and cycles, £427,477, and electrical machinery unenumerated, £393,966) (decrease £716,063); telegraph and telephone cables, submarine (*a*) £46,637 (increase £93,986), (*b*) £274,589 (decrease £156,153); other than submarine, (*a*) £32,835 (increase £20,231), (*b*) £296,085 (increase £70,257); telegraph and telephone apparatus, (*a*) £12,553 (increase £793), (*b*) £128,711 (decrease £48,366); other electrical wires and cables, rubber insulated, (*a*) £20,682 (increase £863), (*b*) £190,011 (decrease £45,849); with other insulation, (*a*) £32,086 (increase £5,404), (*b*) £278,279 (decrease £8,371); carbons, (*a*) £586 (increase £70), (*b*) £5,515 (decrease £1,044); glow lamps, (*a*) £13,828 (decrease £354), (*b*) £95,549 (increase £11,510); arc lamps and searchlights, (*a*) £976 (decrease £1,878), (*b*) £3,314 (decrease £8,503); parts of arc lamps and searchlights (other than carbons), (*a*) £5,155 (increase £3,712), (*b*) £15,947 (decrease £5,280); primary and secondary batteries, (*a*) £19,376 (increase £9,903), (*b*) £135,514 (increase £18,255); meters and measuring implements,* (*a*) £12,065, (*b*) £102,580; transformers,* (*a*) £4,994, (*b*) £48,265; switchboards,* (*a*) £5,269, (*b*) £42,003; electrical goods and apparatus unenumerated, (*a*) £52,097 (increase £5,777), (*b*) £391,817 (decrease £215,452). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £259,130 (increase £113,447), (*b*) £2,008,179 (decrease £196,138).

* Not enumerated or separated in previous years.

TENDERS INVITED.

Turbo-Generators, Boilers, Condensing Plant, &c.

JOHANNESBURG Council also require tenders by noon Sept. 30 for Two (or, alternatively, One) Water-tube Boilers, with Superheaters, Mechanical Stokers and Draught Plant. Specifications from the Controller of Stores, Municipal Offices, Johannesburg.

Generating Plant.

The AUSTRALIAN COMMONWEALTH Department of Defence require tenders by noon Oct. 25 for Power-station Plant and Equipment for the Naval Dockyard Cockatoo Island, Sydney, N.S.W., and by noon Oct. 27 for Machine Tools. Specifications from Director of Navy Contracts, Navy Office, Melbourne.

Electric Lamps and Fittings, &c.

SOUTH SHIELDS Guardians require tenders by 10 a.m. Sept. 27 for six months' supply of Electrical Fittings, Oils, &c.

Tenders are invited by Sept. 27 for six months' supply of Electric Fittings, Fittings and Material for Machinery, &c., to the Midlothian and Peebles District Asylum, ROSSLYNLEE. Forms of tender from the Clerk, 19, Heriot-row, Edinburgh.

Repair of Incandescent Lamps.

The COMMISSIONERS OF H.M. WORKS, &c., invite tenders for the Repair of Incandescent Electric Lamps. Forms of tender, &c., from the Controller of Supplies, H.M. Office of Works, 18, Queen Anne's-gate, S.W., and tenders by 11 a.m. Oct. 1 to the Secretary, H.M. Office of Works, Storey's-gate, London, S.W.

Switchgear, Transformers and Cables, Cut-outs, &c.

SHANGHAI Municipal Council invite tenders for the supply and delivery f.o.b. British port of e.h.t. Switchgear suitable for 22,000 volts working pressure; e.h.t. Static Transformers (22,000 to 6,600 volts) of 4,200 k.v.a. and 2,000 k.v.a. single phase and 3,000 k.v.a. and 1,250 k.v.a. three phase; and Armoured Three-core Cable for 22,000 volts, with Boxes. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders are to be delivered by noon Sept. 29.

JOHANNESBURG (Transvaal) Council require tenders by noon Sept. 28 for supply of 1,000 Sets of Single-pole 25-ampere Iron-clad House Service Cut-outs (contract 21). Specifications from the Controller of Stores, Plein-square, Johannesburg.

Earthenware Conduit.

WARRINGTON Electricity and Tramways Committee require tenders by noon Sept. 28 for 12 months' supply of Earthenware Conduit. Specification, &c., from the Borough Electrical and Tramways Engineer.

Telegraph and Telephone Material, Wire, &c.

The Postmaster-General's department of the Commonwealth of Australia invites tenders (until Oct. 6) for the supply of Poles (iron or steel) and Fittings.

The Deputy Postmaster-General, Brisbane (Queensland), invites tenders until Oct. 6 for supply of Tinned Copper Wire (schedule 357) and Porcelain Pothead Insulators (schedule 360) for the COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Brisbane (Queensland), requires tenders by Oct. 6 for 2,860 yds. Silk and Cotton Insulated Switchboard Cable (schedule 353) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Perth (W. Australia), invites tenders until 3 p.m. Sept. 29 for 2,288 yds. Lead-covered Paper-insulated Telephone Cable (schedule 479 W.A.) for the AUSTRALIAN COMMONWEALTH Postmaster-General's department.

Tender forms from the Contracts Branch Office, 72, Victoria-street, S.W.

Engine and Dynamo, &c.

The Deputy Postmaster-General, Adelaide, South Australia, requires tenders by 2 p.m. Oct. 6 for Portable Internal-combustion Engine driven coupled to Dynamo, and for increasing capacity of 48-cell Battery at Central Telephone Exchange, Adelaide, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications from the Deputy Postmaster-General.

Electric Capstans.

SYDNEY Harbour Trust Commissioners invite tenders by 2 p.m. Oct. 25 for the supply of 6 Electrically-operated Wharf Capstans. Specification, &c., from the office of the Commissioners, Circular Quay, Sydney, N.S.W.

Telephone Exchanges.

Tenders will be received at the Direccion-General de Telégrafos, MADRID, until noon on Sept. 30 for the Construction and Working, for a maximum of 20 years, of Central Telephone Exchanges at Huesca (province of Huesca), Lorca (province of Murcia), Orihuela (province of Alicante), Borjas Blancas (province of Lérida) and Aguilas (province of Murcia). The "Madrid Gazette" of Sept. 4, containing particulars (in Spanish), may be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

METROPOLITAN WATER BOARD.—The Board has accepted the offer of the Maxim Lamp Works (Ltd.) to continue, for six months further, their contract for the supply of metallic filament lamps at existing prices. The offer of the British Insulated & Helsby Cables to continue for a similar period the supply of tapes, at the same price for one item, and at a 5 per cent. increase on two items, has also been accepted.

REDDITCH.—The Council have accepted the tender of Ferranti Ltd. for 12 months' supply of electricity meters and that of C. G. Huins & Sons for additions to the engine house, at £2,150.

SHEFFIELD.—The Electric Supply Committee have accepted the revised schedule of prices for cables submitted by Messrs. W. T. Glover & Co.

YARMOUTH.—The Council have accepted the tender of the Stern-Sonnenborn Oil Co. for motor axle grease at £17.

LOWESTOFT.—The tender of Messrs. Hadfields, has been accepted for the supply of 12 rolled steel car axles at £3. 10s. each.

KEIGHLEY.—The Council are recommended to accept the tender of John Smith (Keighley) (Ltd.), at £783, for the supply and fixing of a 40-ton hand travelling crane; and that of Rees Roturbo Mfg. Co. (at £350) for the supply and fixing of an electrical Rees Roturbo patent pressure chamber centrifugal pump, to deliver 300,000 gallons of water per hour.

SCHOOL LIGHTING.—London County Council received eight tenders for wiring the Winchester-street School (Finsbury), varying from £104 to £242, and the lowest (that of Napier Kimber, Ltd.) has been accepted.

SYDNEY (N.S.W.).—The City Council have accepted the tender of the Australian General Electric Co. for 12 'bus-bar supports (£6 each), and 212 ft. insulated cable (£20. 6s. 4d.), and the British Westinghouse Electric & Mfg. Co. for 1,500-kw. rotary converter, with transformer (£4,562).

The Council are recommended to accept the tender of Lawrence & Hanson for cut-outs for 15-ampere fuse boxes at 2s. 4½d. each, and replacements for same at 11d., 25-ampere ditto, 3s. 11d. and 8s. 6d.; 50-ampere, 4s. 6d. and 1s. 3d.; 100-ampere, 9s. and 1s. 11½d.; 200-ampere, 22s. and 3s. 10d.; 300-ampere, 34s. 7d. and 7s.; that of Standard-Westwood Hercules (Ltd.) for 5,000-volt transformer panels, £97 each; 33,000-volt ditto, £239 each; 33,000-volt incoming feeder panels, £255 each; ditto outgoing, £302 each; 415-volt transformer panels, £221 each; 415-volt summation panels, £67 each; 33,000-volt 'bus-bar chambers, £1 6s. each; 5,000-volt ditto, 13s. each; 33,000-volt operating rods £3 each; 5,000-volt ditto, £2. 5s. each.

The Council are also recommended to purchase from A. C. Cossor (Ltd.): 18 additional h.t. test sticks and 18 spare tubes for testing 10,000-volt lines (estimated at £125), and to purchase under existing contracts from British General Electric Co. 10,000 50-c.p. vacuum lamps, £713 6s. 8d. 2,500 100-c.p. ditto, £312 10s.; and from Australian

General Electric Co., 1,000 750-watt metre lamps, 240 volt, £1,487; 1,000 500-watt ditto, £1,224; 500 300-watt ditto, £525; 1,000 750-watt metre lamps, 45 volts, £962. 10s.; 1,000 500-watt ditto, £662. 10s.; 350 lanterns, £1,137. 10s.; 1,000 reflectors, £130; 200 compensators, 750-watt, 45 volt, £340; and 150 ditto, 500 watt, 45 volt, £225.

Pope's Lamps.—Pope's Electric Lamp Co. have secured orders for several thousands of lamps (both carbon and metal filament) from the Admiralty and War Office, and also from H.M. Office of Works.

Lamp Contract.—H.M. Office of Works has awarded to the "Z" Electric Lamp Mfg. Co. the contract for 12 months' supply of "Z" drawn-wire metal filament lamps.

Government Contracts.—The following tenders were accepted by the British Government Departments during August:—

War Office.—Kartret Engineering Co., distribution boards; Callender's Cable & Construction Co., General Electric Co. and Liverpool Electric Cable Co., electric cable and wire; W. G. Pye & Co. and Walters Electrical Mfg. Co., galvanometers; Phœnix Mfg. Co., generators; General Electric Co. and Siemens Bros. Dynamo Works, electric lamps; Electric Construction Co., Electric & Ordnance Accessories Co. and Mawdsleys (Ltd.), motors and dynamos; Ferguson, Pailin & Co., switchboards; Ancoats Vale Rubber Co., Hooper's Telegraph & India Rubber Works, J. G. Ingram & Son and Chas. Macintosh & Co., rubber tape; Cox-Walkers (Ltd.), electrical work at Richmond Camp; W. D. Wilson, lighting hospital, Ripon Camp.

India Office.—Marconi's Wireless Telegraph Co., wireless telegraph apparatus; Callender's Cable & Construction Co., Shropshire Iron Co., Pirelli General Cable Works and W. T. Glover & Co., cable; Electromotors (Ltd.), fans; General Electric Co., telephone sets.

H.M. Office of Works.—Rees Roturbo Mfg. Co., electrically-driven pumps in connection with engineering works, St. James's Park, London.

Post Office.—Phœnix Telephone & Elec. Works, telephone apparatus; British L. M. Ericsson Mfg. Co., telephone apparatus and battery boxes; Siemens Bros. & Co., telephone apparatus and dry and Leclanché cells; W. T. Henley's Telegraph Works Co., Johnson & Phillips and Union Cable Co., telephone cable; General Electric Co., arc lamp carbons; Benjamin Electric (Ltd.), opal shades; Jones & Attwood, trolley wheels; G. E. Taylor & Co., electric lighting of stores extension, Studd-street, London, N.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstracts are specially compiled by Messrs. Mewburn Ellis & [illegible], 70 and 72, Chancery-lane, London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

7,821 Signal Gbs. Enclosed electric motors for driving machines under water. (29,3,13.)

12,673 Oesterreichische Siemens-Schuckertwerke & Regal Patents Ges. Electric jacquards, card-punching machines, or the like. (30,5 13.)

17,246 Musso. Transmission of electrical impulses over telephone and telegraph circuits of high electrostatic capacity.

A system wherein the electrical impulses are impressed upon the main line, under the control of a suitable transmitting or controlling device, from a local circuit which includes a source of E.M.F., and an inductance coil or solenoid of predetermined self-inductance, which is so proportioned as to balance or neutralise the electrostatic capacity of the main line, and of predetermined output and intensity sufficient for overcoming the ohmic resistance of said main line.

17,328 Berry. Means for controlling the heating effect of electric heating apparatus.

17,329 Berry. Electrical heating apparatus.

18,971 B.T.-H. Co. (G.E. Co.) Electric distribution systems.

A system comprising a phase converter, a motor, and a plurality of secondary transformer windings, a phase of said converter and a phase of said motor being connected between two of the secondary transformer windings so that said secondary windings are interposed between the terminals of the machine windings, another phase of said converter being connected to another phase of said motor and to a secondary transformer winding.

19,013 Hammond. Systems of teledynamic control, applicable to the control of movable [illegible] (6,12 13.)

19,121 Perry. Electrical continuity of electrical conduits and other tubes.

19,238 Storjahann. Electromagnetic track brakes.

19,290 Nyborg. Electric switches.

19,483 Judd, Davies & Eastern Telegraph Co. Electric telegraphy.

A telegraphic system in which the signals are transmitted by impulses of opposite sign and broken up at the receiver into impulses of a frequency to be heard in a telephone.

19,942 B.T.-H. Co. (G.E. Co.) Electric heating for metal working.

21,157 Cumming. Points, switches and the like, of tracks for electrically-driven vehicles.

21,825 B.T.-H. Co. (G.E. Co.) Cooling of dynamo-electric machines.

23,182 Fuller, Fuller & Fuller. Electric accumulators.

23,628 Keller-Dorian. Magnetos and other electric generators. (6,12 13. Addition [illegible] 11

1915 Specifications.

5[illegible] Gas[illegible] & Ele[illegible] [illegible] of movements specially applicable to systems for signalling orders and the like. (Addition to 6,214/14.)

4[illegible] C[illegible] facturing carbons for arc lamps. (13 1.14.)

1,275 Mellersh-Jackson. (Posen.) Pocket electric flash lights. (Addition to 18,809/14.)

3,284 and 4,747 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Electric motor control systems.

5,140 R[illegible] [illegible] Thermo-[illegible] (18.1.15.)

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

August 30, 1915.

12,414 Raven. Electric transmission systems.
12,418 Uren & Nilsen. Joining up electrical conduits.
12,428 Craven. Plug for telephone switchboards and the like.
12,434 Shaw & Fondiller. Loaded telephone line system. (12/9/14, U.S.)*
12,444 B.T.-H. Co. (G.E. Co., U.S.) Systems of electric ship propulsion.

August 31, 1915.

12,516 Kaim[illegible] Sa[illegible]

September 1, 1915.

12,536 Wall. Generating high-frequency electric currents.
12,561 British-Insulated & Helsby Cables & Harrison. Telegraph systems.*
12,564 B.T.-H. Co. (G.E. Co., U.S.) Wireless signalling systems.
12,567 [illegible] Bowden & Rowlands. Railway signalling systems and train controlling apparatus.
12,582 Ottesson. Railway signalling systems.
12,583 Richards. Manufacture of electric insulating materials and the like.

September 2, 1915.

12,614 Fried. Krupp Akt.-Ges. Electrical signalling or distant controlling plant (2[illegible]14, Germany.)*
12,630 Morse & Indo-European Telegraph Co. Selective calling devices for use in electric telegraphy.

September 3, 1915.

12,662 Lecoche. Power transmission.
12,666 B.T.-H. Co. (G.E. Co., U.S.) Rectifiers for electric currents.
12,671 Betulander. Impulse transmitters for automatic telephone systems. (26/1/15, Sweden.)*
12,673 Relay Automatic Telephone Co. Automatic telephone systems. (17/11/14, Sweden.)*
12,680 Correll. Locking device to prevent the theft of electric lamps held by bayonet joints.*

September 4, 1915.

12,702 Cheshire. Electrical heating elements.*

September 6, 1915.

12,730 Hepburn. Bipolar electrode electrolysers.
12,747 B.T.H. Co. (G.E. Co., U.S.) Protective devices for electric systems.
12,748 Chitty. Dynamo-electric machines.

September 7, 1915.

12,772 Wynne. Electrical switches.*
12,781 Smith & Robinson. Electric lighting of vehicles.
12,791 West. Signalling apparatus.
12,792 B.T.-H. Co. (G.E. Co., U.S.) Electric lamps.
12,798 Simonotti & Simonotti. Multiple filament electric lamps.*
12,810 Dey. Controllers for electric motors. (29/9/14, U.S.)*

September 8, 1915.

12,834 Wall. Generating high-frequency electric currents.
12,848 Taylor. Trolley heads.
12,863 Bassington & Silver. Luminous sign.
12,868 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control systems.
12,869 Western Electric Co. & Nash. Microphonic detectors.
12,876 Cowling. (Norman Leslie Cowling, British Expeditionary Force.) Electrolytic production of gaseous fuel for internal-combustion engines and other purposes.
12,882 Marconi's Wireless Telegraph Co. & Wright. Production of continuous electrical oscillations.
12,883 Scott. Electro-mechanical locks for the gates or doors of electric lifts and the like.

September 9, 1915.

12,924 Pate & Wood. Electric heating apparatus.*
12,936 Oldham. Apparatus for use in connection with secondary storage batteries.
12,938 Agar & Chamberlain. Flash-light advertising and the like devices.
12,949 Thomas. Transmission of power.

NEW BOOKS AND NEW EDITIONS.

[Copies of the new books mentioned below can be obtained *post free* from The Electrician Offices on payment of the prices indicated in parentheses. It is only necessary to specify the number when sending remittance.]

568. "All About Oil for Engineers." By A. Cree. 3s. net (3s. 4d.).

569. "Indian Mathematics." By G. R. Kaye. 3s. net (3s. 4d.).

570. "Specification and Design of Dynamo-electric Machinery." By Miles Walker. 32s. net.

571. "The Boy Electrician." By A. P. Morgan. 5s. net (5s. 3d.).

572. "A Rare Earth Industry." By S. J. Johnstone. 7s. 6d. net (7s. 9d.)

573. "The Industrial and Commercial Schools of the United States and Germany." By F. W. Roman. 6s. net (6s. 4d.)

574. "Statics." By R. C. Fawdry. Parts 1 and 2. Each 2s. (2s. 3d.)

575. "Introductory Course of Practical Magnetism and Electricity." By J. R. Ashworth. Third edition. 2s. net (2s. 3d.)

576. British Standard Specification for Electricity Meters (excluding Electrolytic Meters). Revised edition 7s. 6d. net (7s. 9d.)

577. "Continuous and Alternating Current Machinery Problems." By W. T. Ryan. 2s. 6d. net (2s. 9d.)

578. "Heats of Dilution of Concentrated Solutions." By W. S. Tucker. 2s. net (2s. 3d.)

579. Qualitative and Volumetric Analysis. By W. M. Hooton. 3s. net (3s. 3d.)

580. Theory of Mechanics. By R. F. McKay. 15s. net.

581. "Experimental Physics." By H. A. Wilson. 10s. net.

582. The Wireless Telegraphist Pocket Book of Notes, Formulæ and Calculations." By J. A. Fleming. 6s. net (6s. 4d.)

583. "Practical Steam Mechanics and Mathematics." By J. F. Johnson. 4s. 6d. net (4s. 10d.)

584. Introduction to Magnetism and Electricity. By E. W. E. Kempson. 3s. net (3s. 3d.)

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Batley.—The accounts of the electricity supply undertaking for the year ended March 31 show a net profit of £634, compared with £116 for the previous year.

Malvern.—The accounts of the electricity supply department for the past financial year, which were submitted to the Council at its last meeting, show a net profit of £842, compared with £317 for the previous year.

Newcastle-on-Tyne.—The accounts of the tramway undertaking for the year ended March 31 were presented to the Council recently.

Total traffic receipts were £281,854, an increase of £20,837 over those of 1913-14. Adding other receipts, including £7,710 for hiring of cars and public buildings, etc., £3,018 for advertising, made the total income £293,208, as compared with £261,200. Traffic expenses were £79,329, general expenses £25,579, general repairs and maintenance cost £31,120, power and motor maintenance and repairs at station £17,960, electricity for Newburn route purchased from Newcastle & District Co. £1,240, and public lighting £5,279; total £160,457 (against £147,552). The increase in traffic expenses is due to concessions granted to employés in August, 1914, and does not include the £4,364 paid to dependents of men on active service. The gross profit was £132,806 (£113,648). The total to credit of net revenue account after adding bank interest and interest on investments was £136,002 (against £117,734), out of which had to be provided for interest £29,574, special rents £1,491, income tax £5,411 and depreciation of stores £67; sinking fund required £43,355 and loans repaid to Corporation in respect of debt on old horse lines £1,381; bonus to riders was £18,000, paid for chassis £362, allowances to dependants of men on active service absorbed £4,634, and payment for motor 'buses £6,236. To the previous year £12,000 was contributed in relief of rates.

Reading.—The accounts of the tramways department for the year ended March 31 show total capital expenditure £237,102 (increase £26). Contributions to loans fund for redemption amount to £79,224, and £1,978 of loans has been paid off by instalments.

Income was £35,608 (compared with £35,282 in previous year), total operating expenses were £20,654 (£19,979) and gross profit was £16,039 (£16,346). Sinking fund required £5,062 (£5,062), interest £6,709 (£6,716) and income tax £263 (£149), the net profit being £4,005 (£4,419), of which £3,000 (£1,890) has been contributed in aid of rates and £1,005 (£2,529) placed to reserve. Total working expenses were 5·19d. (5·09d.) per car-mile. Passengers carried were 8,881,097 (8,865,128), car-miles run 924,696 (941,303), and units used for traction 1,072,237 (1,055,711).

COMPANIES' MEETINGS AND REPORTS.

DIRECT WEST INDIA CABLE CO. (LTD.)—According to the directors' report for the year ended June 30, submitted at the eighty-second ordinary general meeting of the company, held in London on the 13th inst., the net profit for the year, after providing for debenture interest, amounted to £13,562 12s. 2d., which, added to £5,615 brought forward, left £19,178 12s. 2d. available for distribution. An interim dividend of 3s. per share, less income tax, had been paid, and it was proposed to distribute a further equal payment, free of income tax, on the 1st proximo, absorbing £13,562 12s. 2d., and to carry forward £5,615 12s. 2d. The balance sheet showed the capital account to be £450,000, and the debenture account £88,000. The sum of £5,000 was applied to dividend, and with £2,521 19s. 4d. expended in repairs and renewals during the year, and credited with £11,752 12s. 2d. surplus earnings, the sum of £19,274 7s. 6d. [illegible] During the year the remaining debentures (£8,000) were paid off. The shareholders were asked to approve the establishment of a pension scheme for [illegible]

The report and accounts were approved.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—At the meeting last week the [illegible] result of the working for the past year [illegible] £10,679 2s. 9d., compared with £10,[illegible] An interim dividend of 4 per cent. [illegible] was paid and 2 per cent. proposed to be paid [illegible] £6,000, leaving £679 2s. 9d. to be carried forward. The balance to credit of revenue account, which was last [illegible] £[illegible] 9d., has been [illegible] and £[illegible] 9d. carried forward. [illegible] £[illegible] 6s. 9d. [illegible] £[illegible] 6s. 9d. [illegible] £[illegible] 6s. 9d

NORTHALLERTON ELECTRIC LIGHT & POWER CO. (LTD.)—Return to March 10 gives capital as £6,500 in 2,000 preference shares of £1 each and 12,000 ordinary shares of 10s. each. 1,141 preference and 4,861 ordinary shares taken up. £1 per share called on preference and 6s. per share on ordinary. £2,600 to be paid. Mortgages and charges: £5,400. Return of allotments made up to Aug. 13, 1915, shows a further 20 ordinary shares allotted for cash.

MORTGAGES AND CHARGES.

BRILLIANT SIGN CO. (1907) (LTD.)—Memorandum of satisfaction in full on Sept. 9, 1915, of charge dated April 12, 1912, securing moneys from time to time owing to Lloyds Bank, Limited.

DRY CELLS (LTD.)—Particulars of £2,000 debentures, created Sept. 3, 1915, has been filed, amount of present issue being £500. Property charged: Company's property, present and future. No trustees.

RENEW ELECTRIC LAMP CO. (LTD.)—Debenture dated Sept. 9, 1915, to secure £500, charged on company's undertaking and property, including uncalled capital. Holder: E. G. Fishenden.

TILLING-STEVENS (LTD.)—Issues on various dates from Nov. 25, 1913, to Aug. 31, 1915, of £50,000 first mortgage debenture stock, part of a series of which particulars have been filed.

RECEIVERSHIP.

J. WHITEHOUSE (LTD.)—Notice of appointment of E. B. Russell, 263, St. John-street, Finsbury, E.C., as receiver, on Aug. 31, 1915, under powers contained in mortgage debenture dated Nov. 9, 1914, has been filed.

CITY NOTES.

MEMORANDA (Sept. 22).—Bank rate 5 per cent. (since Aug. 8, 1914) Consols 65. Consols Pay Day Oct. 1. Stocks and Shares Ticket Days Sept. 28 and Oct. 13. Pay Days Sept. 29 and Oct. 14. Price of silver, 23¾d.

A WIRELESS MONOPOLY.—Under this heading, the London "Daily Chronicle" of Sept. 18 published a long circumstantial account of the acquisition by the Marconi Wireless Telegraph Co. of the Poulsen patents. There is nothing particularly new in the announcement, as we seem to remember its being made previously, but the novelty lies rather in the minute description and detail of information of a deal which is not denied, but whose announcement is described as "premature" by the parties concerned. The announcement in the "Chronicle" (which certainly reads like a genuine Marconi financial *ballon d'essai*, not unduly tainted with modesty) was as follows :—

A Monopoly of Wireless. Marconi and the Poulsen System.
All Rivals Now Vanquished.

[illegible] the Poulsen patent rights, and in due course the Poulsen system will become part of the Marconi [illegible] intents and purposes synonymous. But, as a matter of fact, the great Marconi company has had numerous rivals, and has been compelled to go to considerable expense from time to time not only to protect its own patents from infringement, but to strengthen its position by the acquisition of other patents or a controlling interest in concerns owning such [illegible].

From the very first the commercial instinct has gone hand in hand with inventive [illegible]. Mr. Marconi had, in 1896, lodged his application for the first British patent for wireless [illegible] different name—was established with a capital of only £100,000. Since then the capitalist has been freely enlisted to supplement the work of the mathematician, the laboratory experimenter and the inventor. Numerous subsidiaries came into being at regular intervals as developments occurred, while the parent company kept its control of the whole network by its share interests in these sub-companies, making important contracts where it did not seem desirable to float subsidiaries.

It is only during the past decade that the Marconi people have been troubled with serious rivals. We can merely refer in passing to the series of successful actions they have fought in this and other countries in defence of their patents. Other measures have, however, been taken to consolidate the position. Mention should be made of the important acquisition in 1911 of the Lodge-Muirhead patents. Sir Oliver Lodge becoming a scientific adviser to the company, while in the following year the Marconi Company secured the patents of Bellini and Tosi, including those for the wireless direction finder. Early in 1912 the absorption of the competitive concern, the United Wireless Co. of America, by the American Marconi Co. necessitated a big increase in capital, and the subsequent placing of the shares here at a high figure will be recalled.

The last development in the process of eliminating rivals and acquiring valuable patents was announced towards the close of 1913, when the Marconi Company increased its capital substantially in order to take a controlling interest in the Compagnie Universelle de Telegraphie et de Telephonie Sans Fil, which owns the whole of the wireless patents in connection with the important Goldschmidt system.

All these developments have, of course, cost money. The Marconi Company's capital was originally £100,000. It is now not far short of 1½ millions. Much of this capital has, [illegible] taken to render the commercial position a [illegible] system, which is now to be absorbed. It is [illegible] for company [illegible]

British "Poulsen" Syndicate.

[illegible] had a very influential backing. Its official name was the [illegible]

man who took a prominent part in the controversy which raged round the merits of the various systems at that time.

The syndicate had a capital of £100,000, and in April, 1913, the "Daily Chronicle" published a list of the most influential shareholders, which showed that it was controlled by the directors of the Imperial Tobacco Co. and their friends, while it also included important South African mining interests.

Since the Marconi Wireless Chain arrangement was fixed up the Poulsen people have not been idle. Long-distance communication has been developed. After official tests a contract was granted by the United States for a Poulsen installation at Colon, on the Panama Canal, while arrangements were made for a direct Poulsen system service between Canada and Ballybunion, Co. Kerry, Ireland. This latter was taken over by the Government, with the Marconi high-power stations, at the outbreak of war.

Recently the option in connection with the British rights lapsed, though a fresh arrangement would quite possibly have been fixed up. In the meanwhile, however, a syndicate representing the Marconi interests, recognising, no doubt, what a formidable rival the Poulsen system must be in

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	NAME.	Price, Wed., Sept. 22.	Rate per cent.	Yielded.	Dividend Due.
		Electric Railways and Tramways —*Cont.*		£	s. d.	
St.	4½%	Metropolitan Elec. Ry. 4½% First Pref	73½	6	2 5	Feb, Aug
St.	5%	Do. 5% Perp. Deb.	12½	4	12 8	Jan, July
St.	4%	Do. 4% Debs.	75	5	14 0	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	67½	5	16 9	Jan, July
St.	4%	Do. 4% Guar. Stock	71½	5	6 0	Mar, Sept
10	..	Underground E. Rys. of London Shares	1½	..	..	..
1/0	..	Do. A Shs.	1	..	..	..
St.	6%	Do. 6% Inc. Debs.	102½	5	16	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. '16	85	6	0	Mar, Sept
..	4½%	Do. 4½% Bds.	93½	4	11 4	Jan, July
5	..	Yorkshire W. Riding Ord.	½	..	..	March
5	6%	Do. Pref.	4⅞	6	18 8	Jan, July
		Electric Manufacturing, &c.				
1	15%	Babcock & Wilcox Ord.	2½	6	4 5	Apl, Oct
1	5%	Brit. Aluminium Ord.	1¼	4	16 0	Mar
100	5%	Do. Prior Lien Debs.	93½	5	7 6	Jan, July
1	6%	Do. 6% Pref.	1⅛	5	6 8	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅞	7	2 0	Aug, Feb
5	3.0	Do. 6% Cum. Pref.	5	5	9 1	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm. 6% Pref.	1⅛	5	6 4	Mar, Sep
2	7½	Brit. Westinghouse Pref.	1½	9	12 0	Accru
100	6%	Do. 6% Prior Lien Debs.	101½	5	18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73	5	9 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	14½	7	6 4	Jan, July
5	2/6	Do. 5% Pref.	4	6	5	Feb, Aug
1	15%	Castner Kellner	3⅛	4	14 7	May, Nov
1	6%	Do. Kerr & Co. £1 Pref.	1⅛	5	6 11	Sept
5	..	Edison & Swan U Elec Lt. A. £3 pd.	1⅛	..	..	Feb, Aug
1	6%	Elec. Construction Ord.	1⅛	9	1 5	Mar
1	7%	Do. Pref.	1	7	0 0	Jan, July
St.	4%	Do. 4% Deb.	64½	5	15 6	Jan, July
10	6%	General Electric 6% Pref.	7	6	0 3	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	1⅛	6	..	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4½	4	14 4	..
St.	4½%	Do. 4½% Db.	91½	4	18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	8⅝	6	1 2	Feb, Aug
10	5%	Do. Pref.	5⅝	5	16 6	Apl, Oct
100	4%	Do. 4% Debs.	98	4	1 8	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	30½	7	17 5	Mar, July
100	4%	Do. 4½% Debs.	93	4	16 0	Jan, July
1	7½%	Vickers Ord.	1⅝	4	1 1	May, Aug
1	6d.	Do. 5% Pref.	⅛	5	6	May, Aug
St.	4%	Do. 1st Debs.	80½	4	19 3	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99½	4	10 3	Jan, Dec
		Telegraphs.				
100	5%	Amazon Telegh. Co. 5% Debs.	95	5	5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	9⅞	6	3 1	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	22½	6	15 7	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	67	6	3 3	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	6	6	7 6	May, Nov
10	10%	Do. 10% Pref.	15½	6	11 2	..
5	5.0	Direct Spanish 10% Pref.	7⅝	6	13 4	..
10	4%	Direct United States	6	6	15 5	Ja,Ap,Jly,O
St.	..	Eastern Tel. Co. Ord.	13⅝	6	1 9	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	6	5	7 6	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	79½	4	14 7	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	78½	5	1 11	Feb, Aug
10	7%	Do. Ord.	11	5	17 3	Ja, Ap, Jly, O
10	22½	Gt. Northern Tel. Co. with Coup. 8	33½	6	11 4	Ja, My, Jly
25	13%	Indo-European	31	9	5 6	May, Nov
1	1⅛	Marconi's Wireless Tel. Co.	1	5	5	April
1	..	Do. 5% Pref.	1⅛	3	19	July
10	9d.	West Indian & Panama Tel. Co.	11	8	17	May, Nov
10	6%	Do. 1st Pref.	8	7	7	May, Nov
10	..	Western Union 50 yr. Bds.	1⅛	4	13 0	May, Nov.
		Telephones.				
..	$2	American Telephn. & Telgh. $100 Cap.	129½	6	3 7	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	78½	6	12 5	Jan, July
1	7½d.	Monte Video Telephn. Ord.	1⅛	6	12 8	Nov.
..	4½%	New York & Pennsylvania 4½% Bds.	94	4	11 1	May, Nov
1	10%	Oriental Telephone Ord.	1⅝	6	3 4	Apl, Oct
St.	4%	Do. Db. St.	65	6	3 0	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5	3 8	Jan, July
5	8%	United River Plate Ord.	5½	7	5 3	Apl, Oct
5	8%	Do. 8% Cum. Pref.	4⅝	7	3 3	Jan, July
St.	4½%	Do. Deb. Stk.	90	5	0 0	Jan, July
		Financial and Investment.				
10	6%	Globe Trust & Trust	9⅜	6	4	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	9⅜	6	4 6	Sp,Dc,Mr,Jn
100	6%	Mexican Company of London	80	6	5 0	Ja, Apl, Jly,O
..	4%	Do. 4% Debs.	65	6	15 6	Ja,Ap, Jly,O
100	6%	Submarine Cable Trust Deb.	125½	4	15 2	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.				
St.	5%	Anglo Argentine Trams. 5% Debs.	74½	6	14	Jun, Dec
St.	4½%	Do. 4½%	71	6	13	Jan, July
St.	4%	Do. 4%	72½	5	10	Jan, July
5	2/6	Do. 5% Pref.	2	6	5	Jan, July
5	2/9	Do. 5% Cum. Pref.	2½	5	8	Feb,M.Aug,N
100	1½	Buenos Ayres Tramways	48	7	4	Ja,Apl,Jly,O
100	3½	Do. Pref.	..	..	..	May
..	..	Brisbane Trams Ord.	..	..	..	May, Nov
5	2/6	Do. 5% Pref.	4⅜	5	14	..
St.	4½%	British Columbia 4½% Con. Debs.	89½	5	0	Mar, Sep
5	..	Calcutta Elec. Trams. Ord.	1⅛	4	4	Feb, Aug
5	5%	Havana Elec. Ry. 5% Bds.	1⅛	5	1	..
5	5%	Madras Elec. Trams 6% Cum. Pref.	7	6	9	..
100	..	Do.	7	7	11	Jan, July
..	..	Mexican	..	..	..	Fb,M,Aug,N
..	..	Do.	..	..	..	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	94	4	15 11	Feb, Aug
St.	4%	Do.	77	5	17 11	Jun, Dec
100	4½	Do.	11	..	..	Feb, Aug
		Colonial and Foreign Electric Supply, & c.				
		Adelaide Elec. Supply 6% Pref.	1⅛	6	1 0	May, Oct
5	..	Do.	..	..	..	June, Dec
1	..	Bombay E. S. & T 6% Pref.	1⅛	6	1 0	..
..	..	Do.	..	..	..	..
..	..	Do.	..	..	..	..
St.	..	Melbourne Elec. Supply 5% 1st Mt. Debs.	1⅛	5	1 4	Ja, Apl, Jly, O
St.	..	Do.	1⅛	5	1 4	Apl, Oct
..	..	Do.	1⅛	5	1 4	Jan, July
..	..	Do.	1⅛	5	1 4	Ja, Apl, Jly, O
St.	4½	Do.	1⅛	5	1 4	July
..	..	Do.	1⅛	5	1 4	May, Nov
..	..	Victoria Elec. & Power	1⅛	5	1 4	Jan, July
..	4½%	Do. 4½% Mort. Debs.	1⅛	5	1 4	Jan, July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Sept. 22, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	12½d.	English Lead	£24 5 0
Solid Drawn Copper Tubes	13d.	Antimony	Nominal.
Brazed Copper Tubes	13d.		
Brazed Brass Tubes	14d.	**Old Metals:**	per ton.
Brass Wire	12d.	Clean Scrap Copper	£66 0 0
Copper Wire	12½d.	Brazlery Copper Scrap	£59 0 0
Rolled Brass	12½d.	Clean Scrap Brass	£50 0 0
Brass Sheets	13d.	Old Lead	£20 0 0
		Old Zinc	£38 0 0
	per ton.	Hollow Pewter	£100 0 0
Copper Sheets	£96 0 0	Black Pewter	£75 0 0
Spelter	£67 0 0	Gun Metal	£59 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Sept. 21 the following current prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£85 0 0	Old Lead	£19 10 0
Clean Mixed Brass	£63 0 0	Tea Lead	£17 10 0
Clean Copper	£67 0 0	Zinc	£30 0 0
Brazlery Copper	£61 0 0	Hollow Pewter	£110 0 0
Gun Metal	£63 0 0	Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £70; Commercial Tinman's Solder, £90; Blowpipe Solder, £100.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS

LINE.	Week ended.	Amount.	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 15	1,901	+ 353	15	28,981	+ 81
Anglo-Argentine	.. 16	47,626	— 3 600	37	1,880,567	— 139,71
Ashton-under-Lyne	.. 16	500	+ 101	25	12,377	+ 62
Ayr Corporation	.. 15	558	+ 145	18	9,117	+ 32
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	.. 14	1,464	+ 218	25	34,407	+ 2,44
Birmingham Corporation	.. 11	15,535	+ 4,100	25	337,664	+ 33,9
Blackburn Corporation	.. 15	1,503	+ 260	25	33,743	— 7
Blackpool Corporation	.. 16	3,465	+ 1 645	25	34,278	— 4
Blackpool and Fleetwood	.. 16	1,608	+ 656	37	32,082	— 7
Bolton Corporation	.. 14	2,773	+ 176	25	67,842	— 3,2
Bournemouth { Trams	.. 15	2,537	+ 575	24	54,889	+ 1,6
Bournemouth { Buses	.. 15	34	— 8	24	771	— 1
Bradford Corporation	.. 15	6 000	+ 939	24	165,411	+ 6,5
Brighton Corporation	.. 15	1,386	+ 284	25§	30,428	— 3
Bristol Trams { Trams	.. 17	4,692	+ 382	37	174,651	+ 1
Bristol Trams { Buses &c.	.. 17	5,477	+ 1,095	37	181,686	+ 31,1
Burmah E. Trams & Ltg.	.. 11	R3,638	+ R174	37	R132,268	+ R1,0
Burnley Corporation	.. 15	1,743	+ 338	25	54,919	+ 1,3
Burton Corporation	.. 17	309	+ 14	25	1,311	— 3
Bury Corporation	.. 17	1,410	+ 48	25§	34,919	— 1,3
Calcutta Tramways Co.	.. 15	R67,387	+ R1,336	..	..	..
Camborne-Redruth	.. 15	148	+ 12	37	5,106	—
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	.. 16	527	+ 91	37	18,727	— 1
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	.. 14	2,007	+ 288	24	44,965	+ 2,4
*Derby Corporation	.. 18	1,104	+ 131	24½	26,481	+ 4
Dover Corporation	.. 15	368	+ 102	24	8,183	+ 1,5
Dublin & Lucan Railway	.. 17	125	+ 41	11	1,917	+
Dublin United	.. 17	6,645	+ 1,059	37	227,929	+ 7,9
Dundee Corporation	.. 15	1,465	+ 206	18§	24,514	+ 9
East Ham Council	.. 15	1,341	+ 137	24§	32,962	+ 5,1
Exeter Corporation	.. 17	427	— 71	24	9,833	+ 5
Glasgow Corporation	.. 15	23,117	+ 3,306	16§	342,561	+ 23,4
Glossop Trams	.. 15	149	+ 30	25	4,730	—
Gloucester Corpn.	.. 15	304	+ 57	24	8,341	—
Halifax Corpn. { Trams	.. 14	2,537	+ 550	24	56,615	+ 2
Halifax Corpn. { Buses	.. 14	52	+ 10	24	1,265	—
Hastings Elec. Trams Co.	.. 16	1,389	+ 348	37	37,176	— 2
Huddersfield Corpn.	.. 15	2,688	+ 489	24	68,222	+ 8,8
Hull Corporation	.. 15	2,983	+ 1	24	74,844	— 3,6
Ilford District Council	..	..	..	..	..	..
Ilkeston Corporation	.. 14	148	+ 23	24	3,272	+
Ipswich Corporation	.. 15	614	+ 187	23	14,365	+ 2,6
Isle of Thanet Co.	.. 15	735	+ 180	50§	21,957	— 10,7
Kilmarnock Corporation	.. 15	139	+ 14	18	3,195	+
Lanarkshire Trams Co.	.. 16	2,328	+ 578	37	72,153	+ 1,0
Lancashire United	.. 15	2,111	+ 545	37	65,044	+ 3,
Leeds Corporation	.. 15	9,393	+ 1,633	25	224,803	+ 16,
Leicester Corporation	.. 15	3,227	+ 614	38	113,029	+ 4,
Leith Corporation	..	787	+ 134	18	14,390	+
Lincoln Corporation	..	..	..	..	..	..
Liverpool Corporation	.. 15	14,206	+ 1 244	37§	498,492	+ 2
Llandudno&ColwynBayR	.. 15	523	+ 100	12	14,702	+ 1,
London County Council	..	48,130	+ 4,300	13	1,000,448	— 15,
Lowestoft Corporation	.. 15	148	+ 27	8	8,878	— 2,
Maidstone Corporation	.. 15	260	+ 53	24	5,587	+
Manchester Corporation	.. 15	18,466	+ 1,3	24	445,139	+ 10,
Nelson Corporation	.. 15	233	+ 45	25§	4,952	—
Newcastle-on-Tyne Corpn.	.. 15	6,541	+ 776	25	156,154	+ 2
Newport (Mon.) Corpn.	.. 15	..	+ 48	25	21,137	—
Northampton Corporation	.. 17	771	+ 139	24§	18,732	+ 3
Nottingham Corporation	.. 14	3,875	+ 613	24	92,255	+ 5
Oldham Corporation	.. 15	2,448	+ 339	26	60,550	+
Portsmouth Corporation	.. 15	2,810	+ 514	25	66,833	—
Preston Corporation	.. 15	1,031	— 1	24§	23,559	+ 2
Reading	..	..	..	..	..	..
Rotherham Corporation	.. 15	1,238	+ 111	24	27,955	+
Salford Corporation	.. 15	5,365	+ 683	..	131,612	+
Sheffield Corporation	.. 15	9,329	+ 1,949	25	225,836	+
Southampton Corpn.	.. 15	1,668	+ 405	24	37,146	+
Southend Corporation	.. 15	694	+ 171	24	22,945	+
Stockport	.. 15	1,111	+ 183	24	19,390	+
Stourbridge, Hyde, &c., Jt. B.	..	..	..	..	..	..
Sunderland Corporation	.. 15	1 [illegible]	+ 167	24	37,501	—
Swansea Corporation	.. 15	[illegible]	+ [illegible]	24	26,233	—
Swindon Corporation	..	..	..	..	..	..
Tynemouth Corpn.	.. 15	662	+ 108	11	6,773	+
Wallasey Corporation	.. 15	1,425	+ [illegible]	24	33,770	—
Walsall Corporation	.. 15	828	+ 113	25	27,573	+
Wigan	.. 15	[illegible]	+ 1	25	24,163	+
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	..	..	..	..	..	..
Wigan Corporation	.. 15	1,653	+ [illegible]	24	37,180	+
Wolverhampton Corpn.	.. 15	1,155	+ 146	24	27,119	+
Yorkshire W.R. Trams	.. 15	1,607	+ [illegible]	24	[illegible]	+

(a) These comparisons are with the corresponding period last year. * Partly electri
† Including omnibuses, &c. ‡ Minus 2 days. § Minus 3 days ¶ Plus 3 d.

THE ELECTRICIAN:

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NOTES.

London & South-Western Electrification.

ON another page we give some account of the rolling-stock which is to be used on the electrified portion of the L. & S.W. Railway, and in later issues we hope to describe the power house and other details of the scheme. This electrification is of interest as it is the second case of conversion from steam to electricity of suburban railways in the London area, if we omit those lines connected with the Underground. The first case was, of course, that of the L.B. & S.C. Railway. In the present instance we are dealing with the older rival—namely, continuous current as opposed to single-phase working. In many ways we think it is a little unfortunate that there should be two different systems in the London suburbs, but as to which is the best to adopt, or whether both are best under their respective conditions, time alone will show. As will be seen by reference to our article, the trains consist of three-coach units, two of which are motor coaches, and two of these units will be combined when necessary to form six-coach trains. The control is the "all electric" Westinghouse multiple-unit system. In this connection it is interesting to note that the relays act fully at voltages down to 470 volts, the normal voltage being 600 volts; but if the pressure is below 470 volts the relays will not carry the connections through so as to put the motors in parallel, though they will run in series down to 350 volts.

FROM this statement it must not be inferred that the Railway expects to be troubled with low voltages, even down to 470 volts. This is very far from being the case; but accidents sometimes happen, and if low voltage is experienced it is a distinct advantage to have motors so arranged that the pressure is not pulled down still further by the train motors going into parallel, an operation over which the driver has no control beyond turning the controller handle to the desired notch. The controller may be turned to any notch as quickly as the driver desires, but the rapidity with which the various electrical connections are altered depends merely on the relays, and not on the driver. The fact that the control is all electric, and does not depend upon the skill of the driver, is most important, and in such cases in the United States a standard arrangement for 600-volt lines is to set the control so that it will operate at any pressure down to 300 volts. There is, of course, an advantage in placing the limiting voltage rather low, so as to eliminate any possibility of failure to step up, which might be occasioned by carelessness on the part of the maintenance staff. For this reason the General Electric Co., of America, place this limiting voltage at half the normal. Another point about the equipment is that the whole of the contactor gear, resistances and other control equipment, as well as the compressor, are placed in the cab of the motor coach. Undoubtedly, some remunerative space is lost by so doing, but, on the other hand, there is much to be said, from the point of view of efficient working, in favour of placing the equipment so that it can be inspected and adjusted under easy working conditions. For the many other interesting features in this scheme we must refer our readers to our descriptive article.

Tramway Finance.

THE financial stability of tramways is a subject which has given rise to much careful thought on the part of tramway managers during the last few years. There is little doubt that a tramway undertaking should be run on strictly business lines, but it seems doubtful whether this course has invariably been followed. Of late years the policy generally seems to have been one of concession. In some cases large sums have been handed over for the relief of rates, and in many others the length of ride given for a penny has become unduly long, varying from 2 to 3 miles. Meanwhile, wages have been rising considerably, as also the prices of material, and now the situation has been rendered still more serious by the present war conditions. In many cases war allowances are running into very heavy figures, such as £60,000 per annum at Glasgow and £70,000 per annum

at Manchester. In a Paper before the Municipal Tramways Association, Mr. A. Baker, the general manager of the Birmingham Corporation tramways, has had the courage to deal seriously with this subject. He points out, as will be seen on another page, that when the war is over it is unlikely that the men will be inclined to accept a reduction in the wages which they are now earning, and there seems to be every probability that the costs will become still higher.

In his opinion, the obvious solution is to raise the price of the commodity which they are selling, and, consequently, at Birmingham the length of some of the stages has been reduced and many of the fares have been raised, whilst the workmen's penny return tickets have been abandoned. So far the result has been entirely satisfactory, and the financial position is much improved. As to whether this policy is one that can be generally adopted is no doubt open to a good deal of discussion. It is difficult to know whether the raising of fares will have a bad effect on the amount of traffic to be handled. A satisfactory mean must be struck between cheapness of fares, such as will encourage the travelling habit to the utmost, and a tariff sufficiently high to bring in the required revenue. It is, of course, most desirable that the travelling habit should be encouraged, more particularly at times when the traffic is low; but it is just possible that when once people have got the habit of using tramways they will continue to do so when fares are raised, although they might not have been induced to make use of these facilities in the first instance if the fares had been so high. Although we cannot expect everyone to agree with the conclusions that have been drawn by Mr. Baker, we are glad that he has brought the subject forward, and we think that his Paper will probably do good in emphasising the necessity of running tramways on a thoroughly business basis.

Street Lighting Economy.

On another page of our present issue an extract is given from the annual report of the Commissioner of the Department of Water Supply, Gas and Electricity of New York. This shows the savings that were effected in the lighting of streets and public buildings by the substitution of gas-filled tungsten lamps for arc lamps and gas lamps. In round figures the cost of lighting the streets, parks and public buildings of New York amounted to £875,000 in 1913. Of this a sum of £200,000 was spent in the lighting of public buildings. The street lighting bill for 1915 will be some £80,000 less than for 1914, and the Commissioner announces further improvements, including the substitution of electricity for gas over a considerable area, thereby doubling the illumination at a somewhat reduced cost. Before the end of the year it is expected that no less than 15,000 gas lamps will be displaced by electric lamps. At the time of [illegible] gas-filled tungsten lamps were [illegible] for street lighting purposes. It is interesting to note that [illegible] are limited by statute to one year, and equally interesting [illegible] annual rates for the different lighting [illegible]

Transformer Design.

Notwithstanding its inherent electrical and mechanical simplicity, the static transformer has received at least as much attention as most other electrical plant and apparatus. Electrical engineers whose names are household words in the profession have made a special study of the several theoretical and practical problems connected with the design, construction and operation of transformers, and owing to the rapid increase both in size and voltage in recent years, the solution of many of these problems is an achievement of no mean order. Students of electrical design will be interested in the article in this issue by Messrs. Cabot and Cairns, on "The Design of Stationary Transformers." The authors, after analysing the specific methods of procedure advocated by six writers on the subject, conclude that there are in reality only two methods, the first of which is due to Bohle and Robertson and the second to Hobart. The first method proceeds from a minimum of preliminary assumptions directly to all dimensions and data by a single set of calculations, and arrives at a construction to fulfil the preliminary assumptions involving a minimum of cost. In the second method certain assumptions are made in a set of well-recognised algebraical formulæ, and from these the designer can lay-out a preliminary design. As a rule, re-calculation is necessary, and even when the final result is reached the geometrical shape will not in general be that which gives the least cost, although it may not be far from the most economical design.

Although a different line of reasoning is adopted by Cabot and Cairns, their results on analysis are found to be in close agreement with those given by Bohle and Robertson, and the conclusion is drawn that, taking all things into consideration, the core-type of transformer with circular coils is perhaps a more promising construction for satisfying a specification for a single-phase transformer than a core-type of transformer having rectangular or square coils. The analysis covers works which have appeared during the past four years. In some respects it is to be regretted that the authors did not cover a longer period so as to include other and older methods of proved worth. It would, for example, have been interesting to apply the analysis to the method described by Prof. G. Kapp in his treatise on "Transformers," and to Prof. Thompson's ingenious and practical "flux-factor" method. Another useful method, it will be remembered, was described in these columns about three years ago by Mr. Catterson-Smith. The reader should, however, have little difficulty in comparing these for himself.

Validity of a Rate in Aid of Electricity Works.

In reference to the comments of our esteemed contemporary the "Journal of Gas Lighting" upon our notes on this subject last week, we need scarcely point out that we were fully aware the Limerick judgment was not of recent date. Our comment was in reply to something which appeared recently in a gas journal; it was intended to prove that the judgment in the Limerick case was not, in our opinion, in accordance with the law, and that the Town

Improvement Clauses Act of 1847 did not specially apply to a rate levied to meet a deficit on an electricity supply undertaking. These points the "Journal of Gas Lighting" appears not to have comprehended.

A Boron Silicate Insulator.—An insulator manufactured by F. M. Locke, of Victor, New York, is [illegible] material, which consists of an aluminium silicate body fused with boron at a very high temperature, and then formed into shape. This gives a glass-like substance with a dielectric constant of 4·8 instead of 6·5, the figure for porcelain. The coefficient of expansion is only 0·0000035, and the specific gravity 2·26. The boron is said to give the compound the property of retarding the ionisation of the air around the insulator, so that its flash-over voltage is 50 per cent. higher than that of porcelain. The insulators are also claimed to be more resilient in standing mechanical strains and to be valuable in service under great changes of temperature. They will stand without breaking a temperature change from below zero to the boiling point of water.

New Lighting Order for London.—Last Wednesday a new Lighting Order was issued for regulating artificial lighting in the London area, and will take effect from to-day. According to this Order all outside lighting for the illumination of shop fronts must be extinguished, and the intensity of the inside lighting of shops must be reduced so that no more than a subdued light is cast in any direction outside the premises. All sources of light must be screened so as to cut off direct light from windows and doors in all buildings, including private dwellings. All large lighted roof areas must be covered over, or the lighting intensity reduced to a minimum, and the lighting of railway stations and goods yards must be reduced to an intensity sufficiently only for the safe conduct of business. Blinds in railway carriages must be kept down, and lights along a water front must be masked to prevent reflection. Vehicles must show a light in front and behind from half-an-hour after sunset until half-an-hour before sunrise.

Radio Stations on the Panama Canal.—The "Canal Record" reports that the naval stations at Colon and Balboa erected especially for communication with vessels coming to the canal or its terminal ports, are performing increasingly effective service in facilitating canal operations. Over half the vessels coming to the canal or its terminals are equipped with radio apparatus, though only about a fourth of those so equipped have advised the authorities of their approach. The Colon station is now handling approximately 2,300 messages per month, the Balboa station about 400, practically all in communication with vessels. Of these, about one-sixth are handled as a part of the canal work, on which no charges are made. The radii of communication of the stations have extended as far as 1,500 miles under favourable conditions. These terminal stations use the Lowenstein 500-cycle spark sending system and the international code. The high-power station at Darien, which handles Government work exclusively, uses the Poulsen system. The Colon station sends broadcast a news bulletin, a weather forecast and any information concerning dangers to navigation.

Current Topics.

Subjects of current interest dealt with in this issue include the following:—

Mr. T. Carter contributes an article on "Direct-current Motor Speed Regulation by Resistance in the Armature Circuit, with Special Reference to the Diverter Method" (p. 953).

We publish an article entitled "A Note on the Distribution of Flux Around a Continuous-current Armature," by Messrs. B. Hague and F. E. H. Schroeder (p. 959).

A full account of the Annual Conference of the Municipal Tramways is given on p. 949.

A description of the electrification of the [illegible] Western Railway appears on p. 961.

Our Leading Article deals with the question of extravagance in Government Departments (p. 958).

"The Design of Stationary Transformers" is the title of an informative article by Messrs. S. Cabot and C. F. Cairns (p. 944).

An abstract of a Paper on "A Large Electric Hoist," read by Mr. W. Sykes, before the American Institute of Electrical Engineers, is given on p. 955.

Striking figures are given in the Annual Report of the Commissioner of the Department of Water Supply, Gas and Electricity of New York, showing the savings effected by the substitution of metal filament lamps for arc lamps (p. 957).

"Magnetostriction and Resistance of Iron and Nickel" is the title of a Paper contributed by Mr. C. W. Heaps to the "Physical Review," and of which we give an abstract (p. 966).

PERSONAL.

Royal Engineers (T.F.)—The following appointments and changes have been made:—

Durham Fortress Engineers: Pte. E. P. Cheverton (from Tyne Electrical Engineers) to be second lieutenant.

Tyne Electrical Engineers: Second Lieut. T. Henderson is seconded. C. W. Erskine to be second lieutenant. Sapper C. G. Huntly (from London Electrical Engineers) to be second lieutenant.

London Electrical Engineers: Captains T. Rich, A. E. Levin and W. H. Merrett to be temporary majors. Capt. H. M. Edmunds is seconded.

APPOINTMENTS VACANT AND FILLED.

Belfast Tramways and Electricity Committee invite applications for the positions of senior engineer-in-charge and junior engineer-in-charge in their electric generating station. Wages £4 and £3 per week, respectively. Forms of application from the city electrical engineer, Mr. T. W. Bloxam, East Bridge-street, Belfast, to whom applications by Oct. 15. *See also an advertisement.*

Oldham Corporation Electricity Committee invite applications for the position of shift engineer. Wages £2 per week. Applicants must have had good mechanical and electrical training, and have had experience in an electric generating station giving l.t. direct and e.h.t. supplies. Applications to the joint engineer and manager, Mr. Fred. L. Ogden, Greenhill Electricity Offices, Oldham, by Friday Oct. 8. *See an advertisement.*

A professor of organic chemistry (pure and applied) is required for the University of Sydney. Salary £900. Particulars from the Agent-General for New South Wales, 123, Cannon-street, London, E.C., to whom applications must be sent by Oct. 13.

Mr. A. H. Gates, who has been discharged from military service, has been re-engaged as chief technical assistant at Luton, at £3. 10s. per week.

ARRANGEMENTS FOR THE WEEK.

MONDAY, Oct. 4th.

SOCIETY OF ENGINEERS.

7.30 p.m. Meeting at the Surveyors' Institution, Great George-street, Westminster, S.W. Paper on "Law and Engineering," by Mr. S. G. Turner.

WEDNESDAY, Oct. 6th.

UNIVERSITY COLLEGE.

5 p.m. Prof. J. A. Fleming will deliver a public introductory lecture, entitled "Science in the War and after the War."

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

The following orders have been issued for week commencing October 4, 1915:—

Drills, 6.30 to 7.30; 7.30 to 8.30 p.m.

Monday, October 4th.—Section 1, Technical; Section 4, Squad, Signalling Class.

Tuesday, October 5th.—Section 2, Technical; Section 3, Shooting.

Thursday, October 7th.—Section 3, Technical; Section 2, Shooting.

Friday, October 8th.—Section 4, Technical; Section 1, Squad Signalling Class.

Saturday, October 9th.—Company Parade, 2.30 p.m., Route March.

Arrangements have been made to share headquarters with the 4th Battalion Central London Regiment (Volunteers), at Chester House, Eccleston-place (three minutes' walk from Victoria Station, Brighton line).

THE DESIGN OF STATIONARY TRANSFORMERS.*

BY SEWALL CABOT AND C. F. CAIRNS.

During the past four years the following six books have been published dealing with a specific method of procedure in the design of alternating-current static transformers: (1) Bohle and Robertson, "Treatise on Transformers," 1911; (2) Hobart, "Design of Static Transformers," 1911; (3) Ryan, "Design of Electrical Machinery," 1912; (4) Barr and Archibald, "Alternating-current Machinery," 1913; (5) A. Gray, "Electrical Machine Design," 1913; (6) Pender, "American Handbook for Electrical Engineers," 1914. On analysing the methods advocated in these books it will be seen that there are in reality two distinct methods advocated.

Method I.—Bohle and Robertson.

The fundamental general equations of the transformer are differentiated and a set of tables and curves deduced from which it is possible to make a preliminary design, assuming the k.v.a., core loss, copper loss, quality of the iron, temperature of the copper, space factor of the winding, space factor of the iron, and ratio of cost per unit volume of copper space to cost per unit volume of iron space, this preliminary design giving a transformer which will cost the least money to build under the conditions assumed.

If the assumed ratio of core loss to k.v.a. is too great for the volume of iron calculated, the temperature of the iron will be too great or the magnetising current will be too great.

To correct this it will be necessary to re-design the transformer, assuming a less core loss.

Method II.—H. M. Hobart.

The preliminary assumptions made are the k.v.a., copper loss, iron loss, quality of the iron, temperature of the copper, and space factor of the iron, and in addition the assumptions, deduced from commercial practice and set forth in the form of curves and tables, comprising volts per turn, widths of window, maximum flux density and space factor of copper.

Using these preliminary assumptions in a set of simple and well-recognised algebraic formulæ, the designer can lay out a preliminary design which must later be re-calculated and slightly revised, since all of the preliminary assumptions made are not compatible with each other.

With this method there is no means of knowing whether the geometrical shape finally deduced is that which fulfils the specification for a minimum cost.

Ryan advocates Method II., except that he makes no preliminary assumption of copper space factor and width of window, but he does make a vague assumption of geometrical shape substantially as shown in a set of cuts.

Barr and Archibald advocate what amounts to Method I., but instead of giving tables and curves they endeavour to deduce the general formula for calculating each case. They neglect to use calculus at one step, but instead use a very laborious graphical solution. They also make the mistake of assuming that the cheapest transformer is obtained when the costs of active iron and copper are equal. That this is a fallacy is shown by Bohle and Robertson (page 561). Values given by their equations are for this reason slightly incorrect.

Gray advocates Method II. except that he makes no preliminary assumption of the copper loss. Slichter, in the "American Handbook for Electrical Engineers," advocates Method II., except that he makes a further preliminary assumption of current density and ampere turns per inch of core.

Comparing Method I. with Method II., it is the opinion of the writers that Method I. would be superior if the data were correctly set forth in a form easily understandable by the designer, since Method I. proceeds from a minimum of preliminary assumptions directly to all dimensions and data by one set of calculations and arrives at a construction involving a minimum of cost to fulfil the preliminary assumptions. In Method II. re-calculations are usually necessary, and when the final result is reached the geometrical shape will not in general be that which gives the least cost, although it may [illegible] the most economical design.

The writers have also come to the conclusion that, taking all things into consideration, the core type of transformer with circular coils [illegible] transformer having rectangular or square coils. They are led to [illegible] and over the windows [illegible] In the type the [illegible]

density of the leakage flux is smallest, and hence the eddy losses in the copper are a minimum. (c) The labour of winding a circular coil is less, the space factor slightly better, and the ability to withstand mechanical strains slightly better, than for a rectangular or square coil.

The writers have differentiated the fundamental equations of this transformer and plotted the results graphically (*see* Fig. 3).

Although a different mathematical process and method of reasoning from that employed by Bohle and Robertson were used to obtain these results, nevertheless it will be found on analysis that they check the results of Bohle and Robertson, given in Chapter X. of their book.

Inspection of these graphical results shows that the geometrical shape giving the smallest cost of active material changes with the product of the two ratios, cost of active iron per kilogramme to cost of active copper per kilogramme, and space factor of iron to space factor of copper.

In the practical construction of transformers there is not very much change in the product of these ratios for the reason that as the space factor of copper decreases, owing to increased voltage requirements, the cost of insulating material and labour which may be properly associated with each kilogram of copper increases. The resultant value of this ratio is roughly 1 to 2. Adopting that geometrical shape for all transformers which gives the least cost for this ratio equal to 0·5, the increase in cost for values of the ratio anywhere between 0·25 and 1 will be negligible, being less than 2 per cent. at the extreme limits mentioned. The percentage increase is shown by a curve on Fig. 3.

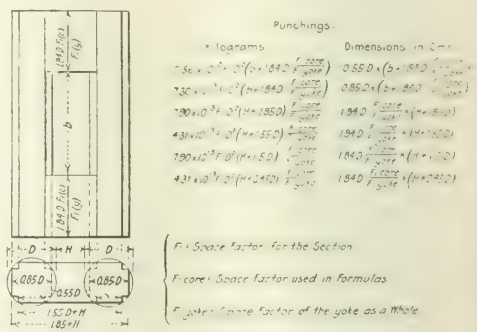


Fig. 1. Circular-core Type. Area of Cores One-half Area of Yokes.

Procedure in Preliminary Design.

The values of the following quantities are assumed :—

Rated output in volt-amperes = W.
Core loss in watts = P_i.
Copper loss in watts = P_c.
Frequency in cycles = f.
High-tension and low-tension voltages.

(1) From a curve showing at different flux densities the watts lost per unit of mass of the iron to be used, calculate the value of the iron constant C_i = watts per kilogramme/(lines per square centimetre)^2, taking the data from curve at the flux density of, say, 12,000 lines per square centimetre.

(2) Decide on the temperature at which the transformer is to fulfil the specifications. The value of the copper constant C_c = watts per kilogramme/(ampere per square centimetre)^2 will then be as follows: —

At 20° C., $C_c = 2{\cdot}125 \times 10^{-4}$.
At 30° C., $C_c = 2{\cdot}210 \times 10^{-4}$.
At 40° C., $C_c = 2{\cdot}295 \times 10^{-4}$.
At 50° C., $C_c = 2{\cdot}380 \times 10^{-4}$.
At 60° C., $C_c = 2{\cdot}480 \times 10^{-4}$.

These values include a 10 per cent. allowance for eddy currents in copper.

(3) Decide on the values to assign to the iron and copper space factors F_i and F_c. These may be obtained from books dealing with the design of transformers, or, better, from commercial designs of transformers of similar specifications. In general, the iron space factor with one step cruciforming of the core will be 0·7 without ducts and 0·65 with ducts. Copper space factors in transformers under 7,000 volts will be roughly 0·4, [illegible] from 0·3 in small transformers to 0·55 in transformers having low voltages and high efficiencies.

(4) Calculate the value of the quantity

$$L = \frac{1{\cdot}6\times10^{6}W}{f\left(P_i - P_c\right)F_i}$$

(5) The maximum flux density in lines per square centimetre may now be calculated by the formula $B_m = 2{\cdot}6\,P_c/F_iL$.

If the specified efficiency is low in comparison with modern commercial requirements, this may give a value of maximum flux density which would cause too great magnetising currents in small transformers or too great a rate of heating in the iron of large transformers; 11,000 and 14,000 lines per square centimetre are roughly the upper limits respectively for the two cases.

The same efficiency requirements may be met and the difficulty obviated by re-calculating L, using a smaller value of P_i and a correspondingly greater value of P_c, such that P_i+P_c is unchanged.

(6) The current density in amperes per square centimetres is given by the formula $Q=2{\cdot}6\sqrt{(P_c/C_cF_cL^3)}$.

(7) The dimensions in centimetres of the transformer may now be calculated, viz.:

$D=1{\cdot}35L$.
$H=0{\cdot}948L$.
$b=3{\cdot}01L$.

The volts per turn will be $6{\cdot}33\times10^{-8}fB_mL^2F_i$.

The weight of iron in kilogrammes will be $K_i=0{\cdot}147F_iL^3$.

The weight of copper in kilogrammes will be $K_c=0{\cdot}147F_cL^3$.

The final design of the transformer will then consist in choosing stock sizes of copper which come nearest to the figures of the preliminary design. The winding layout is then made, modifying the dimensions of the winding space arrived at in the preliminary design as little as feasible. The core dimensions are finally slightly modified to fit the actual layout of the winding space.

Improved Design; Yoke with Double the Area of Core.

The foregoing formulæ are deduced on the assumption that the iron in the yokes is run at the same flux density as the iron in the

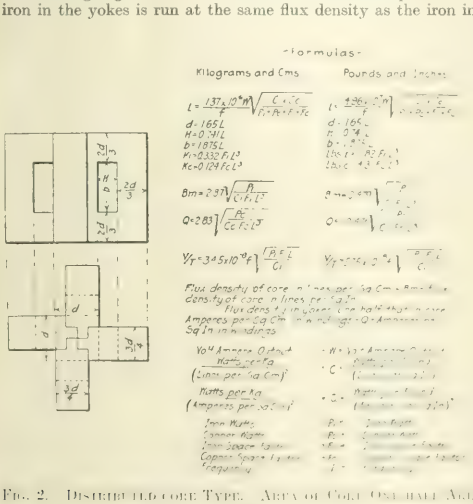


Fig. 2. Distributed Core Type. Area of Core One-half Area of Yokes.

cores. If the net area of the yokes is doubled, it is possible to save roughly 15 per cent. in the cost of active material to fulfil a definite specification of efficiency.

Fig. 2 shows the geometrical shape of a transformer designed on this principle.

The method of design is exactly as above outlined except that the coefficients in the formulæ are as follows:—

$$L = \sqrt[4]{\frac{1{\cdot}41\times10^{6}W}{f\left(P_i - P_c\right)F_i F_c}}$$

$D=1{\cdot}35L$.
$H=0{\cdot}948L$.
$b=3{\cdot}01L$.
$B_m = 2{\cdot}94\sqrt{(P_c/C_cF_cL^3)}$. (Flux density in cores.)
$Q=2{\cdot}6\sqrt{(P_c/C_cF_cL^3)}$.
$V/T=6{\cdot}33\times10^{-8}fB_mL^2F_i$. ($B_m$=flux density in cores.)
$K_i=0{\cdot}228F_iL^3$.
$K_c=0{\cdot}147F_cL^3$.

Since many designers prefer to work in inches and pounds, rather than in centimetres and kilogrammes, the necessary changes to convert the formulæ for Fig. 2 to the inch-pound system are as follows:—

$$L' = \sqrt[4]{\frac{5{\cdot}11\times10^{6}W}{f\left(P_i - P_c\right)F_i F_c}}$$

$D'=1{\cdot}35L'$.
$H'=0{\cdot}948L'$.
$b'=3{\cdot}01L'$.
$B_m' = 0{\cdot}492\sqrt{(P_c/C_cF_cL'^3)}$.
$Q'=0{\cdot}432\sqrt{(P_c/C_cF_cL'^3)}$.
$V/T'=6{\cdot}33\times10^{-8}fF_iL'^2B_m$.
$L/b=8{\cdot}15F_iL'^3$.
$L/b=5{\cdot}25F_cL'^3$.
C_i'=watts per lb./(lines per square inch)$^2=1{\cdot}09\times10^{-2}C_i$.
C_c'=watts per lb./(ampere per square inch)$^2=1{\cdot}09\times10^{-2}C_c$.

There does not seem to be any valid reason why transformers should not always be designed to have greater flux density in the cores than in the yokes. The change in the coefficient in the formula for L takes care of the increased value of the iron constant in the yokes, and also allows for a small amount of eddy-current loss in the lap joints. The flux density at the lap joints is only half that in the cores and thus reduces the magnetising ampere-turns. The yokes are run at a flux density at which the iron has its greatest permeability, and this reduces still further the magnetising currents. The energy loss in the yokes is relatively small, owing to the low flux density, and therefore a considerable portion of the heat generated in the cores is conducted to and radiates from the yokes.

The net result is that the cores may be run at a greater flux density, if desired, without producing excessive heating and too large a magnetising current. The writers have not determined precisely the best ratio of core area to yoke area, but several attempts to ascertain the best value of this ratio indicate 0·5 to be approximately correct.

Comparison of Several Specific Designs.

In order to test this method of design the writers have taken published designs from the books quoted and have analysed them into essential factors given in the foregoing formulæ. They have then in each case worked through two designs on the same specification, using the method above set forth, the first of the two designs being made without increasing the yoke area, in order to compare the cost of active material when the geometric shape was merely changed to that advocated, and the second design using the method advocated with double yoke area.

The results of this analysis are set forth in Table I.

It will be noted that in the case of the designs without increased yoke area an appreciable saving in the cost of active material was effected in every case, with the one exception of the Bohle and Robertson design quoted, in which case the cost was the same. It is significant that this case is apparently the only one of the designs quoted in which pains were taken to ascertain accurately the correct geometrical shape.

It will be noted that the writers have chosen a slightly increased copper space-factor when designing a circular coil transformer to meet the specifications of a rectangular coil transformer. The reason for this is that in the circular-coil type the space between the coil and core is charged against the iron space-factor, instead of against the copper space-factor, as is the case in the rectangular-coil type. Furthermore, better compression of the insulation may be secured with the circular winding.

Modifications in Above Methods.

In case it is desired to use the geometric shape giving the least cost of active material for any specific value of $\frac{S_iF_i}{S_cF_c}$, the values of all the important data may be obtained from the curves of Fig. 3. These curves give data specifically for transformers having the same flux density throughout the cores and yokes.

In case it is decided to adopt the design shown in Fig. 2, where the flux density in the yoke is 0·5 that in the core, the following changes in the formulæ are made:—

L' = 0·889L.
b' = coefficient bL'.
D' = coefficient DL'.
H' = coefficient HL'.
$B_m'=1{\cdot}125$ coefficient $B_m\sqrt{(P_i/C_iF_iL'^3)}$, where B'_m is the maximum flux density in the cores.
Q' = coefficient $Q\sqrt{(P_c/C_cF_cL'^3)}$.
$V/T'=1{\cdot}125$ coefficient $V/T\sqrt{(F_iL'^2/C_i)}$.
$K_i'=1{\cdot}55$ coefficient $K_iF_iL'^3$.
$K_c'=1{\cdot}55K_c$.

Table I.—*Analysis of Published Designs.*

	1.			2.			3.			4.			5.			6.		
	Barr & Archibald. Circular coils.	Circular coils.	Improved circular coils.	Barr & Archibald. Rectangular coils.	Circular coils.	Improved circular coils.	Eddie & Robertson. Rectangular coils.	Circular coils.	Improved circular coils.	Gray. Rectangular coils.	Circular coils.	Improved circular coils.	Hobart. Rectangular coils.	Circular coils.	Improved circular coils.	Ryan. Rectangular coils.	Circular coils.	Improved circular coils.
Kilowatt output ...	100	100	100	100	100	100	100	100	100	15	15	15	20	20	20	15	15	15
Frequency	50 ~	50 ~	50 ~	50 ~	50 ~	50 ~	50 ~	50 ~	50 ~	60 ~	60 ~	60 ~	50 ~	50 ~	50 ~	60 ~	60 ~	60 ~
Efficiency per cent	98·23	98·23	98·23	98·22	98·22	98·22	98·23	98·23	98·23	97·94	97·94	97·94	97·3	97·3	97·3	96·96	96·96	96·96
Low-tension voltage	400	400	400	2,200	2,200	2,200	2,200	2,200	2,200	220	220	220	200	200	200	440	440	440
High-tension voltage	2,000	2,000	2,000	6,000	6,000	6,000	6,000	6,000	6,000	2,200	2,200	2,200	4,000	4,000	4,000	4,400	4,400	4,400
Core loss	900	900	680	965	905	905	900	900	675	99	99	99	190	190	190	185	185	185
Copper loss	900	900	1,120	845	905	905	900	900	1,125	217	217	217	365	365	365	285	285	285
Iron space factor ...	0·7	0·7	0·7	0·82	0·7	0·65	0·8	0·65	0·65	0·9	0·7	0·7	0·94	0·7	0·65	0·88	0·7	0·65
Copper space factor	0·425	0·425	0·425	0·305	0·4	0·4	0·34	0·4	0·4	0·523	0·55	0·523	0·37	0·4	0·4	0·392	0·40	0·40
Weight of iron ...kg.	380	328	383	475	356	392	288	311	368	50	82	92·8	76	95	104·5	0·65	70·4	77
Weight of copper, kg.	190	198·5	150	280	203	156	199	191·5	146·5	83·5	64·5	44·6	68	54·3	41·5	51	40·2	30·6
Flux density	11,150	12,100	13,600	9,500	10,600	14,390	13,500	12,680	14,250	9,850	7,560	10,180	11,000	9,850	13,350	9,300	8,920	12,15
Current density	130	129·5	166	133	139	160	133	136	174	110	120	151	150	174·5	200	164 ht. 135 lt.	181·5	200
Volts per turn	5·7	5·89	5·4	7·4	5·42	5·7	6·89	5·71	5·44	1·52	1·76	1·91	1·6	2·08	2·21	1·11	1·85	1·95
Height window, cm.	50	44·2	40·3	42	45·5	42	40·1	44·5	40·9	29·8	28	25·4	51	29·3	27·1	21	26·5	24·4
Width window, cm.	11·8	14	12·7	15·9	14·4	13·12	17·2	14·05	12·9	11·4	8·84	7·93	8·5	9·23	8·45	11·1	8·35	7·6
Width of iron... cm.	...	...	...	14	...	...	11·5	...	...	6·35	...	...	7	...	...	7·15	...	...
Depth of iron ... cm.	...	...	...	31	...	...	25·5	...	...	10·15	...	...	10	...	...	14·3	...	...
Diameter of circumscribed circle . cm.	21	19·9	18·1	.	20·4	18·7	.	20	18·37	`...	12·55	11·3	.	13·15	12·05	...	11·9	10·85
Ratio of costs	1	0·925	0·894	1	0·89	0·78	1	1	0·91	1	0·914	0·772	1	0·916	0·82	1	0·894	0·70

1. "Alternating-Current Machinery," Barr and Archibald, p. 167.
2. "Alternating-Current Machinery," Barr and Archibald, p. 179.
3. "Treatise on Transformers," Beddie and Robertson, p. 264.
4. "Electrical Machine Design," A. Gray, p. 480.
5. "Design of Static Transformers," Hobart, p. 89.
6. "Design of Electrical Machinery," Vol. II., Ryan, p. 81.

The procedure in design will be precisely similar to that above advocated, except that the coefficients for b, D, H, B_m, Q, V/T and K, and k must be read from the curves instead of taking a fixed numerical value corresponding to a fixed geometrical shape, as outlined above under procedure of design.

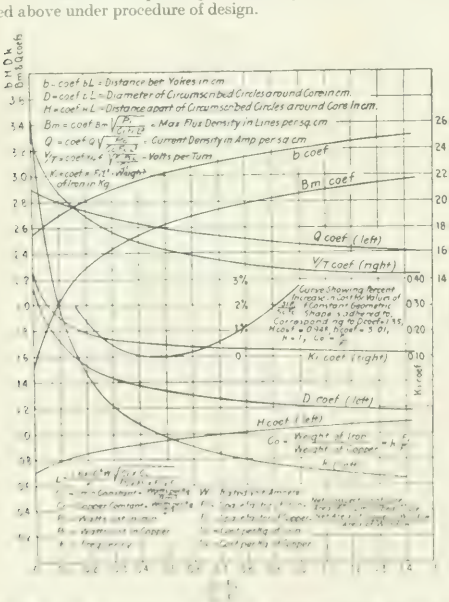


Fig. 3.—Curves for Use in Design of Single-phase Shell-type Transformers.

[illegible] for general lighting and power purposes, [illegible] particularly in transformers for [illegible] pay to depart from the specific geometrical [illegible] In this class of transformer the [illegible] are usually designed to be equal, [illegible] at full load. If the efficiency requirements are not very high, it will be found that using the above recommended specific geometrical shape will give a flux density higher than permissible. Under these conditions the writers recommend the following procedure in design :—

Let F=the flux density which is higher than permissible, let F′= the flux density which is as high as permissible, then coefficient $B_m = 2{\cdot}6F'/F$.

Refer to Fig. 3 and use geometrical shape which has this value of coefficient B_m, using the modified procedure of design above mentioned. This method insures the least departure from the geometric shape giving least cost, and overcomes the difficulty of too great flux density. It will be noted that changing the geometrical shape in this manner to overcome too great a flux density causes an increase in current density. With this type of transformer the copper is usually much further from its safe temperature rise than the iron. If the point is reached by changing the geometrical shape in this manner where both the iron and copper are running at their safe temperature, the transformer will cost the minimum amount for the given rating. The efficiency may be less than modern commercial requirements, yet in cases where the cost of radiating extra heat is low (as in the case of water cooling), it may prove desirable to employ this shape.

In case it is desired to apply the same method of design to the distributed core type of transformer, as shown in Fig. 4, choosing that fixed geometrical shape which best suits the average value S_iF_i/S_cF_c, the formulæ will be as shown in Fig. 4. The cost of active material is roughly 87 per cent. of the improved circular-coil transformer and 72 per cent. of the ordinary circular-coil transformer. It will be noted that with this type of transformer the efficiency must be slightly higher than with the circular-coil type of transformer in order to avoid running the iron and copper at too high a temperature. This increases the cost of active material per kilowatt. With this type of transformer the density of the leakage flux is somewhat greater, on account of the greater number of ampere-turns per unit length of core. These factors make it slightly more difficult to keep down either the cost of active material or the temperature of the winding.

The labour in constructing this type of transformer is somewhat greater than the circular-coil core type, and the space factor of the copper is slightly less. Whether or not this type is superior to the circular-coil type becomes largely a question of manufacturing facilities. Probably this type is better suited to smaller sizes and low potentials than it is to larger sizes and high potentials.

Three-phase Transformers.

Three-phase transformers of the circular-coil type may be designed by the same method as outlined for single-phase transformers. Fig. 4,

like Fig. 3, shows the value of the various coefficients for use in the various formulæ These formulæ are the same as those for single-phase transformers previously given except for the numerical values of the coefficients, which are given in Fig. 4. In case it is desired to use yokes with double the area of the core, the necessary changes in the formulæ are as follows :—

Multiply coefficient L by 0·889.
Multiply coefficient B_m by 1·135.
Multiply coefficient K by 1·54.
Multiply coefficient k by 1·54.
Multiply coefficient v/t by 1·135.

The example below shows the application of the method to the design of a three-phase transformer, the curves given in Fig. 4 being used to arrive at the best geometrical shape with a given specified value of S_iF_i/S_cF_c. The specifications and assumptions were taken from a transformer outlined in Barr and Archibald's "Alternating-current Machinery," p. 188.

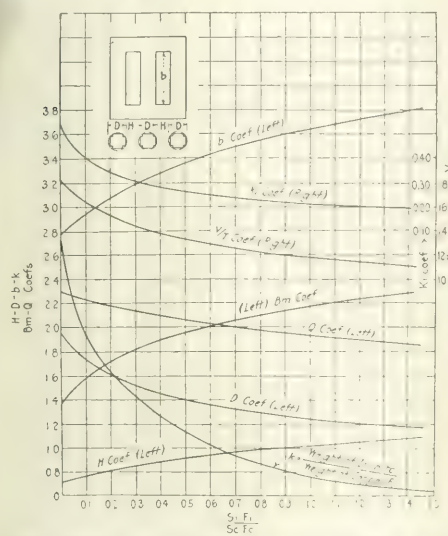


Fig. 4. Circular-coil Type of Transformer. Curves for Calculating Important Data of Cheapest Transformer of a Specified Efficiency.

Specifications and Assumptions.

Rated output, 90,000 volt-amperes ; space factor of iron, $F_i=0·712$.
Core loss, 1,100 watts ; space-factor of copper, $F_c=0·573$.
Copper loss, 1,200 watts ; cost of iron per kilogramme, $S_i=\$0.206=0·82$s.
Frequency, 18 cycles ; cost of copper per kilogramme, $S_c=\$0.30=1·2$s.
High-tension voltage, 2,200 volts ; iron constant, $C_i=1.205\times10^{-8}$.
Low-tension voltage, 130 volts ; iron constant, $C_c=2.18\times10^{-8}$.
The value of $S_iF_i/S_cF_c=0·885$.

The value of $L=\frac{1·6\ \ 10^8W}{f\sqrt{P_i\ P_c\ F_i\ F_c}}\sqrt{\frac{C_c}{C_i}}=17·68$.

The first operation is to calculate the maximum flux density (B_m).

From the coefficient B_m curve in Fig. 4 at the value of $S_iF_i/S_cF_c=0·855$, the coefficient B_m is 2·12, and $B_m=2·12\sqrt{(P_i/C_iF_iL^3)}=10,200$ lines per square centimetre.

From the curve coefficient $Q=1·96$, and $Q=1·96\sqrt{(P_c/C_cF_cL^3)}=82$ amperes per square centimetre.

The dimension coefficients from the curve are coefficient D = 1·27, coefficient H = 1·00, coefficient $b=3·57$. The dimensions in centimetres are then :

$D=1·27L=22·4$ cm. ; $H=100L=17·68$ cm. ; $b=3·57L=63·1$ cm.

The volts per turn coefficient $=12\times10^{-8}$, and, therefore, $V/T=12\cdot10^{-8}f\sqrt{(P_iF_iL_iC_i)}=2·31$.

The kilogramme of iron coefficient $=0·220F_iL^3=860$ kg.

The cost of iron $=860\cdot S_i=\$177=£35·4$.

The value of k from curves is 0·83.

The kilogrammes of copper are equal to the kilogrammes of iron divided by $\frac{kF_i}{F_c}=1·042$; that is, the kilogrammes of copper $=825$ kg.

The cost of copper $=825S_c=\$249=£49·8$.

The total cost of active material $=\$426=£85·2$.

It will be noted that the cost of the active material for the design given by Barr and Archibald for these same specifications and assumptions is $460=£92. (There is an error in the copper space-factor given by Barr and Archibald due to their using the distance between the cores instead of the distance between the circles circumscribing the cores. This error has been corrected in the example given above.)

Conclusions.

1. It is possible that a specific geometrical shape may be adopted advantageously for the purpose of simplifying the process of the preliminary design in the case of the circular-coil core type of single-phase stationary alternating-current transformers.

2. It is possible that by using this method of design the cost of active material to fulfil a given set of specifications is not greater in the circular coil core type than in the rectangular-core type.

3. The core type of transformer may always be advantageously designed to have a greater flux density in the core than in the yokes.

ELECTRIC SMELTING OF FERRO-CHROME.*

BY R. M. KEENEY.

More ferro-chrome is manufactured in the electric furnace than any other ferro-alloy except ferro-silicon. Some experiments were made by the author in 1912 on the production of ferro-chrome from chromite with carbon as a reducing agent. In these experiments, contrary to the usual practice in ferro-chrome manufacture, lime was used as a flux, to show its desulphurising and dephosphorising effect with an ore not so pure as the usual ore used in ferro-chrome production. In usual practice only the purest raw materials available are charged, so as to avoid the excess slag caused by adding lime. The only slag formed is from the coal or coke and chromite.

The conclusions drawn are : (*a*) Ferro-chrome can be easily manufactured directly from chromite in the electric furnace ; (*b*) the percentage of carbon in ferro-chrome cannot be kept low by regulating the carbon charged without excessive loss of chromium in the slag ; (*c*) the percentage of carbon in the ferro-chrome must be regulated by decarburisation with an oxide slag of iron or chromite after the slag from reduction has been tapped off ; (*d*) the proportions of silicon and phosphorus cannot be kept low in the alloy under the strong reducing conditions necessary ; (*e*) sulphur can be easily slagged ; (*f*) as the addition of lime does not seem to aid in reducing phosphorus, it is advisable to use no lime but raw materials as pure as possible ; and (*g*) the power consumption should not exceed 3·7 kw.-hours per lb. of ferro-chrome tapped or 0·15 kw.-year per ton.

Decarburisation of high-grade ferro-chrome is accomplished by melting the alloy with a slag of lime, chromite ore, and a little fluor-spar. For each 100 parts of completely decarburised alloy 39 parts of pure chromite ore are necessary, or for each 100 parts of ferro-chrome containing 10·6 per cent. carbon, 31·3 per cent. iron and 58·1 per cent. chromium, 36 parts of pure chromite ore are necessary for complete decarburisation. The resulting alloy would contain 66·6 per cent. chromium and 33·4 per cent. iron. In practice the lime is added simply to flux any silica in the ore, to assist in elimination of silicon in the ferro-chrome, and to cause possible removal of carbon as calcium carbide, as the operation is performed in an arc furnace. The fluor-spar makes the slag more fluid.

Until the introduction of the electric furnace in 1899 ferro-chrome was manufactured entirely in either the crucible or the blast furnace. In the blast furnace chromite is reduced with some difficulty, with the high fuel consumption of about 3 tons of coal or coke to 1 ton of ferro-chrome produced. Little ferro-chrome is now made by either the crucible or the blast furnace, because it can be made at less cost in the electric furnace in localities where electric power is cheap. The analyses of some of the ores used are given in Table I.

Manufacturers use only chromite containing less than 0·1 per cent. phosphorus and sulphur and about 50 per cent. Cr_2O_3. They use no lime in the charge, as it has been found preferable by them to use pure materials and keep the amount of slag as low as possible. In most plants high-grade anthracite is used as the reducing agent. Coke or charcoal may be used instead of anthracite, but the latter is better, as it may be obtained in a more finely pulverised state, a form in which it makes a more intimate contact with the chromite, and consequently produces a better reduction.

* From a Report to the U.S. Bureau of Mines.

Table I.—*Analyses of Some of the Ores Used.*

Component.	Source of ore. Turkey.	New Caledonia.	California.	Cuba.
	Per cent.	Per cent.	Per cent.	Per cent.
[illegible]	54·7	55·7	52·68	50·00
[illegible]	14·2	13·2	15·30	18·57
[illegible]	14·1	16·2	11·40	12·44
[illegible]	14·3	9·8	16·23	13·38
SiO_2	3·5	0·2	3·40	3·82
CaO	1·7	0·25	...	2·16
[illegible]	0·3	1·05	0·94	...
MgO	...	0·2	0·15	...
[illegible]	...	0·05	...	0·45
S	...	...	...	0·69

There are several types of electric furnace used in the manufacture of ferro-chrome, usually similar to the Héroult steel furnace with vertical electrodes in series. The process of manufacturing ferro-chrome consists of mixing a charge of chromite and anthracite in proportions based upon the theoretical calculations given. The charge is shovelled into the open top of the furnace and around the electrodes.

Ferro-chrome containing as low as 5 per cent. carbon can be made economically when produced directly from ore in one operation. It has been possible to produce an alloy containing as low as 2 per cent. carbon in one operation, but great care in regulation of the charge and operation of the furnace is necessary. The slags from the average ferro-chrome furnace making a 5 per cent. carbon alloy run from 0·5 to 1 per cent. Cr_2O_3.

The refining of the high-carbon grades of ferro-chrome is done in an arc furnace, where the alloy is subject to a prolonged heating with a slag of chromite, lime and fluorspar, proportioned to the amount of carbon and silicon to be removed and the silica that must be fluxed in the chromite used. The ferro-chrome covered by this slag is heated at a high temperature for a length of time dependent on the carbon in the alloy. The resulting slag contains about 25 per cent. Cr_2O_3, and is ground up and sent through the smelting furnace again, so that there is not much loss of chromium. By this method it is possible to reduce the carbon from 10 to 0·25 per cent., but the more usual low-carbon grade contains 0·5 per cent. carbon. The percentage of carbon in the ferro-chrome varies from 9·5 to 0·6 per cent., but the iron increases with the decrease of carbon. This would seem to show that in refining, the iron oxide of the chromite is first reduced, the chromic oxide merely serving to keep a slag with excess chromium, thus preventing any final lowering of the percentage of chromium in the alloy. As the carbon is oxidised so is the silicon, until the content is as low as 0·2 per cent., as compared with 2 to 5 per cent. in the crude alloy. Aluminium is also considerably eliminated and phosphorus and sulphur are reduced to a slight degree.

Processes based on the use of silicon or some reducing agent other than carbon have not been commercially successful, because the cost of such reducing materials as silicon, ferro-silicon and aluminium is much higher than that of carbon. Also the products may be contaminated with the reducing material just as when carbon is used, so that a subsequent refining is necessary. Carbon-free ferro-chrome for high-grade steels has, however, been successfully made by the thermit process, but the amount made in this way is comparatively small. Analyses of various grades of ferro-chrome are given in Table II.

Table II.—*Analyses of Typical Ferro-Chromes.*

Component.	Electric furnace. With 8 to 10 per cent. carbon.	With 7 to 8 per cent. carbon.	With 5 to 6 per cent. carbon.	With 3 to 4 per cent. carbon.	With 1 per cent. carbon.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
[illegible]	64·5	63·5	64·0	64·0	63·5
[illegible]	22·0	21·5	28·5	31·0	35·0
[illegible]	9·5	7·5	3·5	3·5	0·6
Silicon	2·25	5·8	0·4	0·3	0·2
[illegible]	0·80	0·8	0·5	0·4	0·10
[illegible]	0·15	0·15	0·15	0·15	0·10
[illegible]	0·25	0·25	0·25	0·30	0·35
[illegible]	0·04	0·04	0·04	0·04	0·03
[illegible]	0·05	0·05	0·03	0·02	0·02

Power Consumption.

The power consumption of a 500-kw. ferro-chrome furnace of the Meraker [illegible] Co., Norway, was recently given as 0·68 kw.-year per ton of 2,000 lb. in making a ferro-chrome containing 5 per cent. carbon. At Kanawha Falls, West Virginia (U.S.A.), ferro-chrome was made in a crucible electric-arc furnace with a power expenditure of 3·6 kw.-hours per lb., or 0·72 kw.-year per ton. This product contained 70·96 per cent. chromium, 23·23 per cent. iron, 5·21 per cent. carbon, 0·5 per cent. silicon, 0·008 per cent. phosphorus, and 0·078 per cent. sulphur. At both Kopperaaen and Kanawha Falls an ore containing about 50 per cent. Cr_2O_3 was used. The Kopperaaen ferro-chrome contains 65 to 70 per cent. chromium. In the author's experiments a product containing 50 to 68 per cent. chromium and 4·32 to 9·31 per cent. carbon was obtained with an ore containing 46·35 per cent. Cr_2O_3, and power consumption of 3·02 kw.-hours per lb., or 0·69 kw.-year per ton. A 750 kw. furnace at Kopperaaen is of the Alby carbide type.

In Table III. estimates are made of the cost of manufacture of a ferro-chrome containing 60 per cent. chromium and 8 to 10 per cent. carbon from chromite ore containing 50 per cent. Cr_2O_3. The calculations are on the basis of two 750 kw. furnaces turning out a total of 6 tons of ferro-chrome per 24 hours. The Norwegian plant is within 60 miles, the French plant within 200 miles, and the American plant assumed to be within 100 miles of seaboard. Labour conditions are considered to be as found in the various countries.

The figures indicate that it costs 39·2 per cent. more to manufacture ferro-chrome in the United States than in Norway. This increase is due to the higher price of power and increased labour cost. The cheapest figure at which power can be obtained at the present time in the eastern United States is £5. 11s. per kilowatt-year for electrometallurgical purposes.

Table III.—*Cost of Production of Ferro-Chrome per net ton.*

	Norway.	France.	U.S.
3,000 lb. of chromite	£4 5 5	£4 13 9	£4 13 9
500 lb. of coal	0 5 2½	0 6 3	0 5 2½
50 lb. of carbon electrodes	0 8 4	0 6 3	0 8 4
0·68 kw.-year	1 3 6½	2 12 11	3 13 6½
Labour	1 14 8½	1 7 9	3 9 2
Repairs	0 16 8	0 16 8	0 16 8
Amortisation and depreciation at 5 per cent. each	0 10 5	0 10 5	0 10 5
Interest on £10,000 at 6 per cent.	0 6 3	0 6 3	0 6 3
General and Packing	0 16 8	0 16 8	0 16 8
Total	£10 7 2½	£11 16 11	£15 0 0

As shown in Table II., electric-furnace ferro-chrome is made in five grades, of which those containing 4 per cent. carbon are classed as refined, the carbon in the others being regulated in the charge to a certain extent. Ferro-chromes containing less than 2 per cent. carbon are used in the manufacture of tool steels. The alloys containing 3 to 6 per cent. chromium are used principally in the manufacture of steel castings. For the manufacture of armour plate and projectiles the high-carbon ferro-chromes containing 8 to 9 per cent. carbon are generally used. This alloy is cheaper. For the purpose of protecting the chromium from oxidation, armour-plate manufacturers sometimes use a ferro-chrome that contains a high percentage (4 to 5 per cent.) of silicon. In this way the oxides act on the silicon before they act on the chromium.

THE CHANGE OF THE SPECIFIC HEATS OF GASES WITH TEMPERATURE.*

BY PROF. W. M. THORNTON, D.SC., D.ENG.

1. The first report of the Gaseous Explosions Committee† contains a discussion of experimental work on specific heats. It is there divided into three classes: (1) Constant pressure experiments in which the gas is heated from an external source and is at atmospheric pressure; (2) constant volume experiments of two kinds, (*a*) direct determination with the steam calorimeter, (*b*) explosions; (3) experiments in which both volume and pressure are varied, the gas being heated by mechanical compression.

In every case the effective specific heats are found to increase with rise of temperature. The following values of the molecular specific heats, that is, the ordinary specific heats multiplied by the molecular weight of the gas, are taken from a discussion by Lewis‡ and Randall of recent work. The temperature T is in degrees centigrade.

* Paper read before Section G of the British Association at Manchester. British Association Report, Dundee, 1908, p. 308.

† G. N. Lewis and M. Randall. "Summary of the Specific Heats of Gases." (Amer. Chem. Soc. Journ., vol. 34, pp. 1128-1134, Sept., 1912.) "Science Abstracts," A 1912, p. 983.

For N_2, O_2, HCl, HBr, H.I, $C_p = 6{\cdot}5 - 0{\cdot}0010$ T.
H_2, $C_p = 6{\cdot}5 + 0{\cdot}0009$ T.
Cl_2, Br_2, I_2, $C_p = 6{\cdot}5 + 0{\cdot}004$ T.
H_2O, H_2S, $C_p = 8{\cdot}81 - 0{\cdot}0019$ T $- 0{\cdot}0000222$ T^2
CO_2, SO_2, C_p 7·0 + 0·0071 T − 0·0000018 T^2

The mean specific heats of the working substance in a gas engine cylinder have been observed by Clerk and found to differ by about 8 per cent.* from those of Holborn and Kenning by method (1).

The cause of the variation of C_p and C_0 with temperature has been briefly discussed by Callendar† with special reference to radiation, but there is a further possible cause which may play an important part even in steady flow experiments at moderate temperatures.

2. The temperature of a gas is proportional to the mean translational energy of its molecules. In any sudden change of condition, such as explosion, equi-partition of energy is not established at once. About half of the energy of slow combustion is converted into translational or pressure energy at the moment of explosion, about 22 per cent. of it into vibrational or radiation energy. The rotational component cannot be measured directly, but it can be estimated at different stages of an explosion. Both the loss of pressure energy‡ and the total radiation§ have been explained by the cohesion of colliding atoms.

The difference between high and low temperatures in a gas is in molecular velocity and collision frequency, but there is even at low temperature a certain number of molecules moving at mean high temperature velocities. High temperature collision causes dissociation, used here in the physical sense of molecular division without equilibrium. In a steady state the number of recombinations in unit time is the same as that of the molecules dissociated; but if it is admitted that such recombination does not differ in type from the formation of products of explosion, the same process by which heat is suppressed in explosion will occur under conditions of steady interchange, although since the heat of molecular formation is much less than that of combustion, the heat suppressed at each collision is in proportion less.

In the separation of a molecule by bombardment energy is absorbed which is returned at recombination. But when the atoms recombine they spin, and a certain fraction of their energy of combination takes the form of rotational energy. From explosion records the time to establish equi-partition after explosion may be measured in seconds. When then, as in steady flow experiments, a stream of gas is passed through a heater and the temperature of admission to a calorimeter measured, this does not represent equi-partition temperature, for the latter is higher than the thermometer reading according to the degree of physical dissociation of the gas leaving the heater.

3. The loss of heat at each recombination is a definite fraction of the translational energy of the combining atoms. Let N be the number of those collisions a second which gives rise to dissociation, and a the relative suppression of heat in each recombination. The specific heat at temperature T is then

$$C_1 = C_0(1 + aN) \quad \ldots \quad (1)$$

where C_0 is that at zero. Since in a gas at constant volume temperature is directly proportional to the number of collisions a second, (1) may be written

$$C_1 = C_0(1 + bT) \quad \ldots \quad (2)$$

At the temperature of explosion, that is, the maximum which can be reached, C_1 is found to be approximately $2C_0$, bT is then $\frac{1}{2}$.

Expanding (2) the rise of specific heat with temperature should be expressed by

$$C_T = C_0(1 + bT + b^2T^2 + \ldots) \quad \ldots \quad (3)$$

The coefficient a includes any additional radiation which arises from shock at recombination, but does not include absorption of heat caused by permanent dissociation of the gases in the calorimeter, which increases at a higher power than the first and raises the coefficient of T in the experimental series. The first equations expressed in the above form are

For N_2, O_2, $C_p = 6{\cdot}5(1 + 0{\cdot}000154$ T).
H_2, $C_p = 6{\cdot}5(1 + 0{\cdot}000138$ T).
Cl_2, Br_2, I_2 6·5 (1 + 0·000615 T).
H_2O, H_2S, C_p 8·81 (1 + 0·0000215 T − 0·0000002$_5$ T^2).
CO_2, SO_2, C_p 7·0 (1 + 0·00101 T − 0·0000002$_5$ T^2).

* British Association Report, *loc. cit.*, p. 330.
† *Loc. cit.*, p. 340.
‡ "The Lost Pressure in Gaseous Explosions," Phil. Mag., July, 1914, p. 18.
§ "The Total Radiation from a Gaseous Explosion," Phil. Mag., Vol. XXX., Sept., 1915, p. 383.
‖ D. L. Chapman, "On the Rate of Explosion in Gases," Phil. Mag., 5th series, Vol. XLVII., 1899, p. 90.

4. From equations (1) and (2) $aN = bT$. In the case of nitrogen at 500°C. $bT = 0{\cdot}077$, or 7·7 per cent. of the total translational energy of the gas is on this view "suppressed." If gas at this temperature were led into a calorimeter and remained there long enough for equi-partition to be fully established it would give out in cooling both as translational energy and radiation, more heat than the initial temperature indicates. This would be greater than 7·7 per cent. of the whole, since the suppressed energy is divided in the end between all the degrees of freedom. bT is that portion of the whole energy which takes the form of heat, and from which the rise of specific heat is derived.

The object of this note is to offer an explanation of the rise of specific heat in gases with temperature based on the obvious mechanical fact that when moving bodies adhere and spin around their common centre of mass there is loss of translational energy of the whole. A gas in which this action is proceeding contains more energy available as heat than is indicated by its temperature. The specific heats will be therefore raised.

ANNUAL CONFERENCE OF THE MUNICIPAL TRAMWAYS ASSOCIATION.

The Fourteenth Annual Conference of this Association opened on Thursday last with the delivery by Alderman H. Linsley, J.P. (Salford), of his Presidential Address.

After a vote of thanks to Alderman Linsley had been passed,

Mr. James Dalrymple (general manager of the Glasgow tramways) read a Paper on

"Tramway Labour Problems as Affected by the War."

The Paper consisted of notes showing the author's experience in Glasgow. The experience of large systems might not, in many respects, resemble that of smaller systems, and there were probably conditions governing the position in Manchester which would not apply to Liverpool, so that it would be best for each member in the discussion to state the local conditions under which he had been working. If that had been a private meeting they could have said a good many things which they could not say at a public meeting; therefore his remarks were more noteworthy for what they omitted than for what they contained. He divided them under the headings of (1) general staff; (2) traffic or uniformed staff; and (3) a few observations on their experience with women conductors.

So far as the general staff of tradesmen and labourers was concerned the war had not to any appreciable extent affected the working of the department. A considerable proportion of the car works and permanent way staff was at the outbreak of the war over the fighting age, and he secured the services of a few men over 40 years of age to take the places of those who joined the Colours, and in some sections of the work they struggled on with the depleted staff. In the car works the staff in August, 1914, numbered 512. Of that number 129 had joined the Colours, and at the present time the number of men eligible for the Army in the car works was very small. The total staff in the car works was now 393. Although they had 129 fewer men they were doing a considerable amount of war work. That meant that to some extent the usual overhaul work was not being carried out so thoroughly as it formerly was, and they had entirely stopped new work. It was impossible to get tradesmen to replace men who were leaving. The great bulk of the men in the works had received the increase of wages agreed on between the masters and men, or they had been paid a war bonus of 2s. a week.

With regard to the permanent way and building repairs staff, in August, 1914, they had 911 employees; 147 joined the Colours, and the total staff was now 776, or 135 fewer than 14 months ago. All work on extensions had been stopped, and the number of men on repairs and renewals was slightly less than before. The car-cleaning staff had been reduced, and they had worked with a reduced staff, which meant that the cars were not so carefully cleaned. In connection with the traffic staff they had experienced most difficulty. In cleaning cars or repairing or renewing track the work could be delayed, but if they were short of motormen and conductors cars must be kept in the depots and the revenue fell. When the war broke out the uniformed staff numbered 3,249. Of that number 1,902 subsequently joined the Colours (60 per cent.), and the present staff numbered 3,123, including 818 women conductors. Generally speaking the men who were engaged in ordinary times as motormen and conductors were men suitable for the firing line, and consequently he imagined that a larger proportion of the traffic staff would be found to have joined the Colours than of any other section of tramway workers. During the autumn and winter of 1914 they made efforts to keep up their staff of conductors by engaging men unlikely to be

accepted for the Army, but were unable to keep pace with the leakage. Fortunately nearly all their conductors in August, 1914, had been trained as motormen, and as more motormen left the service they were able to draw on the conductors. During the greater part of the past 12 months their men—motormen especially—had worked seven days per week, and even with that help the service during the autumn and winter had to be curtailed.

Before the beginning of 1915 arrangements were made (without the knowledge of the Tramways Committee) for trying how women could take the place of the male conductors, but as more men came forward they were able to go on a month or two longer. As more eligible men went off, by March last they were compelled to try women as conductors. Since that date they had got very few men, and those who had applied for places as conductors were not of the most suitable type, but they were still taking on as many men as they could get. They were still engaging more women conductors, and were training men as motormen as fast as possible. The starting wage for male conductors was 27s. per week, with a war bonus to householders of 2s. per week. The women were also paid 27s. a week, but without the bonus. The working week for the whole staff was 51 hours.

Their experience with women conductors was altogether satisfactory. About 12,000 women applied for situations. They endeavoured to get women of from 24 or 25 up to 35 years of age who appeared to be strong, and who knew what it was to do a day's work. A large proportion of them were married. In the bulk of those cases the husbands were in the Army. There were about 300 married women and about 55 widows. Their training extended over eight days, one day in classes punching tickets and collecting fares and seven on the cars with an experienced male conductor. They were quick at picking up their duties, and the passengers were highly pleased at the way they got through their work. Passengers were encouraged to pay their fares on the platform before going to the top deck. From the start the men employés had taken kindly to the introduction of women, and had done their best to make the work as comfortable and congenial as possible. The women worked the same hours as the men, but they rarely asked women to work seven days in one week. It was sometimes impossible to get women to realise the importance of keeping proper time. Uniform was supplied to the women, and the question of supplying them with gaiters was being considered. The women were working on all routes—some routes of course were quieter and more respectable than others—but even on the roughest routes they found the influence of women conductors all for the good. They appeared to handle an unruly passenger as firmly and in many cases more successfully than a man. He noticed from the Press that on some systems the men appeared still to have the last word in connection with this matter. The public who were the owners and users of the cars had apparently no voice in the matter. On other systems the police appeared to have the last word. If the Councils who owned those systems would hand them over to the Glasgow Tramways Committee for a month or so the police would be put right in double quick time. He believed the employment of women was the only solution of the labour problem so far as the traffic staff was concerned. Last week the Glasgow tramways carried more passengers and drew more revenue than in any previous week in their history.

DISCUSSION

Mr. C. W. Mallins, general manager of the Liverpool tramways, said he had thought there would be used for car cleaning and also as conductors, where there were no steps or dangerous gradients, but he would not like [illegible] to get there [illegible] to explain how an accident was [illegible] about on a steep gradient with a woman conductor. Women were employed as car cleaners at Liverpool, and gave satisfaction. A difficulty arose with the tramway men, who had joined the Army, [illegible] they must be turned adrift if the females were to keep on the cars. The women would have [illegible] previous occupations [illegible] there would be no room for them [illegible] employment if the men were [illegible]. At Liverpool they had considerable trouble in a difficult [illegible] roads [illegible] there was roughly speaking quite [illegible] to be [illegible] [illegible] to the Association might be say the [illegible] and [illegible] of the Association could be used for the protection [illegible] Mr. Lord [illegible] the Minister of Munitions would appreciate anything they could do.

[illegible] work being done by [illegible] Mallins [illegible] the women to do the work, and it has been [illegible] by them [illegible].

[illegible] We must [illegible] Association at the [illegible] of [illegible].

Alderman [illegible], the [illegible], said no one had [illegible] in front of [illegible]. [illegible] women [illegible] [illegible] [illegible]

he thought Mr. Mallins was wrong. They had at Sheffield gradients as steep as any in the country (1 in 9½), and at the previous day's Council meeting £1 was presented to a woman conductress who had stopped a car which the motorman had been unable to prevent from running back. The women were inclined to be a little behind time, but the appointment of a woman inspector had resulted in an improvement in that respect. They did not miss duties any more than the men. They had a 25 per cent. increase of traffic each week over the corresponding week of last year, and the women dealt with it as well as men could. The munition works took away their leading hands by offering them practically double the wages they had been receiving, and consequently the staff was in some instances only 50 per cent. of what it was 12 months ago.

Alderman BANTON (Leicester) said the note sounded from Leeds seemed to be that if women were engaged they should economise in wages. He did not think it desirable that that should go out from that Conference. The men would be up in arms if they found that was the idea underlying the change. If efficient work was got from the women they should be paid honestly.

Bailie KIRKLAND (Glasgow) traversed more or less the same ground as Mr. Dalrymple, and added that in employing 800 out of 12,000 women who applied he did not think they were interfering much with female labour in the district. It was distinctly understood that any man who joined the Colours and was fortunate enough to return would have his job back.

Councillor BISHOP (Walthamstow) said his Council applied to the Commissioner of Police for licences for two men. He kept them waiting nine days in one case and 14 in the other. In the meantime the men started work, the manager was summoned for employing them and the magistrates dismissed the case. Mr. Fell told them the Commissioner allowed them to overcrowd their cars. He (Mr. Bishop) did not consider that advisable. He proposed that a resolution be adopted asking the Commissioner of Police to reconsider his decision in view of the evidence available as to the shortage of men, and the success of the employment of women conductors outside London.

Some delegates did not favour this, and the matter dropped.

Capt. T. PRESTIGE (L.C.C.) proposed and Mr. L. E. HARVEY (tramway manager at Ilford) seconded the following resolution, which was passed:

"That this meeting of the Municipal Tramways Association hereby requests the Executive Committee to approach the Home Secretary with the object of urging the removal of the present restrictions as to the employment of women as tramway conductors in the Metropolitan area."

Mr. W. J. SQUIRES, J.P. (L.C.C.), said he thought tramway managers all over the country would sympathise with the London tramway managers. He had recently noticed the female employés on the Brighton tramways, and he congratulated the manager on the way they were doing their duty.

The VICE-PRESIDENT (Mr. P. Fisher, general manager of the Dundee tramways) said women's labour was scarce in Dundee; they were importing women for the mills working on goods for the Army and Navy, and it would be almost improper for the tramway management to encroach upon that supply of labour. About one-third of the tramway employés enlisted, and others had left for munition work. Since the war started they had never taken on men fit for military service, and of those they took on 60 per cent. had failed through lacking the steadiness required in the tramway service. About 17 per cent. of the staff had left, and gone into other employments. He had come to the conclusion that there was not a sufficient supply of male labour to carry on the tramway business in an efficient way.

The PRESIDENT said they had found the women satisfactory at Salford, and that the amount of sickness was greater amongst the males than amongst the females.

A vote of thanks to Mr. Dalrymple was then passed.

Mr. A. BAKER (general manager of Birmingham Corporation tramways), in introducing the subject of

"Financial Problems as Affecting Tramways During the War,"

said: In the early days of municipal tramways it was generally laid down that the tramways should be run on strict business lines, but in some cases it was held not to be necessary or desirable to make large profits so long as the undertaking paid its way. Yet ratepayers using the tramways infrequently thought it unfair that the users should have all the advantages, and contended that after keeping the system in a sound financial condition substantial sums should be handed over for the relief of the rates. Generally speaking the municipalities have struck the happy medium and have given frequent and cheap services as well as considerable sums to the borough funds. In some cases Corporations seemed to vie with each other as to who should give the longest ride for a penny fare. Many towns gave 2 to 2½ miles for a penny, and some nearly 3 miles. Wages were fixed liberally compared with what had been paid previously, and the municipalities granted concessions here, there and everywhere without counting the cost. During the last three or four years expenses had gone up considerably, constant demands had been made for increases in wages, prices of materials had largely increased and many tramway manager had begun to look at the financial situation somewhat anxiously before the war broke out. Since the outbreak of hostilities still higher wages and war bonuses were demanded and given, and in many towns allowances were made to dependents of tramwaymen who had joined H.M. Forces. With regard to allowances to dependents in Glasgow this year would pay £66,000, Manchester £70,000, Birmingham £3[illegible],000, Liverpool, £35,0[illegible]0, Sheffield £11,500 and Leeds £7,500.

Mr. Baker submitted the following figures showing the increased burdens of tramway undertakings:—

Increased cost of materials in 1915 over 1912-13: Iron and steel bars, 80 per cent.; trolley wire, 30 per cent.; oils and greases, 10 per cent.; steel tyres, 80 per cent.; malleable iron castings, 20 per cent.; car furniture, 10 per cent.; timber, 30 to 80 per cent.; brake blocks, 25 per cent.; trolley wheels, 10 per cent.; gunmetal castings, 15 per cent.; glass, 25 to 50 per cent.

Increased cost of labour, 1915 over 1912-13: Motormen and conductors, 11 per cent.; shedmen, 8½ per cent.; handymen, 8 per cent.; skilled trades, 7½ to 12½ per cent.

Local rates in 1912-13 were £20,218; in 1913-14, £36,790; and in 1914-15, £42,093. These increases were mainly due to a revaluation of the undertaking whereby the assessments were increased 100 per cent.

Income tax on profits: 1912-13, undertaking assessed at £146,586, tax £8,551; 1913-14, £152,137, tax £8,875; 1914-15, £148,445, tax £12,370. On the assumption that in 1915-16 the assessment is same as last year the tax will be 2s. 6d. in the £=£18,556; increase over 1912-13, £10,000.

In 1912-13 receipts were £581,566, interest and sinking fund required £485,794, and depreciation £45,000, the surplus to relief of rates being £62,248. In 1913-14 the receipts were £635,470, interest, &c., was £567,788, depreciation £31,000, and surplus £45,168; while in 1914-15 receipts were £647,014, interest, &c., required £604,844, and depreciation £17,596, leaving a surplus £30,130.

Receipts per car-mile were in August, 1914, 10·17d.; August, 1915, 13·18d. (increase 3·01d.); June, 1915, 11·69d.; August, 1915, 13·18d. (increase 1·4 d.)=£1,666 per week.

Mr. Baker, continuing, said wages had been steadily forced up in Birmingham, and the figures were perhaps indicative of tramways all over the country. With regard to the figures given above for income tax, these were written before Mr. McKenna produced his Budget. Therefore, the figures required modification. Assuming the assessment to be £148,445, the tax, increased from 1s. 8d. to 2s. 6d., would require a payment of £18,556. The net result was that the working expenses with the debt charges in Birmingham got perilously near the point where they would balance the receipts, for the £30,000 mentioned above as the surplus to relief of rates for 1914-15 should have gone to depreciation, but the Finance Committee, no matter what concessions had been made to passengers or to labour, no matter how heavily the receipts might have been hit, generally wanted more every year than the previous year to keep down the rates or to counteract the extravagance of some of the spending committees. Public services ought not to be starved to keep down the rates. The financial problem was becoming acute, and the question arose as to the best way to meet it. It seemed to him there was only one way and that was to increase the selling price of the article they had to offer, viz., the tram ride. Tramways were as much a business as gas or electric light, and the various gas and electric light undertakings had not hesitated to raise their prices. He had heard it suggested that the first effort should be in economy, that reconstruction of track should be put off and repairs and painting of rolling stock should be reduced to the minimum, but they knew that economies in that direction would be of the worst kind and would only result in increasing the financial difficulties by setting up a store of liabilities which would probably never be overtaken. When the proposal to put up the selling price was put fully before the Tramways Committee they saw the wisdom of it failing anything better, and the new scheme of fares was approved by the Council practically without dissent. The new scale reduced the length of the first penny stage from the centre of the city from an average of 2 miles to 1¾ miles, the 1½d. stages were increased to 2d., and the 2d. stages to 2½d. and workmen's penny return tickets were abandoned. Some critics said it was a mistake, and that the financial position of the undertaking would be much worse. The result was that there was no grumbling on the part of the passengers, the venture had proved to be thoroughly justified, which might be seen from the receipts per car-mile already mentioned. The comparison between Aug., 1914, and Aug., 1915, however, was not a fair criterion, and that was why he had stated the earnings in June, 1915 (the month before the new scale was put into operation), compared with [illegible] the August receipts showed a rise of 1·49d. =£1,666 over the June figures. It might be said that the June figures were good enough, and higher than the average of many towns. He agreed that would be so under normal conditions, but the high average was produced to a large extent by overcrowding, owing to a reduction of 10 per cent. in the service which would not be tolerated if it were not war time. It might be suggested that fares would be reduced to their former level after the war, and there would

be a good deal of force in that if wages could be put down again, but who believed that the increases granted on account of the high cost of living would ever go back to the old level or that war bonuses would ever be withdrawn. He did not think so. War allowances to dependents would disappear, but there would be responsibilities to disabled and wounded soldiers which would keep the expenses up. Traffics being higher all over the country, it might be asked why raise the prices. His reply was that they had raised the prices while the money was about. There would be a tremendous slump when the war was over, money would be scarce and they could not put up fares then. They would be £70,000 or £80,000 better off this year.

DISCUSSION.

Mr. C. W. MALLINS (Liverpool) said electric traction was conducted in this country on lines that some people thought were not financially sound. He thought Mr. Baker's figures demonstrated that this was so and that his proposals should be adopted where they were suitable to particular systems.

Mr. ARTHUR ELLIS (general manager of Cardiff tramways) said he thought Mr. Baker's Paper left little room for discussion, but he would have thought that in an important city like Birmingham before considering for a moment the relief of rates they would have secured the payment of a necessary sum to depreciation fund. If during 1912-13 £45,000 was required for depreciation fund, to put by only £17,500 for 1914-15 meant that at a later stage they would have a lot of arrears to make good. He thought they were wise in increasing the fares, and he would advise them to try and keep them at the increased rates. It was laid down by Cardiff Corporation that before any relief of rates was considered the depreciation and reserve funds should be secured. He agreed that economy in regard to cars, &c., would cause discontent amongst passengers and accumulate arrears that would never be got over.

Alderman R. A. SMITHSON (Leeds) said he gathered from some speakers that the fares adopted by tramway undertakings in the early days were fallacious. He thought that a misleading statement. Results had proved in the main that municipalities had adopted a wise course in offering excellent travelling facilities. The public had responded and made the undertakings on the whole sound and prosperous. Managers were naturally keen on having large depreciation funds, but perhaps in later years depreciation was less needed. He agreed with Mr. Baker's procedure in taking the money while it was there. When he heard Mr. Baker say the Birmingham people submitted to the increased fares without a grumble he wondered whether he was listening to a sober financial statement or a fairy tale. He could not imagine the same thing happening in a Yorkshire town. It was futile to try and form any sound judgment as to what would happen in the future, but he thought there was no object in taking a pessimistic view of it. He thought the tramway undertakings would continue to enjoy the confidence of the public.

Bailie ALSTON (Glasgow) said no trading department should contribute to the rates so long as there was any indebtedness to the public outstanding. He thought payment to the rates was bad. It was the worst form of finance and led to reckless and careless expenditure. The best thing was direct assessment of the people—preferably upon income and not rateable values. That was the best method of raising money. He hoped that conference would deprecate strongly the system hitherto obtaining of the municipality going to certain departments and asking for [illegible] instead of to bring in the rates. In Glasgow the tramways were part of the Common Good, and any surpluses went into that fund and could be used for purposes for which they could not come on the rates. The first consideration of all tramway undertakings should be that they were on a sound financial basis, the depreciation and sinking funds being paid before a penny was paid to the rates.

Alderman F. SMITH (Liverpool) said he disagreed with the last speaker. He thought the ratepayers should have some relief from the profits, so that the ratepayers of a few years hence should not have the undertaking entirely at the cost of those who had gone before. He agreed with Mr. [illegible] that it was best to get the money while it was about.

Mr. J. M. McKAY (general manager of Manchester tramways) said Mr. Baker's proposal seemed to be to increase fares to make the rest pay greater. He thought they should be careful before accepting that as a [illegible]. From the fact that the cost of operating tramways [illegible] in many of the large towns the average fare had been [illegible] they had secured increased results. In Manchester they had reduced their fares from time to time, but the average earnings [illegible] the population had gone up. The same thing was true [illegible] in the world. There was a tendency to get more [illegible] population and it was that in the past that had enabled them [illegible] expenses. He had not think it ought to be [illegible] that the right way to meet their present difficulties was to increase their fares.

Mr. [illegible] Bradford tramways) said [illegible] they had had a large [illegible] the policy of raising fares. Mr. Baker had [illegible] Mr. Ellis had [illegible] Alderman Smithson had [illegible] Mr. Alston had [illegible] Mr. Smith had [illegible] Mr. McKay had [illegible] Mr. Mallins had [illegible] Mr. Ellis had [illegible] considering this [illegible] Mr. Baker had [illegible] they were

DIRECT-CURRENT MOTOR SPEED REGULATION BY RESISTANCE IN THE ARMATURE CIRCUIT, WITH SPECIAL REFERENCE TO THE DIVERTER METHOD.

BY THOMAS CARTER.

Summary.—This article, after indicating the conditions of speed regulation under which the use of resistance in the armature circuit of a motor may be considered advisable, and pointing out the accompanying disadvantages as regards low efficiency and instability of speed when regulation is obtained by this device, proceeds to consider the conditions under which diverter resistance may be usefully employed in addition to ordinary series resistance. On the assumption of a certain sequence of operations in causing the speed of the motor to increase from zero to normal, mathematical expressions are obtained showing the corresponding changes in the various parts of the circuit in regard to current, resistance, &c., and the relations are also shown graphically. Some special cases are then considered, including that of the effect of varying stiffness in starting a driven machine, and finally there is an investigation of the changes in speed which result from changes in load while the regulating resistances remain unchanged, showing that, especially at very slow speeds, the change is much less when a diverter is employed than when only resistance is in circuit. The change is shown to be a rectilinear one.

I.

Modern practice demands increasingly large speed ranges in direct-current motors, and while the use of interpoles and other improvements in design have made it possible to procure, by shunt regulation alone, variations in speed very much greater than were usual not so many years ago, there still frequently arise cases where the difference between the minimum and maximum required speeds is too much for shunt regulation only without enormously and unnecessarily increasing the cost of the machine. An example of such a case is found in conditions which require a shunt range from some medium speed to a higher speed, and, in addition, one or two very low speeds for some preliminary purpose, say, only one-twentieth or one-thirtieth of the maximum speed. The requirements of such a case are usually met by putting resistance in the armature circuit and reducing the speed of the motor by reducing the volts at the armature terminals.

The disadvantages of series resistance are well known. As the volts on the terminals of the armature depend on the volts dropped in the series resistance, and as the latter depend on the armature current, it is clear that comparatively small variations in load, especially if the speed reduction be great, may lead to very variable speeds of the armature. Further, the efficiency is reduced enormously, varying practically in proportion to the speed. For if the shunt field remain unaltered, and the torque of the load likewise be unchanged as the speed changes, it is clear that the same armature current is required at all speeds. That is to say, the input to the motor is unchanged, while its horse-power output is proportional to its speed. Hence its efficiency is the same proportion of its normal speed efficiency as its speed is of its normal speed. For a speed of about one-twentieth of normal, with horse-power in proportion, the efficiency may, therefore, be as low as 4 to 4·5 per cent. It will be seen, from what follows, that the use of a diverter, which has many advantages, has, at any rate, the disadvantage of still further increasing the line current, and therefore of reducing this already low efficiency to a still lower figure, possibly as low as 2 or 3 per cent., according to circumstances.

It is clear, therefore, that, in order to diminish the cost of this enormous relative waste, the conditions should be so chosen as to make the horse-power of the motor with full field strength and no resistance in the armature circuit as small as possible. This can be done, in the case of a motor driving a constant torque load, by choosing a shunt range as large as possible consistent with general considerations of economy. This means that the line current necessarily taken from the circuit during series regulation will be smaller than if there had been a smaller shunt range, or none at all. So the efficiency is improved. Suppose a maximum of 30 B.H.P. to be called for at top speed, and a minimum speed of one-tenth of the maximum be called for, the minimum load, on the assumption of constant torque, would be, say, 1 B.H.P. If the whole range were done by series regulation (leaving out of consideration a diverter, which makes matters in this respect relatively worse), the current for 1 B.H.P. would be the same as the current for 30 B.H.P., and if the full load efficiency were 90 per cent., the minimum load efficiency would be only about 3 per cent. If, however, the motor had a speed range by shunt regulation of 3 to 1, the current at full field strength and one-third of full speed would be only that for 10 B.H.P. The minimum speed is one-tenth of the speed with full field strength and no resistance in the armature circuit, and the current for 1 B.H.P. would now be only the same as that for 10 B.H.P. without series resistance. So the efficiency would be one-tenth of the efficiency at 10 B.H.P., instead of only one-thirtieth of the efficiency at 30 B.H.P., which is obviously a great improvement. Approximations have been used in the above statement, which, however, is correct as regards the general order of results.

II.

A motor usually has to exert a torque greater than normal in order to get its load into motion at all. The additional current required varies with the nature of the load, and it may be as much as 100 per cent. overload in current on the motor. This is apart altogether from additional current required for acceleration. As soon as the initial "stickiness" of the load is overcome, the torque probably drops to normal, and correspondingly the armature current tends to drop. But the

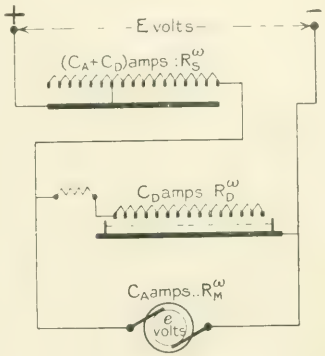


FIG. 1.

series resistance has already been adjusted to allow the greater starting current to pass, and the consequence is that the motor runs up in speed until its back E.M.F. is sufficient just to allow the normal current to pass. The amount of running up clearly depends in some way upon the ratio between initial current and running current. If a very slow initial running speed be required, the speed to which the armature runs up with any series resistance in circuit will generally be much too high. In that case the runaway tendency can be checked by putting a resistance, known as a diverter, across the armature terminals, the diverter and the armature forming a loop in series with the original series resistance. Such an arrangement is shown in Fig. 1, and it is evident that the combination is of the nature of a "potentiometer," with the armature tapped off across a part of the resistance. As will be seen later, there is an initial value of the diverter resistance, greater than zero, which is required merely to keep the armature turning round. This is due to the fact that the motor has a certain amount of internal resistance. So, in the figure, the diverter is shown with a permanent part corresponding to some minimum speed below which it is not required to go, and a variable part, with a range shown by the distance between the two limiting positions of the sliding arm, the travel of which is shown by a dotted line. This variable part is used for gradually increasing the speed, when required, up to the point when the diverter is cut out altogether, and the armature runs with series resistance

only in circuit. After this point the speed is further increased up to the normal by cutting out series resistance.

Before passing on to a mathematical consideration of the condition, it may be said that there are so many independent variables in the problem that it is not easy to reduce it to a graphical form covering all possibilities; but enough guidance is given to enable any case to be dealt with on its merits. The number of interesting problems that may arise is very great indeed; but they are all soluble along the general lines which will now be indicated.

III.

It is assumed in what follows that, unless the contrary be stated, the load is a constant torque one at all speeds. This is not usually exactly true, but in many cases the variation is small, and even if it be not negligible the effect due to it can be easily allowed for. It is, of course, impossible to introduce such a variable, of unknown law, into a general consideration like this. The shunt field is assumed constant, so that torque is proportional to armature current. This may mean neglecting a small error due to armature reaction. It is also assumed that the procedure in starting up is to reduce the series resistance, if necessary, until the motor just starts, and to leave the series resistance afterwards unaltered, until the diverter region has been entirely passed through. The diverter resistance is supposed to be switched in as soon as the motor starts. There are many ways of doing this, mechanical and electrical means both being employed, but the details of these are not relevant to the present purpose. The diverter resistance is then increased to infinity, and after that the series resistance is all cut out. To fulfil these conditions the series resistance must be at least great enough to limit the line current to the amount required for the easiest starting conditions. It may have to be greater than that to comply, say, with a power company's stipulations; but that need not be considered here, as the present investigation starts from the assumption that the resistance has been adjusted to suit the actual starting conditions of the motor.

It may be necessary, in order to keep the volts between contacts down to a suitable amount, to use a greater number of steps in the series and diverter resistances than would be needed for producing only the specified number of different speeds. The permissible value of volts between contacts, from the point of view of sparking at the contacts on altering the value of the resistance, is influenced by the current dealt with, by the shape and material of the contacts themselves, and by other more or less experimental conditions, so little dependent on considerations determinable by theory that it is not possible to deal with them in the present article.

IV.

Let the motor speed with full volts, E, on its terminals (*see* Fig. 1) and full field strength be N, and let the speed under any other conditions be n. Let n be $\frac{1}{p}$N, *i.e.*, let $p=N/n$. Let C_A be the armature current, C_D the current in the diverter resistance, and C_A+C_D, in consequence, the current in the series resistance. Let the total resistance of the motor armature, and any series windings there may be, be R_M (assuming, with sufficiently small error to be negligible for the present purpose, a constant brush contact resistance), let R_D be the value of the diverter resistance, and R_S that of the series resistance. Let e be the back E.M.F. of the armature corresponding to the speed n. Let the internal lost volts in the motor be l times E, *i.e.*, let C_AR_M be lE. Then, as the back E.M.F. at N revs. per [illegible] $E-C_AR_M=E(1-l)$, it is clear that

$$e/N=E(1-l)/p, \text{ or } e=E\,.\,(1-l)/p.$$

Let $C_D=qC_A$, so that the current in the series resistance is $(1+q)C_A$. Let the initial current required to overcome the "stickiness" of the machine, and just produce motion, be k times C_A.

The starting [illegible] had down calls for a value of R_S which will let $(1+r)C_A$ pass, the diverter being out of circuit *i.e.*, R_S is such that

$$E-(R_S+R_M)=(1+r)C_A,$$

from which it is easy to deduce that

$$R_S=\frac{E}{C_A}\cdot\frac{1-l(1+r)}{1+r}=\frac{E}{C_A}\left(\frac{1}{1+r}-l\right).$$

The speed now runs up if no diverter be introduced until the armature current goes down to C_A, *i.e.*, until

$$(E-e)/(R_S+R_M)=C_A, \text{ or until } e=E-C_A(R_S+R_M).$$

i.e., until $e=E\,.\,r/(1-r)$, by simplification. The value of p corresponding to this is given by

$$\frac{p}{N}=\frac{E\,.\,\frac{r}{1-r}}{E(1-l)}=\frac{r}{(1+r)(1-l)}.$$

The "runaway" speed, therefore, is such that

$$1/p=r/(1+r)(1-l).$$

If, however, the diverter be at once introduced, R_S remaining at the value above determined, the conditions are entirely changed, and the relations between the various parts of the circuit are now to be determined.

Since $E=(C_A+C_D)R_S+C_AR_M=(1+q)C_AR_S+qC_AR_D$,

$$R_D=\frac{E}{qC_A}-\frac{1+q}{q}R_S=\frac{E}{qC_A}\left[1-\frac{(1+q)\{1-l(1+r)\}}{1+r}\right].$$

Also $C_DR_D=qC_AR_D=e+C_AR_M=e+lE=E\left(\frac{1-l}{p}+l\right)$

$$\therefore\quad R_D=\frac{E}{qC_A}\cdot\frac{1-l+pl}{p}=\frac{E}{qC_A}\cdot\frac{1+l(p-1)}{p}.$$

From these two expressions for R_D it is clear that

$$1+l(p-1)/p=[(1+r)-(1+q)\{1-l(1+r)\}]\div(1+r).$$

This equation, solved for q, gives

$$q=\frac{pr-(1+r)(1-l)}{p\{1-l(1+r)\}}=\frac{r}{1-l(1+r)}-\frac{(1+r)(1-l)}{1-l(1+r)}\cdot\frac{1}{p}.$$

The insertion of this value of q in the equation

$$R_D=\frac{1}{q}\cdot\frac{E}{C_A}\cdot\frac{1+l(p-1)}{p} \text{ shows that}$$

$$R_D=\frac{E}{C_A}\cdot\frac{1-l(1+r)}{pr-(1+r)(1-l)}\cdot\frac{1+l(p-1)}{p}.$$

Thus the values of q and R_D are found in terms of previously known quantities, and are seen to vary in a definite relation to p as the sole variable, as long as the torque is unchanged and R_S remains at its initial value. It is clear from the expression for R_D that, when R_D becomes infinite, $pr-(1+r)(1-l)=0$, or $1/p=r/(1+r)(1-l)$, which is the "runaway" speed expression already determined for the case of series resistance only. The two methods of arriving at the same conclusion must obviously agree with each other, as they do.

After $R_D=\infty$, R_S is gradually reduced to zero, the speed then becoming N. For any intermediate position

$$E-C_AR_S-C_AR_M=e, \text{ or } e=E(1-l)-C_AR_S.$$

$$\therefore\quad R_S=\frac{E}{C_A}\left\{(1-l)-\frac{1-l}{p}\right\}, \text{ since } e=E\,.\,(1-l)/p$$

$$i.e.,\quad R_S=\frac{E}{C_A}\cdot\frac{(p-1)(1-l)}{p}=\frac{E}{C_A}(1-l)\left(1-\frac{1}{p}\right).$$

V.

In order to get a graphical representation of the above relations, take a numerical example and assume $r=1\cdot0$ (*i.e.*, the motor takes 100 per cent. overload in current at starting) and $l=0\cdot5$ for full load. From these assumptions the following values are obtained. The initial value of R_S is $0\cdot15E/C_A$. If

o diverter were used the speed would run up to 0·527N. But a diverter be used, $q=\frac{p-1\cdot9}{0\cdot9\ p}=1\cdot11-\frac{2\cdot11}{p}$.

$$R_D=\frac{E}{C_A}\cdot\frac{0\cdot9-0\cdot045(p-1)}{p-1\cdot9}$$

nd, after the diverter has been passed,

$$R_S=\frac{E}{C_A}\cdot\frac{0\cdot95(p-1)}{p}.$$

The three quantities, q, R_D and R_S, are thus expressed in erms of p. and. by taking values of 1 p from 0 to 1·0, *i.e.*, of from zero to N, successive values for the three dependent ariables are obtained as set forth in the following table :—

$1/p$	0·0	0·1	0·2	0·3	0·4	0·5	0·527	0·6	0·7	0·8	0·9	1·0
p	∞	10	5·0	3·3	2·5	2·0	1·9	1·67	1·43	1·25	1·11	1·00
$R_D=\frac{E}{C_A}\times$	0·045	0·161	0·349	0·720	1·61	9·45	∞	...	...	...	...	...
q	1·11	0·90	0·69	0·48	0·27	0·06	0	...	...	...	...	...
$R_S=\frac{E}{C_A}\times$	0·450	0·450	0·450	0·450	0·450	0·450	0·450	0·380	0·285	0·190	0·095	0
Line amps. $=C_A\times$	2·11	1·90	1·69	1·48	1·27	1·06	1·00	1·00	1·00	1·00	1·00	1·00

Fig. 2 shows the result of plotting the dependent variables against $1/p$, and from such a diagram as this the values of R_D and R_S can be found for any specified value of $1/p$. It will be noted that q follows a straight line, and R_S goes down to zero in

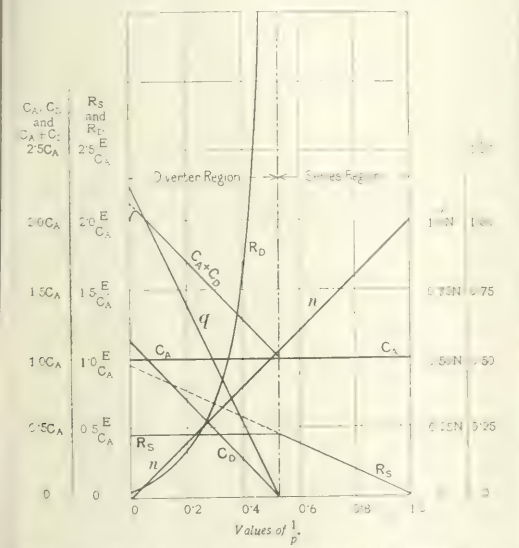


Fig. 2.—Curves for Speed Regulation by the Diverter Method ($r=1\cdot0$: $l=0\cdot05$).

a straight line which, produced backwards as shown dotted, cuts the zero ordinate at $0\cdot95E/C_A$, *i.e.*, at $(1-l)E/C_A$, which is the value of R_S required when $r=0$. It is interesting to note in passing that the diverter region shrinks in width as r becomes smaller, and that, should r be zero, *i.e.*, should the starting and running currents be the same, no diverter is required at all, as a gradual increase of speed from zero to maximum is possible by the use of R_S alone. Diverter resistance is therefore increasingly useful the greater r is. A careful study of the diagram with frequent reference to the general expressions for the various parts of the circuit is extremely useful, as it enables the character of the various changes to be realised which occur in all parts of the circuit when the mechanical and other determining conditions happen to alter.

(*To be concluded.*)

A LARGE ELECTRIC HOIST.*

BY WILFRED SYKES.

Summary.—A description is given of an electric hoist recently installed in a mine at Butte, Montana (U.S.A.), having a depth of shaft of 4,000 ft., net weight of load 14,000 lb., weight of skip and cage 9,000 lb., and maximum hoisting speed 3,000 ft. per minute. Some operating results are given.

The mining conditions in Butte (U.S.A.) require the handling of large quantities of ore from depths of 2,000 ft. to 4,000 ft., and eventually from 5,000 ft. In the past steam hoists were used, but the difficulty of getting good water supply, and the high cost of fuel, made their operation expensive. Cheap hydro-electric power is available, and a few years ago an attempt was made to decrease the cost of operation and still utilise the greater portion of the existing hoists, by arranging them for compressed air operation. A central compressor plant was installed, the compressors being driven by synchronous motors for supplying the air not only to the hoists, but for other underground operations. Although the central compressor station is the largest in existence, the supply of air is not altogether adequate, and with the continually increasing requirements for underground working the alternative had to be faced of either increasing the compressor station, if new hoists are added or of driving new hoists by some other means. The use of compressed air is attended by all the usual difficulties of transmission, leakages, &c., and in order to obtain its economical operation, preheaters are necessary for each hoist which require the use of fuel and labour to fire them. The air hoist has the same characteristics as the steam hoist, and is therefore not very satisfactory from the standpoint of manœuvring. It has, of course, a large number of wearing parts, requiring attention, and the maintenance is at least as high as the steam hoist.

Recently the North Butte Mining Co. put into operation a new shaft, and after a consideration of the various factors it was decided to use an electrically-driven hoist instead of compressed air. The new shaft will be finally sunk to a depth of 5,000 ft., and the requirements of the hoist are representative of the conditions in the Butte field. The operating conditions are as follows :—

Depth of shaft, 4,000 ft., eventually 5,000 ft. ; net weight of load,

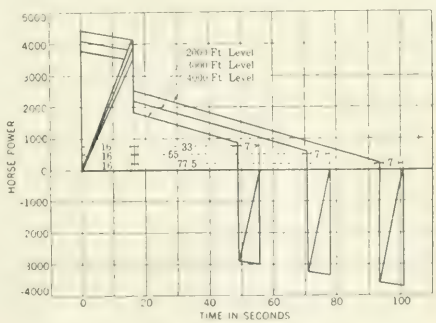


Fig. 1.—North Butte Mining Co. Hoist Cycle.

14,000 lb. ; weight of skip and cage, 9,000 lb. ; size of rope, 1⅝ in., 4·1 lb. per foot ; drums, 12 ft. in diameter, maximum hoisting speed 3,000 ft. per minute, and normal hoisting speed 2,700 ft. per minute.

To meet the above conditions it was estimated that the load on the motor for the various depths would be in accordance with the diagram, Fig. 1. These estimates show that the power peaks will be approximately 4,500 H.P., and, under the conditions that power is purchased in Butte, the cost would be excessive if a hoist operated by an induction motor were installed. Apart from other conditions of operation, this feature alone was sufficient to eliminate an alternating-current motor drive for the hoist. It was, therefore, decided to use a flywheel motor-generator set which would limit the input to the equipment, the peaks being carried by the flywheel. It was not attempted to instal a flywheel of sufficient capacity completely

* Paper read before the American Institute of Electrical Engineers slightly abbreviated.

to equalise the load, as this would have required a much larger wheel than the one installed and the continuous losses would have been very greatly increased. It was estimated that by the use of a 50-ton flywheel the input to the hoist could be limited to the following figures during normal operation :—

Depth.....	2,000 ft.	.....	3,000 ft.	.....	4,000 ft.
Input.....	1,250 H.P.	.....	1,420 H.P.	.....	1,850 H.P.

The efficiency of electric hoisting with this system is naturally lower than if the power were utilised more directly, due to the conversion and friction losses. The elimination of the elaborate controlling apparatus that would be necessary, the absolute control over the speed of hoisting, the generally more satisfactory results, and the elimination of high peaks are sufficient compensation for the extra power required. The calculated efficiency of operation

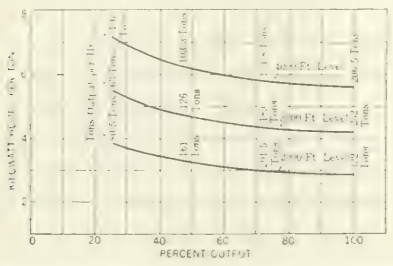


Fig. 2. North Butte Mining Co. Power Consumption Curves of Hoist.

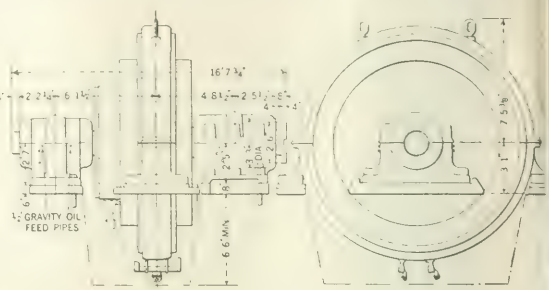


Fig. 3.—Hoist Motor.

is shown in Fig. 2, which shows the power input per ton hoisted from various loads. Considerable importance is attached to the reduction of the light-load losses to a minimum, as the flywheel motor-generator set runs continuously, only shutting down about once a month for cleaning. Consequently the lower the light-load losses the higher would be the general overall efficiency of the equipment. The mining conditions in Butte call for hoisting at full capacity for four or five hours at a time twice each day. The remainder of the period of hoist is handling waste, timber and men. Guarantees under very heavy penalties were therefore required for the light-load losses, and as they could be readily measured there was no difficulty in checking the manufacturer's figures. Estimates of power consumption per ton of material hoisted cannot be readily checked without special efforts being made to operate the hoist exactly on the cycle on which the estimates are based, and as it is almost impossible to

of $1\frac{5}{8}$ in. rope in two layers. The drum shell, brake rings and spide are made of cast-steel, the latter being fitted with heavy bron bushings, each bushing being provided with four large grease cups f lubrication.

The clutches are of the friction type, consisting of two heavi ribbed annular rims faced with wood, supported on a six-arm spid keyed to the shaft. These rings clamp a flat steel plate bolted to t drums and are moved by six sets of toggle arms connected to a slidi sleeve and rock-shaft and operated by an oil cylinder. All of t parts of the clutches are made of steel. The clutches are design to take a load of 50,000 lb. on a 12 ft. diameter, and all of the par are figured for a factor-of-safety of not less than eight. The clutch and the motor were subjected to a load of $2\frac{1}{2}$ times their rated cap city and under this load developed no weakness. The post-brak are made of plates and angles in the form of a box girder, and a

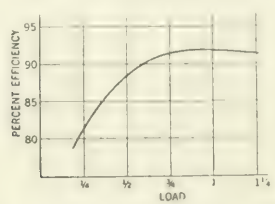


Fig. 4.—Efficiency Curve of Hoist Motor.

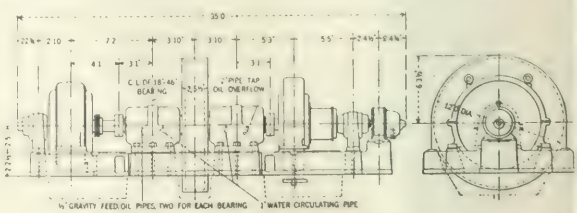


Fig. 5.—Flywheel Motor Generator Set.

determine accurately the mechanical efficiency of the hoist, such tests could not be relied upon to check the efficiency of the apparatus. From the individual efficiency curves of the machines and the known light load losses, the power required under any stated condition can be readily calculated.

The hoist consists of two drums, each fitted with a clutch, post-brake and band brake. The drums are mounted on a shaft supported by three bearings, the shaft having a flanged coupling to connect to the motor shaft. The clutches and post-brakes are operated by oil cylinders, the pressure being supplied by an accumulator and an electrically operated triplex pump. The band brakes are operated by hand wheels. All of the operating levers are grouped on a large operating platform with double stairways. The control and reverse levers are separate, but so interlocked that when the control lever is in the "on" position the reverse lever cannot be moved. The safety devices include a mechanism for moving the control lever to the "off" position when the skip has reached a pre-determined point, holding this lever in this position until t reverse lever has been moved to its opposite position, the opera being thereby prevented from starting the hoist in the wrong dir tion. There are two solenoids which automatically apply the po brakes if the skip is carried too far after the current has been cut An indicator with a large dial is provided for each drum, and accurately spotting the skip or cage, the brake rings on the dru next to the middle bearing are extended 8 in., affording a large s face on which to paint marks. On the platform there are moun in front of the operator a panel holding a voltmeter and an ammet also a target which is connected to the reverse lever showing wh drum is hoisting. Grouped around the sides of the platform are signal gongs, lights and telephone. The drums are 12 ft. in d meter by 9 ft. 4 in. face, each with turned grooves to hold 5,000

lined with basswood blocks readily renewed. The post-brakes ar the parallel acting type applied by gravity and released by o cylinders. The band-brakes are for emergency service, and a operated by means of hand wheels and screws. Proper provision h been made for operating these by power later on if desired. The bearings for the drum shaft are of the pedestal type with quarte boxes adjusted both vertically and horizontally. They are lubri cated by a continuous gravity-feed oiling system with the necessary tank, filters and pump, the latter being driven directly from the drum shaft, oil being supplied to the bearings whenever the hoist is i operation. The drum shaft is of open-hearth forged steel, 22 in. i diameter by 40 ft. $5\frac{1}{2}$ in. long, and has a flanged coupling forged a one end to be connected to the motor shaft. All of the operating connections and auxiliaries are placed on or above the floor level i full sight of the operator, so that any derangement of any of th working parts can be quickly observed. The combined weight of th

ɡim shaft with the two drums and two clutches is 300,000 lb. The rlius of gyration is 4·86 ft.

The hoist is driven by a direct-connected continuous-current ɪtor running at about 71 revs. per min. normal, which is mounted r sole plates built into the foundations. Fig. 3 shows the principal ɾnensions of the motor, and the heavy construction of the mecha- ɾal parts will be particularly noted. The motor is wound for 600 lts and has 16 poles. The armature is 10 ft. in diameter, the out- e diameter of the frame being 14 ft. 1 in. The motor will develop ɔ00 H.P. for short periods without injury, and particular care is ɛen to build a machine that would stand high temperatures thout injury. The frequency of hoisting and the duration of the isting period is somewhat uncertain, and as a factor-of-safety, mica d asbestos insulation has been used throughout the machine. e armature coils are all mica insulated, and the field coils are pper strap wound on edge, with asbestos insulation. The insula- ɔn is such that an ultimate temperature of 150°C. could be carried thout injury. For hoists of this size it is important to guard ɛainst failures of insulation due to temperature, as the ventilation the motor due to the periods of rest and the slow speed when nning is not particularly good. The total weight of the rotating ɾt of the motor is approximately 70,000 lb., and the radius of gyra- ɔn is 4·1 ft. The motor is separately excited at 250 volts. The sts conducted on the machine show high efficiency for a machine of is type, and are given in Fig. 4.

The motor generator set, Fig. 5, supplying power to the hoist motor driven by a 1,400 H.P. 2,200-volt, 60-cycle, 14 pole induction motor ınning at a maximum speed of about 505 revs. per min. The ɛnerator is designed to deliver about 6,000 amperes during period acceleration at a maximum of 600 volts. It is connected solidly ith the motor, the control of the speed and the direction of rotation ɛing by means of the excitation on the generator. To enable the

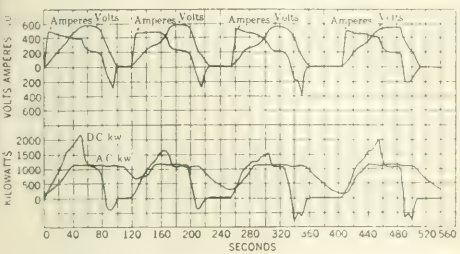


FIG. 6.—TYPICAL CYCLES UNDER PRESENT CONDITIONS.

eak loads to be satisfactorily commutated, on account of the high ɔeed, a commutating machine with interpoles was built. The rmature has a diameter of 66 in., and the field has 10 poles, so that uring the acceleration peak period 1,200 amperes are collected per rush-arm. The generator is arranged for separate excitation at 250 olts, from the direct-connected exciter. As the speed of the set varies uring operation, and it is desirable to maintain a constant exciter oltage, an automatic voltage regulator was installed for this pur- ɔose. Mounted between the motor and the generator is a steel plate lywheel having a diameter of 12 ft., and a weight of 100,000 lb. The ɔeripheral speed of the wheel is about 19,000 ft. per min., and it is ɔuilt up of steel discs cut from solid plates, the discs being held ogether by rivets. The wheel is shrunk on the shaft and finished ll over. It is protected by a case which completely encloses it. This case reduces the windage very appreciably and also affords mechanical protection. The flywheel is carried by two water- ɔooled gravity-feed lubricated bearings 18 in. in diameter by 46 in. long. In spite of the high bearing speed of about 40 ft. per second, the bearings run quite cool. The flywheel and its shaft are built up as a unit, the shaft having a forged flanged coupling at each end to which motor and generator are coupled. In case any repairs are necessary to the motor or generator, the rotating parts can be re- moved without disturbing the flywheel. The whole of the set is mounted on a bedplate built into the foundation. The speed of the set during operation is controlled by an automatic slip regulator. The slip regulator also is used for starting the set, and the input for which it is adjusted can be readily changed by varying the amount of the counterweight. As previously mentioned, the hoist operates for periods of three or four hours at a time at full capacity, and during the remainder of the time the work is decidedly intermittent.

The slip regulator limits the maximum input during each period to practically the same value, and between trips the loads drop down to practically the friction load of the set. This is due to the fact that the interval between trips is longer than is necessary to bring the flywheel up to full speed. A typical day's work shows the following hoisting conditions:

Trips hoisting ore	131
Trips hoisting waste	36
Trips with timber	13
Trips with men	18

Fig. 6 shows typical cycles when operating under present conditions. The hoist at present is working from a maximum depth of 2,800 ft., and the acceleration peaks are not as high when working from 4,000 ft. These curves show the direct-current volts and amperes, the direct-current kilowatt and the alternating-current input. The overall efficiency from these curves, including all mechanical and shaft losses as well as electrical losses—that is, the ratio of input to the actual work required to lift the material is 48 per cent.

It was estimated when the hoist was installed that the light-load losses would be approximately 126 H.P., including excitation for the hoist motor, or, in other words, for the equipment in condition to start hoisting. Tests made after installation showed that these losses did not exceed the above figure and were probably slightly less. The actual input could not be determined within 1 H.P. or 2 H.P. due to variation in reading of instruments. The hoist has been in operation continuously since the middle of May and has carried the load of the new shaft and occasionally the existing shaft during the time the old steam hoist was out of commission.

This hoist is noteworthy as it is the largest electrically-operated hoist in the United States, and it marks a decided departure from previous practice in handling large quantities of ore in the metal mining fields.

STREET LIGHTING ECONOMY.

In his annual report for 1914 Mr. W. Williams, commissioner of the department of water supply, gas and electricity of New York, shows what savings were effected in the lighting of streets, parks and public buildings by the substitution of metal filament lamps for arc lamps. From the abstract of the report given in the "Electrical World," it appears that at the beginning of 1914 there were 2,643 miles of street and 19 sq. miles of parks to be lighted. There were over 40,000 electric lamps and 45,000 gas lamps. The administration set out to make certain savings, and an account is given in the report of the methods pursued and of the changes made. Two net results stand out—the street lighting bill for 1915 will be £80,000 less than for 1914, and the nitrogen-filled tungsten lamp has largely supplanted the arc lamp. As a result it is believed that many important streets of Greater New York are among the best-lighted thoroughfares in the world.

The use of the nitrogen-filled tungsten lamp is being rapidly introduced all over the city. The Commissioner states that there are still further improvements in contemplation, including the substitution of electricity for gas throughout the entire borough of Manhattan, thereby furnishing double the illumination (at the points now lighted by gas) at a somewhat reduced cost. Before the end of the year it is confidently expected that 15,000 gas lamps will be displaced by electric incandescent lamps.

To light the public buildings of New York costs the city over £200,000 a year, and there, too, the administration has succeeded in effecting considerable economies. On most of the bridges arc lamps have been displaced by 300 watt nitrogen-filled incandescent lamps, and the annual cost of lighting the Queensboro' Bridge was reduced in this way by £800. Similar savings were effected on all of the other great bridges and in many of the numerous public buildings.

In round numbers, the cost of lighting the streets and parks of Greater New York was £676,400 in 1913. The city has contracts for street and park lighting with various companies, and the term of each contract is limited by statute to one year. The rates for nitrogen filled tungsten lamps in Manhattan during 1915 are £14 a year for the 300 watt lamps and £15 4 a year for the 400 watt lamps. The cost of arc lamps was reduced from £18 to £17. Rates equally favourable were obtained in the other boroughs. At the time of the report over 13,000 gas-filled incandescent lamps were used for street lighting purposes.

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"PHYSICIAN, HEAL THYSELF."

At a time like the present it is the duty of public bodies to exercise the most rigid economy in their expenditure and ruthlessly to cut down their estimates to the irreducible minimum. A memorandum to this effect has been issued, we believe, by the Local Government Board. We venture to think that economy would be observed by local authorities without instruction from a Government Department: but, assuredly, such instruction would carry greater weight if economy was practised in Government Departments. Instances abound of flagrant and unbridled waste in expenditure in regard to the construction and administration of temporary and semi-temporary camps and hospitals, and in military works generally. The question was discussed editorially in a recent issue of the "Sanitary Record and Municipal Engineering," and of the several examples of such waste cited by out contemporary the following speak for themselves.

For heating purposes 18 boilers are scattered over a certain camp, and the pipes for the distribution of the water are to be in wrought iron, costing 100 per cent. more than cast iron (which is almost invariably used elsewhere), whilst each length of wrought-iron pipe is to be provided with a special connector. The cost of the heating plant alone for this temporary camp of galvanised iron huts for the accommodation of 2,500 to 3,000 men prisoners is to be over £3,000! In the case of a naval camp, which is in course of construction, certain fittings costing £4. 10s. each, exclusive of fixing, are to be used. Suitable fittings are procurable at 25s. each, and these low priced fittings have, in fact, been fixed in another camp, where the work has been carried out from the plans of a civilian engineer. It may reasonably

be urged that heating and sanitary engineering do not come within the sphere of activity of the Royal Engineers. If this is the case, we wonder why such work is entrusted to and undertaken by them? Road making, beyond question, is an art with which the Royal Engineers should be familiar. A borough engineer was asked by the War Department to cover a road with broken Guernsey granite 12 in. thick, costing 15s. per cubic yard. He, very properly, refused to be a party to the wasting of national money, and after some demur he persuaded the War Department to use an 8 in. hard core for a foundation costing about 1s. per cubic yard, and 4 in. of broken granite on the top. As a result a sum of close upon £1,000 was saved.

Equally flagrant is the expenditure on electrical works. At the end of December a large workhouse "somewhere in England," already wired, was handed over to the military authorities for use as a hospital for the accommodation of 2,000 patients. Wiring firms and electrical contractors were given orders to carry out certain works with all possible speed. No specifications were issued. Verbal orders given one week by an officer in charge were either cancelled or modified the following week by another officer in charge. At the commencement of the work it was announced that the wiring firms and contractors would be paid a reasonable percentage on the net cost of the material, together with a sum of 2d. per man-hour. There was no supervision by or on behalf of the War Department. There was no checking of the material brought in or taken out, and there was no checking of the time-sheets! The job lasted close upon seven months, and was carried out at high pressure seven days per week with considerable overtime. The time-sheets bear eloquent testimony to the physical fitness and endurance of the wiremen. When the time came for payments to be made the War Department found itself unable to pass the accounts. A civilian engineer was called in to issue certificates and to inspect the work. Three months after the first certificate had been given (and eight months after the commencement of the work) the War Department made the first payment. The merits of such engineering are on a par with those of a certain leg of mutton on which Dr. JOHNSON dined, and which he pronounced to be "as bad as bad could be; ill fed, ill killed, ill kept and ill dressed."

A system which gives to a tradesman a free hand to supply goods of any quality he likes, which allows him to put in such workmanship as his conscience dictates, which compels him—in many cases against his will—to keep men working more than twice the normal hours for long periods, and which permits him to give to the work such supervision as he conveniently can without interrupting other work on which he happens to be engaged, bears the hall-marks of incompetence and inefficiency.

In their legitimate military work we believe that most of the responsible officers of the Royal Engineers are competent men. Many of them are men of extraordinary talent, and in normal times it is probable that the engineering *business* of the War Department would be conducted on more efficient and economical lines than at present. Furthermore, we believe that most of the able officers of the Royal Engineers are engaged on definite military work, as distinct from the building of huts and the equipment of hospitals at home.

If this is the case, and remembering that during the past year the work to be executed has probably increased fifty-fold, the extravagance to which we have referred is due to the lack of properly skilled men in the War Department. We must also remember that, besides an increase in the volume of work to be handled, there has been a corresponding increase in the importance of the work. But there is no lack of men skilled both in engineering and business in the country. The remedy is at hand. To our knowledge many able engineers have offered their services—in some cases free of cost—to the country, and to secure the services of these men National Registration is unnecessary. Outside Government Departments it is generally known that the engineering talent of Britain has been mobilised for many years. An appeal to the engineering institutions would place at the disposal of the War Department all the engineers likely to be required. If engineers capable of supervising work of this kind were lacking there would be some excuse for this waste; but it is well known that at the present time consulting engineers and their staffs are very adversely affected by the war owing to the great curtailment of capital expenditure. This applies to most branches of public works. Why should not the services of these engineers be utilised? There is no question that the gain to the country through economy and increased efficiency would be very considerable.

We feel that the engineering institutions themselves are, to a certain extent, to blame. It is patent to most people that the need is great, and the engineering institutions, already mobilised, are silent. At a time like this it is infinitely more patriotic to speak the truth than to hide it, and on the eve of the commencement of the new session we urge these institutions to do their duty by claiming the right to guide the State in all engineering matters. By so doing much of the extravagance to which we have referred would be eliminated, and one section at least of the War Department would be based on a sure foundation. When the story of the war comes to be told it is not improbable that we shall find that our enemies mobilised their engineers a long time before the declaration of war.

A NOTE ON THE DISTRIBUTION OF FLUX AROUND A CONTINUOUS-CURRENT ARMATURE.

BY BERNARD HAGUE, B.SC., A.C.G.I. AND FRANCIS F. H. SCHROEDER, A.C.G.I.

This note has reference to a point of interest which came under the notice of the authors in the course of some experiments on a continuous-current armature.

It is well known that the magneto-motive force (M.M.F.) produced by the current flowing in the armature of a continuous current dynamo is a maximum in the brush axis and is distributed over the pole-pitch in the form of a triangular curve, as shown in Fig. 1, where (*a*) represents the conductors in the slots, (*b*) the distribution of the ampere conductors, and (*c*) the magneto-motive force of the armature winding, as obtained by integrating (*b*). The dotted line in (*c*) shows the mean M.M.F. curve which would obtain with a uniformly distributed winding. When the armature is removed from the disturbing influence of poles and iron yokes, this M.M.F. produces a flux distributed

in a similar manner over the core of the armature as in Fig. 2. Thus, the core of the armature presents definite poles of flux. When the armature rotates, these poles remain practically stationary in space and would be quite stationary if the number of slots was very large. All this, of course, is quite well recognised.

It was of interest, however, in the authors' experiments to know not only the distribution of flux round the core, but also round the end-connections and round any given coil in the armature. The end-connections or overhang of a continuous-

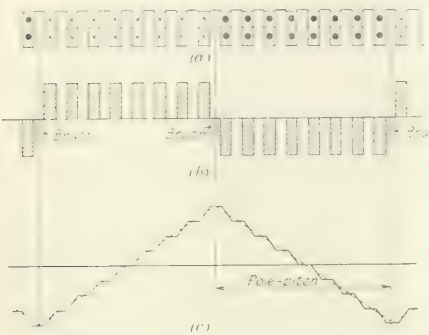


FIG. 1.—M.M.F. OF DOUBLE LAYER WINDING.

(a) Conductors in slots.
(b) Peripheral loading ampere conductors per cm.;
(c) Magneto-motive force.

current armature winding usually consists of two layers of conductors crossing at a definite angle and, at first sight, might seem to present a somewhat complicated problem. Accordingly, the authors determined to make an investigation of the distribution of flux round the end-connections of a double layer commutator winding, by means of a Grassot fluxmeter and search coil.

A suitable lap-wound armature mounted in bearings away from disturbing poles and iron circuits was used for the tests, and the flux distribution over its surface when carrying a known

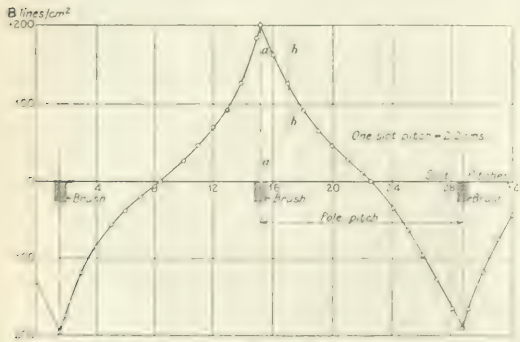


FIG. 2.—PERIPHERAL FLUX DISTRIBUTION AT MIDDLE OF CORE.

current was then investigated. The principal dimensions of the armature were as follows: Diameter over top of slots, 30·4 cm.; length of core, 7·6 cm.; length of overhang, 8·25 cm. It had a four pole lap winding with 51 slots and 18 conductors per slot, and the tests were carried out with a current of 5 amperes per conductor. The results of the experiments are shown in Figs. 3, 4 and 5. In Fig. 2 the curve gives the ordinary peripheral distribution of flux round the centre of the core, as measured midway between the

edge of the core and the end of the overhang is shown in Fig. 3. It will be seen that, like the core, the end-connections present definite poles practically coincident in space distribution with those on the core. Fig. 4 gives the distribution of flux along two coils, starting at the middle of the core and following the contour of the respective coils to the axial extremity of the winding. The coils chosen lie in the positions marked *a* and *b* in Fig. 2. The marked dip in the portion of the curves over the core is due to a deep circumferential groove in the latter to receive a binding band. From these curves we see that no matter which coil be investigated the flux dies off to zero as we approach the end of the overhang.

These results may be briefly summarised as follows: The M.M.F. due to the end-connections of a double-layer winding produces poles on the overhang in just the same manner as those created upon the surface of the core by the M.M.F. of the conductors in the slots. The fact that the density of the flux dies off to zero as we approach the axial extremity of the winding shows that *all the flux emanating from the armature sweeps over peripheral paths*, and none passes over the end of

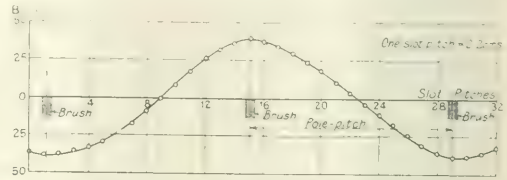


FIG. 3. PERIPHERAL FLUX DISTRIBUTION AT MIDDLE OF END CONNECTIONS.

the winding from the outside to the inside of the overhang or vice versa.

Fig. 5 illustrates how the distribution of flux on the end-connections just experimentally proved can be predicted theoretically.* In this figure the double-layer end-connections for a simple winding are shown; the dotted lines constituting

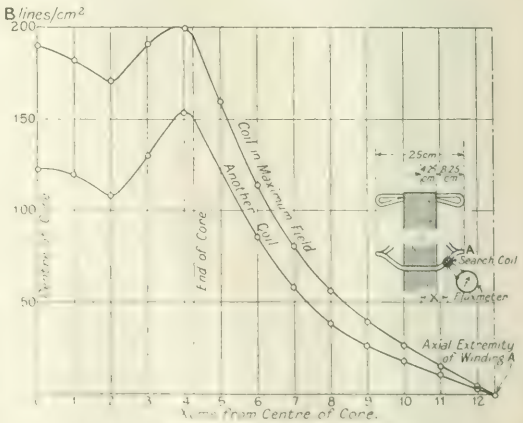


FIG. 4.—DISTRIBUTION OF FLUX ALONG A COIL.

the lower layer and the arrows indicating the direction of current. The coil undergoing commutation forms the boundary of the systems of current marked A, B, C, D, &c. Now consider one of the separate meshes *abcd* in the system A, its sides carrying current in the directions shown. It is easy to see that by splitting up the currents meeting at the corners of the mesh into peripheral and axial components, the former, on the whole practically neutralise each other numerically (except for the

* We are indebted to Mr. C. C. Hawkins and independently to Dr. G. W. O. Howe for this method of explaining these results.

space between layers) and only the axial components remain active. A similar argument applied to a mesh *efgh* in the system of current B will show that the peripheral components persist therein, the axial components practically neutralising. Applying this method to all the meshes we get the diagram in the lower part of the figure, the overhang being practically

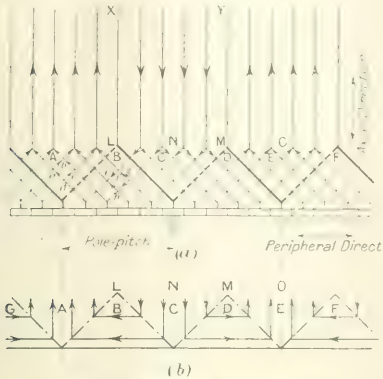


Fig. 5.—Equivalent Overhang.

(*a*). Distribution of current in end-connections.
(*b*) Equivalent system of Current Sheets.

equivalent to the arrangement of current sheets shown. Such current sheets give rise to poles of flux which have equal but opposite maxima at L and M, dying off to zero at N and O. Furthermore, it is also obvious that such a current distribution gives rise to a flux dying down to zero in an axial direction as the extremity of the overhang is reached. An inspection of Fig. 5 shows that the poles occur in the same position in space as those on the core due to the conductors in the slots and have the same sign. These latter occur, of course, at LX, MY.

The similarity of the flux distribution about the end-connections of a commutator winding to that of a coil winding is very noteworthy, and Fig. 5 shows that the end-connections of a double-layer or commutator winding are practically identical in effect with the overhang of a single layer coil winding.

In Fig. 6 is given a graphical representation of the flux on the overhang, showing the density and direction of the lines of magnetic force, in accordance with the practical and theoretical results just established.

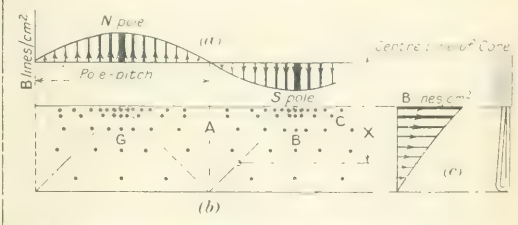


Fig. 6.—Distribution of Flux due to Current Sheets of Fig. 5.

(*a*) Typical curve of peripheral distribution;
(*b*) Plan of Current Sheets, dots represent lines of force:
(*c*) Typical curve of distribution along a coil.

In conclusion we desire to express our thanks to Mr. J. T. Irwin for his suggestions during the experimental stage and to Mr. C. C. Hawkins and Dr. S. P. Smith for their friendly criticisms during the writing of this note. The work was carried out at the City and Guilds (Engineering) College under the direction of Prof. T. Mather, F.R.S.

ELECTRIFICATION ON THE LONDON & SOUTH-WESTERN RAILWAY.

Although London was one of the earliest cities to adopt electric traction, this was restricted for many years to the tube railways and then to the "Underground" with its surface extensions. Then came the electrification of the South London line of the London, Brighton & South Coast Railway, in 1909. some time, and the first to be completed is that of the London & South Western Railway.

The electrification of the London suburban system of the London & South Western Railway forms one of the most important schemes of this kind that any British railway company

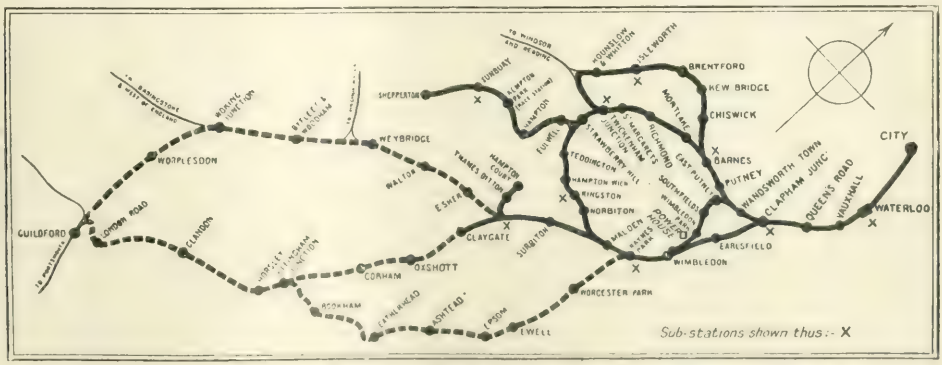


Fig. 1.—Map of the L. & S.W. Railway Suburban Lines, showing Lines actually Electrified and those on which Electrification is Contemplated.

Although this railway has adopted an ambitious electrical programme since that date, progress on other London railways as regards electrification has been small. Now, however, further progress is evident; other schemes have been in progress for has yet undertaken. The lines which are now being electrified are the circular route from Waterloo via Wimbledon, Kingston, Twickenham and Richmond and back to Waterloo, the Hounslow loop line, and the Hampton Court, Claygate and Shepper-

ton branches. The total length of these routes is about 47 miles, equivalent to nearly 150 miles of single track. At a later date a further system of about 50 miles of route, the equivalent of 150 miles of single track, may be undertaken. As shown in Fig. 1, this will include the three lines through Leatherhead, Cobham and Woking respectively to Guildford.

After a careful and exhaustive study made by the engineers of the London & South Western Railway of all systems in commercial use, it was decided to adopt direct current with a pressure of 600 volts on the third rail.

The Rolling Stock.

For the electric trains the original rolling stock, consisting of the usual compartment coaches with side doors, has been used, the necessary alterations being made to fit them for the electrical apparatus. This applies to the motor coaches as well as the trailers. The trains are equipped for multiple-unit working, and for convenience in handling are made up of three-coach units, consisting of two motor coaches with a trailer coach close-coupled between them. The individual three-coach units are intended to be permanently coupled, and form convenient and handy units for traffic. It is intended to operate these units as three or six-coach trains, depending upon traffic requirements. Each unit weighs 94 tons unloaded, seats 190 passengers and is equipped with four 275 H.P. motors, 590 revs. per min., geared 21/59 on standard 42½ in. driving wheels; these motors are arranged in pairs on the bogies underneath the driving compartments at opposite ends of the unit, *i.e.*, each motor coach is provided with two motors on a single bogie. All the electric control gear is placed in thes compartments, each pair of motors being controlled by its own set of control gear. The arrangement of the control gear in the driver's cab was decided upon by the railway company's engineers in preference to having it underneath the coach on account of the greater ease of access for inspection, cleaning and adjustment. The positions of the individual pieces of apparatus have been carefully arranged with this end in view. Access to the control apparatus is obtained on the one side from the driver's compartment and on the other through large hinged doors in the partition between the driver's and luggage compartments. There is also an advantage in placing the control apparatus in the driver's cab in that the weight of this apparatus comes over the driving bogie and so increases the adhesive weight on the driving wheels. Fig. 2 shows a view of the train, and Fig. 3 shows the general arrangement of the control gear in the cab.

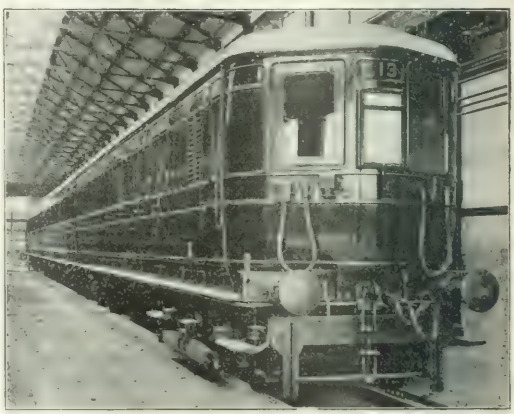
The history of the development of railway motors has been one of steady improvement, and the construction of the motor adopted for this scheme is the direct result of a vast amount of experience, experiment and close attention to details. When dealing with large railway motors, the restrictions in design are very great on account of the small space available and the severity of the operating conditions, so that nothing but the most rigid form of construction will withstand the service. Rugged construction has consequently become one of the most important considerations in design.

The electrical equipment is by the British Westinghouse Co. As is usual, the motors are series wound, with commutating poles and totally enclosed, a box-type frame being used. The motor casing is carried by a suspension bracket, which is supported through rubber springs from the truck transom. The bearings are carried in end housings and the motor is equipped with commutating poles. A view of the bogie with motors is seen in Fig. 4.

The difficulties met in machining the box type of yoke are overcome by the use of specially designed machine tools. As an illustration, it is essential for the pole bolt holes to be very accurately placed, but the necessary accuracy could not be guaranteed if they were drilled from the outside. Special machine tools have therefore been designed by means of which the bolt holes are drilled from the inside of the yoke with perfect mechanical accuracy. Another most troublesome difficulty which has been successfully overcome by the use of special machine tools is the pressing of the interpole seats which lie as it were in the corners of the box-type frame. The universal use of special jigs and gauges in the manufacture of these motors ensures perfect accuracy and interchangeability.

The field poles are laminated and the interpoles are made solid and have a special shape of tip. Spring washers are used in both cases to keep the coils firm in their places and to prevent chafing due to vibration. The design of the armature embodies strength, compactness and solidity of construction. A fan is provided on the armature for air circulation on the axial system. Air drawn through openings in the commutator spider and armature core passes through the fan and back between the field coils and over the armature and commutator. Openings to the atmosphere are not provided, the whole of the cooling being due simply to radiation from the case, but the circulation of air ensures even temperature throughout the motor.

The construction of the brush gear is very rigid; the holders themselves are substantial bronze castings, and are clamped to the machined face of the casting, which is supported by two insulated rods bolted to the motor frame. The insulation is of pure mica directly surrounding the rods which are forced into their place in the casting by a considerable pressure, the mica being protected during this process by hardened steel split tubes. The completed holder with its insulated supports is subjected to a mechanical test of some 40 tons to ensure that the rods with their insulation are properly secured to the holder. The brushes are arranged for radial adjustment to allow for wear of the commutator and are readily accessible for inspection and adjustment through the commutator trap door.



"Electrician" Photo.

Fig. 2.—View of one of the Trains.

The lubrication of all bearings is effected by means of long fibre wool waste, which syphons the oil up from a separate oil reservoir to the bearings and provides a continuous and automatic supply. Suitable oil wiper rings and guards prevent the oil from the bearings getting into the motor casing, and the oil thrown from the wiper rings passes to a waste pocket of ample capacity in the bearing housing from which it may be drawn off periodically.

Fig. 5 is interesting as showing the performance of one of the electric trains. The curve A is the usual time-speed curve, and the curve B is the corresponding curve of current. It is seen that a speed of about 53 miles per hour is reached in three minutes. The curves C, D are time-distance curves, corresponding to the run where coasting starts at time E, and the run where the brakes are applied at the time F without any coasting. The extra energy to gain the 20 seconds, forming the difference between the two runs, is instructive.

The control of the trains for multiple unit working is effected by the Westinghouse Company's "All Electric" system of automatic relay control. In this system the motor current

is handled by a suitable number of electrically operated contactor switches, the operating coils of which are connected to control wires running throughout the length of the train and actuated by small master controllers. The contactors are provided with interlocking switches connected in their operating circuits to ensure the correct sequence of changes in the connections.

The motor equipment on each coach is controlled during the accelerating periods by its own relay, which is independent of the other relays on the train; hence the motors on the different coaches are notched-up in accordance with their individual requirements, which are, in a measure, dependent upon the diameter to which the wheels may be worn and the slight inherent differences in the characteristics of the motors. This system, therefore, helps to equalise the load on the different motor coaches and gives a low energy consumption. The adjustment is also such that the series coils will come into

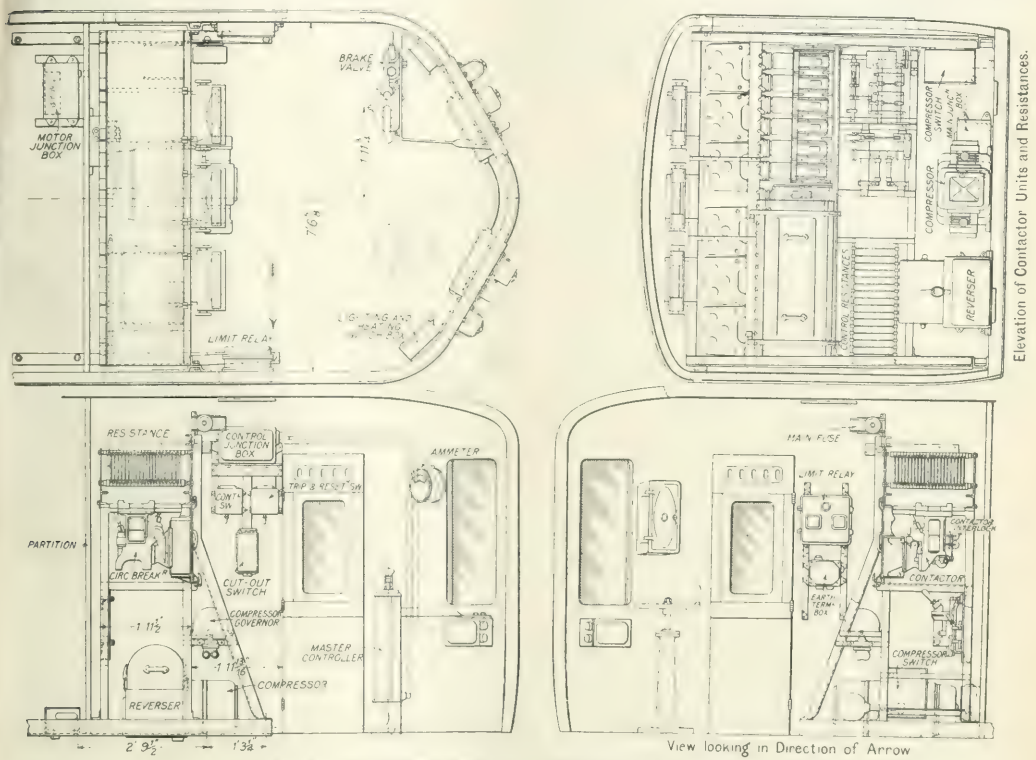


Fig. 3. Arrangement of Electrical Equipment in Driving Cab.

current. The arcing tips are of hard-drawn copper, which can be easily and cheaply renewed. A wiping action between the contacts is provided, so that any roughness due to arcing when opening the circuit does not interfere with the contact surface when the switch is in the closed position.

Each contactor and circuit breaker is carried by a pressed-steel plate clamped to mica insulated steel tubes, which are fixed to two channel irons running the full length of the switch group. This method of construction is light and strong, and has the necessary flexibility to withstand vibration. It also renders the withdrawal and replacement of a contactor switch an extremely easy matter.

The interlocking switches mentioned above are fixed at the back of the contactor switches, and are operated by a lever from the movable core of the contactor solenoid, thus ensuring a definite position of the interlocking switch, corresponding with a definite position of the contactor. These interlocking

action with as low a pressure as 350 volts, but they will not proceed to the parallel connection if the pressure is below 470 volts. The advantage of this adjustment is that if the pressure through some accident is brought very low it will not be further reduced seriously by attempting to run the motors in parallel on the reduced pressure.

With this system the master controller becomes a very simple piece of apparatus, and this is important, because it is the only piece of apparatus handled by the drivers, who are generally non-technical men. The operation of the controller is extremely simple, the driver having merely to move the controller right round to the full "on" position, and the relays automatically do the rest. The master controller is seen in Fig. 6.

Powerful magnetic blow-outs are fitted to all pieces of apparatus where there is a possibility of arcing when breaking

switches have been most carefully designed with a view to ready inspection, renewal and withdrawal when necessary. The smallest possible number of different parts is used in the construction.

The frame carrying the contactor switches forming the motor car group lies across the width of the coach in the driving compartment. It also carries the necessary motor-starting resistances and the main fuse above the contactors. The motor resistances are of the usual three-point suspension grid type, mounted on mica insulated tie bars fixed to pressed-steel end frames, giving a strong and rigid construction.

A view of the front of the switch group is shown in Fig. 7, from which may clearly be seen the interlocks at the back of the switches and the arcing tips and arcing boxes at the front of the group. The circuit-breaker is similar in construction to the contactor switches and may be seen in the

middle of the group. It is provided with heavy laminated brushes in addition to the contact jaws, and adjustable overload and trip coils.

The reverser is of the drum type. The drum castings are clamped to mica insulated shafts provided with heavy copper contact segments. The fingers are made with renewable tips and provided with swan-neck finger springs and heavy copper shunts. The finger bases are clamped to mica insulated bars. The interlocking of the control circuits for operating the

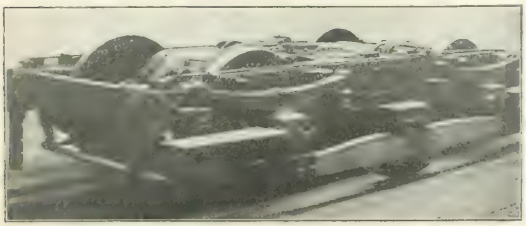


Fig. 4.—View of Bogie and Motor Equipment.

reverser is effected by an additional contact drum attached to the main spindle, so that a fixed relationship between the making and breaking of the main control circuits is obtained. A powerful magnetic blow-out is provided for the interlock fingers, which are identical with the swan-neck fingers used in the master controller.

The master controller is of the drum type, and is provided with both main and reversing handles, so interlocked that the reversing handle must be either in the forward or reversed position before the driver can operate his controller. The main handle embodies the "dead man" feature, the arrangement being such that in the event of the driver releasing upwards at any time, he must bring the operating handle to the "off" position again before he can release the brakes. When coasting and when making ordinary service stops the driver moves the main handle to the "off" position and keeps his hand on the handle, thereby preventing the automatic application of the brakes.

The main handle of the master controller has four operating positions: The first position, usually called the "switching" position, gives series connections to the motors with all resistance in circuit; the second position brings the automatic relay into operation and the resistances are cut out of circuit step by step until full series is obtained; the third position connects the motors in parallel, the well-known bridge connection being used in passing from series to parallel; the fourth position brings the automatic relay into operation again, cutting out the resistance step by step until full parallel is obtained. It is unnecessary to pause on each notch of the controller until the corresponding motor connections are completed; the handle may be moved directly to either the series or parallel positions, when the control apparatus automatically notches up step by step until the position is reached corresponding to the particular notch on which the handle is placed.

The starting current, and therefore the rate of acceleration, may be adjusted by means of the setting of the automatic relay; this relay consists of three coils, two of which have movable plungers fitted with copper discs for bridging contacts in the control circuit, the three coils having a common magnetic circuit. The two coils which have movable plungers are connected in the control circuit and the third coil is a heavy current coil connected in the motor circuit. The function of the two coils in the control circuit is to lift the short-circuiting copper discs and thereby open one of the control circuits, the discs being held up until the motor current in the series coil has fallen to the predetermined value for which the relay is adjusted. The contacts in the relay are never used for breaking circuit, and are, therefore, not liable to cause trouble by burning. The construction of the control apparatus throughout is of non-

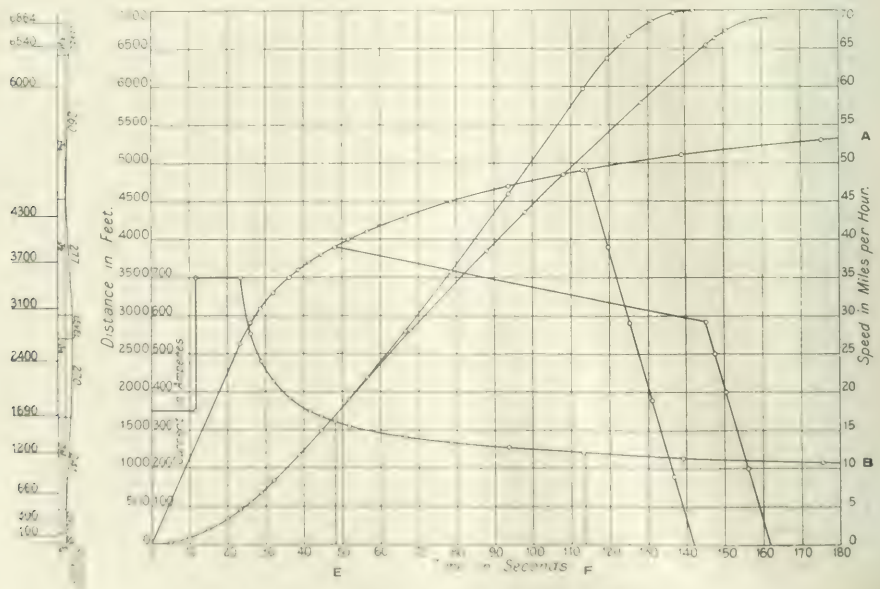


Fig. 5.—Performance Curves of 101 ton Three coach Train unit.

inflammable material, and the whole of the insulation is of mica. Practically all the wiring is in the driver's cab, and the connecting train wires and through shoe cable are fixed on the roof

of the coach as so to be quite out of reach of unauthorised persons. This has the further advantage that should a train be derailed the wiring is less liable to suffer than where it is partly attached to the truck and partly to the underside of the car body. The socket connections for the jumper cables are made with four pins, instead of merely one pin, so that increased contact surface is obtained with the socket.



FIG. 6. VIEW OF MASTER CONTROLLER.

The lighting of the compartments has been the subject of very careful study by the railway company's engineers and a suitable and tasteful fitting has been adopted. The coaches are heated by electric radiators suitably grouped in the various compartments.



FIG. 7. VIEW OF CONTROL [illegible]

The West inghouse brake used on the coaches comprises cylinders 12 in. and 14 in. in diameter, and the triple valves are of the newest design, which passes on the application of the driver's brake valve to the rear of the train a quick-serial movement, resulting in the almost simultaneous application of the brakes on a train 600 ft. long, which ensures a smooth and efficient brake service. The air is supplied to the brake system by small compressors direct-driven by slow-speed motors, one of which is placed in each motor car. The action of all these compressors on a train is controlled by a master governor and switch, which produces uniform compressor labour throughout the train, as all compressors start and stop simultaneously. Thus the bulk of the work is not taken by the compressor placed where the pressure variation is greatest (that is, at the front of the train), as is the case when compressors are controlled individually. This arrangement is known as the Westinghouse Governor Synchronising System.

(To be continued.)

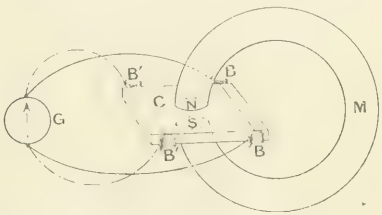
CORRESPONDENCE.

THE LAWS OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I beg permission to add a further letter to mine of last week. Suppose that we take Mr. Hering's figure, and replace the copper block with Mr. Hering's insulated laminæ. Now if this block be made to vibrate forwards and backwards in the air-gap, so that the laminæ cut the lines of force, each lamina will become a small generator. If then we slide the contacts BB along the edge of the laminæ, the galvanometer needle (assuming that the galvanometer is made to respond to alternating currents) will become increasingly deflected until the middle laminæ are past, and the needle will come back to zero when the contacts have come on to the outside laminæ which do not cut the flux.

This experiment I think will sufficiently prove my contention that in moving the sliding contacts along the block we have



not unlinked the original circuit at all, but have really formed a new circuit with each movement of the contacts. To justify Mr. Hering's contention, that part of the copper block between BB should have been moved to the position B′B′, but actually it remains obstinately in the same place. If Mr. Hering can manage to coax the copper lamina BB to the position B′B′, or if he can alter the lines of force passing through the circuit, without altering the constitution of the same and without generating an E.M.F. in it, he may claim that Maxwell's law is dead and that Hering's reigns in its stead.

If he cannot do this, I fear that he must resign himself to the fact that the desperate attempts of his opponents have succeeded. I am, &c.,

North Shields, Sept. 23. C. TURNBULL.

THE FIELD LEAKAGE OF TURBO ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am most interested to learn that the [illegible] serious error occurring three times in Mr. Jakeman's Paper is merely to be regarded as "somewhat loose wording."

So far as the "flux per tooth" method of calculation is concerned the method is a perfectly obvious one, and has been used by myself and probably many others long before the publication of the Paper referred to by Mr. Jakeman. The diagram and explanation of the paths of the magnetic lines with cylin-

dical rotors given in my letter of August 31st also are based on notes made by myself some seven or eight years since. I find that the explanation coincides exactly with that given much more recently in the above-mentioned Paper.

Mr. Jakeman's explanation of the observed shape of the E.M.F. wave induced in the armature conductors is not admissible; if the wave shows perfectly regular steps, the only possible explanation is that the outside teeth carry their normal proportion of useful flux. In cases where the wedges are so deep and the teeth so narrow that non-magnetic wedges would be generally used for the "outside" slots, the use of magnetic wedges would undoubtedly cause a reduction in the useful flux carried by the outside teeth. In such cases—as stated in my previous letter—there is justification for Mr. Jakeman's method, and oscillographic records will undoubtedly show the reduction in the flux carried by the outermost teeth of the pole.

The example cited by Mr. Jakeman in which the two outermost teeth would carry, neglecting leakage, 7 per cent. of the total pole flux is that of a *highly saturated* 600 *kw.* 1,500 *rers. per min.* machine—hardly typical of modern practice! The figure given by me of 2 or 3 per cent. was for the common case of about 18 slot pitches per pole. But perhaps, in this case Mr. Jakeman, in his discretion, would omit the flux in the two outer teeth at each side of the pole—that is, three times as much as the flux in the outermost teeth!—I am, &c.,

Leicester, Sept. 22. A. E. CLAYTON.

THE MAGNETOSTRICTION AND RESISTANCE OF IRON AND NICKEL.*

BY C. W. HEAPS.

Summary.—The author describes experiments on the magnetostriction and resistance of iron and nickel in a magnetic field, both these properties being studied under the same conditions, and the results obtained, and their relation with each other.

The experiments described in this Paper were undertaken with the object of making simultaneous measurements of the magnetostriction and resistance in the same specimens of iron and of nickel. The importance of making different experiments on the same specimens is very evident when a comparative study is to be made. The galvanometric properties of a metal are so intimately connected with the other properties, such as purity, hardness, crystalline structure, &c., that results of different investigators using different samples cannot be compared with each other with any degree of exactness.

Hitherto most experiments have indicated that a bar of iron has a tendency to increase parallel to the direction of a weak magnetic field and decreased when the field is strong. A bar of nickel shows a decrease in length for all fields. Different samples of these metals, however, behave differently. Indirect data that has been obtained in one specimen of iron a contraction for all field strengths, and S. R. Williams† has observed an initial lengthening in the case of nickel.

The importance of considering magnetostriction in connection with resistance is made evident by the failure of theory to explain the effect of magnetic fields on the resistance of metal conductors, unless some definite assumption is made as to the configuration of the molecules in the metal. A



FIG. 1.—APPARATUS FOR MEASURING MAGNETOSTRIC-

constituting the current to change their

* Abstract of a Paper in the Physical Review.

† Phys. Rev., Vol. IV., 1914.

‡ Phys. Rev., Vol. I., p. 270, 1913.

The apparatus used is shown in Fig. 1. The iron or nickel wires A and A', each about 8 cm. long and 0·022 cm. in diameter, were contained in a glass tube, CC'. By using two wires and a lever, G, the effective length of wire was made 16 cm. They were connected [illegible] so that by joining the copper ends K and K' to a suitable Wheatstone bridge the total resistance of the wire could be accurately measured. Changes of resistance were measured by a method of balancing shunts, correcting carefully for the resistance of the leads. The change of resistance of these copper leads in the magnetic field was neglected. The supporting plugs B and B' were of hard rubber, and were firmly cemented into the glass tube. A silk thread extended from the end of A' to the lever DEF. One leg of the mirror M rested on the lever, and the other two on a support. O is rigidly attached to the glass tube. The bearings at G and D were of glass on glass. The image of an electric lamp filament was reflected from M upon a scale 1 or 5 metres away. Other dimensions were as follows: FO=0·2 cm., DE=0·565 cm., EF=3·0 cm. The magnifying power was calculated to be 32,890. In order to be sure that no disturbing effects were present, the wires A and A' were replaced by silk threads and the apparatus placed in the magnetic field. No deflection resulted when the magnetic field was thrown on or off. Throughout the experiment the weight W was 10 grammes and the temperature was that of the room, about 22° C.

The longitudinal magnetic field was furnished by a solenoid 15 cm. long and giving a field of 100 C.G.S. units for a current of 1 ampere. No attempt was made to correct for the non-uniformity of the field. However, any irregularity in the field would probably not affect the value of the data as far as purposes of comparison are concerned.

For producing the transverse field, a Weiss electromagnet with pole-pieces 10 cm. in diameter was used, of which the pole-pieces could be brought as close together as 1·7 cm. The magnetic field

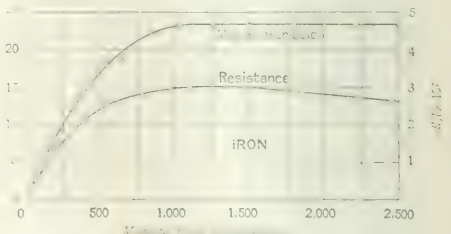


FIG. 2.—CURVES FOR IRON WITH LONGITUDINAL FIELD.

was measured by the use of a bismuth spiral. The chemical composition of the metals was not definitely determined. Soft Norway iron wire was used in one case. The nickel was of the ordinary kind furnished by Eimer & Amend.

In taking the data it was found inadvisable to make simultaneous observations of resistance change and length change, because the current through the wire produced disturbing heat effects. Consequently, a series of readings for magnetostriction was taken and immediately afterwards a series for resistance, the observations [illegible] in every case with a maximum field and ending with the weak field.

The curves shown are plotted from the data obtained, dl/l being change in length divided by length, and dR/R change of resistance divided by resistance. The external magnetic field measured in gauss is plotted without correction being made for the demagnetising effect of the metal wires. If the resistance increased, values of dR/R are plotted above the axis of abscisse; while if the length decreased, dl/l is plotted [illegible] on the same diagram, except in Fig. 5, where dl/l represents a contraction.

The drop in the resistance curve of Fig. 2 is due to transverse mag- [illegible] It has been shown theoretically that in the case of uniform fields there is no initial increase of resistance in a transverse [illegible] and that the [illegible] is responsible for the initial increase observed in iron in the present experiments.

Iron was found to contract for all values of the longitudinal magnetic field. The contraction is in agreement with one of Bidwell's curves, but is at variance with the results of other workers. [illegible] from theory it was expected that in larger fields an elongation might result, as the course of the

† Lees and Mahan, [illegible] Phys. Rev., Vol. IV., 4 1914, p. 315.

irve indicates that "saturation" has not been reached at 12,000. n nickel the transverse field produced an elongation and the longiadinal field a contraction.

In Figs. 2 and 3 there is remarkable parallelism between the resis-nce curves and the magnetostriction curves. An increase of sistance is associated with a decrease of length, and it seems probable that whatever causes operate to change the resistance also perate according to much the same law to change the length of the nductor.

Assuming Drude's theory of conduction, and assuming that by hanging the arrangement of the molecules the longitudinal magnetic eld affects the mean free path of the electrons, it can be proved that $R\ R = dL/L$. It seems reasonable to suppose that when the intermole-ular distances are made smaller the length of the conductor as a hole should decrease proportionally. That is, we might expect

$$\frac{dR}{R} \propto \frac{dl}{l}$$

In Fig. 6 the values of dR/R are plotted against corresponding alues of dl/l. In the case of iron a straight line results, as is to be

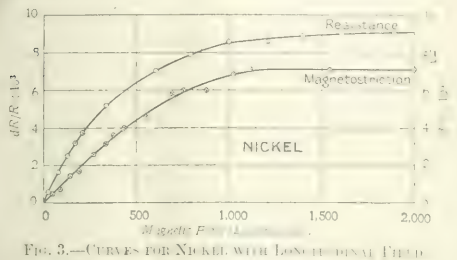


Fig. 3.—Curves for Nickel with Longitudinal Field.

expected from the above theoretical considerations. No values are taken from the resistance curve for fields above 1,200, as transverse magnetisation causes a drop above that point. The curve of Fig. 6 for nickel is also a straight line for large fields, but for small fields the law of direct proportionality no longer holds. W. A. Jenkins* comes to the conclusion that dR/R is proportional to $\sqrt{dl/l}$ for fields below 100 C.G.S. units. Data taken from the observations of other experimenters do not support this. It seems possible that in the case of nickel one cannot assume the change of intermolecular distance for small magnetic fields to be proportional to the total change of length as in iron.

In the case of a transverse magnetic field two factors enter to change the resistance, (1) the molecular rearrangement, and (2) the direct deflection of the electrons by the magnetic field. We would, therefore, expect the magnetostriction and resistance curves of Figs. 4 and 5 to resemble each other only when term (1) is large com-

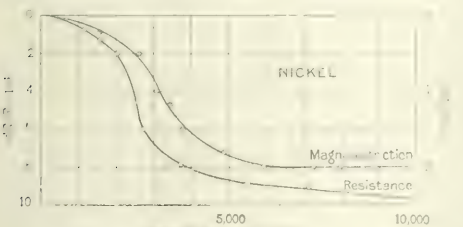


Fig. 4.—Curves for Nickel with Transverse Field.

pared with term (2). This seems to be the case in the nickel specimen studied, though even here the effect of term (2) is evident. When the magnetic field is made as large as 6,000 the molecular rearrangement is complete, and the length ceases to increase. The resistance, however, continues to decrease slightly as the field increases, and this decrease must be attributed to the second term of the above equation.

The curve for iron (Fig. 5) shows that the molecular rearrangement is not complete for fields as large as 12,000. That is, the length change is still dependent on the magnetic field when it has that value. The result seems rather surprising in view of the previous statement of investigators to the effect that the magnetic field is the factor which determines the form of the curve, and it would be difficult to explain it transversely to the above theory.

* "Phil. Mag.," Vol. XXVII., 1914, p. 751.

In all of the curves except those of Fig. 5 the resistance increase is coupled with a length decrease, and vice versa, and for iron the tendency is towards this relation, as is pointed out above. Though a law of direct proportionality may not hold good in all cases, it is noteworthy that those metals showing large magnetostriction also show a large resistance change. The magnitude of the two effects follows the order: nickel, Heusler alloy, iron, If the analogy holds good for other metals, we might expect dl/l in the non-magnetic metals to be of the order 10^{-8} or 10^{-9}.

The data obtained in this experiment permit of a comparison being made between the longitudinal and transverse magnetostrictive effects, though, as has been pointed out by S. R. Williams, the crystalline structure parallel to the length of a wire is different from that perpendicular to the length, so that comparisons cannot be carried too far. If we neglect this factor, we find that iron contracts at right angles to the magnetic field as well as parallel to the field. The resulting decrease of volume per unit volume is of the order 10^{-6}. Nickel expands perpendicularly to the field and contracts in the direction of the field. The calculated maximum decrease in volume

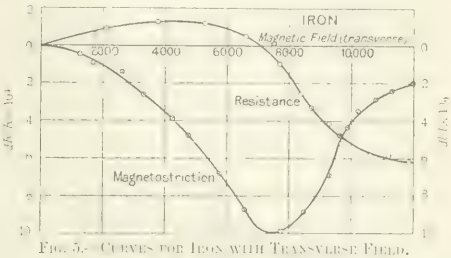


Fig. 5.—Curves for Iron with Transverse Field.

of nickel is 3×10^{-6}. These conclusions are in contradiction to the experiments of Nagaoka and Honda, who found an increase in volume for both iron and nickel.

S. R. Williams, in a series of recent articles, has sought to attribute magnetostriction to the orientation of molecular magnets having the form of oblate spheroids. For this theory to hold good, transverse elongation of a conductor would have to be associated with longitudinal contraction, and vice versa. In nickel this is the case, but in iron the phenomena seem to be of too complex a nature to allow of such a simple explanation. It is probable that some sort of struc-

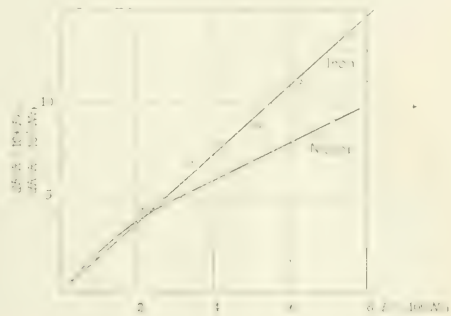


Fig. 6.—Curves showing Relation between dl/l and dR/R.

tural modification takes place in which the molecular grouping is changed by the magnetic field, and this changed molecular grouping may be taken in connection with a theory of oblate spheroids to explain most of the phenomena observed.

Summarising the results, we have:—

1. The specimens of nickel were found to contract when magnetised either transversely or longitudinally.

2. The specimens of nickel contracts in the direction of a magnetic field and expand perpendicularly to the magnetic field.

3. For a longitudinal field the magnetostriction and resistance curves are found to be very similar, as iron the resistance increase is proportional to the contraction.

4. For a transverse field the magnetostriction and resistance curves are found to be very similar, but no definite relationship between

the two effects. In iron the relation ship is also evident, but is more complex than in the case of nickel.

5. Except with iron in a transverse field, contraction is always coupled with an increase of resistance and expansion with a decrease of resistance.

6. Application of the electron theory to the experimental results is as satisfactory as could be expected, though ignorance of the laws governing intermolecular actions in different metals prevents to a considerable extent the testing of any theory.

EDUCATIONAL NOTES.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

The Calendar for the 1915-16 Session has been recently published, and gives full particulars of the courses of instruction, teaching staff, examinations, fees, &c. The head of the electrical engineering department is Prof. W. C. Thornton, D.Sc., D.Eng., and the ordinary pass course for the degree of B.Sc. in engineering extends over 3 years. There are well-equipped laboratories and good facilities are given for practical work. Copies of the Calendar may be obtained (post free) for 1s. 4d.

Northampton Polytechnic Institute.—The day classes will commence on October 4 next, but the evening classes started on the 27th ult. In the engineering day college there are full-day courses in the theory and practice of civil, mechanical and electrical engineering.

The courses in civil and mechanical engineering include specialisation in automobile and aeronautical engineering, and those in electrical engineering include specialisation in radio-telegraphy. These courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. Eng. of the University of London.

In technical optics there are full and part-time courses in all branches, and instruction is given in specially equipped laboratories and lecture rooms. Full particulars as to fees, dates, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to the principal, Dr. R. Mullineux Walmsley, St. John-street, London, E.C.

The special classes for Post Office workmen and boy messengers, started two years ago, are being continued, as are also the classes in submarine cable work for the employees of the various cable companies who have their headquarters in London. The elementary and advanced classes in radio-telegraphy are also being announced. In all the departments the programmes of the various classes have been brought up to date, and full particulars of classes, fees, &c., are set out in "Announcements."

Borough Polytechnic Institute, London.—At this institute courses of instruction, extending over four years, are provided for electrical engineering students. There are also evening classes, with special classes for electric wiremen. The head of the electrical engineering department is Dr. John Henderson, and further particulars may be obtained from the principal, Mr. C. T. Millis.

LEGAL INTELLIGENCE.

Alien Enemy Patents.

In the Patents Court last week the Lilleshall Co. applied for power to manufacture a water-cooling valve for internal combustion engines, under patent No. 409 of 1913, which belongs to the M.A.N. Co.

It was stated that in 1906 the Lilleshall Company entered into an agreement with the M.A.N. Company by which they paid down £2,500 for the right to manufacture in England large gas-engines. Under the agreement the patentees were to supply them with all drawings and plans and to provide them with drawings of subsequent improvements as [illegible] entered into. It contended that the patent of 1913, for which they now sought a licence, came under that arrangement.

Mr. R[illegible] for the patentees, contended that it could not [illegible] the subsequent improvements mentioned in the contract related to the double-acting four-cycle gas-engines, and the patent of 1913 was for a [illegible] which was applicable to [illegible]. It was certainly [illegible] to the subject-matter of the contract, and the [illegible] had been [illegible] to pay for the [illegible], as well as royalties.

Mr. [illegible] replied that the original arrangement [illegible] applied to the [illegible] four-cycle engines. [illegible] possibly [illegible] to two-stroke engines, and the valve which [illegible] Company wished to make they desired to make [illegible] from applied.

Mr. Ward [illegible] application was [illegible], and they had made that particular valve already, and he should have thought the [illegible] the agreement [illegible] 2½ royalty on about 2½ per [illegible] had not [illegible] he should pay down on [illegible] sum.

Mr. Justice [illegible] thought the valve was suitable for cooling internal combustion engines of all kinds, and, while he considered there was no question that a licence should be granted to the Lilleshall Company to make it, he thought it clear that such a valve as that was not in contemplation when the contract was entered into. He would report to the Board of Trade.

PARLIAMENTARY INTELLIGENCE.

POST AND TELEPHONE CHARGES.

In the House of Commons on Wednesday the Postmaster-General (Mr H. Samuel) stated, in reply to questions, that the postal and telegraphic charges for which legislation was required could only take effect after the passage of the Finance Bill. He hoped it might be possible to bring them into effect on Nov. 1. Legislation was not required for the increases in trunk telephone charges and call office fees and the charges for postal orders, and those would take effect from Oct. 1. Fixed annual "flat rate" payments for telephone service would be raised in each case at the end of the period for which rental had already been received, or at the earliest date thereafter on which existing agreements could be terminated.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from copies of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

12,910 Heberstadt & Tempest. Method for generating high-frequency electric currents.

Consists in setting up a rotative field having local concentrations of magnetic density by means of exciting coils fed by polyphase currents, and providing a plurality of [illegible] coupled to the exciting coils so that by rotation of the field, voltage impulses are set up in the generating coils from which currents of a much greater frequency than that of the original polyphase currents can be obtained.

19,191 St. Helens Cable & Rubber Co. & White. Holders for electric incandescent lamps.

19,237 Marks. (Morkrum Co.) Mechanism for printing-telegraph systems.

19,319 Tyler & Beere. Electric connections.

19,322 Mackenzie. (International Electric Tool Co.) Electromagnetic percussive devices.

21,368 Cooke. Electric contact-breakers or interrupters.

32,881 British Thomson-Houston Co. (General Electric Co.) Electric connections for resistance bodies.

Consists in providing a terminal which is united with the silicon surface intimately, so as to entirely exclude the air, and thus prevent the formation of the oxide film, and which gives rise to only a small thermo-E.M.F., and consequently inappreciable local heating. This terminal consists of an alloy of silicon and a metal, such as an alloy of silicon and aluminium.

1915 Specifications.

641 Conner. Current-interrupting devices for magneto-ignition apparatus.

2,490 Sheppard & Yarwood. Starting-means for electric motors.

4,748 Radley. Electric circuit controllers of the drum type. (30/3/14.)

7,510 Sturge. Devices for adjustably suspending electric and other lamps, electroliers, gas pendants and other objects.

8,189 Mossay. Accumulator cases for motor-vehicles.

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously [illegible] Names within square brackets are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

September 10, 1915.

12,974 Gaunt. Electrical heat-diffusing apparatus for medical and other purposes.

12,978 Ballington & Skeaw. Track ramps for signalling and train-stopping apparatus (Addition to 5,807/14.)*

12,984 Grogan & Burder. Electrical cooking apparatus and switchgear therefore.*

12,994 Mackay. Electric lamps. (12/9/14, U.S.)*

12,995 Orange. Electric lamps. (12/9/14, U.S.)*

12,999 Sperry. Searchlights. (16/4/15, U.S.)*

September 11, 1915.

13,033 Reeve. Transmitting signals electrically.

September 13, 1915.

13,051 John. Replaceable electrical safety fuses.*

13,062 Quincey. Electric absorbers for pendants, stand lamps, and the like.

[illegible]

13,080 Brockie. Projector arc lamps.

13,088 Guinness. Sparking-plugs and their manufacture.

September 14, 1915.

[illegible]

13,129 Otto. Arrangement for producing short unidirected high-tension current impulses.*

13,145 Derbies. Apparatus for cutting down wire entanglements, telephone and telegraph or other wires from a distance, also applicable for grappling purposes.

September 15, 1915.

13,176 Morrison. Power-transmission systems. (15/9/14, U.S.)*

September 16, 1915.

13,216 Southgate. Electrical methods for sounding church and other bells.

13,220 Paul. Electrical terminal.

September 17, 1915.

13,283 Duffy. Means for regulating the output of dynamo-electrical machines driven at variable speeds.

13,287 Nieuland. Dynamo-electric machines.*

[illegible]

September 18, 1915.

[illegible] Apparatus [illegible] capable of [illegible] cutting down wire entanglements, telephone and telegraph or other wires.

[illegible] Means [illegible] and reflectors [illegible]

THE ELECTRICIAN
COMMERCIAL & INDUSTRIAL SECTION.

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LABOUR PROBLEMS.

The response to the call for men for the fighting line and [illegible]e making of munitions for the present great war will [illegible]suredly go down to history as a remarkable testimony to [illegible]e grit and patriotism of the working classes of this [illegible]untry. The commercial and industrial system of the [illegible]esent day furnishes an almost automatic classification labour into two distinct groups, namely, skilled and [illegible]skilled. The latter by far exceeds the former in [illegible]mbers, and if anything the tendency is to increase [illegible]ther than decrease the army of unskilled labour. This [illegible]ndition of affairs is brought about by an industrial [illegible]d commercial system which aims at production by [illegible]achinery tended by unskilled labour; the use of labour this class quite naturally has an important influence [illegible]pon works costs of every kind.

Enormous difficulties were experienced up to the outbreak of war in meeting the demands of Labour so as to [illegible]dmit of reasonable competition with other countries [illegible]here the industrial conditions differ greatly from our [illegible]wn, and where, speaking generally, labour is cheaper than is here. As with many other problems of a social and [illegible]ommercial character, the war has dropped into the melting [illegible]ot the whole of the labour question, and many of our most [illegible]ble industrial chiefs are deeply concerned with what the [illegible]utcome may be. Some slight idea of the difficulties which [illegible]must certainly arise may be gathered from the discussion, [illegible]which we publish in another part of this issue, by the Municipal Tramways Association on the employment of [illegible]emale labour as conductors on tramcars. The subject was [illegible]ably introduced by Mr. J. Dalrymple, general manager of [illegible]the Glasgow Corporation Tramways, and the experience of [illegible]that city with female conductors was fully detailed by him. The discussion which followed was of more than ordinary interest, and its tone can be regarded as indicative of what may be expected to occur on a general scale throughout the country. Mr. C. W. Mallins, general manager of the Liverpool tramways, is evidently a student of labour problems, and we should say also an able judge of human nature. He raised what we think is undoubtedly the vital point of this matter: What is to become of female labour after the war, particularly having regard to the fact that vast numbers of men have enlisted upon the promise of their employers to reinstate them should they be fortunate enough to return. It is to be presumed that this promise will be kept, even should men come back in a crippled condition. The delegates attending the tramway conference seemed, and we think unjustly, to have the idea that Mr. Mallins would repudiate this promise, for several speakers disagreed with him, and by their remarks gave the impression that they resented the discussion of the matter in any shape or form.

If the war continues for another 12 months, and there are not yet any definite signs to the contrary, the army of temporary female workers, shall we call them, will be enormously increased. At the time that peace is concluded these women will have been in service maybe a year or more, and their employers will have adapted the particular business in which they are engaged to whatever manner the use of such a type of labour may have required. We very much doubt, even assuming that a high percentage of men return or wish to return to their former employment, that so great a number of women could be economically and conveniently re-absorbed by the spheres of life in which they were engaged previous to the war. There are many who believe that the able-bodied men and effectives who return from the front at the peace will not be anxious to return to sedentary or indoor occupations. It is expected that they will wish to continue under outdoor conditions, and will endeavour to find places in the Colonies. This would appear to be a fairly reasonable and by no means an unjust forecast of what may happen. An extremely small percentage of effectives will no doubt return to their former employment; the balance, as we have just said, will probably be absorbed by the Colonies; the remainder, and it is not a very comforting thought, who will mostly be crippled, and, therefore, only partially available for commercial and industrial work, will be at the disposal of the country. Should this prove to be the case, the women will be retained in the work for which they were engaged ostensibly "for the duration of the war," and commerce and industry must then face the fact that they have come to stay.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

Two Weeks ended Sept. 26, 1915, to Sept. 25, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

U.S.A.: Electrodes, 113 pkgs.; insulating cable, 75 pkgs.; unenumerated, 29 pkgs.

London.—*U.S.A.:* Elec. machinery, £5,830—92 pkgs.; carbon candles, £129; telephone materials, £248; elec. lamps, £1,693; wire and cable, £1,124; unenumerated, £3,902—95 pkgs. *Switzerland:* Carbon candles, £450; unenumerated, £542. *Holland:* Elec. lamps, £2,669—267 pkgs.; telephone materials, £45. *France:* Elec. lamps, £1,093—472 pkgs.; carbon candles, £310; elec. machinery, £200; lamp parts, £315; unenumerated, £222. *Denmark:* Elec. machinery, £2,130; unenumerated, £498. *Italy:* Carbon candles, £65; wire and cable, £3,957. *Sweden:* Lamp parts, £674; elec. machinery £3,478; unenumerated, £460. *Canada:* Elec. motors, 26 pkgs. *Norway:* Telephone material, £98. *Victoria:* Unenumerated, £83.

Manchester.—*U.S.A.:* Elec. bulbs, 24 pkgs.

Southampton.—*France:* Elec. lamps, 10 pkgs.; unenumerated, 27 pkgs.

EXPORTS.

To Australasia.—*Auckland:* Wire and cable, £28; unenumerated, £1,081. *Melbourne:* Wire and cable, £2,120; elec. machinery, £42; unenumerated, £1,084. *Sydney:* Elec. machinery, £77; wire and cable £2,280; unenumerated, £1,830. *Wellington:* Unenumerated, £936. *Brisbane:* Wire and cable, £10; unenumerated, £128. *Christchurch:* Unenumerated, £52. *Dunedin:* Wire and cable, £92; elec. machinery, £25; unenumerated, £152. *Hobart:* Unenumerated, £42. *Lyttleton:* Unenumerated, £41. *Townsville:* Unenumerated, £58. *Adelaide:* Wire and cable, £96; unenumerated, £77. *Fremantle:* Unenumerated, £19. *Perth:* Unenumerated, £12.

Africa.—*Durban:* Wire and cable, £513; elec. machinery, £537; unenumerated, £1,824. *Port Elizabeth:* Unenumerated, £134. *Cape Town:* Unenumerated, £757. *East London:* Elec. machinery, £30; unenumerated, £185. *Beira:* Elec. machinery, £21; unenumerated, £90. *Delagoa Bay:* Unenumerated, £25.

South and Central America.—*Buenos Ayres:* Wire and cable, £72; unenumerated, £1,960. *Antigua:* Unenumerated, £28. *Barbados:* Unenumerated, £69. *Rosario:* Wire and cable, £797; unenumerated, £1,601.

China.—*Hankow:* Unenumerated, £22. *Shanghai:* Unenumerated, £171.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Elec. machinery, £130; unenumerated, £896. *Calcutta:* Elec. machinery, £81; unenumerated, £341. *Ceylon:* Unenumerated, £65. *Singapore:* Telegraph material, £28; unenumerated, £511. *Penang:* Unenumerated, £684. *Bankok:* Unenumerated, £29. *Karachi:* Unenumerated, £55. *Port Swetenham:* Unenumerated, £151. *Sourabaya:* Unenumerated, £34. *Kilindini:* Unenumerated, £145.

West Indies.—*Demerara:* Unenumerated, £20. *Grenada:* Unenumerated, £20.

France.—*Dieppe:* Unenumerated, £25. *Paris:* Unenumerated, £31. *Boulogne:* Unenumerated, £24. *Marseilles:* Wire and cable, £30.

Russia.—*Archangel:* Wire and cable, £445; unenumerated, £128. *Petrograd:* Wire and cable, £129; unenumerated, £1,500.

Malta. Wire and cable, £73.

Greece.—*Salonika:* Elec. machinery, £71. *Piracus:* Unenumerated, £23.

Portugal. *Lisbon:* Elec. machinery, £270; unenumerated, £9.

Spain.—*Casablanca:* Unenumerated, £70. *Malaga:* Unenumerated, £17.

Holland.—*Amsterdam:* Wire and cable, £1,014. *Rotterdam:* Unenumerated, £25.

Norway.—*Christiania:* Wire and cable, £4,539; unenumerated, £610.

Denmark.—*Copenhagen:* Wire and cable, £20,922; unenumerated, £1,210.

Gibraltar. Wire and cable, £106; unenumerated, £118.

Canada.—*Montreal:* Elec. machinery, £261; unenumerated, £459.

Belawan Deli.—Unenumerated, £40.

FOREIGN GOODS (duty paid and free).

Wellington: Unenumerated, £1,350. *Melbourne:* Unenumerated, £29. *Brisbane:* Unenumerated, £595. *Adelaide:* Unenumerated, £9. *Cape Town:* Unenumerated, £36. *Port Swetenham:* Unenumerated, £85. *New York:* Unenumerated, £506. *Sydney:* Unenumerated, £29. *Durban:* Unenumerated, £35.

IN TRANSIT.

Wellington: Elec. lamps, £320.

Note.—The [illegible] misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

[illegible] Electric Lamps (1915) Ltd. and Osram Lamp Works, Ltd.] have been incorporated and the business will in future be carried on under the title of Osram Robertson Lamp Works, Ltd. The new company has purchased the entire interest in the Lamp Works, Ltd., but the company will continue under its present [illegible] Osram Robertson Lamp Works, Ltd. has taken over the [illegible] of these companies.

[illegible] Edmundson, Electricity Corporation, Ltd., Edmundson Electricity Corporation, Ltd., Salford, Manchester, Telephone [illegible].

[illegible] Co., Ltd., have removed to Cannon House, Lincoln's Inn Fields, W.C. Telephone [illegible] Holborn 1185.

Plant for Sale. [illegible] Ltd. [illegible] Works, Ltd., 61, Bridge-street, Manchester, advertise for sale [illegible].

Patent Development. [illegible] Works, Ltd., 61, Bridge-street, Manchester, [illegible] Patent No. 21,584 (1911), relating to "Secondary electric cells," and No. 21,584 (1911), for "A process of making metal films useful for incorporation with the active material of storage battery electrodes," desires to sell the patents or to licence British manufacturers to work thereunder. Further particulars from Messrs. Boult, Wade & Tennant, 111-112, Hatton-garden, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against Tom Arthur Flather, electrical engineer, late trading at Park Electrical Works, Speedwell-street, Leeds, are to be sent by Oct. 13 to Mr. H. C. Bowling, 24, Bond-street, Leeds, preparatory to the payment of a dividend.

The examination of Archibald B. Gillespie, electrical engineer, 499, George-street, Aberdeen, took place last week at Aberdeen.

Debtor said he had been in business since 1912, when he started with little capital. He had carried through some large contracts, and attributed his failure to taking on contracts too cheaply and to bad debts. Liabilities were £218 and assets £46.

British Electric Automatic Machines (Ltd.) is being wound up voluntarily. Mr. D. Johnston, 1, Bridge-street-place, London, E.C., has been appointed liquidator.

ELECTRICITY SUPPLY.

EXTENSIONS.

Basingstoke.—The Council recently authorised extensions of the electric supply cables at a cost of £430.

Bootle.—The Corporation have decided to apply for sanction to borrow £8,000 to instal additional electric generating plant.

Capt. McLellan, who inspected the supply works on behalf of the Ministry of Munitions, stated that all loads engaged in making war munitions must receive the full supply of electricity required, even if the tramways and private consumers had to be disconnected.

A letter received from the Ministry of Munitions stated that the Ministry was convinced of the necessity of installing additional plant at the generating station, so as to secure the supply of power to the firms making, or shortly to be engaged in making, munitions of war. The installation of two additional boilers represented the quickest and most satisfactory solution of the difficulty, and the Ministry would co-operate in expediting the matter. The Ministry were successful in obtaining two boilers partly completed for another body by Messrs. Babcock & Wilcox and they would be transferred to Bootle, subject to the Corporation accepting their tender, and the Electricity Committee proposed to borrow £8,000, being £5,500 for the boilers, and £2,500 to defray expenses incurred by their erection.

The Chairman of the Committee (Mr. J. J. King) said it was a case of urgency and a direct order from the Ministry. It was the only plant that would carry them through the winter, and they would have asked for it themselves but for the difficulty of getting borrowing powers from the Treasury at present. As a matter of fact they would require another turbine very shortly.

The Committee's proposal was confirmed.

Hammersmith (London).—To meet the demand for electrical energy, necessitated by the activity of many factories on war work in the northern part of the Borough, the Electricity Committee propose to purchase seven additional 200 kw. transformers, at a cost of £1,050.

It is proposed to give a supply of electric current to the premises of Regal Films (Ltd.). The cost of extending the cables is estimated at about £100.

Plymouth.—Extensions of electric supply cables, estimated to cost £100, have been authorised by the Corporation.

Sheffield. The Finance Committee has [illegible] reported on the question of extensions at the electricity works.

[illegible] power supply, it was necessary that additional machinery should be purchased for the electric supply department, and the Ministry of Munitions were urging that such machinery should be purchased as soon as possible and they were assisting the Corporation to get plant. The estimated cost of the new machinery and work was [illegible]. The Committee had been in communication with the Ministry of Munitions, and the Government proposed that [illegible] but the Committee were of opinion that the Government should be prepared to [illegible] the money for the whole plant. The Committee had agreed to the plant and leave the question of [illegible] when the war is over.

At a subsequent meeting the Town Council reported that [illegible] a letter from the Master of Munitions who suggested that [illegible] should be made with the Government for the provision of the [illegible] for the extension of the power on which money the Corporation would pay interest and sinking fund during the war, and at the end

of the war the Government should have the [illegible] the plant from the power station or selling it to the Corporation if they wished to buy [illegible]

St. Pancras (London).—The Treasury have decided to raise no objection to the proposal of the Borough Council to borrow the amount necessary to cover the cost of the new [illegible] at King's Road electricity works. It is intended to raise a loan of £11,265.

Watford.—Application is to be made to the L.G. Board for sanction to borrow £1,560 for mains extensions, &c.

GENERAL

Bedford.—A sum of 50 guineas is to be given to the Electrical Engineer for work done by him outside his duties as engineer, particularly in preparing specifications and supervising work in connection with the isolation hospital, Corporation buildings and all centres controlled by the Education Committee.

Bethnal Green (London).—The consulting electrical engineer (Mr. H. W. Couzens) has reported that in the area of New Tyssen-street sub-station there are sundry premises which are likely to become users of electricity if a supply were available.

Mr. Couzens pointed out that the h.t. feeder cables will be laid from the sub-station along Rapley-place and Satchwell-rents to Bethnal Green-road, but there was no distributing cable provided for in Sir John Snell's report, as it was not anticipated that the sub-station would be situated at New Tyssen-street, and it had now been decided that when the road is opened for laying the mains, a distributor cable shall also be laid along those thoroughfares.

Braintree.—A canvass of the district shows that there is likely to be a good demand for electric current for lighting and power.

Brighton.—Last week the Council considered the report of the Lighting Committee recommending increases in the charges for electric current. The report, which was abstracted in our last issue, was adopted, except that a flat rate of 4 d. (instead of 5d.) per unit will be charged for current [illegible]

Increase of Charges for Electric Current.—Many additional electric supply undertakers have decided to increase the charges for electric current.

East Ham Council [illegible] increased 6 pence, [illegible] been increased from 3¾d. to 4d. per unit, maximum demand consumers 1d. to 1¼d. On power the increase is from 2¼d. to 2½d. per unit for first 450 units; time switch rates are to be raised from 8s. to 9s. for the first 50 units.

Hackney (London), *Harrogate* and *Fleetwood* Councils have made a 10 per cent. increase [illegible]

Luton.—The electrical engineer (Mr. W. H. Cooke) has reported that he is of opinion that, as the high-tension mains to the sub-station would probably have to be duplicated in five or six years' time, it would be ultimately more economical to lay the cables in ducts (instead of in wooden troughs), through which any additional cables could be drawn hereafter, at an extra cost of £670.

Poplar (London).—The electrical engineer (Mr. J. Horace Bowden) reports an increase in the output for the June quarter of 1,076,456 units, or 31 per cent.

The total income increased by £3,297, while the coal bill was only increased by £1,858. The [illegible] corresponding quarter of last year, due entirely to the favourable purchase of coal in November last for future delivery.

Stepney (London).—The execution of the agreement with the Port of London Authority for the supply of current for pumping purposes, and the fixing of the date of its commencement, is to stand over until such time as the P.L.A. desire to bring it into force. The Authority are taking a supply of current for pumping and paying therefor at the same rate as that embodied in the draft agreement for the supply of energy.

Swindon.—It has been decided to supply electrical energy for power to Messrs. [illegible] of an overhead [illegible] at £231

West London Linking-up Scheme.—In a report on the scheme for linking up the Hammersmith electric supply undertaking with Battersea and Fulham, Hammersmith Electricity Committee states that it understands that the London County Council has made arrangements for the Borough Council's application to borrow their share of the cost of the scheme (£8,313) to be reconsidered.

[illegible] should be [illegible] a proposed supplemental [illegible] principal [illegible] powers by the Hammersmith Council [illegible]

TRACTION NOTES.

Light Railways.—The report by the Light Railway Commissioners of their proceedings to Dec. 31, 1914, and the report of the proceedings of the Board of Trade under the Light Railways Acts, 1896 and 1912, have been issued.

On Dec. 31, 1913, six orders were before the Board of Trade awaiting confirmation: five of these were confirmed in the following year, and the remaining one is still under consideration. During 1914 nine fresh orders were submitted to the Board by the Light Railway Commissioners for confirmation; three of the orders were confirmed in the year, making, with the five above referred to, a total of eight orders: two have since been confirmed; and the remaining orders are still under consideration. In no case did the Board refuse to confirm an order. The orders confirmed in 1914 authorise about 37 miles of line, at an estimated cost of £365,587. Since the date of the last report, the Treasury have conditionally offered a special advance under sec. 5 of the Act of 1896, as amended by sec. 5 of the Act of 1912, not exceeding £7,000, towards the construction of the proposed Falkland Light Railway, and have also increased, from £17,000 to £25,000, the amount of the special advance conditionally promised in aid of the proposed Swaledale (Richmond to Reeth) Light Railway.

In the 18th annual report of the Light Railway Commissioners for 1914 it is stated that a total of 665 applications for orders to authorise light railways (including 119 applications for amending orders) have been made since the commencement of the 1896 Act. In respect of 438 applications (nine in 1914 and 429 in previous years) orders have been submitted to the Board of Trade for confirmation; eight other applications in respect of which orders are under settlement, have been approved by the Commissioners; and 210 have been rejected or withdrawn. The inquiries with respect to four applications have been deferred at the request of the promoters and under existing circumstances, while five new applications made in November last remain to be considered.

Liverpool.—Sir Chas. Petrie claims that out of 47 cities and towns Liverpool has contributed the highest percentage of tramway employés to H.M. Forces.

Liverpool employed 2,807 persons in the tramway service, and 1,125 (or 40 per cent.) had joined His Majesty's Forces. In London there were 12,612 employed, and 2,354 (18·5 per cent.) had joined; in Manchester 5,000 employés, and 1,978 (39·56 per cent.) had joined; while the percentage in Birmingham was 31,83, and in Glasgow 38.

Luton.—Mr. A. E. Wray, the newly appointed tramways manager, is to confer with the Borough Engineer and settle all outstanding matters relating to the tramways, including the condition of the track in certain places. Women conductors are being engaged, and the service generally will be improved.

Stepney (London).—In July the L.C.C. asked the Board of Trade for an assurance that no order would be made under sec. 41 of the Tramways Act, 1870, declaring their powers in respect of the tramways in Burdett-road, &c., to be at an end in the event of the rails along certain sections of the route being removed.

The Board have replied to the effect that they doubt whether the provisions of sec. 41 of the Act would apply and that the Board would not, in any case, be disposed to make any order under the section. In view of this letter the L.C.C. has advised the Borough Council of its intention to electrify the lines as soon as circumstances permit.

TELEGRAPH & TELEPHONE NOTES.

Hull Telephone Service.—On Monday the Hull Telephone Committee received a report on complaints of the service given.

The manager (Mr. T. Holme) said that during the 25 working days in August 3,416 complaints were received either by letter, messenger or telephone, and in 869 cases no fault could be detected by the inspectors. During the same period the switched calls exceeded 2,000,000. The average was about two faults per instrument per annum, which was about the standard of efficiency aimed at.

Radiotelegraph Notes.—Mr. T. Waage, the British vice-consul at Stavanger, Norway, reports that the new Marconi station at Stavanger for communication between Norway and the United States is completed. The receiving station is at Ullanhaug. Power is supplied by the Stavanger Corporation Electricity Works, the contract being for 600 electric h.p. annually. It is proposed to erect a wireless [illegible] scheme for establishing a chain of low power [illegible] Norway coast and one station in Eastern Finland [illegible] with Spitzbergen and Ingria, and also with the projected Russian stations on the Murman and Siberian coasts, which will serve the shipping of the White Sea and Archangel.

The opening of the new Marconi station at Hawaii in conjunction with the reported early opening of the stations in Japan, is a matter of interest, as when these Japanese stations are opened it will be possible to send radio messages across the Pacific. There are two stations at Hawaii, one at Kokohead, the south-eastern end of the island of Oahu (receiving station), the other at Kahuku, the northernmost end of the island. At Kokohead the st tion has five 300 ft. masts, and is chiefly intended for receiving messages from San Francisco. A station has been established at the top of Koko Crater, 1,200 ft., for receiving messages from Japan. The Kahuku station has twelve 300 ft. masts and that at Kokohead covers 40 acres, the cost of erection and equipment being over £200,000.

Telephone in Norway.—Considerable extensions of the telephone service have been made in Norway, and a trunk line has been taken right up to Narvic, in the Arctic Circle, communicating with the Lofoten and Vesteraalen Islands. This latter line, however, is not working any too well at the moment. In addition to several new lines, another telephone line is being made via Lillehammer to Geiranger, Walesund. A committee is considering the question of a new telephone exchange at Christiania, and has recommended the construction of a main exchange with four local exchanges and a gradual transition to the automatic system. The percentage of telephone subscribers to population in Christiania is 1 in 12.

EMPIRE NOTES.

Australasia.—"Tenders" (Melbourne and Sydney) says Tenterfield (N.S.W.) municipality intend submitting to the ratepayers a proposal to borrow £6,200 for an electric lighting scheme.

Goulburn (N.S.W.) municipality will shortly take a poll of ratepayers on the question of making additions to the electric lighting plant. It is proposed to instal an additional generating set, switchboard, overhead mains, &c., at a cost of £7,500.

Bundaberg (Queensland) Council recently waited on the Minister of Public Works and asked that the Bundaberg Electric Light Co. be allowed to extend its mains into the Woongarra Shire Council's area, in which the pumping station was situated, so that, if the Council thought it was desirable, electric motive power could be applied to the works at the station. The Minister thought it would be wiser to consider the question of extending power from the Bundaberg Co's Co., for which an Order in Council had been requested by the Council, enabling the company to provide an electric supply in the Woongarra area.

The net profit of the electric lighting undertaking of Port Melbourne [illegible] for the year ended June 30 was £335.3s.3d. Receipts were £2,570 8s 10d. A profit of £450 for the year is estimated.

New Zealand State Telegraphs and Telephones.—The report of the N.Z. Post and Telegraph Department for the year ended March, 1915, states that, including miscellaneous receipts and Government telegrams, the total value of the telegraph and telephone business was £665,938 (against £579,816 in previous year). The length of pole line telegraph and telephone is 16,463 miles (increase 905).

On the outbreak of war a military guard was placed at each of the wireless stations. Four operators and two men with engineering capabilities were sent with the first expeditionary force. Communication with Fiji was soon established, and from Oct. 19, 1914, telegrams were accepted for transmission to Samoa. Communication continued to be carried on through that route for some time. Regulations for controlling the use of wireless on British and foreign ships, not registered in New Zealand, while they are within territorial waters, were [illegible] 16, 1915, and are now in force. Observations are still being made at N.Z. land stations of atmospheric electrical disturbances which interfere with the reception of signals. The data collected are communicated to the British Association for the Advancement of Science.

[illegible] telephone subscribers increased by 3,805 [illegible] 2,40, made up of 62 central and 188 [illegible] The total number of telephones connected with [illegible] 1,261 compared with [illegible] 1,629 miles of telephone exchange line and 113,479 [illegible] The number of telephone stations at the 10 principal [illegible] on March 31, 1915, was as follows:—Auckland, [illegible] 6,084; Dunedin, 4,672, [illegible] Wellington, 4,108; Napier, 1,379; Invercargill, 1,364; [illegible] Palmerston North, 1,096. New exchanges were [illegible] Kaiwaka, Kohukohu, Ohaupo and Te Kauwhata, Kohukohu, [illegible] Hikurangi, Kohukohu, [illegible] Te Kauwhata district at Cobden, [illegible] Waiuku. The construction of [illegible] exchanges [illegible] a considerable [illegible] as also the [illegible] During the year 50 miles of [illegible] 48 miles of [illegible] cable were laid, [illegible] Auckland. A new [illegible] made at Christchurch, [illegible] and [illegible] works will be completed [illegible]

[illegible] Exchanges. The building to accommodate the apparatus of the new system at Courtenay Place, Wellington, has been finished some time, and the alterations to provide for like apparatus at Newtown have been made. Some of the apparatus has come to hand, and has been placed in position in both buildings. The automatic exchange building at Masterton has been completed, and some of the equipment erected. Further work is hindered by reason of non-arrival of materials. The contracting company was manufacturing at Antwerp and London the apparatus for the several exchanges for which tenders had been accepted. When Antwerp fell into the hands of the Germans the company was able to get away to London large quantities of the manufactured goods and the special tools used in their manufacture. There is, however, little immediate prospect of large arrivals of the necessary materials to get on with the automatic exchanges. The present Strowger automatic plant will be continued in use for some time even after some of the exchanges of the Western Electric system are in operation, and special apparatus designed to enable that to be done is being provided.

FOREIGN NOTES.

Argentina.—The accounts of the tramway companies in Buenos Ayres for the half-year ended June 30 show that the receipts (m/n) were as follows:—

Anglo-Argentine, $13,398,221 (compared with $15,311,224 in the corresponding half of 1914); Lacroze, $2,900,286 ($2,998,599); Electricos del Sud, $202,665 ($132,022); Provincia y Cindad de Buenos Ayres, $392,117 ($467,866). Total, $16,893,289 ($18,909,711).

The units supplied by the Cia Alemana Transatlantica de Electricidad in the first half of this year were 34,523,313 for light (compared with 36,865,652 last year), 13,543,905 (15,374,980) for power and 31,076,038 (32,593,483) for traction.

In the first half of 1915 passengers carried on the Rosario tramways were 13,089,927 (compared with 14,051,574 in the corresponding half of 1914), and the receipts were $1,308,990 ($1,405,159) m.n.

Electrical goods imported into Argentina in the first half of 1915 were valued at $1,765,083 (gold), a decrease of $3,032,393 compared with the corresponding half of 1914.

A municipal decree has been issued instructing the lighting, tax and public works departments of Buenos Ayres municipality to study and report upon the application presented by La Positiva Telephone Co. for permission to establish a telephone service in the Federal Capital in connection with its existing system in the province of Buenos Ayres.

New York Lighting.—The annual report of Mr. Wm. Williams Commissioner of the department of Water Supply, Gas and Electricity, for 1914 states that at the beginning of the year there were 2,643 miles of streets and 19 sq. miles of parks in the city to be lighted, and there were 40,000 electric and 45,000 gas lamps.

Economies were effected, and the total cost of lighting for 1915 will be $400,000 less than in 1914. The nitrogen filled tungsten lamp has largely superseded the arc lamp, and it is claimed that the important streets of greater New York are now among the best lighted thoroughfares in the world. In the borough of Manhattan electric lamps are superseding gas lamps, and about 15,000 gas lights will be displaced during the current year. On most of the bridges arc lamps have been discarded for 300-watt nitrogen-filled incandescent lamps, and in the case of one bridge alone the saving effected by the change was $4,000 per annum.

Norway.—Consular reports on the trade of Norway in 1913 contains the following:—

The question of transmitting electric power to the towns and districts south of Porsgrund from a power station owned by Porsgrund, Gjorpen and Solum municipalities is in a fair way of being solved.

It is reported that the directors of the company owning the only paper mill in the Christiansand district are considering the erection of an electric cable transporter from Aalefjær, on the Tepdelsfjord, to Christiansand, a distance of about 4 miles.

[illegible] Mining Co. have put down two new turbine-driven generators of 4,000 kw. and 2,000 kw. respectively. The magnetic separating works at Bogen, in Ofoten, worked for part of 1913. The Rodsund magnetic separating works in Nordmoen for the treatment of titanic ore—produced about 7,000 tons of "slich," and are to be increased to about twice their present extent. Magnetic separating works are also being constructed at Fosdalen in Beitstad. The Melö mine on Gjerko produced about 11,000 tons of slich ore, and exported about 12,000 tons. The Dunderland Ulefos produced about 21,000 tons, while the Langö mines near Kragerö produced some 8,300 tons, of which 2,500 tons were exported [illegible] to the electric ironworks at Notodden. By the end of November, 1913, the total exports of iron ore, slich and piece ore were estimated at 329,536 tons, besides 186,712 tons [illegible] briquettes, against for the whole year the export was about 300,000 tons and the production 400,000 tons, valued at £400,000.

[illegible] Norway. The electric power station at Tysse, Hardanger, was [illegible] in the spring of 1913. It was carried on throughout the year at Tysse. Telephonic [illegible] at the end of November a new [illegible] the Indre [illegible] was carried at Ulefos ironworks. [illegible] the electric power station of 2,000 h.p. has been built at

which 1,400 H.P. is required for the furnace and 450 H.P. for the Fehn mines. The Stavanger electro-steel works, which make steel from iron, began working in March, 1913, and produced about 2,000 tons of steel by the end of the year.

Nickel Refining.—The nickel refining works at Christiansand employ Hybinettes' electro-metallurgical process, and turned out 600 tons metallic nickel and 350 tons copper, against 400 and 200 tons in 1912.

Copper.—The Sulitjelma mines, the largest copper mines in Norway, produced in 1913 about 125,000 tons export pyrites and 1,385 tons of copper. About 11,570 tons of hut and fine ore, and 14,580 tons Elmore concentrate, were smelted, giving on the average about 5·3 per cent. copper. About 290,000 tons ore passed through the sorting house at Sandnæs, and 180,000 tons through the washing house. The entire works are now being extended so as to increase the production from the year 1916 to 165,000 tons of pyrites and 2,000 tons copper per annum. The following extensions were almost completed by the end of 1913: Power station enlarged by two new turbine sets of together 2,400 H.P.; boring machinery at the principal mines and electric locomotives in certain parts of the mines.

Electric Power Works.—The Vice-Consul at Skien refers to the re-utilisation of the water-power of the celebrated Rjukan station No. 1 at a second station (No. 2), each station affording about 140,000 H.P., employed in the saltpetre industry, also states that about 12,000 H.P. is transmitted some 50 miles to the Skien Fjord from the Aarlifos waterfall in Hiterdal. The Skien Corporation were constructing during 1913 a station to transmit electric power from Slemdal, about 7 miles away, so as to supply Skien with about 3,000 H.P. The Aarlifos Company are said to have contracted to supply a Swiss company of alloy manufacturers with 10,000 H.P. The Vice-Consul at Porsgrund adds the information that the factory, for alloys of iron and for carbide, is to be erected on the Island of Roligheden and connected with Porsgrund by a bridge. The Corporation of Porsgrund, Gjerpen and Solum will soon have at their disposal about 3,000 H.P. for the development of industries.

The Vice-Consul at Christiansand says the Otteraaens Brugseierforening has obtained Government powers for regulating the Otra river so to secure an increase in the present power of the river, which it is believed will enable power stations to be established at the now unused waterfalls of the river, and a municipal committee is planning the building of a power station at one of the falls belonging to the municipality of Christiansand. The Christiansand electricity works, owned by a company, have increased thir plant by 1,500 H.P.

Electrical Machinery, &c.—The Vice-Consul at Skien says the Norwegian armature factories, though numerous and said to be efficient, are still alleged to suffer keenly from dumping in Norway by foreign firms at ruinous prices. One of the chief makers of electric machinery and appliances at Christiania, particularly well known for its telephones, has started a branch in Italy, and has also formed a new Norwegian company in conjunction with a well-known Swedish firm for the manufacture of electric motors and dynamos.

Carbide and Cyanamide Works.—The Vice-Consul at Bergen says the plant of the Tysse Waterfall Co. (A./S. Tyssefaldene) has a total capacity, including reserves, of 86,340 H.P., of which 56,000 H.P. is supplied to carbide and cyanamide factories. The total capacity in 1915 will be 129,840 H.P., when the power at Tyssedal is fully harnessed, and to this must be added an eventual utilisation of the power at Skjæggedal. A dividend of 18 per cent. was paid for 1913. Extensions are in progress at the Vadheim electro-chemical works on the Sognefjord.

The Aura Company, in Romsdal, has been established with a capital of about £2,200,000, to dam up the lakes in the mountains between Sundalen and Romsdalen, and bring the water down to Lilledalen, where a factory for the production of nitrogen is to be built. The owners both of the waterfall, which will yield 250,000 H.P., and of the projected factory, are the Nitrogen Products & Carbide Co.

Spain.—The installation of a telephone system throughout the Provinces of Catalonia has been authorised.

A concession for the construction and working of an electric tramway from Mongat to Tiana (Barcelona Province) has been granted to Senor Juan Gari, and a concession for a similar line from Densto to Ibarreco-landa (Vizcaya Province) has been granted to the Cia Vizcaina de Electricidad.

Don José E. Lavin and others have been authorised to utilise the waters of the Rio Cares in Posada de Valdeon (Province of Leon) at rate of 3,400 litres per second, for the production of electric power for lighting and other industrial uses.

MISCELLANEOUS NOTES.

Electro-Harmonic Society.—The first Smoking Concert of the 1915-16 season will be held in the King's Hall of the Holborn Restaurant on Friday evening next (Oct. 8th), at 8 p.m.

Exports to China and Siam. A Royal Proclamation relating to the exportation of articles to China and Siam during the present war prohibits the export of any article to China or Siam unless consigned to such person or persons as may be authorised by or under the Proclamation to receive such articles.

A schedule to the Proclamation gives a list of some of the authorised persons, among whom are the following:—

China.—Messrs. Edgar Allen & Co., American Machinery Co., American Trading Co., J. H. Andrew & Co., Babcock & Wilcox, Belgian Trading Co., British Insulated & Helsby Cables (Ltd.), Brunner, Mond & Co., Brush Electrical Engineering Co., Butterfield & Swire, China Agents Co., China Engineering Co., Cie d'Eclairage de Tramways de Tientsin, Cie Française des Tramways, de l'Eclairage Electrique et des Eaux de Shanghai, Thos. Cook & Sons, Dunlop Rubber Co., Eastern Extension, Australasia & China Telegraph Co., Eastern Trading Co., Energie Electrique, General Electric Co., General Electric Co. of China, General Electric Co. of New York, Great Northern Telegraph Co., Hankow Light & Power Co., Inniss & Riddle New Engineering & Shipbuilding Works, S. Pearson & Son, Reuter's Telegram Co., Rose, Downs & Thompson, Samuel & Co., Shanghai Electric & Asbestos Co., Shanghai Electrical Construction Co., Standard Oil Co., Takata & Co., Tientsin Gas & Electric Light Co., Vacuum Oil Co., Worthington Pump Co., Yangtse Engineering Works.

Siam.—Siam Electricity Co., Standard Oil Co., United Engineers (Ltd.) and Vacuum Oil Co.

Russian Year Book.—The 1915 edition of the Russian Year Book has been published later than usual owing to the disturbance caused by the war.

The present edition has been edited by Mr. N. Peacock, who has modified the ordinary scheme of the work by the omission of the sections on trade Reports, Russian literature, &c., but there is a good resumé of the economic and industrial condition of Russia in the first six months of the war, an interesting account of the directions to which British commercial enterprise may be turned, a translation of the New Customs Tariff with the regulations made thereunder, and a diary of the war to the end of June. Many of the old features have been retained and brought up to date, but we could wish more technical information on the electrical and engineering progress, especially in the large towns and industrial districts. We note that in 1912, out of 1,063 towns with a population over 10,000 only 219 had organised water supply, and in 1904 only 38 towns were drained, 55 possessed tramways and 105 had electric or gas lighting. Electric current is now supplied at 6½d. to 7d. per unit, and many power stations have been erected in recent years. The municipal stations, which are mainly in the smaller towns, are about 48 per cent. of the total. The new edition of the Year Book should prove invaluable to those who have, or hope to have, trade or commercial relations with Russia, for it contains much useful information on the laws, tariffs, administration, ways and communications, ports and shipping, postal services, natural resources, mining, &c. It is published by Messrs. Eyre & Spottiswoode, East Harding-street, E.C., at 10s. 6d. net.

TENDERS INVITED.

Electric Cables, Transformers and Switchgear.

LITTLEBOROUGH Urban District Council invite tenders for the supply and laying of High tension Cables, &c., and for Transformers and Switchgear for sub-station. Specifications, forms of tender, &c., from the Clerk to the Council (Mr. Geo. H. Wild), to whom tenders are to be sent by Friday, Oct. 22. Plans and specifications may be seen at, but not obtained from, the office of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C. *See also an advertisement.*

Cooling Towers.

PEMBROKE Urban Council require tenders by 10 a.m. Oct. 3 for supply and erection of a Cooling Tower at their electricity works. Specification from the Clerk, Ball's Bridge, co. Dublin.

Engine and Dynamo, Boilers, &c.

The Deputy Postmaster General, Adelaide (South Australia), requires tenders by 2 p.m. Oct. 6 for Portable Internal combustion Engine driven coupled to Dynamo, and for increasing capacity of Storage Batteries at Central Telephone Exchange, Adelaide, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications from the Deputy Postmaster, General.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for the supply and maintenance for 12 months of two Water tube Boilers and Accessories at Newcastle, N.S.W. Specification, &c., from the Electrical Engineer, 61 Hunter-street, Sydney, N.S.W.

Arc Lamp Carbons.

Tenders to be received by noon Oct. 14 for the supply of 2,000 pairs of Negative Arc Lamp Carbons for Sydney electricity department. Forms of tender, &c., from the Borough Electrical Engineer.

Generating Plant.

The AUSTRALIAN COMMONWEALTH Department of Defence require tenders by noon Oct. 25 for Power-station Plant and Equipment for the Naval Dockyard Cockatoo Island, Sydney, N.S.W., and by noon Oct. 27 for Machine Tools. Specifications from Director of Navy Contracts, Navy Office, Melbourne.

Telegraph and Telephone Material, Wire, &c.

The Director-General of the Commonwealth of Australia invites tenders (until Oct. 6) for the supply of Poles (iron or steel) and Fittings.

The Deputy Postmaster-General, Brisbane (Queensland), invites tenders (until Oct. 6) for the supply of Thread Copper Wire (schedule 357) and Bronze Wire (schedule 360) for the COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Brisbane (Queensland) requires tenders by Oct. 6 for 2,860 yds. Silk and Cotton Insulated Switchboard Cable (schedule 353) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Electric Capstans.

SYDNEY Harbour Trust Commissioners invite tenders (by 2 p.m. Oct. 25) for the supply of 6 Electric Hydraulic Wharf Capstans. Specification, &c., from the office of the Commissioners, Circular Quay, Sydney, N.S.W.

TENDERS RECEIVED AND ACCEPTED.

BETHNAL GREEN (London).—The Electricity Committee recommends the acceptance of the tender of the Higginbottom & Mannock for supply of two travelling cranes for the sub-stations for £270. The only other tender received was from Carrick & Ritchie at £300.

SUNDERLAND.—The Council have accepted the tender of Ferranti Ltd. for e.h.t. switchgear and meters; that of the British Insulated & Helsby Cables and India Rubber, Gutta Percha & Telegraph Works Co. for cables; and that of E. C. Rees for transformer oil.

STEPNEY (LONDON).—The Electricity Committee recommends the acceptance of the tender of Strachan & Henshaw (at £67) for the supply of two ash skips for the telpher track at Limehouse station.

NEWPORT (MON.).—The Corporation have placed an order with the British Thomson-Houston Co. for converter plant, and with the British Electric Transformer Co., for transformers.

Meter Contract.—The annual contract for the supply of d.c. meters to Melbourne (Australia) City Council has been placed with the Reason Manufacturing Co.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Commonwealth Government Departments:—

Director of Naval Dockyard, Melbourne: Wm. Langley & Sons, 60,000 wrought spindles for Victoria, 33,000 ditto for Queensland, 10,000 ditto for South Australia, 14,000 ditto for Tasmania, all at 9s. 9d. per 100; Western Electric Co., 100 and 250 lamp receptors, £2. 11s. each; Wolverton, Parker Ltd., one Pneumatic battery for Wyndham radio telegraph station (W.A.) £340, one ditto for Mount Gambier (S. Australia) £345, one ditto for Flinders Island £305, one ditto for Rockhampton £305.

Postmaster-General's Department, Melbourne: Siemens, Palmer & Preston, 50 telephone sets 30s. each, and 4,000 protectors for subscribers' stations 3s. 9½d. each; Western Electric Co., 50 receivers, 11s. 6d. each.

Postmaster-General's Department, Perth: A. J. Todd & Co. (for E. B. Cook) 15,000 copper jointing sleeves £3. 14s. 5d. per 1,000, 5,000 ditto £3. 19s. 8½d per 1,000; Western Electric Co., copper jointing sleeves 4s. 5d. per 1,000, 5,000 ditto £3. 12s. 6d. per 1,000, 72 pliers 19s. 10d. per dozen, 3 ditto 25s. 8d. per dozen, 60 ditto 13s. 7d. per dozen, 60 ditto 16s. 11d. per dozen, 10 gross thimbles £1. 11s. 4d. per gross; John McIlwraith & Co 100 lead earth plates, 10s. 6d. each.

Director of Naval Ordnance, Melbourne: British Insulated & Helsby Cables, h. and l. cables, at rates; Australian General Electric Co., arc lamp carbons £46. 10s. per 1,000; R. W. Cameron & Co., Kerite insulated wire, at rates; India Rubber, Gutta Percha & Telegraph Works Co., Silvertown generator (30 kw.), with shunt regulator, &c., £138. 10s.

Director of Naval Ordnance, Fremantle: Chas. Atkins & Co 15,000 metallic shaft lamps, at prices ranging from 2s. to 11½d. each.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Colchester.—The accounts of the electricity department for the year ended March 31 show total capital expenditure £96,794 (increase £1,681), of which £34,945 has been repaid.

Revenue was £18,110 (increase £17,[illegible]) and expenses were £10,296 (£10,147), leaving a net profit of £7,814 (£7,611), against £2,631 (£2,007), and making [illegible] of £3,853 (£3,669) [illegible] (£1,085) [illegible] accounts, &c., the net result being a surplus of £812 (£649). Average price obtained per unit sold was 2·09d. (2·10d.) [illegible] (2·24d.) for public lamps, and 1¼d. (1½d.) for traction. Total costs [illegible] (£8,184). Maximum demand was 924 kw. (1,029 kw.), and load factor was 20·49 (18·01) per cent. Units [illegible] (1,625,206) [illegible] (1,911,[illegible]) [illegible] (1,[illegible]) [illegible] (1,[illegible]) [illegible] (1

NEW COMPANIES, MORTGAGES & CHARGES AND STATUTORY RETURNS.

NEW COMPANIES.

BIDDLE'S RAILWAY PATENTS SYND. (LTD.) (141,658)—Reg. Sept. 24, capital £7,500 in 5,000 preference shares of £1 and 50,000 ordinary shares of 1s. each, to acquire certain letters patent relating to improved apparatus for controlling safety of railway traffic and to enter into agreements with the Biddle Automatic Signal (Ltd.) and with W. H. Biddle. Private company.

ELECTRODE CO. OF SHEFFIELD (LTD.) (141,654)—Reg. Sept. 23, capital £40,000 in £1 shares, to manufacture, buy, sell and deal in electrodes and other electrodes used in connection with electric furnaces and other materials and appliances for the manufacture of steel and alloys or otherwise, and to carry on the business of ironmasters, smelters, engineers, &c. Private company. First directors nominated by firms whose names are given in parenthesis: D. Vickers and W. Clarke (Vickers Limited), H. Peile (Newcastle Alloy Co.), W. H. Ellis (John Brown & Co.), F. C. Fairholme (Thomas Firth & Sons), J. B. Mills (Hadfields Limited), C. W. Kayser (Kayser, Ellison & Co.) and Samuel Osborn & Co.

INSTITUTE OF INDUSTRY (OF GREAT BRITAIN & IRELAND) (LTD.) (141,643) Reg. Sept. 22 as a company limited by guarantee with an unlimited number of members, each liable for £5 in the event of winding up, to promote, increase and develop the industrial, scientific, financial and commercial activity of the United Kingdom of Great Britain and Ireland, and H.M. overseas dominions, colonies, dependencies and possessions, and generally to further and encourage inter-imperial trade throughout the British Empire by all lawful means, and to capture, retain and develop branches of industry, trade and commerce which have fallen into the hands of those who are now alien enemies of Great Britain, to watch over the interests of non-alien traders in connection with rates charged by railway and shipping companies, &c. Subscribers are: S. R. Illingworth, W. P. Thomson, J. Hay, Sir H. H. Bartlett, A. Home-Morton, Sir James Heath, Bt., and J. Taylor Peddie. The subscribers and such following named persons as shall consent to become members shall be the first members of the Institute: Sir Wm. Beardmore, Bt., Sir Clifford J. Cory, Bt., A. Du Cros, J.P., M.P., C. Johnson, G. A. Wills, G. McLaren Brown and Sir Geo. Watson, Bt. The management is vested in a court of directors. The first directors are: Sir H. H. Bartlett, Bt., Sir Wm. Beardmore, Bt., Sir Clifford Cory, Bt., Arthur Du Cross, J.P., M.P., L. Evans, Sir James Heath, Bt., G. B. Hunter, C. Johnson, J. W. Macdonald, W. J. Noble, J. Taylor Peddie, Sir Adolph Tuck, Bt., J. Turner, Sir Wm. G. Watson, Bt., G. A. Wills, G. McLaren Brown, W. Deakin, S. R. Illingworth, T. C. Moore and A. Home-Morton. Until otherwise determined, the entrance fee payable on election shall be five guineas in the case either of an individual member, not being a representative member; 10 guineas in the case of a partnership firm, company or corporation with a paid-up capital not exceeding £200,000, or by any unincorporated association or body not having a share capital, or by a member representative of any partnership, company, corporation or association with a paid-up capital exceeding £200,000; but no entrance fee shall be payable by any of the first 1,000 members of the Institute (including the subscribers to the memorandum of association). Sec.: L. Atkinson, Aldwych Site, W.C. Reg. office: Exhibition Buildings, Aldwych Site, Strand, W.C.

SPECIALITY MFG. CO. (LTD.) (141,669)—Reg. Sept. 24, capital £2,000 in £1 shares (500 6 per cent. cumulative preference), to carry on the business of engineers, founders, millwrights, makers of machinery and munitions of war, dealers in electrical and gas appliances, &c. Private company. First directors are L. Wearden (managing director and chairman), F. Guyler and E. Gregory. Reg. office: 12 Newhall Buildings.

MORTGAGES AND CHARGES.

BRILLIANT SIGN CO. (1907) (LTD.)—Mortgage and land registry charge on Paragon Works, Shepherds Bush, and charge on book debts, to secure all moneys due or to become due to Capital & Counties Bank. Also debenture and collateral security charge, dated on even date, to secure £9,000, charged on company's undertaking and property, present and future. Holders: Capital & Counties Bank.

TYER & CO. (LTD.)—Memorandum of satisfaction in full on Sept. 11, 1915, of debentures dated March 10, 1911.

Particulars of £15,000 debentures, created Sept. 14, 1915, have been filed. Whole amount being now issued. Property charged: Company's undertaking and property, present and future. No trustees.

STATUTORY RETURNS.

CHAMBERLAIN & HOOKHAM (LTD.) £100,000 in £1 shares (10,000 preference shares taken up. £5 per share called up on 7,298 preference, £2 10s. per share called up on 702 preference shares. Mortgages and charges: Nil.

CHISWICK ELECTRICITY SUPPLY CORPN. (LTD.)—On June 2 capital was £100,000 in £1 shares, 62,500 being issued. Mortgages and charges £50,000.

CONSOLIDATED ELECTRICAL CO (LTD.) Capital £1,000,000 in £1 shares (100,000 preference shares taken up. £1 per share called up on 100,000 preference shares. £2 10s. per share called up on 109,243 ordinary and 5s. per share on 109,243 ordinary. £13,067. 15s. paid. £81,932. 5s. unpaid. Has paid, being 15s. per share on 109,243 ordinary. Mortgages and charges: Nil.

CITY NOTES.

MEMORANDA (Sept. 29).—Bank rate 5 per cent. (since Aug. 8, 1914) Consols 65. Consols Pay Day Oct. 1. Stocks and Shares Ticket Days Oct. 13 and 27. Pay Days Oct. 14 and 28. Price of silver, 23 11/16 d.

ASSOCIATED FIRE ALARMS (LTD.)—The accounts for the year ended June 30, after allowing for depreciation, show a loss of £615, which reduces the credit balance to be carried forward to £250. Last year £250 were placed to a bad debt reserve and £864 carried forward.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—The directors have decided not to declare an interim dividend on the preference shares.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—This company has exercised the option to purchase about 308 acres of land at Barking for the erection of a new power station. Only a portion of the land will be required for generation purposes, and the Lower Thames Land Development & Power Co. has been formed to acquire and develop the whole property. The new company will have an authorised issue of £100,000 5½ per cent. 25-year 1st mortgage bearer debentures, of which £80,000 will be issued forthwith at par to share and debenture-holders of the County of London Co., which will guarantee principal and interest.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The directors have declared a dividend on the preference shares at the rate of 4 per cent. per annum for the six months ending 30th inst.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—The directors have declared an interim dividend at the rate of 6 per cent. per annum (3 per cent. actual), the same as in 1914.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—The directors have declared an interim dividend at the rate of 6 per cent. on the preference shares.

WESTINGHOUSE ELECTRIC & MFG. CO. (U.S.A.)—A quarterly dividend of 1¾ per cent. has been declared on the preferred and of 1½ per cent on the common stock.

WINNIPEG ELECTRIC RAILWAY CO.—The directors have declared a dividend at the rate of 2½ per cent. for the quarter to Sept. 30, being at rate of 10 per cent. per annum on the capital stock.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Sept. 29. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shres.	Last Dividend	Name.	Price, Wed. Sept. 29.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9¾	7 2 8	Mar, Sept
10	4½	D. 4½% Cum. Pref.	9	4 15 8	Feb, Aug
10	6	D. 6% Cum. 2nd Pref.	9¾	6 0 0	Feb Aug
5	10	Brighton & Kemp Town Ord.	5¾	6 9 2	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St.	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs...	91	4 1 4	Jan, July
5	2 3	Do. 4½% Pref.	5	6 5 0	Aug. Feb
5	6	Do. Ord.	4	6 5 0	Aug. Feb
10	5	City of London & Elec. Lts. Ord.	12⅞	7 11 4	Feb, Aug
10	6	D. 6% Pref.	17½	4 17 0	Mar, July
St.	5	Do. 5% Deb. St.	100	5 0 0	Jun, Dec
10	7½	County of London Ord.	103†	6 15 0	Mar. Sept
10	6%	D. 6% Pref.	90	6 13 3	Feb, Aug
St.	4½	Do. 2nd Deb.	91	4 11 3	May Nov
St.	4½	Edmundson's Elec. Supp. 4½% Debs...	91	5 17 8	July
St.	3½	Kensington and Knightsbridge Ord.	71	7 5 5	Feb, Aug
St.	4½	D. Deb. St.	96	4 13 0	Jan, July
5	3	London Elec. Supp. 6% Pref.	4½	7 1 2	..
St.	4	Do. 4% Mort. Debs.	90½	4 11 11	Jan, July
	3½	Metropolitan E. Supp. Ord.	71	7 . 4	Mar, Aug.
St.	4½	D. Debent. D.	91	4 11 3	Jan, July
St.	4½	Midland Elec. Corpn., 1st Mort. Deb. St.	91	5 1 0	Jan, July
5	5½	Newcastle & Dist. E.L. 6% 2nd Dbs	94½	6 1 10	Mar, Sept
St.	5½	Newcastle-on-Tyne E.S.5%2dMt.Db.St.	110	5 0 0	Mar, Sept
1	5½	North Metropolitan E. P. Supp. 6% Pref	1⅛	5 11 7	Apl, Oct
St.	5½	South London E.S. 1st Mort. Debs.	91	5 5 3	Jan, July.
St.	4½	Urban Elec. Supp 4½% Db. St.	91	5 0 11	Apl, Oct
1	..	Waste Heat & Gas Elec. Gen. Stations	1	5 0 0	Mch, Aug.
1	..	Westminster E.S. Corp. Ord.	1⅛	5 5 0	Mar, Sept
1	4½	D. 4½% Pref.	1⅛	5 5 0	Jan, July
		Electric Railways & Tramways.			
..	..	Central London Pref.	..	4 11 .	Jan, July
..	..	Do. Def.	..	4 11 .	Jan, July
..	..	Central London Guar. Assented Ord.	..	5 15 1	..
St.	4%	Do do. Assented Def. Ord.	..	..	..
St.	4½%	Do. 4% Deb. St.	..	4 11 .	Jan, July
..	..	City & S. London Deb.	..	4 11 .	Jan, July
..	..	Do. 4% Deb. St.	..	4 15 3	May. Nov
1	..	[illegible]	..	4 11 .	Jan, July
1	1	[illegible]	..	1 1 .	..
1	1	[illegible]	..	1 1 .	Jan, July
1	..	[illegible]	..	7 5 .	Mar, Sept
St.	4½	Do. 4% Debs.	..	4 11 .	Jan, July
1	1	[illegible]	..	4 11 .	Feb, Aug
1	..	[illegible]	..	1 11 .	Feb, Aug
..	..	[illegible]	..	1 11 .	Feb, Aug
..	..	[illegible]	..	4 11 .	Jan, July
..	..	[illegible]	..	4 11 .	Jan, July
..	..	3½% Debs.	..	4 11 .	Feb, Aug
..	..	Metropolitan Dist. Ry. Ord.	..	..	May, Nov
St.	4%	[illegible]	..	4 11 .	Feb, Aug
St.	4½	[illegible]	..	6 2 5	Feb, Aug

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price, Wed., Sept. 29	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways—*cont.*	£ s. d.		
St.	6%	Metropolitan Elec. Rly. 6% Perp. Deb.	125½	4 12 8	Jan, July
St.	4%	Do. 4% Deb.	[illegible]	5 11 0	Jan, July
St.	4%	Do. 4% Deb. (1903-5)	[illegible]	5 11 0	Jan, July
St.	4%	Do. 4% Cons. Stock	79½	5 0 4	Mar, Sept
10	..	Underground E. Railway, London Shares	11	..	..
1/0	..	Do. A Ord.	1	..	..
St.	6%	Do. 6% Inc. Debs.	103	5 16 7	Mar, Sept
..	6%	Do. 6% Inc. Bds., Met. Coup. Nos.	79½	5 7 6	Mar, Sept
..	4½%	Do. 4½% Bds.	103	4 11 4	Jan, July
5	..	Yorkshire W. Rating Ord.	8	..	March
St.	6%	Do. Pref.	44	6 17 3	Jan, Jly
		Electric Manufacturing, &c.			
1	1½	Babcock & Wilcox Ord.	21	6 4 5	Apl, Oct
1	6%	Brit. Aluminium Ord.	10	4 13 6	Mar
100	5%	Do. Prior Lien Debs.	103	5 5 6	Jan, July
1	6%	Do. 6% Pref.	20	6 12 6	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	107	7 0 5	Apl, Oct
5	30%	Do. 6% Cum. Pref.	511	5 9 1	Jan, July
1	6%	British L.M.E. Mfg. Co. 6% Pref.	9	5 6 4	Mar, Sep
2	7½	Brit. Westinghouse Pref.	1	9 12 ..	April
100	6%	Do. 6% Prior Lien Debs.	121½	5 12 5	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73½	5 9 1	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	142	7 0 5	Jan, July
5	25%	Do. 5% Pref.	44	5 17 3	Feb, Aug
1	15%	Crompton & Co. Ord.	34	4 14 9	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	11	8 6 11	Sept
5	..	Edison & Swan U. Elec. Lt. A. £3 pd.	1	..	Feb, Aug
1	6%	Elec. Construction Ord.	3	4 1 2	May
1	7%	Do. 7% Cum. Pref.	1	7 19 0	Jan, July
St.	4%	Do. 4% Debs.	64½	6 4 0	Jan, July
10	..	General Electric Ord.	10	9 15 6	July
1	6%	Do. 6% Pref.	20	6 7 3	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	123	5 9 0	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4	4 14 9	..
St.	4½%	Do. 4½% Deb.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7	6 6 6	Feb, Aug
10	5%	Do. Pref.	8½	5 15 6	Apl, Oct
100	4%	Do. 4% Debs.	96½	4 4 1	Apl, Oct
12	22½	Telegn. Con. & Main. Co.	34½	6 7 10	Mar, July
100	..	Do. 4% Debs.	93	4 6 0	Jan, Jly
1	7½	Vickers Ord.	12	4 12 1	May, Aug
1	6d.	Do. 5% Pref.	5	5 11 4	May, Aug
St.	4%	Do. 1st Debs.	87	4 12 7	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99½	4 10 3	Jan, Dec
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	97½	6 1 6	Feb,My,Aug,N
St.	14%	Do. Def. Ord.	24½	6 15 7	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	77	6 0 3	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7½	6 7 ..	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6	6 13 5	Ja,Ap,Jly,O
St.	2%	Eastern Tel. Co. Ord.	11	6 1 3	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	42½	5 5 6	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	77½	5 0 5	May, Nov
St.	4%	Eastern Extension Tel. Co. 4% Debs.	92½	4 6 1 11	Feb, Aug
10	7%	Do. Ord.	11	6 17 3	Ja. An, Jly, O
10	22½	Gt. Northern Tel. Co. with Coup. 8	33½	6 13 3	Ja. My, Jly
25	13%	Indo-European	41½	7 2 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1½	5 6 ..	April
1	7½	Do. 7½% Pref.	1½	5 0 0	July
10	9d.	West Indian & Panama Ord.	11	5 17 0	May, Nov
10	6%	Do. 1st Pref.	9	7 2 10	May, Nov
10	7	Western Telegh. Co.	11½	5 17 7	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	79½	5 0 7	Jan, Dec
..	44½	Do. 2nd Deb.	96	4 13 9	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telegh. $100 Cap.	1½	6 3 7	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	7½	6 13 5	Jan, Jly
1	7½	Monte Video Telephn. Ord.	1½	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	94	4 15 1	May, Nov
1	10%	Oriental Telephone Ord.	11½	..	Apl, Oct
..	..	Do. Def.	8½	5 0 0	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St.	85	5 5 4	Jan, July
5	8%	United River Plate Ord.	7	7 3 1	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4½	5 3 3	Jan, July
St.	4%	Do. Deb. Stk.	90	5 0 9	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	11½	6 3 1	Sp,Dc,Mr,Jn
10	..	Do. Def.	6½	6 5 5	Sp,Dc,Mr,Jn
100	5%	Mexican Continental Corporation	4½	6 3 6	Ja,Ap,Jly,O
..	..	Do. Def.	1½	5 13 6	Ja,Jly,O
100	6%	Submarine Cable Trust Certs.	12½	4 11 7	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	101	4 12 ..	Jun, Dec
St.	4½%	Do. 4½% Debs.	93	4 17 5	Jan, July
St.	4%	Do. 4% Debs.	83	5 10 5	Jan, July
5	5%	Do. 5% Pref.	8	7 11 ..	Jan, July
5	7½	Do. 5½% 2nd Pref.	8	7 10 ..	Jan, July
100	5%	Buenos Ayres Tramways	99	5 1 ..	Ja.Ap.Jly.O
100	5½	Do. Pref.	85½	7	Ja.Apl,Jly,O
5	..	Brisbane Trams Ord.	6	4 4 3	May
5	7½	Do. Pref.	8	.. ..	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	94	.. ..	Mar, Sep
5	4%	Do. Pref.	4	.. ..	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	8½	6 0 0	..
100	5%	Manaos Trams 5% Debs.	69½	7 4 11	Jan, July
..	..	Mexico Trams Common St.	11	.. ..	Fb,My,Aug,N.
..	..	Do. 5% Bds.	41	12 3 11	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	91½	4 13 10	Feb, Aug
10	..	Rio de Janeiro Tram. L. & P. 50 yr. Bds.	72½	6 17 11	Jun, Dec
10	4½%	Do. Ord.	32½	4 12 ..	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	7½	Adelaide Elec. Supply 6% Pref.	8½	6 1 ..	Mar, Sept
10	..	Do. Ord.	1½	.. ..	Jan, Dec
1	..	Barcelona Tramways Ord.	1½	6 13 ..	..
1	..	Do. Pref.	1½	6 13 1	May, Nov
1	..	Barcelona Traction Ord.	1½	6 13 1	Mar, Sept
100	..	Do. 6% Pref.	104½	5 14 1	Ja,Apl,Jly,O
5	..	Do. Def.	5½	.. ..	June, Dec
St.	..	Bombay Elec. Supply Deb. St.	93	5 1 ..	Apl, Oct
5	..	Calcutta Elec. Supply Ord.	7½	4 14 ..	Jan, July
5	..	Do. 5% Pref.	11½	4 7 ..	Ja,Apl,Jly,O
St.	4½	Do. 4½% Deb. St.	94	4 15 ..	May, Nov
1	..	Victoria Falls & Transvaal Power	1½	.. ..	Jan, July
1	5%	Do. 5% Pref.	1	.. ..	Jan, July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Sept. 29, the following as the present basis prices of

New Metals.	per lb.		Old Metals.	per ton.	
Solid Drawn Brass Tubes	12½d.		English Lead	£25	0 0
Solid Drawn Copper Tubes	13d.		Antimony	Nominal.	
Brazed Copper Tubes	13d.				
Brazed Brass Tubes	14d.				
Brass Wire	12½d.		Clean Scrap Copper	£66	10 0
Copper Wire	12¾d.		Brazierv Copper Scrap	£63	0 0
Rolled Brass	12¾d.		Clean Scrap Brass	£51	0 0
Brass Sheets	13¾d.		Old Lead	£18	0 0
			Old Zinc	£32	0 0
	per ton.		Hollow Pewter	£110	0 0
Copper Sheets	£98 0 0		Black Pewter	£85	0 0
Spelter	£66 0 0		Gun Metal	£59	0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Sept. 28, the following approximate prices of SCRAP METALS:—

	per ton.			per ton.	
Aluminium Cuttings	£85	0 0	Old Lead	£22	0 0
Clean Mixed Brass	£54	0 0	Tea Lead	£20	0 0
Clean Copper	£67	0 0	Old Zinc	£19	0 0
Brazierv Copper	£61	0 0	Hollow Pewter	£110	0 0
Gun Metal	£63	0 0	Shaped Black Pewter	£75	0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £70; Commercial Tinman's Solder, £93; Blowpipe Solder, £98.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or dec. (a)	No. of weeks.	Aggregate. Amount.	Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	Sept. 22	1,673	— 165	16	30,654	+ 979
Anglo-Argentine	,, 23	50,319	+ 1,307	38	1,930,886	— 138,424
Ashton-under-Lyne	,, 25	597	+ 67	26	12,884	+ 724
Ayr Corporation	,, 24	342	+ 30	19	9,458	+ 336
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	,, 26	1,423	+ 185	26	35,830	+ 2,610
†Birmingham Corporation	..	..	..	..	..	..
Blackburn Corporation	,, 22	1,563	— 187	26	35,306	— 610
Blackpool Corporation	,, 23	2,674	— 260	26	56,953	+ 436
Blackpool and Fleetwood	,, 25	1,304	— 340	38	33,386	— 458
Bolton Corporation	,, 26	2,677	+ 185	26½	70,519	— 3,114
Bournemouth ... { Trams	,, 22	2,478	+ 614	25	57,366	+ 2,268
Bournemouth ... { Buses	,, 22	32	— 15	25	803	— 120
Bradford Corporation	,, 25	6,405	+ 743	26	171,879	+ 7,258
Brighton Corporation	,, 25	1,278	— 118	26½	31,706	— 244
Bristol Trams { Trams	,, 24	4,666	+ 259	38	179,317	+ 361
Bristol Trams { Buses, &c.	,, 24	5,095	+ 1,176	38	186,781	+ 32,368
Burmah E. Trams & Ltg.	,, 25	R3,463	— R20	38	R135,731	+ R1,028
Burnley Corporation	,, 25	1,576	— 224	25	55,495	+ 1,545
Burton Corporation	,, 23	300	+ 16	26	7,611	— 354
Bury Corporation	,, 25	1,487	+ 167	26½	35,406	— 1,209
Calcutta Tramways Co.	,, 25	R62,872	— R3,203	..	..	..
Carmarthen Trams	,, 22	147	+ 11	38	5,253	— 23
Cardiff Corporation	,, 25	2,564	— 150	25	70,841	— 3,338
Cork Electric Trams Co.	,, 25	507	+ 70	38	19,285	— 57
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	,, 17	1,995	— 419	25	26,960	+ 2,835
*Derby Corporation	,, 25	1,071	+ 128	25	27,553	+ 548
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	,, 24	179	— 24	12	2,093	+ 33
Dublin United	,, 24	6,469	— 847	38	234,398	+ 8,849
Dundee Corporation	,, 22	1,307	+ 103	14½	25,884	+ 1,100
East Ham Council	,, 25	1,300	+ 143	25	34,261	+ 5,341
Exeter Corporation	,, 24	..	— 64	25	10,241	+ 606
Glasgow Corporation	,, 25	22,277	+ 2,004	17½	364,838	+ 25,944
Glossop Trams	,, 20	151	+ 39	3½	4,881	— 19
Gloucester Corpn.	,, 22	357	+ 61	25	8,697	+ 42
Halifax Corpn. ... { Trams	,, 21	2,437	+ 146	25	53,853	+ 437
Halifax Corpn. ... { Buses	,, 21	57	+ 6	25	1,315	+ 1
Hastings Elec. Trams Co.	,, 23	1,273	+ 271	38	38,449	— 2
Huddersfield Corpn.	,, 25	2,674	+ 211	25	70,896	+ 9,133
Hull Corporation	,, 25	3,078	+ 132	25	77,922	+ 2,826
Ilford District Council	,, 25	680	+ 92	25	17,206	+ 2,676
Ilkeston Corporation	,, 22	147	+ 25	25	3,420	+ 47
Ipswich Corporation	,, 25	576	+ 157	25	14,952	+ 2,246
Isle of Thanet Co.	,, 25	396	+ 299	51½	22,493	— 10,929
Kilmarnock Corporation	,, 20	162	+ 15	19	3,355	+ 64
Lanarkshire Trams Co.	,, 23	2,172	+ 396	38	74,325	+ 2,041
Lancashire United	,, 22	1,859	+ 273	38	66,946	+ 3,772
Leeds Corporation	,, 25	9,054	+ 1,406	26	233,883	+ 17,815
Leicester Corporation	,, 25	3,222	+ 360	39	116,252	+ 5,403
Leith Corporation	,, 25	794	+ 111	19	15,185	+ 724
Lincoln Corporation	..	..	..	..	..	..
Liverpool Corporation	..	..	..	..	..	..
Llandudno & Colwyn Bay R.	,, 24	437	+ 114	43	15,139	+ 1,272
London County Council	,, 19	45,414	+ 5,888	24	1,048,862	— 9,269
Lowestoft Corporation	,, 25	140	— 52	21½	9,018	— 2,234
Maidstone Corporation	,, 25	250	+ 28	24	5,837	+ 51
Manchester Corporation	,, 25	18,408	+ 1,826	25	463,547	+ 11,923
Nelson Corporation	..	..	..	..	..	..
Newcastle-on-Tyne Corpn.	,, 25	6,538	+ 837	25	162,678	+ 23,390
Newport (Mon.) Corpn.	,, 25	886	+ 80	25	22,002	— 56
Northampton Corporation	,, 24	832	+ 137	23½	19,465	+ 4,057
Nottingham Corporation	,, 13	3,739	+ 1,713	25	95,994	+ 6,542
Oldham Corporation	,, 24	2,340	+ 247	27	62,896	+ 1,066
Portsmouth Corporation	..	..	..	..	..	..
Preston Corporation	,, 24	941	— 37	25**	24,553	+ 191
Rochdale Corporation	..	..	..	..	..	..
Rotherham Corporation	,, 24	1,207	+ 118	25	29,162	+ 3,064
Salford Corporation	,, 25	5,283	+ 424	25½	136,900	+ 3,892
Sheffield Corporation	,, 25	6,613	+ 1,713	25	165,210	+ 29,260
Southampton Corpn.	,, 25	1,650	+ 451	25	35,806	+ 3,078
Southend Corporation	,, 25	..	— 60	26	23,852	— 6,976
Southport Corporation	,, 25	..	— 93	24½	20,210	— 350
St. Helens, Rainhill, Ormskirk & Prescot	..	..	..	..	..	..
St. Helens, Ryde, &c., Jt. Bd.	..	..	..	..	..	..
Sunderland Corporation	,, 25	1,492	+ 114	26	39,294	— 797
Sunderland District	,, 25	1,492	+ 114	26	39,294	— 797
Swindon Corporation	,, 25	..	— 36	47	26,168	— 670
Tynemouth Tram Co.	,, 1	657	— 73	11	7,434	+ 47
Wallasey Corporation	,, 25	1,320	+ 113	25½	33,...	+ ...
Walsall Corporation	,, 25	..	— 147	38	28,374	+ 4,040
Warrington Corporation	,, 25	845	— 142	25	25,055	+ 3,047
Warrington Corporation	,, 25	845	— 142	25	11,530	+ ...
Wigan Corporation	,, 25	..	— 35	25	11,530	+ ...
West Ham Corporation	,, 25	3,114	+ 400	25	80,517	+ 631
Weymouth Corporation	,, 25	1,572	+ 172	25	38,751	+ 1,068
Wolverhampton Corpn.	,, 25	1,154	+ 221	25	28,273	+ 1,080
Yorkshire W.R. Trams	,, 25	1,...	+ 1...	39	62,172	+ 5,222

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses &c. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 3 days.
¶ Plus 2 days. ** Compared with one week more last year.

THE ROUND TABLE.

Event of the Week. The King's Example. Who follows?

* * * * *

What is the answer to the following electrical query?
When did the series transformer?

* * * * *

Our American friends are just ahead, not of violating their neutrality, but well it seems inevitable, but it's true of adopting concentric wiring!

* * * * *

One of the turns at the Empire Theatre, London, is that of Capt. Sorcho (late N.S.A. Submarines), who descends in diver's costume into a large tank and speaks through a head-dress telephone, as he puts it, "to the outer world." In his pamphlet the interesting statement is made that "the weight of Capt. Sorcho's paraphernalia is estimated at 30 tons." Some weight that!

* * * * *



As applied to Pole.



As applied to Trench Periscope.



As applied to Walking Stick.



As applied to Sporting Rifle.

The adjoining illustrations show a simple form of trench periscope invented by that veteran patentee Mr. C. W. Denny, the repeater fuse inventor. Mr. Denny calls our attention to the fact that the instrument can be applied to rifle, pick, walking stick or pole, and when not in use can be carried in the pocket. To prevent loss, we think that the two mirrors should be connected with a piece of cord or flexible wire. Officers who affect the moderne may also find the method

* * * * *

The editor of "Cassier's Magazine," in his current (April) issue, must have recently returned from the States, judging by the error which he makes in describing Sir John Snell as the president of the *Institute* of Electrical Engineers. One looks for this mistake among contractors and other loose-worded individuals, but not in the columns of an engineering magazine.

A goodly company of Batti-Wallahs assembled at the informal meeting held last week and presided over by Mr. W. Wyld, one of the vice-presidents of the Society. The musical programme was contributed by the members and their friends. Bobbie Smith refused to sing "I am the Pirate King," as requested, his excuse being that he only knew Scotch songs, and no Scot was ever found out to be a corsair. The chairman also refrained from appearing in pearlies according to programme, but he officiated in complete compliance with the best Hampstead traditions.



Oh 'appy 'appy 'ampstead

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).	Mr. W. G. Pickvance (Wrexham).
Mr. H. F. Street (Southampton).	Mr. H. Gray (Accrington).
Mr. W. H. Cosker (Luton).	Mr. S. E. Fedden (Sheffield).
Mr. T. Roles (Bradford).	Mr. H. F. Friederichs (West Ham depôt).
Mr. A. S. Blackburn (Sunderland).	Mr. J. W. Beauchamp (West Ham).
Mr. C. S. Davidson (Barnes).	Mr. A. H. Shaw (Ilford).
Mr. A. H. Seabrook (St. Marylebone).	Mr. C. Furness (Blackpool).
Mr. E. R. Hill (Reading).	Mr. C. M. Shaw (Worcester).
Mr. J. W. Hamer (York).	Mr. H. A. Nevill (Wakefield).
Mr. S. F. Allen (Wolverhampton).	Mr. Frank Ayton (Ipswich).
Mr. F. W. Purse (Carlisle).	Mr. C. N. Hefford (Leeds).

"Igranic" Patent "Conspede" Panels do not represent merely a number of ordinary pieces of apparatus mounted on a frame and enclosed. There's a reason for every detail!

'IGRANIC'
CONSPEDE PANELS FOR WORKSHOP USE.
IGRANIC ELECTRIC CO., Ltd., London & Bedford.

The whole design is carefully thought out, and each unit is interlocked with the others to make the panels really foolproof and suitable for workshop use.

SIEMENS

ELECTRIC MOTORS

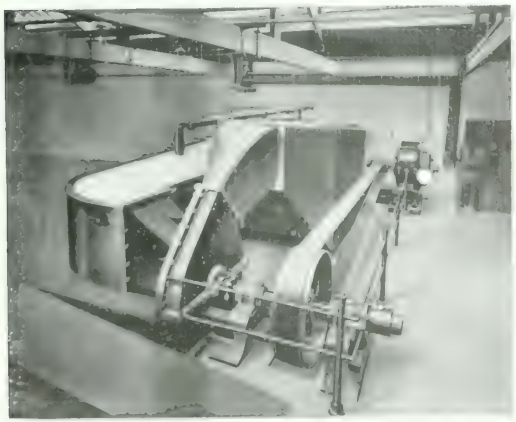


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ELECTRIC DRIVE FOR PAPER MAKING MACHINERY.



THE LIGHTING OF THE YACHT "PIONEER."



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INSULATION BEADS

The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.

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Lightning Arresters and Static Dischargers for all Voltages.

Electrical Apparatus up to 80,000 Volts & 4,000 Amps.

Telephone: 5223 VICTORIA. Telegrams: "GABIONAGE VIC LONDON."

Tintaut glass can be supplied in the following tints, which Tintaut has been found to harmonise with: "Tintaut Cream" and "Tintaut Opal." The latter glass appears white when undighted, while the other two appear slightly tinted. When portable complete installations in Tintaut glass are required, or other tints than those mentioned, please state.

The production of a glass to correctly match daylight has been a lengthy and exhausting one, and the British Thomson-Houston Co. (Ltd.) are to be congratulated on being in a position to place such desirable glassware on the market as one capable of perfect colour matching. Photographers, colour printers, dyers, paper manufacturers, wall paper manufacturers, engravers, painters, lithographers, and those interested in the treatment of skin diseases, artists, &c., will doubtless find such value to them in the glassware as when half watt lamps are used Daylight colour matching can be proceeded with for the whole 24 hours of the day if necessary, and there is no need for further reliance to be placed on a fickle climate.

Tintaut glassware for use with gas lamps is also made. It has been specially compounded for half-watt lamps, which, owing to their high intrinsic brilliancy, are more like sunlight in colour than previous incandescent lamps.

THE G.E.C. GAS DETECTOR.

The accompanying illustration, which is taken from the recently issued "Mining and Colliery Equipment" of the General Electric Co., shows a portable instrument, adapted for use in mines, for the purpose of indicating the percentage of fire damp present in the atmosphere of mines. A number of similar devices have been put on the market within recent years, but the majority of these involve rather laborious testing, and as a result electrical instruments have come in for the purpose. A feature of this detector lies in the fact that the deflection of the galvanometer is absolutely proportional to the percentage of [illegible]. The detector is read off directly from a scale, and a test can be made with this instrument by an unskilled observer in less than a minute. The detector is portable and robust, and [illegible] can be con-



[illegible] Detector for Fire Damp.

nected to the apparatus from a number of different points, and the presence of fire damp at any of them can be immediately detected. We understand that an electrical mining expert, who has tested this instrument, prefers to accept the reading of the instrument rather than [illegible]

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE,
Brass and Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
PHOSPHOR COPPER.
TRADE MARK
CHARLES CLIFFORD & SON, Ltd.
BIRMINGHAM.

ELECTRICALLY-OPERATED CARRIAGE DRIVE GATES.

At a country house in the North of England a pair of gates with supporting stone pillars is electrically operated by gear constructed by the Witton-Kramer Electric Tool & Hoist Co. The motive power is supplied by a 1 h.p. motor geared through a chain to a mechanism for opening and closing the gates. The motor and mechanism are housed in a small turret under the gate. Power



is supplied from the house at 230 volts, and the starting switch is operated from the gates. On pressing a button the gates open up and a solenoid circuit energised, thereby connecting the motor to the [illegible]. On the other hand, when the gates are found closed on the return journey [illegible] by means of a push button. The gates are fitted with [illegible] & Wilkinson, Tipton, Staffs.

THE "SIMPLEX" CHEMICAL FIRE EXTINCTEUR.

Small fire-extinguishers, when properly designed and constructed, are often proof of enormous value. It is a matter of interest that Mather & Platt have devoted their attention to them, and have produced an appliance which, they claim, can be depended on under all conditions. The form of "Simplex" extinctеur now made by the company, has been specially designed to meet the requirements of the British Government, who have placed an order with the firm, which is believed to be the largest ever given for fire extinctеurs. The pattern extinctеur which Messrs. Mather & Platt are now putting on the market is identical with the Government appliance in every detail, with the sole exception of the Royal cipher. The "simplex" extinctеur depends for its operation on the reaction of sulphuric acid upon a bicarbonate of soda solution. The acid is contained in a hermetically sealed bottle, suspended over the liquid, which is discharged through the jet upon smashing the bottle by striking a knob at the top of the extinctеur. The fluid, which has great extinguishing power, is ejected to a distance of 50 ft. or 60 ft. In this appliance there are no valves or rubber hose, and the jet orifice is protected from glass splinters or other foreign material by a cone-shaped sieve.



SIMPLEX FIRE EXTINCTEUR.

At one end of the top [illegible] is provided, through which the acid bottle can be withdrawn for examination.

The body of the extinctеur is constructed of 16 S.W.G. steel, and tested hydraulically to a pressure of 350 lb. It is coated thickly with lead in the centre, and [illegible] the top and bottom, both inside and outside, to prevent corrosion, and every seam is riveted as well as soldered. After testing, the extinctеur is enamelled, the brass parts highly polished and then lacquered. The chemicals with which the machine is charged undergo no change with the passage of time, and the extinctеur will, therefore, operate as satisfactorily after 10 years as on the day on which it was first charged. A special wall bracket has been designed for [illegible] extinctеur is required in a convenient position for use. In one form this bracket holds the extinctеur on the lid of a metal box containing new charges, and a brass pin, which must be withdrawn before the appliance can be operated, keeps it safe from any risk of accidental discharge. Messrs. Mather & Platt have just issued a catalogue relating to their fire [illegible] and will be glad to send a publication to Page Workers [illegible].

EDISWAN
EVERYTHING — ELECTRICAL



A PLACE
IN THE SUN
may be very desirable, but why not put
THE SUN
IN ITS PLACE
by using
POPE
Elasta
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Special Terms on application.
POPE'S ELECTRIC LAMP CO., LTD.,
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The lamp with a living in it

RUBBER BELTING.

Some interesting information on the above subject is given in a brochure which is being distributed to the trade by the North British Rubber Co., Edinburgh. It is stated that the adhesion of rubber belting to the pulleys is greater than that of leather, and this fact, coupled with its tensile strength, is one of the principal reasons advanced by the makers for the employment of rubber belting. They point out that first cost, while it is an important consideration, should not entirely decide the question of belt purchase. The operative efficiency of the belt must be considered, also its non-slipping properties, and the life of the material of which it is made. They claim that properly made rubber belting is superior to leather belting, and they also state that the difference in price, which at one time placed rubber belting at a disadvantage by comparison with leather belting, has almost disappeared with the increasing cost of leather. The company referred to carried out a number of experiments with various qualities of their rubber belting on small lathes and machine tools giving quick reverse action. They state that these experiments showed that leather belts even with the use of practically every variety of dressing, slipped considerably when the reverse was applied and also "dwelt" for an appreciable time on the reverse before taking up the full speed. Several seconds elapsed before these rubber belts were running satisfactorily after the reverse had been put in. In the case of the rubber belt the tests are said to have shown that this immediately took up the reverse at full speed.

A further advantage attaching to the use of the rubber belt, additional to its increased grip of the pulley, is its ability to resist the effects of damp and warm atmospheres. Also it possesses an element of flexibility which enables it to take up shocks to a considerable degree, the absorption of these shocks relieving shafting, bearings, driving motors, &c. The North British Rubber Co. point out that the introduction of rubber belting 60 years ago, and to the present time, readily perfected the design of the belt as well as improved the quality of the materials from which it is made. They frankly admit that the poorer classes of rubber belting have given the rubber belt a bad name, but they as frankly aver that if good material is used and the belt is made to suit the satisfactory operation can be guaranteed. In the brochure referred to a number of pages are devoted to useful notes which will assist belt users in taking care of belting in every [illegible] Systems of jointing by lacing, splicing and riveting are also described and illustrated by simple diagrams. Technical data is also given to assist the belt user in finding the length of belting required, the speed of the belt, the diameter of driving pulley and of a driven pulley necessary to obtain any speed required. It is stated that a belt should not be run under 200 ft. per minute, and the best service will be obtained if it is run at about 2,000 ft. per minute. A copy of this useful publication will be supplied free on application to the company at Edinburgh.

HIGGS MOTORS.

We gather from List C which is issued by Messrs. Higgs Bros., Balsall Heath, Birmingham, that they are makers of D.C. motors, ranging in output from $\frac{1}{8}$ H.P. to 25 H.P. These machines are substantially built and are supplied shunt series, or compound wound. They are built in three classes, protected, ventilated and totally enclosed. The standard voltages are 115, 230, 460 and 500. They are also supplied for 100, 210 and 430 volts with only a slight speed variation and a slight difference in temperature rise. The speed will vary approximately 0·5 per cent. for each 1 per cent. voltage variation. The compound wiring costs an extra 5 per cent. and motors with vertical spindles are supplied 7½ per cent. extra. The totally enclosed machines are also 5 per cent. extra to the list price. A complete specification of these motors is given, from which we take the following particulars:—

On the smaller machines the poles are of laminated charcoal iron, the pole cores and shoes being stamped in one piece; on the larger machines mild steel poles are used, which are cast into the frame and fitted with laminated pole shoes. The armature is built up with "Stalloy" iron plates insulated from one another by a special process. All coils are former wound and subjected to a special impregnating process to expel all moisture. The armature is carefully balanced to prevent vibration, and set in the magnetic field in such a way as to avoid end thrust. The commutator is of hard-drawn copper segments insulated with selected mica, and assembled in taper press rings under hydraulic pressure. The diameter can be materially reduced before the bars require renewing.

Ball bearings ("Hoffmann") are fitted throughout, thus enabling the machine to be fixed on floor, wall or ceiling, without any alteration. Running attention is also reduced to a minimum, and all

after which two coats of grey paint are applied. Each machine is

enclosed 90°F., after this four hours' run, based on an air tempera-

of two megohms and will stand a flash test of four times their normal

This range of machines will carry 25 per cent. overload for one hour, and 50 per cent. for short periods.

B.T.H. FANS AND FAN MOTORS.

to meet the requirements of various classes of service. The fans covered by list No. 7,100-B just issued, embody all the features of well-known designs, while several new types are included. The fans are quiet in operation, light in weight, efficient and reliable. The desk and bracket fans can be adjusted to work in any position and can be supplied with or without oscillating mechanism. The motors are wound for either alternating or continuous-current operation. The bearings are self-aligning and self-oiling. The frame and

and lacquered brass. All alternating-current fans will operate satisfactorily over a range of 5 per cent. above or below normal voltage or frequency. The sum of the variations in voltage and

The motors are designed for three operating speeds, a control switch with an "off" position being mounted in the base casing. This control switch is of an improved lever design, with a notched guide for ensuring a positive setting at each speed. Both oscillating and non-oscillating designs have swivel and trunnion mounting, permitting the movement of the fan horizontally or vertically

type is a useful feature. The swivel-trunnion type of fan is popular

as well as from the tip. The guard is sufficiently stiff to permit

and moving blades for their oscillating movement. They are of the positive geared type. The oscillating mechanism is mounted on the back end-shield, and employs a reduction mechanism enclosed in a

section of the gear box and operates a disc which carries a con-

upon a stud fixed to the stationary fan support. Adjusting nuts for regulating the angle of the oscillation, and for instantly starting or

the fan is in operation, and each gives a definite result. An additional adjustment in the pedestal permits swivelling the ring mounting for the fan body, and therefore the centre of oscillation, within a range of 90 deg. Thus the oscillator, having a maximum stroke of 90 deg. and a swivel adjustment of 90 deg., may be adjusted to any point within an arc of 180 deg. A simple friction device in the reducing mechanism prevents the motor from overturning or burning out should it encounter an obstruction during the cycle of oscillation. The steady and smooth operation is due to a two-bearing support for the motor body, a straight connecting rod, and a correctly designed train of gears.

Particulars of other types such as marine fans, ceiling fans, an

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ELECTRICALLY-OPERATED BRICKWORKS.

Where the nature of the subsoil favours brick making, there exists the opportunity of installing motor drive in the brickworks. But here are few installations where the electrification has been carried out so completely as at the plant of the Springfield (Ill.) Paving Brick Co., recently described in "Electrical World." Electrical operation begins with the digging of the clay, and hauling the shale, dumping the cars, grinding, conveying, mixing, forming the brick and conveying the finished product are accomplished electrically. The coal burned in the kilns is hauled from an electrically-operated mine over a narrow-gauge motor-driven tramway. A list of the motors, together with their ratings and the machines they are driving, is given in the table below. All motors except those used in hauling

One of the most unusual instances of motor drive found in this

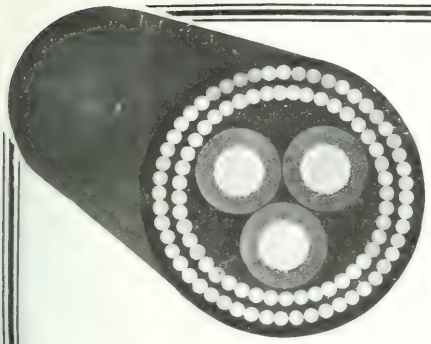
and the trip on the shovel scoop is operated by an extra man. It is proposed to replace this extra helper by an electromagnetic trip to

The control of the shovel is unique in that notched back relays are utilised on the panel board to increase or decrease automatically the resistance of the motor circuit as the shovel load demands. One of the motors is on the shovel boom and the other inside the housing.

operates under changing load conditions.

On the industrial railway operating over the tops of the kilns and

Machine driven.	Rating. H.P.	Speed. revs. per min.
	37	900
	52	960
Geared to Lidgerwood shale hoist	35	960
	3	1,700
	Two 7	760
	40	860
	20	860
	15	
	50	885
	150	720
Conveyor for defective green bricks	5	130
	10	860
	7½	800
	12	775	1,100
Forge blower	0·25	
	½	1,500
Automatically controlled 250-gallon-a-minute fire service pump	10	1,200
	7½	1,000
Coal haul tramway	15	850



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supplying coal from a nearby mine one mile; housed at the upper end of the trestle, clear of the handling. In connection with this machine a system of push-button control has been worked out so that an operator riding on a coal car can stop or start the machine. An auxiliary wire suspended overhead also allows the operator to trip the motor switch from any place on the track, but when this emergency is resorted to the operator must walk to the nearest kiln and push a starting button to move the car. A less serious fault has occurred on this little industrial railroad, as no provision had been made for taking care of the slack on the hauling cable, which continuously and operated around a hoisting drum geared to the hauling motor. Now a tension carriage has been added and is arranged so that in case the coal car should jump the track the cable will slip on the hoisting drum and not continue to pull the derailed car along and demolish the trestle structure.

When the plant was formerly operated by steam, record months showed a production of 1,500,000 bricks, but last June more than 2,009,000 were made, and the record for one day, 103,000 bricks, shows a peak considerably above the average for the month's production. During the month of June, when the 2,009,000 bricks were made the company's meter showed that it had used 52,830 kw.-hour, and hence the energy cost was 26·2 kw.-hour per 1,000 bricks, including the energy required for every operation from digging the clay to handling the completed product. On the day when the record of 103,000 bricks was established it was found by checking the meter on the day that the consumption had dropped to 19·2 kw.-hour per 1,000 bricks. However, this figure is below that which is expected as an average, and it is thought that when the maximum output of the plant, 2,500,000 bricks a month, has been reached the energy used will be about 24 kw.-hour per 1,000 bricks.

EXTRA COPIES OF

ELECTRIC VEHICLE PROGRESS SUPPLEMENT

"THE ELECTRICIAN" PRINTING & PUBLISHING COMPANY,

"D.B.S." GEARS.

The subject of gear cutting has been made a specialty by Messrs. David Brown & Sons, Huddersfield, for many years past. More than ordinary interest attaches to their latest publication, a printed prospectus of some 140 pages, in which they deal specifically with double-helical gears. The value of this class of gear for use with electrical motors will be known, and the successful attempts which the company has made in producing double helical gears points to the fact that they possess practically the best type of speed reduction medium for the transmission of electric power. For many years past gear manufacturers have employed involute gearing for the accurate cutting of double-helical gears. With this type of gear a great advantage is derived in the continuous contact of the teeth as the pressure between the gear teeth should be transmitted on the pitch line, because it is only at this point that there is pure rolling contact. With straight-cut spur gear the contact on the pitch line is only instantaneous, and the double-helical gear has been designed to overcome these disadvantages. The geometry of the subject is discussed at some length, with diagrams, in the opening pages of the publication referred to. Reference is then made to the various processes by which the teeth are produced. Gears made in halves, the rotary cutter process, the double-cut process, the planing process, and the end mill process with continuous teeth are all dealt with, and their respective advantages and disadvantages discussed.

The attention of the reader is, however, specially called to the Sunderland patent planing process with continuous teeth, a process by which the double-helical continuous teeth are directly generated from the solid blank. The makers claim that by the process of the patent rights of this process, and claims that by it they are able to produce perfect double-helical gears. The planing of the teeth is theoretically correct, and by means of the fact that the generating centre can be displaced a certain distance each stroke, and that the completed gear is finished without backing, any error due to deflection in the machine is corrected. The small amount of run going out of the teeth is then finished off by means of a rotating end cut and the process

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which accompany the letterpress make the operation quite clear. It is pointed out that with the Sunderland system the teeth are generated directly from the cutter and not indirectly by means of a former. The Sunderland gear wheels have continuous teeth and are so designed that actual rolling contact takes place along the entire face of the width of the gear. The process makes it possible to turn out wheels smaller and lighter, power for power, than those of other types, this being due to the absence of waste space or ineffective working gap between the teeth of the helicals. It is claimed that it is not possible to avoid noise with mill, hobbed or staggered gears.

In order to ensure the accurate alignment of these gears, the makers recommend their customers to employ their standard single or double reduction cases, which are designed specially to suit each arrangement of gear which works in them. It is pointed out that if a double-helical pinion is rigidly mounted on an electric motor shaft the sideplay of the armature, even though it be small, will slightly reciprocate the pinion, transferring the load first on one half and then on the other half of the gear, causing noise and wear. By mounting the gear wheels in reduction cases with suitable flexible couplings, they are put into service under the best possible conditions and furthermore, they are self-contained and isolated from external [illegible]. The [illegible] of gears and gear cases is to be recommended, and the study of Messrs. Brown's catalogue shows how carefully it has been worked out and how the various standard patterns of gears are grouped and classified. The illustrations in the catalogue clearly point to the existence of a very considerable volume of [illegible]. There is an index of every especially [illegible] of reduction gearing transmitting heavy horse-powers under severe working conditions. A [illegible] is given up to table and formulæ relating to gears of various classes, and these particulars will [illegible] present and prospective gear users. We would particularly recommend this publication to electric power [illegible] engaged in the application [illegible] They will find it [illegible] they will probably get [illegible] and general applications [illegible] electrical torpedo.

ELECTRICITY IN PAPER MILLS.

The Carne Paper Co., Ohio, formerly operated its mill with steam from two 100 n.p. boilers working through reciprocating engines. Recently all but one of these steam engines have been removed and motors substituted. Machinery formerly operated through long line shafts is now individually driven, and although the low price of paper has kept the mill idle of late, a 17-day run on, both with the new equipment showed that 302,600 lb. of wrapping paper was produced with an energy consumption amounting to 17,050 kw.-hour, or 17·7 lb. of paper per kilowatt-hour. Besides making this record in steam energy consumption, the paper company has been able to reduce the regular force of workmen by two men. It is fully expected that when the mill is again operating at its full rating even better specific energy consumption will be shown, although even the above figure the electrical machinery will save the paper company £80 a month. The motors used are all of the 440-volt, three-phase, 750 revs. per min. type, and to operate them energy is supplied from the lines of the Valley Light & Power Co., at Canmer, Ohio, over a 33,000-volt transmission line. The transformer station outside the factory is designed to be equipped with three 75 kw. transformers, operating temporarily with open delta connection. The two old boilers which formerly supplied the engines and steam for the "cooking" process are still furnishing steam to drive one engine and to cook the paper stock.

CHEAP WIRING v. CHEAP ELECTRICITY.

The following letter appeared in a recent issue of the "Electrical World," and is of interest on account of the controversy on the subject in this country :—

We hear nowadays the hue and cry of central stations that only by the introduction of cheap wiring can there be obtained an increase in the central station load. The fact of the matter is, however, that an increase in energy-consuming devices will bring better loads to central stations than cheaper house wiring ever will. Central station managers always assume that the electrical contractor is charging exorbitant prices for his work, and on account of this belief many central station managers are introducing wiring campaigns. As a matter of record, it is a well-known fact that such ventures are very expensive to central stations. After such campaigns, which prove disastrous financially, the central station manager congratulates himself that it was worth the money to secure the extra load. The fact is that if central stations desisted from such unnecessary losses and stopped selling electrical devices "at cost" which is at a loss, of course—the additional expenditures would bring better results if applied toward the reduction in the selling price of energy. A consumer is not interested in the cost of an appliance so much as in the cost of the energy it will consume.

The legitimate business of all central stations is the selling of energy as economically as possible. Under the guise of public benefactors they are permitted to monopolise the field of cities and territories. Any encroachment upon their territories is viewed with alarm, and justly so, for they represent a natural monopoly. However, in the majority of cases they make very little attempt to reduce their rates. It is a fact that very few central stations voluntarily reduce their rates even when they have quadrupled their output.

ELECTRICAL PURIFICATION OF MILK.

Interest attaches to a new plant that has been installed for the electrical treatment of milk at a large milk company's dairy in the United States. The milk arrives in large cans and is emptied into a dumping tank, whence it is pumped to the clarifier. This removes all dirt and foreign material from the liquid. The clarifier and pump are both driven by an 0·5 h.p. motor. The milk passes from the clarifier to a 400 gallon mixing tank, and is then taken through a series of steam-jacketed coils to the purifier, where it is subjected to an electrical pressure of about 2,200 volts. The milk is finally cooled and run into bottles. The whole process is carried out electrically, and a large number of bacteriological and pathological tests show that the milk is rendered free from disease-carrying organisms without any impairment of the digestive or nutritive qualities.

THE ROUND TABLE.

EXPERT OF THE WEEK.—Mr. S. E. Britton, Chesterfield, joins the Point Fives.

When Britton met an Hertz
Arose from out the ozone Dutz.

Mr. A. Joseph (Earl-street, Southwark, S.E.) is asking for applications for a set of blotting pads, about 9 by 7 inches overall. Each card bears a patriotic illustration, one of the least apt of which are silhouettes of the burning of the "Emden," and "Somewhere in Flanders." The rubber [illegible] and are sufficiently explanatory of Mr. Joseph's business.

A correspondent suggests that rather than be the butt of the gas journals, "Kukri" Grogan should go to the front and make himself useful somewhat as shown in the adjoining sketch.



He might perhaps regard the goat as the symbol of the [illegible] rudiment of one of his critics, who for special reasons shall be nameless.

The result of the advertising competition [illegible] which the names of electrical firms were [illegible] rise by drawings [illegible] as far as we can [illegible] opounding. A few of the titles appended [illegible] iguous, and one at least was undignified. The puzzle picture showed a cup-tie football crowd fighting for admission to the ground and the official answer is given as the B[illegible] Engineering Co.!

The current "Barti-Wallahs Journal" contains the following which, since the King's example, will need modifying to read buns instead of beer :—

Baby Beevor's having tea at Bobbins,
Both bright and ruddy bottled beer by Baby Beevor buys.
So the "Spectator" wields his thistle
And sato[illegible]ously says this "I'll
Be the best of bitter bottled beer that Baby Beevor buys.

If you are involved in a heated discussion as to the positions of some of the towns in the Central European war area, keep a "Herdex" pocket war map on you. It may save you the price of a tot of [illegible] beer.

Among the "Books Received" recently is one entitled "Electric Wire and Cable Terminology." A Scotch correspondent writes that it suggests to his mind "Terminal-ogical inexacttudes."

By the addition of Mr. Britton to the Point Fives the number of the members is brought up to 23, within one of the number which we gave after the Harrogate Convention as the limit to which we would continue to publish weekly the names of the members. We will award a Hot Plate to the twenty-fourth member [illegible] of the occasion.

Irascible American (on 'phone): Hallo! Hallo! That you Hirnbaum?

Office Boy: No, sir; Mr. Hirnbaum is in, sir; do you want to speak to him?

I. A.: Why, Holy Smoke, yes! D'ye think I want to sing to him!

A London printing house which operates a large plant by individual motors had occasion to return to the makers a blanket (used on the printing cylinder) which had worn unevenly. A letter was sent making a complaint, and the reply was couched in the following terms :—

Your letter received re blanket and we are going into same.

The firm must be in the North of England where they do things that way.

HOT PLATES

No. 196 to

The "Railway Gazette" for the following in a notice of B.T.H. direct-current motors :—

Communicating poles have been incorporated in the design, which produce a marked improvement in the operating characteristics.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).	Mr. H. Gray (Accrington).
Mr. H. F. Street (Southampton).	Mr. S. E. Fedden (Sheffield).
Mr. W. H. Cooke (Luton).	Mr. H. F. Friedrichs (West Hartlepool).
Mr. T. Roles (Bradford).	Mr. J. W. Beauchamp (West Ham).
Mr. A. S. Blackman (Sunderland).	Mr. A. H. Shaw (Ilford).
Mr. C. S. Davidson (Barnes).	Mr. C. Furness (Blackpool).
Mr. A. H. Seabrook (St. Mary's).	Mr. C. M. Shaw (Worcester).
Mr. E. R. Hill (Reading).	Mr. H. A. Nevill (Wakefield).
Mr. J. W. Hume (York).	Mr. Frank Ayton (Ipswich).
Mr. S. T. Allen (Wolverhampton).	Mr. C. N. Hefford (Leeds).
Mr. F. W. Purse (Carlisle).	Mr. S. E. Britton (Chesterfield).
Mr. W. G. Pickavance (Wrexham).	

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For Direct Current



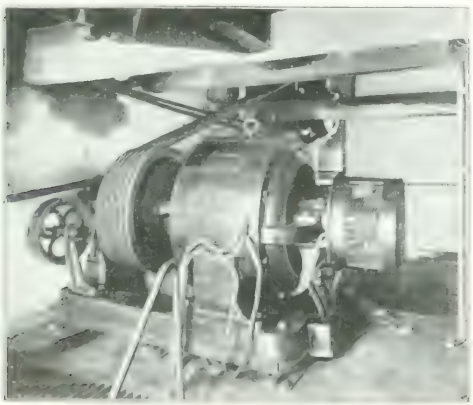
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LIVERPOOL—St. Mary Street. SHEFFIELD—22, High St. (Bldgs. Ltd.)
GLASGOW—150, Waterloo Street. SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

DOUBLING FRAME INSTALLATION.

It is now generally held that the case for textile mill electrification does not depend upon the question that the cost of a brake horse-power hour from an electric motor is more than that from steam, gas or oil central drive. Power economy is only one of the benefits to be derived from electrification. The power costs of a textile mill average



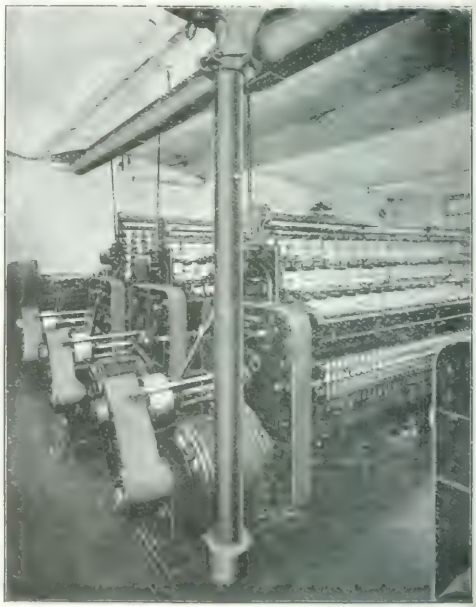
[illegible]

[illegible] drive. Figures have also been quoted showing the advantage of the individual electric drive as against the group driving of the loom line shafts. Textile mill engineers realise the increase in pro-



A General View of the Doubling Frames Driven by Three Phase Motors.

[illegible] section, travel lower than 5 per cent., and the profits rising to 15 or 20 per cent., which follows upon the ability to operate the machinery at approximately uniform speeds. There is also an improvement in the quality of the product which enhances the selling price.



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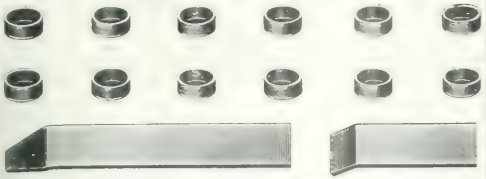
A good example of the electrification of textile mills is the doubling frame installation in the New Bank Spinning Mills of Messrs. Thos. Reynolds (Ltd.), of Stockport. In this installation the main "Wit

EDISWAN

EVERYTHING—ELECTRICAL

[illegible] 13).

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The Elementary Theory of Alternate Current Working

BY

Capt. G. L. HALL, R.E.

The aim of the author is to lead the student to elementary principles of alternating-current work in as simple a form as possible and to endeavour to rob electrical phenomena of the mystery with which they are often associated in the mind of the beginner by reducing them, as far as possible, to every-day mechanical equivalents. The latter part of the book deals with the simple theory of the action of alternating-current machinery, all reference to the construction, testing and design of actual machines being omitted. The book is intended for those who already have some knowledge of the simpler electromagnetic phenomena and of continuous-current working.

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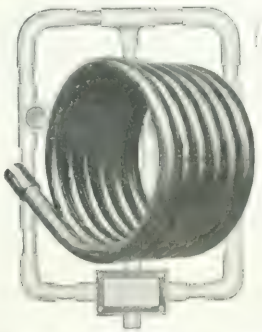
Johnston says:

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Had he been speaking to Engineers in particular he would certainly have advised the use of

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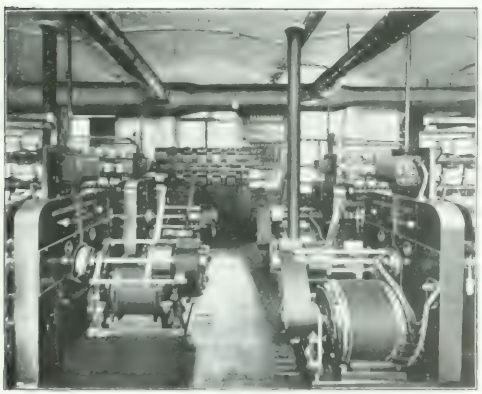
See article in "The Electrician" of April 9th.

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...for a total of 150 h.p. ... 385 ... cycles three phase current, 500 volts, 25 cycles, and ... through ropes from a main mill engine. One of the ... is connected to a 120 h.p., 400 revs. per min. ... slip-ring motor, which drives about 6,000 spindles from a central point. This motor works in conjunction with two Leyland water turbines running in parallel. The water turbines draw their water from the river Mersey, and an ingenious arrangement has been adopted to overcome the variation in the water supply. The motor is of sufficient capacity to take the full load of the 6,000 spindles when the water supply lasts. When there is no water supply available the arrangement is such that the turbines take as much load as the water supply will permit and the motor develops the additional power. This is accomplished by means of a special clutch which ... through the ... of the ... the ... turbines ...



... View of the Interior of Messrs. Mac... Spinning Mill, Rochdale.

Another circuit passes to distribute power in another part of the mill wherein are installed 10 doubling frames aggregating 4,000 spindles. These frames are individually driven by three-phase squirrel-cage "Witton" 1,490 revs. per min. motors. Each motor ... whole gearing can be slung over approximately 45 deg., thus making ...

be left to the operation of the work people. They are provided with mistake-proof devices which fully protect the motor against damage.

We understand that this installation has solved for the owners a difficult problem, as the small purchase available would have made mechanical transmission an impossible solution. We are indebted to Messrs. Thos. Reynolds (Ltd.) and the G.E.C. for the information and illustrations which make up the foregoing article.

SIEMENS RAILWAY AND SHIPS' FITTINGS.

The adoption of metal filament lamps for railway and steamship lighting has resulted in the production of better illumination for less generating cost. The bulb shapes of the lamps, however, differ materially from those of carbon filament lamps, and fittings designers were confronted with the task of originating new fixtures to meet the altered conditions. Some of the latest Siemens designs embody ... effective and improved arrangements for lamp and ... reflector replacements. Fig. 1 illustrates a ceiling ship fitting with a stiletto holophane reflector bowl. The supporting ring is rigidly fixed to the wood block, and is provided with hinge and lock, so that by the use of a railway key either the bottom reflector or the lamps are easily accessible. Fig. 2 shows a side bracket with angle ceiling plate and holophane pine. For ships' saloons, lounges, &c., where the height is necessarily limited, these two designs are proving exceptionally useful. For carriage lighting the ceiling fitting is almost ...



Fig. 1.



Fig. 2.

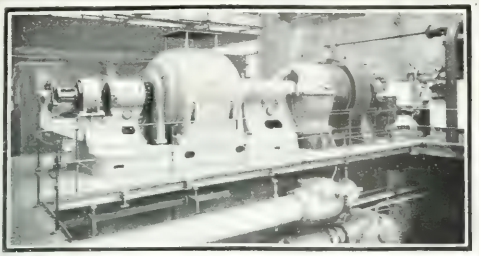


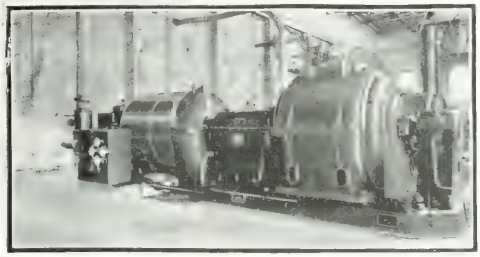
Fig. 3.

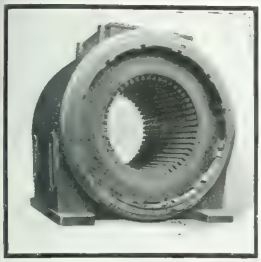


Fig. 4.

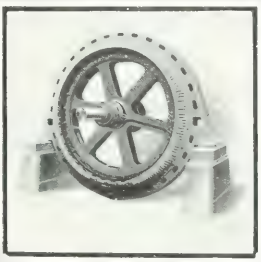
... interesting design which deserves reference. These are being supplied to the London & North-Western Railway Co. for the already electrified portion of their system ... Euston and Watford. The ... of hard wood, with metal rings securely fixed. The upper ring contains a white vitreous enamelled ... from ... and ... to ... The ... is ... (Fig. 4).





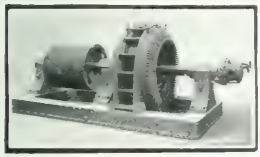


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3, Staple Inn, London, W.C.
TELEPHONE: 6323 HOLBORN
TELEGRAMS: "FERRYDOM, LONDON."

[illegible] improvement on the existing patterns. The lamp is centred in a parabolic reflector, which ensures a perfectly even [illegible] the front glass fixed in front. The bulb's [illegible] dispensed with, as a beam of light may cause inconvenience to drivers of trains travelling in the opposite direction. An [illegible] plate provides a [illegible] to the dashboard from behind, and the front ring provides a fastening from the front. Consequently, it is possible to replace the lamp from the inside or the outside. A considerable quantity of these fittings are in use on this railway system. Messrs. Siemens Bros. Dynamo Works are prepared to design and supply all classes of fittings for railway and steamship work.

LONDON'S LATEST IN SHOP LIGHTING.

That the lighting of a shop can be so good as to be the subject of praise by the shoppers is, to say the least, unusual. We give particulars herewith of an installation which, by the excellence of its results, has, we gather, earned public appreciation.

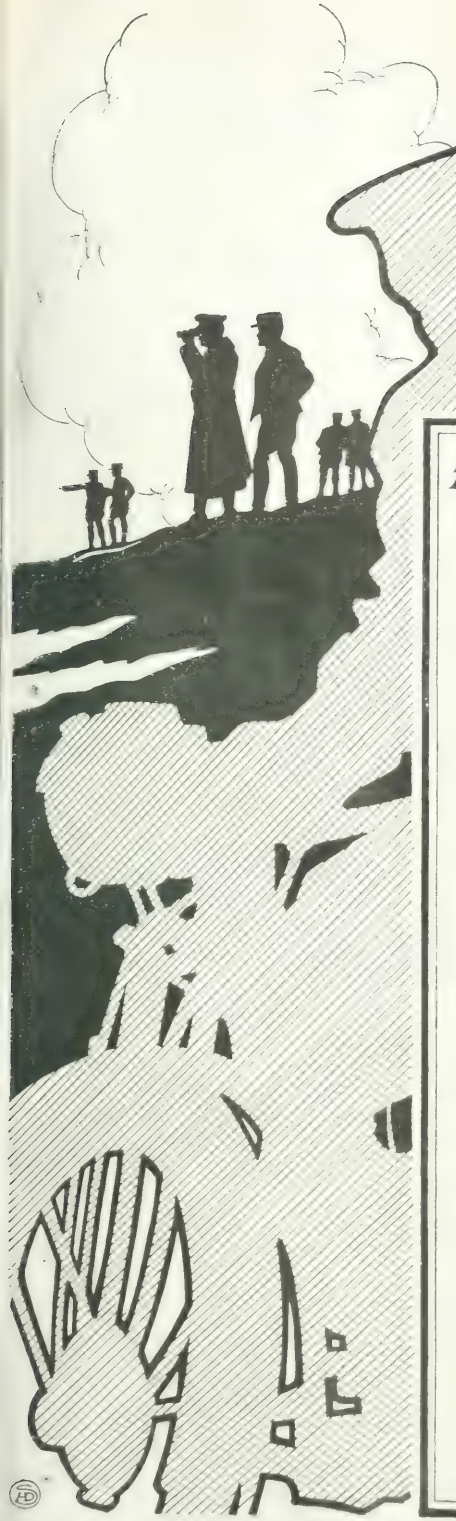
When it was recently announced that a provision department was to be inaugurated at Selfridge's it was expected that it would represent the last word, [illegible] accordingly it was decided to light the new annexe with half-watt lamps. It was recognised that if these were not properly installed their brilliancy would be too great for comfort. [illegible] of various forms



Selfridge & Co., Ltd., Oxford Street, W. View showing North End of Marble Market. B.T.H. "Lumina" Semi-Indirect Fittings with Half-watt Lamps.



[illegible] Co., The Grand Stores, W. [illegible] Drapery First Floor. B.T.H. [illegible] Semi-Indirect Fittings with Half-watt Lamps.



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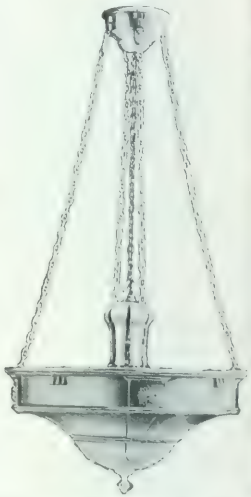
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GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Mantels, Turners and Lavatories.

of lighting were made, and after tests it was agreed that the system of lighting which met the case from all points of view was the B.T.-H. Co.'s "Eye-Rest" system of indirect lighting. When equipped with ornamental bowls characteristic of the "Eye-Rest" system the dazzling filaments of half-watt lamps provide an agreeable lighting result.

The system is installed on the ground floor and the first floor of this large block of buildings, as shown in the photo reproductions. These are, we understand, from untouched artificial light photographs, but we are informed that they do but scant justice to the installation. The lighting must be seen to realise the value of the illuminating engineering skill applied. The "Eye-Rest" fittings



Showroom, A. C. Lee, Queen's Square, W. Illuminated by Provision Department, Ground Floor. B.T.-H. "Eye-Rest" System of Indirect Lighting with Half-watt Lamps.



B.T.-H. "Eye-Rest" Indirect Fitting as used in Provision Department.

are equipped [illegible] reflector which can be properly located position with the half-watt filament, and which redirects the light on to the ceiling from whence it is distributed below. In the basement semi-indirect lighting with half-watt lamps is employed, and the [illegible] pattern of fitting is used. The lighting is [illegible]

The general appearance of the shop reader is referred to Messrs. Mc Hall Clarke, electrical engineers and Messrs. Benjamin Electrical Department. The contractors Messrs. Enoch Pugh & Co.

Many [illegible] throughout, and we may record that their intrinsic brilliancy is eight times greater than that of ordinary metal filament lamps; the filaments therefore must be obscured, they must be equipped with well ventilated fittings, so that the heat may be properly carried off. Attention to these details will [illegible]

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ELECTRIC HEATING & COOKING APPARATUS.
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PUSH-BUTTON PRINTING PRESS CONTROL.

The Igranic press control, while it retains advantages secured by the newspaper printer, including starting, stopping, crawling, "inching," retarding, accelerating and dynamic braking, is so simple and comparatively inexpensive that it is being rapidly adopted by many printing offices for the control of wharfedales and even smaller machines. This new button controller has four pushes, marked respectively "start and accelerate," "retard," "inch" and "stop." The feature which simplifies the design is the patent compensated solenoid which is employed to operate the contact lever. This solenoid is designed so that its "pull" can be varied at will by pressing the push button. The magnetic strength of the solenoid is thus under the control of the push buttons, so that by pressing one or other of them the operator causes the contact lever to move up or down over the contacts or stop in any position according to requirements.

If the "start and accelerate" button is pressed momentarily, the motor will commence to revolve and will continue to run at the lowest or "crawling" speed even after pressure on the button is withdrawn. If the pressure is maintained, the motor will gradually accelerate until full speed is reached or until the pressure is released. Immediately the operator ceases to press the button the movement of the contact lever ceases and the motor consequently continues to revolve at the speed which has been attained. To "inch" the press, it is only necessary to press the "inching" button, which will cause the motor to run at its lowest speed so long as pressure on the button is maintained. Directly the button is released the motor circuit is opened. If the "retard" button is pressed when the motor is running, it has the effect of slowing down the motor, but as soon as pressure on the button is released the contact lever of the controller immediately ceases to move, the slowing-down process stops and the motor continues to revolve at the speed which had been reached. A depression of the "stop" button will always, under any circumstances, open the main motor circuit by means of the controller and so bring the motor to rest. The "stop" button is a master button; that is to say, if any other button should be pressed at the same time as the "stop" button it would have no other effect than to stop the motor.

It is possible with this controller to employ field regulating resistance for increasing the speed above normal, series-regulating resistance for reducing speed below normal, and armature-diverting resistance for obtaining a crawling speed, so that practically any range of speed control can be provided.

The Igranic Electric Co., Queen Victoria-street, London, E.C., will supply fuller details and prices on application.

THE ROUND TABLE.

EVENT OF THE WEEK.—A gas explosion [illegible] the night in Walthamstow is mistaken for the attack of a Zeppelin.

Even the lift boy is the enemy of H.I.M. the Kaiser, as is aptly shown by the adjoining illustration which we reproduce from that excellent house organ of Merryat & Place. "The Engineering Gazette." Some lift boys will [illegible] for that



"WRONG LIFT, SIR! THIS ONE'S [illegible] BASEMENT."

matter, are quite without humour. The [illegible] however, has excelled himself, [illegible] lower than the basement would naturally be the Kaiser's destination.

An advertisement in the Electrical [illegible]

WANTED.—Electrician Mechanic at mansion of titled gentleman, to Take Charge of Electric Heating and Small Plant, 75 volt, and supervise Maintenance of Motor Cars, [illegible] lodge. Garden well furnished with fruit trees, 2½ miles from station. Excellent trains to large city 7 miles away. Private [illegible] situation, leaving for more important position.

He must have been a [illegible] hundred thousand practically going for the asking!



"EXCUSE, PLEASE!" [*Broadway Leader.*

A SONG OF FOOT CANDLES.

Once by Queen Anne's ancient Gate the dilettantes dwelt,
Their origin was partly Yank and partly Anglo-Celt
They manufactured globes and shades for various kinds of lamps,
And when they'd nothing else to do they licked Insurance stamps.
And all the world drove up to see how they could demonstrate
That half a watt within their globes would well illuminate
A showroom and an office and a demonstration booth,
Now steam-boilers, rat! rather would the senses gently soothe.
It soothed the staff so wondrously that they were half asleep
And nodding o'er their musty books. The shareholders might weep
And wail, "We have no dividends, have pity, we are poor."
The Staff could scarcely raise a yawn, and answered with a snore.
[illegible] to rouse them from their dreams
With methods of efficiency and systematic schemes
To tear them from their torpid ways with Transatlantic hand
And teach them how a man who owned desired to be to pound.
But when they found they had to work there was an awful row,
[illegible] wail, and once them was heard to say "Bow wow!"
But now they have to be at work at thirty after eight,
And are reproved if they should be more than an hour late.
And only have an hour for lunch 'twill ruin their digestion —
And not have tea till half-past five. This rule they also question.
A "boss" there is to every man to see he does his work,
Slackers to be deported and to go to fight the Turk.
A meeting of the Board takes place on every blessed day
[illegible]
And [illegible] and [illegible] a most polite request
That he shall have his salary raised because he is the best]
And [illegible]
But once they answered with a snore—the Board now with a laugh.
O! I could tell you many things, and none of them be lies,
But personal [illegible] and merely generalise
And should [illegible] what I mean to [illegible] my disgusted lay,
I merely answer with a grin, and go upon my way,
"O Sugar," Dr. Spurr moved me, and I had to leave my say."

ANON.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. E. B. Hill-Reedings (Bromley).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickavance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
Mr. H. F. Friederichs (West Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).



57E Patent 'Igranic' Compensated Solenoid Self-Starter which controls the speed regulation as well as starting and stopping the motor by means of push buttons. Ideal for Machine Tools

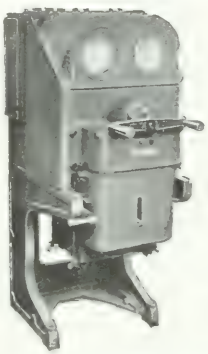
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IGRANIC ELECTRIC CO., Ltd.
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57E-2 Ironclad Push-Button Station. Note that each separate push is recessed and protected against accidental operation. The construction is robust and suitable for workshop use



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Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
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CARDIFF—94, St. Mary Street. SHEFFIELD—92, High St. (Bldgs.
GLASGOW—66, Waterloo Street. SOUTHAMPTON—46, High Street
Branches in Principal Towns Abroad.

ELECTRICAL INSTALLATION AT BRADFORD KURSAAL.

In our issue of March 19 we gave some particulars of the cooking equipment installed by the Bradford Corporation electricity department at the new Kursaal, Queen-street, Bradford. Mr. T. Roles, the borough electrical engineer, has now kindly supplied us with some additional information regarding the lighting and power installations, and these will be found of interest. What is now known as the Kursaal was formerly one of the many baths which the Bradford Corporation has put down [illegible] large auditorium it is now possible to [illegible] the Kursaal for [illegible] purposes. During the summer months the Bath Hall, over Lounge to the King's Hall, is thrown open for swimming [illegible] Hall, is immediately adjoining, and [illegible] by the raising of fireproof curtains, [illegible] the Bath Hall [illegible] Hall [illegible]

[illegible] basin was boarded over and the hall used as a ballroom, the gas lighting was found totally inadequate, and was supplemented by four flame arc lamps. When the Baths Committee decided upon the building of the Queen's Hall the illumination was entrusted to electricity, and semi-indirect units were installed. The effect of this was so satisfactory and created such an impression with the Committee that the Lucas gas lamps in the King's Hall were removed, and the illumination was uniform with that of the Queen's Hall by the installation of modern semi-indirect units. These fittings will also be noticed in the illustrations. After so long a period of vascillation between the two methods of lighting the electricity department feels particularly proud of the fact that the electrical system has been finally adopted throughout the building. In this connection they regard their triumph as complete by the recent installation of the electric cooking equipment, which we have already fully described.

The whole of the electric lighting installation was carried out under the supervision of the Bradford Corporation electricity department. The Queen's Hall installation was put in by Messrs. Collinson Bros., of Bradford, the wiring being run in solid-drawn screwed conduit. All fittings were supplied by Messrs. Peyton & Peyton (Ltd.), Birmingham. The general lighting of the hall is semi-reflected by means of 30 chain pendants with Pearlite bowls. The cafés situated on the ground and first floors and the large dining hall in the basement are also illuminated by means of Pearlite bowl chain pendants. Extraction fans (electrically-driven) are fixed in the roof of the main hall, and also in the dining hall.

The stage lighting consists of two battens, fitted with 32 c.p. lamps, 56 white, 18 red, and 18 green; a float fitted with 75 white, 22 red and 22 green lamps; and proscenium lengths each containing 20 white lamps. Liquid dimmers are fixed in these circuits. Portable stage arcs are also provided. The stage is so situated that it can be used for either the Queen's Hall or the King's Hall, fireproof curtains being lowered or raised as required. The float and proscenium lengths are semi-portable, so that they may be used for the Queen's or the King's Hall. Electric programme indicators are also fitted on the walls of both prosceniums.

The stage lighting and that of the auditorium of the Queen's Hall are controlled from a board on the stage consisting of two panels, equipped as follows:—

No. 1.—A d.p. "black-out" switch is provided for the battens,

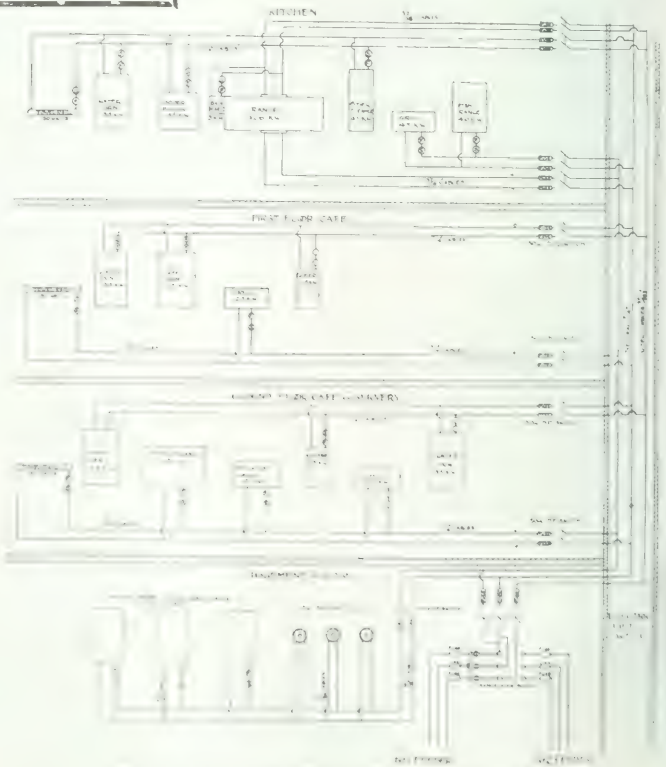


Diagram of Cooking and Heating Circuits, Bradford Kursaal.



1. The Dome of the Queen's Hall.
2. The Middle Gallery, Queen's Hall.
3. The Queen's Hall and [illegible] Entrance to the Kursaal Hall and Swimming Bath.
4. Another View of the Middle Gallery.
5. The Kursaal Hall Swimming Bath.
6. The Entrance Saloon, Queen's Hall.
7. The Entrance Kursaal Queen's Hall.

BRADFORD KURSAAL ELECTRICAL INSTALLATION.

ARMORDUCT CONDUIT

The standard by which other Conduits are judged.

Write for particulars and prices

The ARMORDUCT Manufacturing Co., Ltd.
Farringdon Ave., London, E.C.
Bathurst Works, Witton, B'ham



...floor and gallery at back. A separate switch to the level for each batten and the floor, also circuit switches and fuses for motor and lamps in hand-rail. D.P. switches and fuses are provided for the stage switchgear.

No. 2 panel is a "blackboard" switch for auditorium lighting, also "dimmers" for the King's Hall and "dimmers" for the stage lamps. D.P. switches and fuses for the main circuits, and a main switch and fuse for general lighting.

Three switch plugs are fixed on each floor for use with a vacuum cleaner or for temporary lighting arrangements. The lighting of the cafés, cloak rooms, &c., is locally controlled.

The lighting of the King's Hall is also carried out by means of Pearlite bowls and chain pendants, for which purpose 27 are used, eight containing 500 c.p. lamps, and the others being fitted with three 50 c.p. lamps in each. These fittings, also the "Exit" and other signs, are controlled from another switchboard on the stage, which is also supplied from No. 2 panel on the ground floor.

In the dressing room 12 three-light fittings, with Holophane shades, are installed. These fittings and the lighting of the offices, waiting and refreshment rooms, are locally controlled.

The King's Hall installation was not carried out until a few months after the wiring of the Queen's Hall, the Baths Committee having entered into an agreement with the Corporation that the latter should not grant permission to any other firm to tender to submit a scheme for the lighting of the King's Hall. This was done and the installation duly carried out by Mr. James Tate, of Bradford.

A cinema operating room is built in the Queen's Hall. A switch board is fixed here for controlling the lantern and spot arc; it consists of a voltmeter and ammeter, fuses and a D.P. change-over switch [illegible]

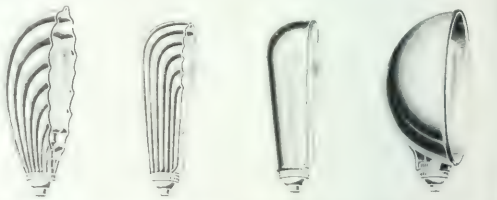
...connected or through a stand-by resistance on the Corporation mains. Two regulating resistances are fixed, also a dimmer for the auditorium lighting, this being necessary when the hall is used as a picture house.

Direct corporation supply mains are brought into a small room in the basement set apart for the meters, &c. A duplicate supply at 230 and 460 volts direct current is available, this being obtained through a triple-pole change-over switch, from which the following d.p. switch-fuses are supplied: Two each of 300-ampere for cooking apparatus, one 150-ampere for No. 2 panel of stage switchboard, one 100-ampere for No. 1 panel of stage switchboard, one 100-ampere for stand-by resistance, one 60-ampere for motor-generator.

As it had not been decided to install electric cooking apparatus until the decorating was practically complete, it was found necessary to run most of the wiring on the surface. The mains were carried up the lift well in screwed conduit to distribution boxes on each floor. From these boxes to the d.p. switch-fuses screwed conduit was also used. From the switches to the apparatus it was decided to employ twin lead-covered V.I.R. cables, the lead sheathing being used to earth the apparatus. The cooking equipment was supplied by the Brompton & Kensington Accessories Co. (Ltd.), of London, with the exception of the geysers and towel rails, which were obtained from the British Electric Heater Co. (Ltd.), of Glasgow, and the copper boilers in the basement servery which were provided by the Bradford Corporation electricity department. The makers claim that the cooking apparatus installed is capable of providing a table d'hote dinner for 500 persons.

SHOP WINDOW LIGHTING.

Interest generally attaches to any attempt made to standardise articles of everyday and almost universal use, especially when to such standardisation is added the re-designing of these familiar objects on scientific lines. An important case of the kind is the



...complete series of seven shop window reflectors just brought out by the General Electric Co., consisting of the following types: (1) Shell, (2) fluted scoop, (3) plain scoop, (4) hemispherical, (5) horizontal



parabolic, (6) vertical parabolic, (7) conic, all of which (except the hemispherical) are made in two sizes, the smaller designed for a lamp [illegible] the 50 watt size, the larger for lamps up to the 60 watt size.

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[illegible]



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POPE
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embody all the strength of the cold carbon lamps with the remarkable economy of the metal filament. They have not only the initial strength of the drawn wire lamps but maintain their strength throughout their life—without becoming brittle or losing their brilliancy.

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For every class of installation, as manufactured by the Western Electric Co. Ltd. at their works at North Woolwich. Western Electric Telephone, Telegraph and Power Cables are known for their satisfactory service in all parts of the world.

We recommend no better than to refer all your cable schemes to our staff of engineers for expert advice in the matter concerning the choice of the most suitable cable for your particular purpose.

Our Cable Handbook will be gladly sent upon request.

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Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
PHOSPHOR COPPER.
CHARLES CLIFFORD & SON, Ltd.
BIRMINGHAM.

correct reflector.

All these reflectors are more efficient than their predecessors, and in addition to having scientific contours, they effectually screen the light from the eyes of persons looking in shop windows, so desirable at all times, and also very necessary at the present time to comply with the police regulations. Special care has been taken to see that the shade carrier ring, which holds the reflector in position, is easily accessible. The special feature in the case of the deep conic and vertical parabolic patterns is the provision for the necessary ventilation.

The finish is nickel plating, which assures the maximum amount of reflection being obtained, while the contour being scientifically designed, the light is projected in a manner which turns it to fullest advantage. A neat folder, No. F.1902, giving particulars and illustrations of these reflectors in tabulated form, together with a table of lamp prices, will be sent on application.

This effort at standardisation is, we understand, attributable to the General Electric Co.'s illuminating engineering department, who may be consulted on all shop illumination matters in which they

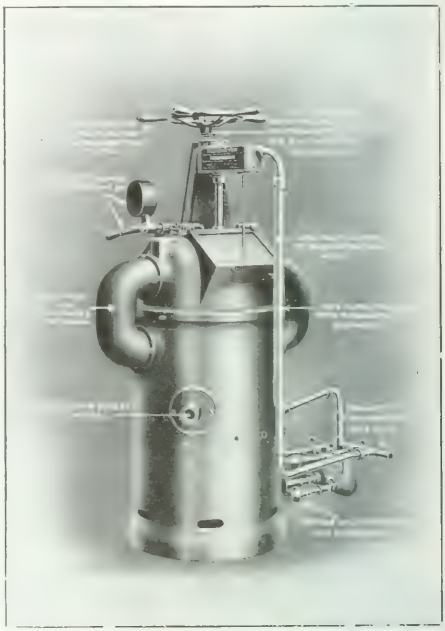
AN INTERESTING ALUMINIUM FURNACE.

has extended so considerably in recent years that the subject of their melting now appeals to a number of manufacturers. Generally, the

which allow atmospheric oxygen to attack the molten metal with the consequent formation of dross. Other drawbacks to melting aluminium in this manner are known to those familiar with the subject. A gas-fired furnace, on entirely new principles, for melting aluminium and its alloys has been evolved after a number of experiments by the Monometer Mfg. Co., Aston, Birmingham, in which the difficulties usually met with have been overcome in a novel and ingenious manner. Metal melting pots are open to the objection that the reaction which takes place between the molten aluminium and the impurities in the metal of which the pot is composed, spoils the aluminium. In the furnace in question, this re-action is eliminated by the employment, in the parts subject to attack, of a special composition of metal, which, we understand, experience has shown to be resistant to the action of impurities. It is well known that a considerable proportion of the molten metal goes to waste as oxide, and to prevent this deleterious action, the melting pot is installed in a chamber containing *inert* gases incapable of oxidising the molten metal. As there is no oxidation it follows that there is no dross, and

in causing the products of combustion to traverse the melting chamber on their way to the outlet flue. This sealing of the melting chamber precludes, further, the ingress of dirt and other foreign

the melting of aluminium is automatically maintained. The bunsen burners under the melting pot are of peculiar construction, with contracted nozzles of such a design that a proper admixture of the gas and air takes place, resulting in complete combustion and full utilisation of the heat in the fuel. The heat obtained by these low-pressure atmospheric burners, which are connected to the ordinary town supply, is comparable with that attained by high pressure gas, but without using compressors or fans. The equipment of the furnace is completed by a central core valve seated in the bottom of the melting pot, and controlled by a conveniently arranged hand wheel, by which the molten metal issuing from the pouring spout can be regulated to a nicety or entirely shut off. At the top of the furnace



[illegible] ARRANGED FOR USE WITH THE MONOMETER SMELTING FURNACE, SHOWING HEAT REGULATOR.

are located two doors through which the swarf or metal is introduced into the melting pot, these doors being balanced so that they remain either in the closed position or in the open position, without being held by the operator. A good idea for facilitating casting is the mounting of the furnace on a wheeled carriage, which can readily be moved on the rails from one part of the foundry to another, flexible gas pipes providing the means for taking up this movement of the

TOPICAL FAN ADVERTISING.

During the Brighton I.M.E.A. Convention the G.E.C. [illegible] a case of Osram lamps [illegible] from the Shoreham Aerodrome to Hove Park. Owing to bad weather the journey was [illegible] a week later, but it was successfully made. The G.E.C. has not yet instituted the delivery of these lamps by aeroplane, but it has always had a keen eye for the advertising value of aerial [illegible] by [illegible] Their [illegible] campaign now opening, it is distributing a neat folder in which the reader is advised to [illegible] by using "Frezon" lamps, and

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
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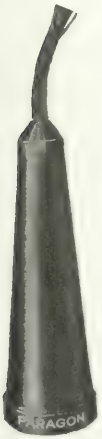


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filled with small charcoal or coke. a small hole is needed. It is reliable and permanent.

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Solvent Recovery and Derisinating Plant a Speciality.

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SEND US YOUR ENQUIRIES.

We can Supply the following Specialities from Stock :

ARMOURED SWITCHGEAR, *6,000 to 12,000 volts.*
IRONCLAD DRAW-OUT SWITCH PILLARS, *500 to 3,000 volts.*
" **DISTRIBUTION BOXES** *(up to 400 amps. per way).*
" **SWITCH TYPE FUSES,** *50 amps. single pole.*
SWITCHES *(Air or Oil Break Patterns).*
WALL PLUGS *(For PORTABLE DRILLS and LIGHTING).*

A. REYROLLE & CO., LTD.

HEBBURN-ON-TYNE.

GERMAN & BRITISH AIRCRAFT

How to distinguish between the two.



also by studying the chart of British and foreign aircraft, which occupies the centre pages of the folder. This chart has been circulated as a poster throughout the length and breadth of the land, but should there be a hot air raid one of the posters may not be conveniently handy for comparison purposes. The obvious remedy is, therefore, to keep cool by having a "Freezor" leaflet in one's possession. Electrical contractors can obtain a quantity of these ingenious topical advertisements on application to the company. They will be overprinted with name and address without charge. The aircraft chart which is reproduced herewith is the copyright of our always interesting weekly contemporary "Flight."

OF INTEREST TO STATION ENGINEERS.

We have received from the Spray Engineering Co., Federal street, Boston, Mass., two pamphlets which deal respectively with sprays for cooling condensing water and air washers and filters for turbo-generators. The last named is distinctive on account of the use of a special spraying nozzle which has been designed with a view to a preliminary breaking up of the water and which when used in conjunction with a number of other nozzles produces a dense mist which entirely fills the spray chamber. This atomizing effect can also be enhanced by the use of screens which are placed immediately in front of the spraying nozzles. The constructional features of the filter principally follow standard practice in so far as there is a spraying chamber and a series of eliminator plates which remove all free moisture from the air before it passes into the duct communicating with the stator and rotor of the turbo-generator. We gather from a published list that these washers are already installed in 28 of the large steam-turbo-electric power houses in the United States. The capacity of the largest of these equipments is 240,000 cubic ft. of air per minute. A considerable number of 80,000 cubic ft. of air per minute equipments have also been put down, notably three for the Commonwealth Edison Co., Chicago. The sprayers employed for the cooling ponds are also of interest. A similar design of nozzle to that employed in the air washer is made use of and the nozzles are either fixed in single rows or in triangular groups of three sprays. One of the largest of these is installed at an 8,000 kw. plant where the spray operates at 6 lb. pressure. We shall give a description of these interesting equipments in our next issue.

Printed and Published by GEORGE TUCKER at the Electrician Printing and Publishing Co., Ltd., 1, 2 and 3, Salisbury Court, Fleet Street, E.C., in the City of LONDON. Friday, April 23, 1915.

THE ROUND TABLE.

The latest thing in bargain sales is the Ford headlight dynamo. Come early to avoid the cars.

The "comp." sometimes has his own ideas as to how technical terms should be spelt. This week, for instance, he very nearly had us by writing "air-washer" as "air-waster." Probably some engineers would agree with this latter rendering.

An ancient story is being revived. A small boy was reproved by a parson in the streets of Manchester for using bad language. "My boy," said the cleric, "you should not swear like that; do you not know that it is written 'All flesh is grass.' We are here to-day and gone to-morrow."

"Oh," said the boy, "you are another of these electrical contractors, are you!"

Interest in the electric battery vehicle is increasing. A prominent central station engineer is already enamoured of the idea of a battery-driven road roller. Nothing could be easier. The battery can be built up in cylindrical form, and if provided with a gelatinous electrolyte can be readily fitted into each set of rollers. Heavy carbon brushes will conduct the current to the propulsive mechanism!

We hear that a well-known electrical supply house in the City recently vacuum-cleaned its large fittings show-rooms. Offers are invited for the dust sucked out of the carpet, hangings and nooks and crannies of the show-room. If planted during the spring season a plentiful supply of fittings, fires, signs, fans and other electrical accessories properly variegated may be expected, so early application is necessary.

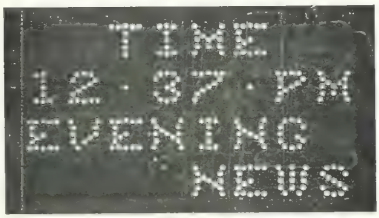
The fan season is with us, or will soon be, judging by the activities of some of the manufacturing firms. The illustration adjoining arrived in pamphlet form at our house in the morning



mail, and was placed near the door containing the breakfast rasher. Before one streaky slice could be served the contents of the dish were frozen solid and then we woke up, and found that the sun was really shining. In order to avoid any possibility of misunderstanding, we are asked to state that Ediswan fans never reverse their polar-ity, and no matter what the temperature or humidity of the atmosphere may be keep their bear-ings!

Chicago feels very proud of its latest electric sign, which has 60 letters, is 50 ft. by 15 ft., carries 3,000 lamps, and is controlled by no less than 2,400 keys. Some sign that but Mr. Naylor, of Naylorgraph (Ltd.), says the old country has the





The Advertisement of the Naylorgraph Sign at Night.

laugh of this sign in his particular invention, which can perform the same functions with 95 keys. Evidently the Chicago sign is "nothing to write home about."

The American name for the "'bus pirate" is "Jitney." In London a few pirate 'buses are still running, but evidently the provinces afford no facilities for traffic sharks. Judging by the agitation in the United States press there will soon be a "Jitney war," a campaign of advertising having been "gotten up" against the promiscuous use of converted ancient automobiles for public passenger service. Some of the headlines in the papers pointing out the evils of "Jitney Riding" are distinctly funny.

"JITNEY THUGS MAUL TWO."
"DEATH TOLL OF JITNEYS."
"DANGER TO GIRLS LURKS IN JITNEYS."
"THREE IN BED AS RESULT OF JITNEY SMASH."

The last one is evidently typical of the American stunt headline.

HOT PLATES.

No. 197 to—

Mr. H. Tomlinson Lee, for having the courage of his convictions, and converting gas-heated presses to electric heating in Messrs. Stevenson's box factory, Wimbledon.

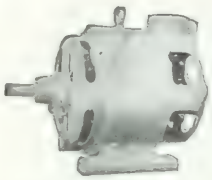
THE "POINT FIVES."

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Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
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Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
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Mr. H. Gray (Accrington).
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ELECTRIC MOTORS



For Direct Current



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CARDIFF—89, St. Mary Street. SHEFFIELD—22, High St. (Bldgs.
GLASGOW—66, Waterloo Street SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

THE NAYLORGRAPH SIGN.

The development of the illuminated sign has been carried a step further by the introduction of a patented element, which can be grouped up in a rectangular space to form an alphabetical monogram. The element comprises a cylindrical case, one end of which is closed by a white opal hemisphere and at the other end there are suitable electromagnets for operating a rectangular shield, which has a horizontal aperture, and which normally covers the opal hemisphere. By grouping a number of these elements in the manner described, and connecting the operating magnets to suitable circuits, it is possible to uncover combinations of "eyes" which represent a letter of the alphabet. The sign has been developed by Messrs.



THE OPERATOR AND ONE OF THE KEYBOARDS OF THE NAYLORGRAPH.

Naylorgraph Ltd., who have erected a large sign 400 ft. square on a building immediately adjoining and at right angles to the Holborn Viaduct, London, W.C.

The sign faces all traffic coming westward from the Bank, and may be clearly read from the corner of Chancery-lane, a distance of about a [illegible] feet. [illegible] by 2 ft. and contains 23 elements. The sign itself is 33 ft. 6 in. long by 12 ft. high, and has been mounted on the face of the wall about 60 ft. above the pavement.

[illegible] gene ator set for supplying low pressure (16 volts) to some of the auxiliary apparatus. There are 52 monograms in the sign, arranged in four lines of 13, so that there is a considerable scope for the display of reading matter.

The general details of the operating mechanism of the sign are not available for publication at the moment, but we understand that the many unique features of the device are fully protected by patents in some 33 countries. The design of the monograms and the letters displayed are also covered by 17 registrations. The monograms are under the control of three sets of keyboards, upon which the matter to be displayed is respectively set, displayed and cleared. The matter is spelt out letter by letter, and is displayed for a sufficient length of time to be read and absorbed by the public. At the present time the clearing is also done in the same way, but the inventor has in hand a mechanism for blacking out the entire sign at one operation. The sign is at present used only for daylight displays, but the construction of the element is such that a lamp is placed behind each opal hemisphere, and by this means brilliant and effective illumination is possible at night. The police restrictions, which are at present being rigorously enforced, do not admit of any night display for the time being.



THE NAYLORGRAPH SIGN AS SEEN FROM THE STREET.

We are informed by Mr. Naylor, the inventor of the sign, that there is practically no limit to its application. It has already been successfully tested by the War Office for signalling from the ground to aeroplanes. In this case the sign is mechanically operated. Railway engineers will be interested in it as a convenient means of signalling the arrival and departure of trains, and for indicating to drivers entering large termini the platform into which their particular train is being switched. The sign is also suitable for clock dials, in this case the time being displayed in large plain figures. Cinematographs, theatres and music halls can also make use of it, both for proscenium programme indicators and also for the duplication of these numbers in various parts of the house. The same may also be used at bandstands. We understand that an indicator showing figures up to 99 can be connected to a controller, containing only 10 20 SWG wires in addition to two conductors, representing the mains. Although the present time is not a good one for the general boosting of anything of a sign character, there is likely to be a boom in signs after the war, and interested contractors should take an opportunity of inspecting Mr. Naylor's apparatus at 240, High Holborn, London, W.C. Mr. Naylor will be pleased to explain the method of control, and he would also like to hear from individuals evincing interest in his foreign patents.

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FOR ELECTRICAL PURPOSES.

NON-CONDUCTING

BEST QUALITY INDIARUBBER.

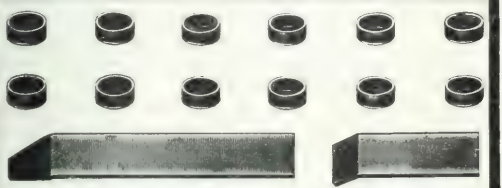


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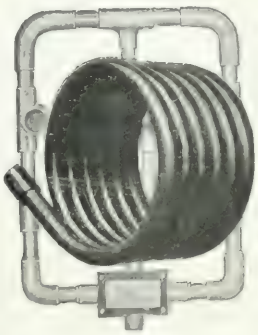
Johnston says:—

"The value of Quality is always recognised—sooner or later, but inevitably—and whatever reasons we may hear in favour of Quantity, the value of Quality is gaining recognition every day, and sooner or later we shall know that we can afford the best."

Had he been speaking to Engineers in particular he would certainly have advised the use of

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BRISTOL—11, Denmark Street.
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[illegible]—4, White Horse Street.
[illegible]—76, [illegible]
CARDIFF—11, [illegible] Street.
[illegible]—4, [illegible] Street.
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ELECTROLYTIC CONDENSERS

FOR

ELECTRO-PERCUSSIVE WELDING.

(See article in "The Electrician" of April 9th.)

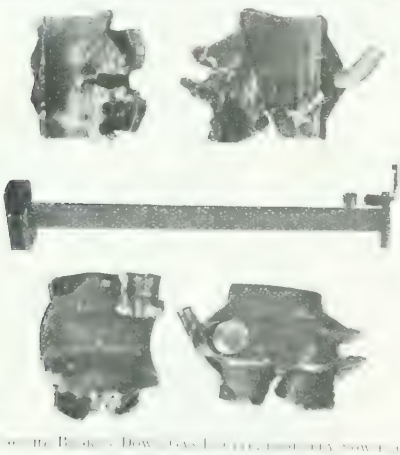
We have for many years given our careful attention to this type of Condenser, and have evolved a strong, practical type.

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Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, etc.

A BOX FACTORY AND HEATING INSTALLATION.

On the outbreak of the war, central stations engaged in many parts of the country were confronted with the [illegible] loss of load, both from lighting and power circuits. The lighting load has [illegible] owing to restrictions imposed by the authorities upon anything in the shape of brilliant illumination in shops and public places, but the power load has commenced falling off for rather different reasons. A certain number of factories automatically closed down when the war broke out, and in certain important industrial districts the decrease was quite alarming. Fortunately, the Government decided that factories equipped with machine tools of all classes would be compelled to work at high pressure in order to meet the requirements of the War Office and the Admiralty, for munitions and other material. There are to



[illegible]

record at present would indeed be how to what extent the activities of many industrial works have brought the power load of electricity works back to normal, or increased it above normal. There are many [illegible] in which electric motors were hurriedly requisitioned either to replace overload or broken down [illegible] and thereby avert factory stoppages. At the [illegible] the [illegible] was available for all [illegible] in the district.

An extremely instructive example of the employment of electric motors, under comparatively emergency conditions, is that which has recently been [illegible] at the Wimbledon Works of Messrs. Hall [illegible] Stevenson & Sons, Ltd., makers of London and Manchester, who have also factories in four other towns. These works, which at one time [illegible] on the Leeds of the [illegible] Company, [illegible] other source. [illegible] experienced a big rise in the [illegible] this [illegible] immediately followed by an unprecedented demand for goods which, under normal conditions, are seldom made in any quantity. The immediate result was that the plant was overworked, and the existing gas engines which furnished the requisite power failed to cope with the overload. The services of the Wimbledon Electricity Department were hurriedly requisitioned, and Mr. H. Tomlinson Lee, the energetic electrical engineer, undertook to have the factory working within 24 hours of the breakdown. The proceedings during this comparatively short period would doubtless furnish material for an exciting story, but, unfortunately, we are unable to detail them at this juncture. Suffice it to say that Mr. Lee, assisted by The Langdon-Davies Motor Co., who supplied the emergency motors at practically a moment's notice, kept his promise, and the proprietors have had occasion to bless the day when the gas engines so ungratefully refused to work overtime.

The original factory buildings date back over 100 years, and it has been found necessary to vacate them for more commodious and modern premises immediately adjoining on the same site. The old shops are used as stores, both for raw material and finished work.

The various operations which enter into the manufacture of cardboard boxes and tubes demand the use of a certain amount of



ENTRANCE TO WORKS.

specialised machinery of certain classes, which on grounds of efficiency should be driven by a power agent having an even turning moment and regularity of speed. Needless to say, these requirements were met in an ideal fashion by the single-phase 50-period motors, which have been installed. In certain other processes, presses, guillotines and stitchers, are employed, and these furnish an intermittent form of load which is also satisfactorily dealt with by the motor drive. We do not propose to enter into the details of the manufacture of the many different patterns of boxes and cardboard products which Messrs. Stevenson & Sons turn out. Emphasis may be laid on the manner in which the various motors are fixed on the ceilings, from which positions they drive the various lengths of shafting by open belts. In some of the shops where the ceiling is low this plan has proved admirable, more particularly as the work required necessitates a large amount of floor space to be kept clear at the level of power, as the case may be, previous to its passing through the machines, and [illegible] they leave the machines. [illegible] of the electric

ator in a factory of this class has been fully exemplified by the ving of the motors on the ceilings.

We give below a table which shows the number of motors installed, heir capacity, and the class of work upon which they are in service. They are squirrel-cage, single-phase, open-type machines.

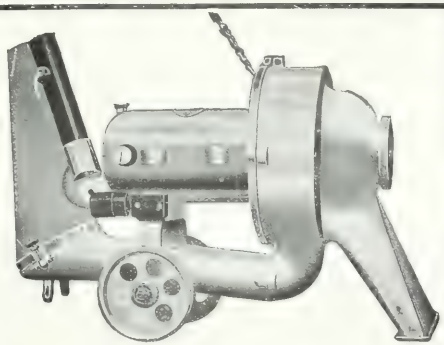


TYPICAL DRIVE FROM MOTOR ON CEILING.

The supply to the factory is given by means of a lead covered, iperie nulated, concentric cable, operating at 2,200 volts. The able is armoured with steel tape, except where drawn into earthen- are pipe, and is laid partly underground across the Corporation's

H.P.	Location.	Drive.	Speed. Revs. per min.	Class of machine driven.
3	Lining room . .	Belt	1,400	Lining machines.
4	Cutting room.	..	1,440	Bender and roller embosser.
6	..	..	1,440	Bender and sheet cutters.
4	..	.	1,440	Slotters and corner cutters.
1	..	.	1,440	Lift.
9	.	.	1,440	Printing machines.
9	..	..	1,440	Cutting and creasing machines.
12*	..		1,440	Guillotines.
3	Metal edge dept.	.	1,400	Stitchers, saws and brightwood machine
7½	Press room	.	1,440	Cap stamping presses, disc cutters, &c.
5	..	.	1,440	Cap stamping presses
4	Fitters' shop .	..	1,440	Lathes, drills, grinding machines, &c.
7½	Tube room . . .	.	1,440	Spiral tube machines, tube cutters, paper splitter, &c.
5	..		1,440	Tube cutters. Stokes and [illegible] machines, paper plitter, champhering machine.
4	..	.	1,440	Gluing and tube rolling machines.
2	Carpenter shop .	.	1,440	Small circular saws
4	Corrugating room	.	1,440	Rotary cutters.
7½	..		1,440	Corrugating machines
4	Cutting room...		1,440	Rotary cutting machines, paper splitters, corner cutters, &c.
3	..	..	1,440	Corner stayers and [illegible]
9	Fitters' Dept.	..	1,440	Lathe, milling, shaping, &c.
3	Covered box dept....	..	1,440	Box [illegible] machine

* Arrangement are also being made for the 12 h.p. motor driving a 5 in. high lift Worthington turbine pump direct coupled through a clutch, for fire extinguishing purposes.



THE NEW MODEL

MAGIC CLEANER

The most substantial and reliable of portable cleaners.

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sewage farm, and partly on suspension brackets attached to a concrete wall forming a portion of one of the filtering beds. The cable is run in duplicate, and is lowered without further protection on to the bed of the river Wandle, which it crosses before entering the substation at the factory. This sub-station is a lean-to brick building, and contains two 75 k.v.a. Berry type formers, 2,000 to 220 volts.

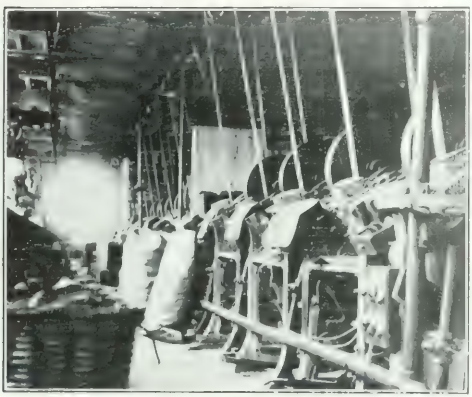


VIEW OF TUBE DEPARTMENT, SHOWING MOTOR ON CEILING.

The primary is protected by switch-fuses at the generating station, and the secondaries are brought out to bus bars from which the various motor circuits are led out through porcelain handled fuses. There are nine circuits in all. The lighting supply is at 220 volts, and there is a separate connection from the low-tension board to a distribution board [illegible] of the shop. The service is metered on

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the high-tension side of the transformers. The necessary wiring and fixing of the motors was done by Messrs. Stevenson & Sons themselves. Considerable interest attaches to a method of heating the dies of the presses which are used in connection with the manufacture of circular cardboard boxes and lids. These dies are placed in ordinary power operated presses of the lever type, and the blocks upon which the cardboard blank is placed require to be heated to a temperature of 350° F. A large number of these presses are used in one room, and until quite recently the heating has been done by open bunsen flames, which play on to the outer surface of the die block. The girl who feeds in the cardboard blanks, which are converted into the completed boxes or lids, requires to work immediately over the die, and in that position receives the products of combustion from the gas burner full in the face. They rise from around the outer surface of the die block, and it is quite impossible for them to



Near View of Presses, showing Connections for Die Heating Circuits.

be avoided; it is also not convenient to fix any extracting hood over the machines; therefore the atmosphere of the room in which these presses are used rapidly becomes foul and injuriously affects the health of the workers. The low temperature required made the problem of heating the die blocks a comparatively simple one, and Mr. Tomlinson Lee decided to undertake the conversion from gas to electricity. We understand that he was unable to get any of the firms who make electric heating apparatus to do this work because of its being of a special character, and therefore outside their standardised products.

Mr. Lee therefore tackled the problem himself, and, after a few simple experiments, an annular heating element which can be enclosed within the die block, and yet is readily accessible for renewal should this be necessary, was evolved under his direction in the workshop of Messrs. Hugh Stevenson & Sons. Nickel-chromium ribbon, 0·003 by 1·32 in., is wound on a flat mica ring, and the channel in which this rests is also lined with mica. The entire element is then tightly clamped up within the die block, and the connecting leads are brought out to a pair of simple terminals. The current is under the control of a double-pole switch and fuses placed at the front of the press and a series-parallel switch of the "Diamond H." pattern. These elements are rated at 350 watts for working temperature, and 1,000 watts for rapidly heating up the dies before commencing work, and they are worked off the 220 volt circuit. It is understood that other arrangements have been made by Messrs. Hugh Stevenson & Sons, whereby they are able to carry out [illegible] at a comparatively nominal cost. They also found the actual work of conversion was extremely inexpensive, a they are particularly pleased with the result. We understand th they are now proceeding with the conversion of the whole of t presses. A feature of the electrical system is the uniform heati obtained, and the entire absence of noxious fumes, and the operat have not been slow to appreciate the infinitely more hygienic c ditions of working secured for them by the introduction of electri heating in place of gas.

The adjoining illustrations give a fair idea of the motor drive one or two of the shops, and a view is also shown of a row of pres in which the heating elements above described are being install The photographs were somewhat difficult to take, owing to the li roof and the obstruction of the light from the windows by piles paper, boxes, &c.



View of Press Room. These Presses are being converted to Electric Heating.

We are indebted to Mr. A. H. Stevenson for his courtesy in showi us the shops, and explaining the many processes in use, and o thanks are also extended to Mr. Tomlinson Lee and his chief assistar Mr. R. W. Klitz, for kindly calling our attention to this interesti installation, and for supplying us with the material and illustratio for the foregoing article.

A NEW AIR WASHER AND SPRAY COOLER.

As the capacity of an electric generator is dependent upon temperature, which in turn depends upon the air conditions, ample supply of cool, clean air is of importance. Dust or so deposited within the machine greatly reduces the efficiency air as a cooling medium. The accumulation of dust and dirt particularly rapid when the ventilating air contains oily vapour, is generally the case in all engine rooms. Perhaps the most serio effect of dirty air and excess heat is to reduce the life of the insulatio of the machine.

It is a notable fact that the percentage of loss of generato through burnouts due to clogged air passages, etc., is far less Europe than in the United States where, as a rule, little attentio has been paid to conditioning air for generators. As generator usually reach maximum efficiency at or above full load, spra washers produce the double benefit of high efficiency and full rate capacity. Cooling the entering air from 90° F. to 70° F., which ca

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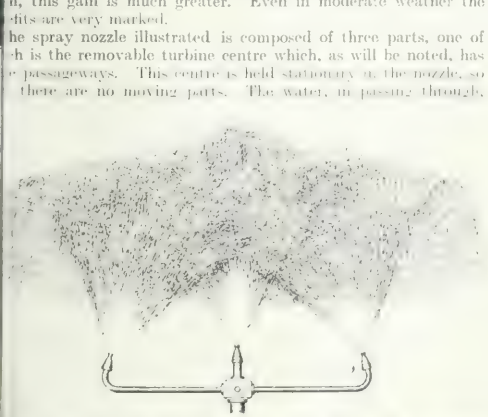
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one with air at a relative humidity from 35 to 40%, results in easing the capacity of the generator by approximately 18%. is based on taking the load at 25° C. (77° F.) as 100%: the of the permissible loads at 70° F. and 90° F. being 105 : 89. In er weather, or where ventilating air is taken from the hot engine n, this gain is much greater. Even in moderate weather the fits are very marked.

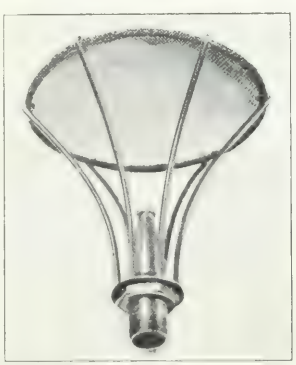
he spray nozzle illustrated is composed of three parts, one of h is the removable turbine centre which, as will be noted, has e passageways. This centre is held stationary in the nozzle, so there are no moving parts. The water, in passing through,



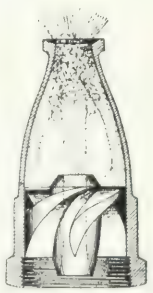
NERAL APPEARANCE OF SPRAYING EFFECT PRODUCED BY THREE NOZZLES INCLINED TO EACH OTHER.

given a rapid rotating motion. A central drawing p[illegible] the rotating water at the orifice ejects it as a fine, dense and form spray.

These nozzles are operated at a low pressure and give out extremely e spray. The central driving jet fills in the centre of the spray, as giving it a solid conical formation. Owing to the unique sign of the spray nozzle, the water is atomised in a dense homo- neous mist, entirely filling the spray chamber. The air passing through this dense mist is brought into repeated contact with fine particles of water, which in falling, precipitate all dust contained in the air. To insure the complete removal of any dust particles which may have passed through the first set of sprays, the air is again subjected to the action of cross scrubbing sprays, placed beyond the first set of sprays. The air is next passed through a screen, which removes a large part of the entrained water, and



COMPLETE NOZZLE AND ATOMIZING SCREEN.



SECTION THROUGH SPRAYING NOZZLE.

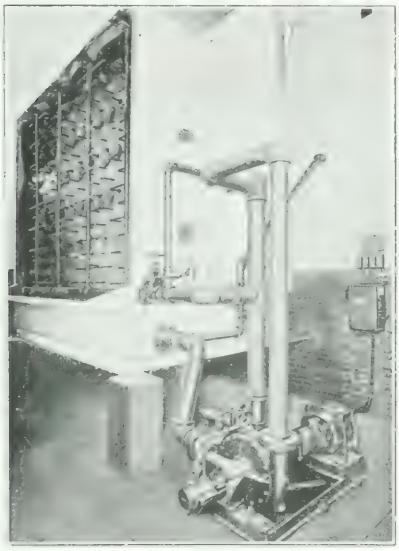
prevents any large stratum of air from passing through the washer without coming in contact with wet surfaces. All free moisture in the air is then removed by the eliminator plates, the air leaving the washer clean and dry, but with a relative humidity of 100%. Spray atomising screens are used to atomise the water beyond the possibility of any spray action alone. The increased density of the spray thus formed is very marked.

The spray system, in conjunction with the nozzles referred to,

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mical to operate. It is also claimed that it costs less to install than any other system of cooling water, and where there is an existing pond, the cost is limited to the spray nozzles and piping. In spray system the [illegible] so that when it falls into the basin or pond, its temperature is sufficiently reduced to permit of it being used over again, thus affording, at small expense, an abundant supply of cool water [illegible] where the plant may be located. This feature is frequently of great value, as a plant can be located where it is convenient to a fuel supply or distributing centre, and without considering a condensing water supply, which can be furnished by a spray system at comparatively



[illegible]

small expense. It also affords a simple remedy by which many power plants, now handicapped with hot condensing water, can reduce their operating costs.

The Spray Engineering Co. claims that by reason of the improvement in the nozzles, they have been enabled to reduce the power to operate sprays, fully 50 per cent. of what was formerly thought necessary. Under ordinary conditions, the power necessary to operate the sprays will average less than 1 per cent. of the power generated by the engine, whereas the average cooling tower will require the operation of from 3 per cent. to 5 per cent. The [illegible] a circulation of air, the power required to operate [illegible] purposes. The operating cost of the sprays averages only one-half of that required for a cooling tower.

[illegible] of the sprays. In the system described herewith the nozzles a arranged in groups and are so inclined towards opposing nozzl that, when the sprays are operating, they are made to collide wit each other. By reason of their collision the drops of water a broken into much finer particles than could be effected by the acti of the nozzles alone. As the finer the spray the greater will be t cooling effect, the advantage of this arrangement is apparen



LARGE COOLING POND, SHOWING SPRAYS IN OPERATION

Grouping the nozzles also increases the circulation of air among t spray particles, due to the accumulative driving action of the spra in the same group. Natural ponds without sprays require abo fifty times more area than a spray cooling system, and in the summ seldom cool the water sufficiently.

The above details are taken from pamphlets recently issued the Spray Engineering Co., Boston, Mass.

SIX-COLOUR CLOTH PRINTING MACHINE.

An interesting example of the electric drive as applied to t printing industry has recently been installed by the G.E.C. T machine is a six-colour cloth printing machine arranged to pri squares or rectangles with side and cross borders in any length fr 1 yd. to 10 yds. increasing by 1 in. and using rollers 18 in. in circu ference. The machine is driven by a 25 H.P. three-phase "Witto motor, the controller resistance being mounted on the bedplate the machine. As will be observed, the motor is completely out the way, and the management are very pleased with the comp nature of the drive. The electrical equipment was supplied by t General Electric Co.

EXPLOSION-PROOF SWITCHGEAR.

In addition to an extensive application in fiery mines "Witto explosion-proof motors and switchgears are occasionally put service in a number of unusual circumstances. Gunpowder factor one of the many works fitted with this class of motor in the north country, but a curious application has been found in a hydrog factory where it was specified that the switchgear should be explosi proof in order to guard against explosions due to gas leakages. T General Electric Co. supplied the switchgear for this installation.

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ELECTRIC HEATING & COOKING APPARATUS.
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EDISWAN
EVERYTHING—ELECTRICAL
(See [illegible] pages xix.).

THE ROUND TABLE.

EVENT OF THE WEEK.—"Kuki" Grogan decides to forsake his old love "Tricity," after eight years' courtship and devotion.

* * * *

A contemporary is appealing for men to assist in emergency electrical service for supply stations. Cannot the example of the railways and tramways be followed, and the fair sex be pressed or persuaded into doing duty? They might form a "S'Nice Switchers' Section" in the local volunteer corps, which are now so popular in most towns.

* * * *

As dictated, the frictional losses.
As transcribed, frictional glosses.
As dictated, the final devaporising chamber.
As transcribed, the flannel devaporising chamber.
As dictated, on which set of dials.
As transcribed, from which side of the wheels.

* * * *

THIS WEEK'S CHESTNUT.—A youthful electrician who had joined the forces recently timorously approached the sergeant:
"Please, sergeant, I want a day's leave."
"What for?"
"To see my fiancée."
"Your what?"
"My fiancée, sergeant."
"Your fiancée (and more fiercely), your fiancée!! I'll have yer know that fiancées are for the officers, sweethearts for the N.C.O.'s, and for you blooming privates just *birds*."

* * * *

The adjoining photograph kindly supplied by the Swedish General Electric Co., Ltd., shows one of the bearing blocks of a

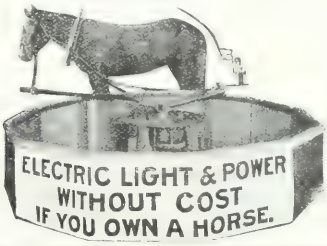


24,000-h.p. hydro-electric [illegible] to be used in supplying the odyssey we can only remark, "Some bearing!"

For the first time in its history electric and gas interests met together yesterday under the sheltering roof of the Institution of Electrical Engineers. Truly this war has a deal to answer for.

* * * *

The "horse-dynamo" has been a long time in arriving, but it is, according to the "Canadian Electrical News," now available. The adjoining illustration, taken from our contemporary, gives some idea of "him." His output is 60 watts



THE HORSE DYNAMO WITH ELECTRIC WHIP GOVERNOR.

at 40 volts, and his speed is kept within 0·1 per cent. by the electric whip which may be seen near his tail. Previous to its application, say, with a drop of 0·01 per cent. in his speed, a bell rings, and if this is not warning enough to him then he is electromagnetically whipped.

* * * *

THE PONDERING CONTRACTOR.

Ponder and Lead, Ponder and bend,
Which lamp is best for me to vend?
There's "Tantaswan," "Mazram,"
"Osdown," so many my mind to vex.
Ah! Ponders End's in Middlesex!

As we go to press we hear that the member of our staff who evolved the above has (after many bends) finally broken his back! Had this not have happened we should have recommended that his keepers squirt, suter and suspend him during the Royal (Ediswan) pleasure.

* * * *

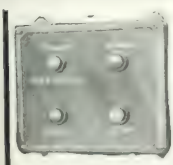
THE "OLD EFFICIENCY" RAG.
(An Unfinished Ragtime Number.)

He was energetic, most kinetic and Amurrican,
Then he wrote, yes, he wrote round to all the boys
Just a note—an orange note—"Leave all your toys
And get here in the morning when the day is dawning.
Bustle up! Hustle up! that's Amurrican.
You dictate it (how they all will hate it)
Grind away! Grind away, Old Efficiency
Underline it, don't you stop to sign it,
For you're just gone potty on Efficient C."

The foregoing is *not* taken from the "Efficiency Magazine."

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Margyle
Mr. E. R. Hill (Reading). [bone).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
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Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Holford (Leeds).
Mr. S. E. Britton (Chester).



No 57E-3. Push Button Box which not only starts and stops an electric motor, but also controls its speed either faster or slower at the will of the operator. All instructions are on the box, and are too simple to be mistaken.

Buttons to press, that's all!

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No 57E-1. Patent Compensated Solenoid type Automatic Electric Motor Control Panel, fully protects the motor against damage, while enabling it to be stopped, started, accelerated or retarded by means of the Push Button Box illustrated opposite.

Buttons to press, that's all!

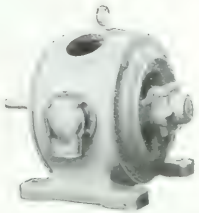


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GLASGOW—66, Waterloo Street. SOUTHAMPTON—46, High Street.
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SEALING BELLS FOR POWER TRANSFORMERS.

In the majority of sub-stations single cables are used for connecting up the terminals to the switchboards. In these cases the cables have to be of rubber, and where they pass through the switch chamber to the transformer room floor insulators, to withstand the full voltage, must be used, as it is not sufficient to rely entirely upon the insulation on an unsheathed cable. In order that metal-sheathed



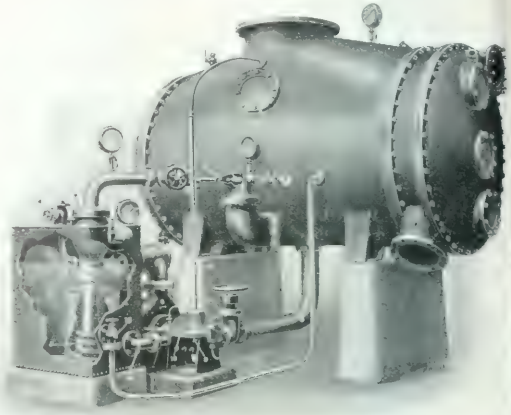
[illegible]

[illegible] makes a safer job of the wiring in the power transformer chamber, and is especially essential in the tropics, where there is risk of the unprotected insulation being damaged by ants. The detail of the sealing bell is shown in the illustration. The body is in cast-iron for sizes of cables 0·25 sq. in. in area or under, and in cast brass for large sizes. Standard designs are made for all voltages up to 12,000.

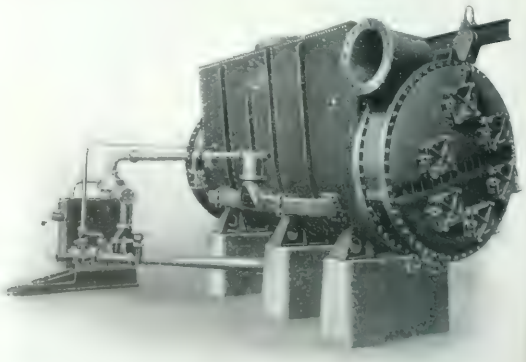
Similar sealing bells are used, but with brackets for bolting to concrete bases instead of the flange for single cables connecting large generators to switchgear, when, in addition to the spigot on the gland on which the lead covering is wiped, a pair of clamps are provided to receive brass wire armouring.]

CONTRAFLO KINETIC CONDENSING PLANT.

The steam turbine is now accepted as standard in every modern steam generating station. The perfection of the turbine has brought into prominence problems of the auxiliary plant which did not crop up with reciprocating engines. The latter were usually of comparatively small output, and the exhaust steam could be dealt with by condensers of accepted design. With the steam turbine matters are different. The high efficiency of the turbine is almost entirely dependent upon the vacuum which can be obtained in the condenser.



SECTIONAL VIEW OF CONTRAFLO KINETIC CONDENSING PLANT.



[illegible] KINETIC CONDENSING PLANT FOR 6,000 KW. PARSONS UNIT.

[illegible] the steam turbine [illegible] a compact generating unit, a large capacity is available from a small floor space occupied. In order to cope with the [illegible] condensers, the study of condensers and condensing plant has become necessary, and the result is that

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a number of specialised firms have established themselves, and their business is entirely confined to the designing of complete condensing plants. The Contraflo Company is one of these specialised concerns, and has already established a reputation for efficiency in design and reliability in operation of their products.

This company has designed condensing plant for generating sets, which vary in size from 500 to 25,000 kw., the last named being for the mammoth sets of the Commonwealth Edison Co., Chicago. In an interesting brochure recently issued, a full list of these installations is given. The largest of the British installations is that of the Newcastle-on-Tyne Electricity Supply Co. for its 16,000 kw. sets at the Dunston power station, Newcastle-on-Tyne. In order to emphasise the importance of high vacuum in connection with steam turbo-generating plant, it is pointed out in the opening pages of the pamphlet that the loss of power per lb. of steam consequent upon a vacuum of 26½ in. as compared with 28½ in. would correspond, other things being equal, to that which would be caused by a reduction of pressure at the turbine inlet, of from 200 to 110 lbs. It is also pointed out that if high vacuum is to be really effective, it must exist in the exhaust chamber of the turbine. It is stated that the economy resulting from a high vacuum at the air pump suction is only attained in proportion to the extent of its influence on the last row of low pressure blades; high vacuum at the turbine blading is only attainable if the design of the condensing plant and of the exhaust end of the turbine casing is suitable. The statements of Sir Charles Parsons and Prof. Rateau are reiterated, to the effect that high vacuum is relatively of even more importance in the low pressure exhaust steam turbine than it is in an ordinary high pressure turbine.

The list contains a useful table which shows approximately the amounts by which the steam consumption of modern turbines is reduced by an increase of vacuum from 27 in. upwards. At the lower limit from 27 in. to 28 in. vacuum there is a 6 per cent. reduction in steam consumption, and at the upper limit from 27 in. to 29¼ in. it is 19 per cent., these figures being for a high pressure turbine working at 175 lb. pressure and 150° superheat. The Contraflo Co. in calling specific attention to these important principles, claims that it designs condensing plant which will secure for users of steam turbine plant the whole of the economies which are obtainable in this field. It is also stated that by the employment of the Contraflo Kinetic system of surface condensation, the highest possible vacuum is obtained at the turbine exhaust under all working conditions. They particularly plead for a consideration of their condenser, with its corresponding air pump, as one condenser unit and not as separate items, the argument being that there is in reality no point at which it can definitely be stated that the work of the one ceases and that of the other commences.

The essential principle of the Contraflo condenser design is that of condensation and air concentration in wedge-shaped chambers, so assembled as to utilise the kinetic energy of the inflow from the turbine to drive the air downwards into and through the narrow ends of the wedges. By this arrangement the air delivered to the air pump is of greater weight per unit of volume than elsewhere in the condenser. The economic effect of this design is the production in a given condenser of the highest vacuum and the least running cost for circulating water. A sectional illustration through a large condenser is given, and it is pointed out from this that the admission area to the tube nests extends over a large percentage of the entire periphery, and therefore the frictional resistance through the wedge-shaped condensing chamber is reduced, and the air, after passing through the final devaporising chamber, is delivered to the air pump at a temperature which will enable the pump to reduce the insulating effect of air on the tube surface to the attainable minimum.

The company's system of air extraction is based on the use of a steam jet ejector in conjunction with a water jet ejector of high efficiency, the only moving parts being an ordinary simple centrifugal water pump. Such pumps in practice have proved

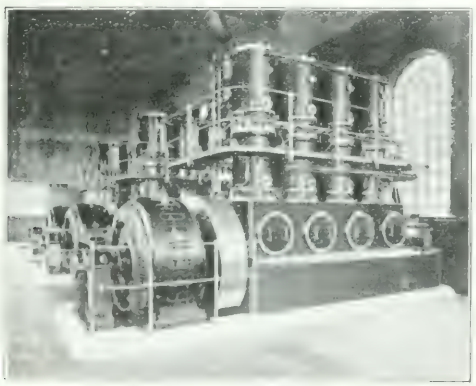
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CHARLES CLIFFORD & SON, Ltd.
BIRMINGHAM.

...ing of the bearings with a minimum of wear. By the use of steam as a motive power, a vacuum can be obtained in the condenser which is independent of the temperature of the water used in the water jet ejector, consequently the water employed for the latter can be the condensed water removed from the condenser. By this simple provision all the energy in the steam jet and the frictional expenditure in the centrifugal pumps are absorbed, and the feed water is returned to the boilers at a temperature correspondingly higher than that at which it was removed from the condenser.

The brochure proceeds to describe in detail the constructional features of this interesting plant. Space will not admit of our going into these details, but engineers who are interested in problems of condensing should obtain a copy of the publication, and we feel sure that they will peruse it with both pleasure and profit.

WINDING PLANT AT BURLEY COLLIERY.

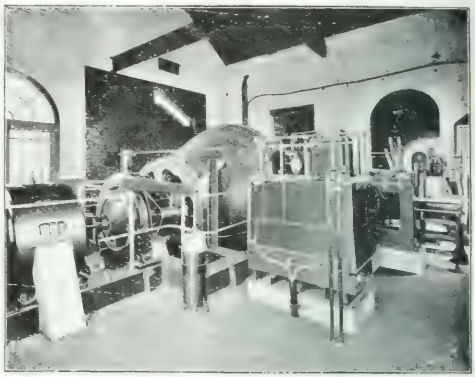
An interesting electrical colliery plant is that at the Burley Colliery of the Midland Coal, Coke and Iron Co., where extensive use is made of the electric power generated from waste gases, both coke oven and blast furnace gas being utilised. The power house contains three 375 kw. three-phase alternators driven by "National" gas engines, generating power at 550 volts, 25 cycles. The main winder is situated at the Burley Pit, the Company closing down their Sladderhill Pit as far as coal winding is concerned, the coal from the latter being brought up by way of the up cast shaft of the [illegible] Pit.



[illegible] Motor-Generator Set.

...in connection with the main winder, which involves a new principle,

pulleys to a float in a separate tank. When the float rises, the dippers are lowered and cut out the resistance. The float tank is constructed in two portions, an inner and outer tank, water being kept constantly in circulation from the outer to the inner, by means of a small motor-driven centrifugal pump. This water flows from the inner tank unless the valve is closed by the control lever, when the level of the water rises at a predetermined rate, carrying with it the float, which lowers the dipper blades in the control tank, and runs the motor up to the required speed. The speed to which the [illegible]

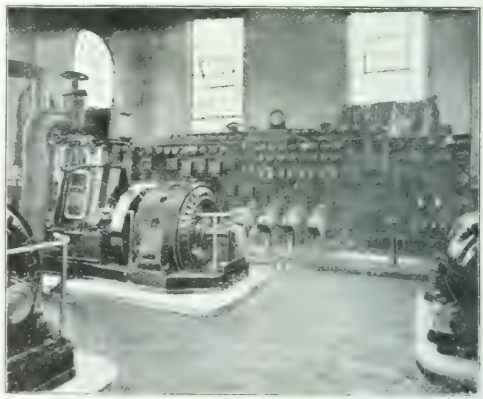


Winder at Burley Colliery showing Controller in Foreground.

...one side of the inner tank, this shutter being itself controlled by a separate lever which can, if desired, be permanently placed in any position. If this second lever is put to the slow position, the motor will accelerate to the slow speed, when the main control lever, which is normally used by the driver, is put either in the forward or the reverse position. If the regulating lever is pushed into the full position, the motor runs up to full speed when the main lever is put over.

There are two stator switches, one for each direction of running, so interlocked that they cannot both be put on at the same time. The rotor connections accommodate the fixed terminals in the starter tank. The main operating lever actuates both the reversing switches and the valve in the control tank.

An important feature is a speed lever [illegible] switches being left partially on contact. The latter also [illegible]



Main Switchgear and Motor-Generator Set.

...the driver reading, by rapidly switching on or off. There are three notches only for this lever, an off position and a full-on position for either direction. The regulating lever is mounted outside the main control lever, and has a number of notches representing different speeds, it can be set for any one of these by the driver to any required speed. The winding gear is equipped with safety devices to



In the Spring a young mans fancy lightly turns to thoughts of love

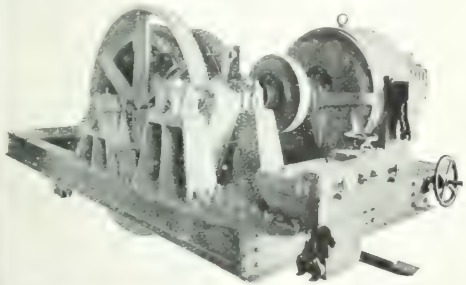
Let not your fancy turn lightly to love only; force it to turn–electric-lightly–to the

POPE Elasta British Made Wire Lamps

Advt. of Pope's Electric Lamp Co., Ltd. Also makers of Carbon and Radiator Lamps. Hatton Road, Wednesbury, England.

The lamp with a living in it

pe with every conceivable safety. There is a depth indicator of the ertical type, driven from the drum shaft, and provided with an verwinding attachment, which cuts off the current, and releases weighted brake when the cages pass a predetermined point. The ake lever is fitted with a dash pot. In addition to the overwinding vice, an over-speed gear of the high speed Hartnell governer type provided, and controls the speed of the cage at each point in the aft. Should the driver fail to effect the necessary reduction in eed when nearing the end of the wind, the over-speed device, hich is set to operate on a 5 per cent. speed increase, opens the otor circuit and applies the weighted brake lever.



100 H.P. PIPE-VENTILATED MOTOR COUPLED TO HAULAGE GEAR.

The power cost of raising coal from the full depth of the shaft by his gear is stated to be 0·5d. per ton. The electrical equipment as supplied by the General Electric Co., Ltd., of Magnet House, Kingsway, W.C., and M. B. Will, Birmingham, were responsible for the mechanical portion of the winding gear.

The electrical equipment of the colliery also includes a number of pumps, haulages and so forth. A good example of pumping plant is shown herewith, representing a two-throw pump driven by a 80 h.p. slip-ring motor. Two of these pumps are installed, each being capable of lifting 300 gallons per minute, against a total head of 1,550 feet, with a maximum lift on the suction of 250 feet. The haulage is of interest, inasmuch as the gear was constructed by the colliery engineers themselves. It is driven by a 100 h.p. pipe-ventilated motor. The equipment of the colliery is up-to-date in every respect, and reflects considerable credit upon the colliery management.

"PIVOT" SINGLE-WAY AND TWO-WAY TUMBLER SWITCHES.

The chief feature of the movement of the Pivot switch is the variable-leverage action, due to a slot in the moving contact-arm working over a fixed fulcrum pin. The use of the single spiral coil



TWO-WAY KEY PATTERN PIVOT SWITCH.



PIVOT SWITCH WITH LARGE COVER.

control-spring, which is tin-plated to prevent rusting, ensure an easy and agreeable "on" and quick "off" action, there is a long break, and the contact-arm is locked in its "on" position. The control-

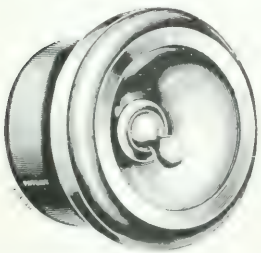
stretched between a hook formed on the bridge and another on the moving contact arm. The result is a positive and easy action, ensured by the slight eccentric action of the two contact-arms as they enter and leave the contact springs, this movement being due to the slot already mentioned. The contact springs are now of the double-clip type, and are some distance apart with a shielding portion of the porcelain base between them. They are tinned to prevent corrosion.

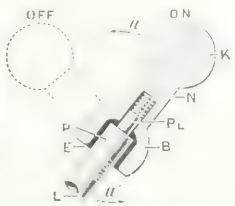
After considerable experiment, Messrs. Lundberg inform us that they have been able to apply successfully a patented application of mica for the insulation of current-carrying parts. A switch fitted with this has successfully withstood a breakdown test of 2,000 volts.

Mica is unaffected by moisture, and is capable of resisting high temperatures. The rocking contact-arm of the switch and its mica insulation, after being subjected to a high temperature, are practically unaffected. The parts are firmly rivetted together, so that any jar caused by working the switch cannot possibly produce any loosening.

By reason of the independent action which is now fitted to the "Pivot" single-way switches, the "off" movement of the contact blades is independent of the operator. Even if the knob be moved very slowly, the blades will spring "off" sharply from the fixed contact springs, and the sparkwear will be kept down to a minimum. The contacts consequently remain clean and bright.

The details of the arrangement are shown in one of the illustrations K is the knob, N the neck, and B the base of the switch lever, B turning on a cross-pin rivetted to the screwed neck of the fixed switch bridge. This cross-pin is shown in section at P. L is the lever which actuates the switch mechanism, and which in ordinary constructions forms one piece with K, N and B. In our improved construction it is quite separate, though it turns on a similar pin P. Assuming that K shows the "on" position of the knob, and that it



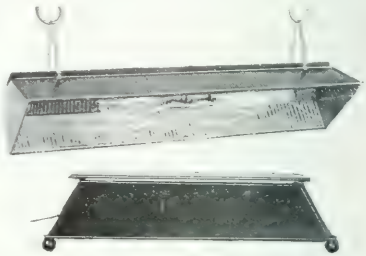


Switch.

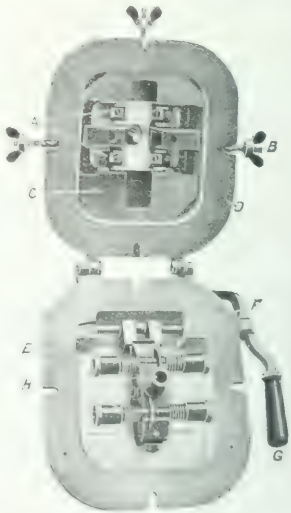
would be moved to the "off" in the direction of the arrow *a*, the independent action may be described as follows:—

The lower edge E of the base B bears against the neck of L and forces it over in the direction of the arrow *a'*; the lower end of L actuating the rocker of the switch. As soon as the rocker passes a certain point the control spring pulls it over sharply, and the blades fly out of the contact springs even if the knob K is held stationary. In other words, L can make the remainder of its "off" movement in the direction *a'* irrespective of the position of B. PL is a small flat-ended spring plunger which bears lightly on the flat head of L, and which tends to keep K, N and L in alignment, and to prevent K, N and B rocking loosely about P when the knob is released by the hand.

SHOP WINDOW REFLECTORS.



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Western-Electric Company, Limited.

BIRMINGHAM GLASGOW LEEDS MANCHESTER
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the retention of explosive gases. The following features of the Adanac explosion proof, interlocked combined fuse-switch with break are therefore of interest:—Great mechanical strength; all size for a given output; wide machine-faced surfaces in comparison with the cubical contents of the case; current-carrying contacts renewable from the front; movable switch contacts can be revolved to present an entirely clean switch contact when required; current is broken upon each pole, upon two contacts in series, and with a parallel action; contacts mischief-proof; positive quick



Flameproof Switch and Cut-out.

ike and break action. [illegible] cable [illegible] until the moving switch contact [illegible] cannot be closed, cables may enter cable at the top or bottom, and without [illegible] the switch "upside down." The apparatus is fitted with Berry's patent magneto blow-out fuses. Without [illegible] any other tool these can be re-fused with ordinary copper wire in a few seconds, and there is no possibility of accidental shock during renewal.

We understand that the switches were examined and tested by the Underwriters' Laboratories, Inc., at Chicago, U.S.A., in December last. A sample 20 ampere 200 volt switch was operated 12 times by hand, closing and opening a circuit in which a continuous current of 30 amperes at a pressure of 315 volts was passing, first with the switch cabinet earthed, and afterwards with the generator alternately earthed on the positive and negative side. Strips of copper were placed in parallel with the fuses to prevent the latter from blowing. The contacts were only slightly burned. The insulation resistance was measured with a 500-volt Megger, and the result was:—Positive to negative, 50 megohms; positive to negative to earth, seven megohms. The two poles of the same switch were connected to the terminals of a transformer and starting at 800 volts the pressure was gradually raised to 2,000 volts and maintained for one minute. The test was repeated with the transformer terminals connected to the switch contacts and metal case respectively. The insulation satisfactorily withstood this test.

The illustration shows an ironclad fuse-switch cabinet with the cover open; the cabinet is provided with [illegible] D, with similar provision on the hinged cover. When the cover is closed and the metal surfaces are together, they are clamped by four equally-spaced wing nuts as at B. The cover having been closed, the lever C can now be operated by means of the quick acting lock, bolt E, to throw the rapid-acting toggle joint carrying the magnetic blow-out fuse carriers F in to their respective base contacts at A. This operation of closing the switch automatically locks the cabinet by means of the engagement of a male bolt in the centre of the base with the female projecting tube H. It is impossible to open the cover until the bolt is withdrawn by moving the switch to its "off position." Shrouding of the cable connections in the base to meet the Home Office requirements is provided by the insulating screens as at C. To [illegible] these [illegible] fuse carriers F can be out-sprung in one second, re-fused and in-sprung into position in under 30 seconds for the complete operation. The apparatus is low in price and simple in construction. Every part is interchangeable; it is "made like a gun."

Messrs. Berry, Skinner & Co., of 78, Upper Thames Street, London, E.C., have brought this unique switch to our notice, and they will supply [illegible] [illegible] on request.

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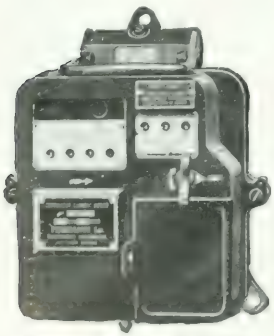
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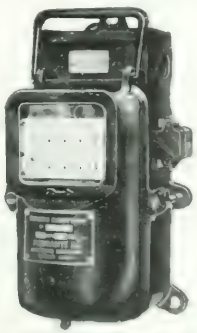


FERRANTI HOUSE METERS.

A little while ago a number of pamphlets dealing with these meters were issued by Ferranti, Ltd. The pamphlets, which contained descriptions of the meters, their principles of construction and details of the tests, were accompanied by sectional illustrations and by views of the meters in parts. Following this pamphlet are a number of others which deal respectively with two-wire, three-wire, two-rate, and prepayment meters, all of the ampere-hour type. A



Ferranti Two-wire Meter.



Ferranti Two-rate Meter.

been improved from time to time in accordance with the extension o experience with it in actual service. The adjoining diagram explain in a simple manner the principle of the action of the ampere-ho type of meter. It will be observed that there is a disc of coppe placed in mercury between specially shaped poles of two permanen magnets. The disc revolves in jewelled bearings, and its upper ex tremity is provided with a worm through which the recording train either of the cyclometer or dial pattern, is driven. The current flow from the positive terminal to the circumference of the mercury bath through the mercury and the copper disc and out at the centre of th bath, whence it passes through a compensating coil to the negativ terminal. The inter-action between the flux from one of the per manent magnets and the current through the disc exerts a drivin torque on the disc and causes it to rotate. When the disc rotate eddy-currents are set up in it by the flux from both permanen magnets, and the inter-action between these eddy-currents and th flux exerts a retarding torque on the disc. The flux from one magn produces both a driving and a retarding torque, and that from th other magnet a retarding torque only. When the speed of rotatio is constant the driving and retarding torques must be equal. I frictional losses are disregarded the speed of the disc will be propor tional to the current. The compensating coil is introduced to dis count the effect of mercury friction which increases with the spee The coil therefore increases the driving flux, and it is so adjusted tha the driving torque is increased by an amount corresponding to th increased friction. By means of a cylindrical weight on the drivin spindle, and also by externally placed weights attached to radia

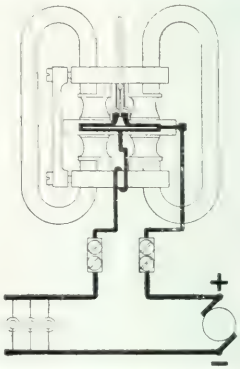


Diagram Explaining Principle of Ferranti A.H. Meter.

arms, the copper disc is balanced in the mercury bath, and the pressur on the jewels is reduced to a minimum.

An illustration is also given of the two-wire prepayment hous service meter. This is fitted with a fraud-proof mechanism, and provided with four main and two test dials in both the current cloc and coin cyclometer dials. The mechanism is suitable for the inser tion of a total of 12 coins consecutively. It records the consumption of energy in the ordinary way and also moves back the coins-used pointer to zero, and at this point trips the switch and interrupts th circuit. The standard box will hold 150 pennies, but a larger box can be supplied to hold 220 pennies. The meters can be supplied to ad any size of coin between a three-penny bit (16 mm.) and a penny (31 mm.) diameter.

We also show an external view of the two rate two-wire type o meter, which is provided with dials giving two readings, the lower registering during the low-rate and the higher during the high-rate periods of the day. Contained within the meter is an electromagnet which is connected by a time switch across the mains. This magnet is energised at any suitable time so as to set either the lower or the higher counting trains. There is a pointer at the left-hand corner of the dial which shows on which set of dials the meter is registering. It is stated that the losses in the shunt coils of the change-over magnet occur only during the high-rate period when the time switch is closed and the magnet excited. These losses vary from 1·2 watt hours in a 60-volt meter to 10 watt hours in a 500-volt meter. In the 200-volt meter there are four watt hours. These meters are supplied in sizes from 3 to 500 amperes capacity, and above 50 amperes are worked from a shunted circuit.

We are asked to state that interested engineers will be supplied with a copy of the above-mentioned three pamphlets on application to

THE ROUND TABLE.

EVENT OF THE WEEK.—The Synchronome Co. ticks off the Germans at the British Industries Fair.

* * * *

THIS WEEK'S CHESTNUT.—Volunteer Coal-heaver (formerly waiter) to housewife: "How will you have these coals, madam, *à la carte* or *cul-de-sac*?"

* * * *

We regret to record the decease of Mr. H. F. Fredericks, borough Electrical Engineer, West Hartlepool, one of the original members of the Point Five Association, and the first to be removed by death.

* * * *

The Benjamin Electric Co. is introducing a new type of half-watt fitting. In order to comply with the prevailing fashions in "frightfulness," this fitting is provided with a skeleton neck. None the less, it is BRITISH to the backbone.

* * * *

The Report of the Sanitary Committee on Air Pollution, issued by the city of Manchester, ought to be presented to every factory owner who runs his plant by steam power. (Incidentally, a copy might be posted to the Kaiser.)

* * * *

There is a rumour that the gas undertakings all over the country are contemplating ordering the removal of gas cooking stoves in all domestic establishments. Why? Just to make room for the little Kitcheners!

* * * *

At British Industries Fair a home-produced insulating material (displacing the German original) has been dubbed "Erinoid," doubtless out of deference to the appreciation for the Irish Party, which, according to some authorities, including the Batti-Wallah Society, is "the real cause of the war."

* * * *

Ultimately what were once exclusively scientific terms will become absorbed into the expressions and writings of everyday life. Thus, Twells Brex in the "Daily Mail" (our italics):

> many things untoward for us in the war [illegible] to the work of those subtle *conductors* of the state and Germany with limitless funds and inborn Germanic treachery.

* * * *

Belfast City Council is quarrelling over the retention of its electrical engineer. According to one of the aldermen, "the whole campaign of persecution had been originated by a few dissatisfied employés at the electric station." The agitation seems to bear out the old description of an Irishman—namely, that he does not know what he wants, and won't be happy till he gets it.

Mr. Barnard's stirring epic, written to immortalise the memory of the engineers who went down to a man with the ill-fated "Titanic," may appropriately be reproduced at the present time as a reminder of the many brave men who are likely to be in the same case, both on our battleships and in the merchant services.

* * * *

REMEMBER THE "LUSITANIA."

AND THE ENGINEERS.

What of the men below?
Stripped to the grimy waist and oil-
Deaf with the sound of the engine-broil:
Blackened with coal-dust—hot with heat:
Counting the throbs of the engine-beat:
Buried below with the rats and mice:
With never a thought for the world of ice
You on the deck, there! What do you know
Of the men below?

Tang! Tang! Tang! Signal by "Half speed! Slow!"
"Slow it is," says the man below.
Tang! Tang! Tang! "Extra hot speed! Aye! Aye!
Stem it!" ... and he wonders why.
How should they guess, in the depth below,
Till the vessel shivers from stem to bow
With a rending, grinding, tearing shock,
And they KNOW.

"God! It's the ice!" "It's a berg!" "It's a rock!"
"Steady there, stokehold! Watch your steam!
Hustle those pumps!" and ... "Damn it, No!"

Up through the floor-plates well-nigh waist-deep,
Rising, swirling, from none knows where,
How shall we guess at their black despair,
We on the deck where the night-wind's blow?
All are in peril, but we are free:
Free for a plunging fight for life.
Collar that lee-oar! "Out to sea!"
Better to die in a hopeless strife
Gaping the wind and the waves and the white-necked foe
Than be drowned like a dog below!

So!
And did you cry? Ah, no!
But a MAN, and the way of a man to show
He will hold to his work to the death, below
While his comrades trust to the iron will,
To the fertile brain, to the craft and skill,
Of the children of Tubal Cain.

"If the steam will hold up and the pumps can gain."
No!
Down they go.
And there's never a man on that hell's below
But his God shall know.

V. STUART K. BARNARD.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. E. R. Hill (Reading).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
West Hartlepool.
Mr. J. W. Beauchamp (West Ham).
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Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
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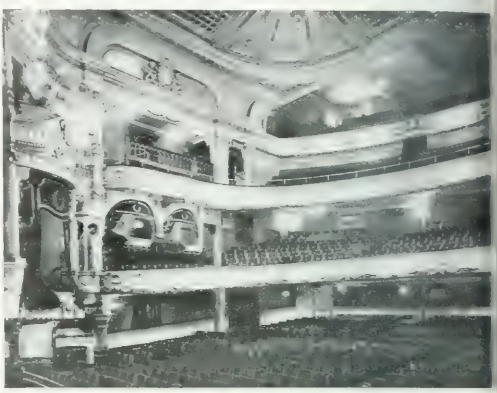
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THE LIGHTING OF A MODERN MUSIC HALL.

One usually imagines huge pendant fittings, sometimes lavishly decorated with crystals, when one thinks of theatre or music hall lighting. Such artificial light photographs as those which accompany this article bring a realisation that the old system of lighting is as dead as the old style music hall, with its ribald chorus songs and smoke-laden atmosphere. The modern house of entertainment is usually a thing of architectural beauty, and the comfort of its patron is catered for by the provision of well upholstered seats and a cle atmosphere.

Good lighting is one of the most important of the creature comfort and the Moss Empires, Ltd., have a keen appreciation of this fac judging from the care given to the lighting of the Finsbury Pa Empire. This hall is lighted throughout with Mazda drawn wi lamps and P.T.H. Veluria reflectors. The ceiling as will be se



THE AUDITORIUM, FINSBURY PARK EMPIRE.

from one of the illustrations, is one of the features of the auditoriu

We have previously described Veluria white glass reflectors, a we understand that they are very popular in theatrical circles. Fu particulars of this glassware (which is made not only in reflector for but in many beautiful bowl patterns) can be obtained from t British Thomson-Houston Co., Ltd., Mazda House, 77, Upp Thames-street, London, E.C.

SECTIONING SWITCH FOR TRAMWAYS.

At the request of a large municipality the G.E.C. has constructed sectioning switch for pole mounting on tramway circuits. It co sists of a 300-ampere "Peel" switch fixed in a cast-iron case, t case being of such a length that the switch can be fully opened a the lid closed. The lid is provided with a spring lock and a spec key. The method of fixing this switch to the pole is as follow The sides of the switch case extend some distance beyond the ba and these sides fit on to the po The complete switch is clamped the pole by two steel bands, t ends of which are screwed a provided with nuts and washe These pass through the horizont apertures seen at the top and bott



THE CHISWICK (G.E.C.) AUDITORIUM, FINSBURY PARK EMPIRE.



300 AMPERE TRAMWAY SECTIONING SWITCH.

THE NEW

BELLING BOILER

new line which we can recommend with confidence.

e 37/6
bject.
12" 12"
4" high.
iding 1½
Kw.



Complete with 3-heat control switch, 2 yards of flexible, and earthing terminal.

ILS, FRIES or TOASTS—and DOES IT QUICKLY.

It is a very handy practical article, and made to stand the ghest kitchen wear and tear.

t is going to be a quick seller, as its utility is so apparent, can be so forcefully demonstrated to a prospective buyer.

Any pots or pans can be used on it, and it appeals to every ...and cook is ... easy to work, and so quick."

Starting all cold it boils two pints of water in just over minutes. It does not matter what is spilt on the nent—soup, milk, water or anything else.

By the way, get the first boiler you buy installed in the hen of the most talkative cook you know of. Have ther one in your Showroom in readiness for the other ks and mistresses who will be coming in to see it—and y will!

We are rather proud of the mechanical and electrical struction of this new line, so we should like you to take right to pieces. You will see that we have given much ught to every detail, and the almost crude simplicity of final article is the result.

Next to the Belling Fire we feel that this is the most ful and the most practical article we have ever brought ward, and we hope all our friends will have one down to t for themselves, at our risk and expense. It will help to keep our booking straight if you send us an official ler marked "On approval."

Our distribution leaflet (overprinted and supplied free in any antities) also gives particulars of our new breakfast cooker.

LING & CO., Electric Heating Specialists, Derby Road, Edmonton, LONDON, N.

WARNING

Statements are being circulated to the effect that GERMAN interests predominate in the Simplex Company.

As all such statements are absolutely false and devoid of any foundation, and as they can only have been circulated with the object of injuring the Company's position in the Electrical industry, immediate proceedings will be taken against any person using or repeating such libellous allegations.

We here repeat that SIMPLEX CONDUITS, Ltd., is entirely a BRITISH Company. The Directors, Shareholders, Staff and Employees are ALL BRITISH.

Admiralty Contracts of considerable magnitude are being executed in the Works, and approximately one-third of the Company's employees are serving with the Forces.

A Substantial REWARD will be given for any information which will enable us to strike at the root of these libellous statements.

SIMPLEX CONDUITS, Ltd.,
GARRISON LANE, BIRMINGHAM.
113, Charing Cross Rd., London, W.C.

MANCHESTER—[illegible]
GLASGOW—72a, Waterloo Street.
NEWCASTLE—41, Hood Buildings.
BRISTOL—11, Dorset Street.
[illegible]—6, White Horse [illegible]
[illegible]—[illegible] Whit[illegible]
CARDIFF—11, Hewitt's Street.
[illegible]—4, Westgate Street
[illegible]—1, Cri[illegible] House.

OHMS

Keep one of our Departments always busy. We manufacture them in the form of

RHEOSTATS

of all types, values and carrying capacities, from the SMALLEST SLIDER to the LARGEST LOAD or CALIBRATION Set.

BRITISH MADE ONLY

ISENTHAL & CO.

DEPARTMENT 4

Denzil Works, Neasden, LONDON, N.W.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster General, etc.

CURRENT TRADE LITERATURE.

STAFF WITH THE COLOURS.—A neat pocket list is being issued giving in alphabetical order the names of the employés of Siemens Bros. & Co. and Siemens Bros. Dynamo Works who are serving with His Majesty's forces at the present time. There is a total number [illegible] they have been drawn from the various works of the companies, from their office staffs and from the branches in Great Britain, and [illegible] The booklet, which was published in April, is the first edition of its kind, and will doubtless be followed by others in the future.

[illegible] contains in the centre a reproduction in miniature of the War Calendar issued some months ago by this firm and which received such an appreciative reception from engineers in all parts of the country. The [illegible] engines, paper and bitumen cables, V.I.R. cables, joint box com-

B.T.-H., Rugby.—Descriptive lists Nos. 2,213 and 2,255, which [illegible] type DH [illegible] type D 2 [illegible] laminated contacts, direct and alternating-current air-break circuit-

on dusty situations and fiery mines, oil break switches and circuit-breakers for three-phase lines up to 90,000 volts, switches for high-tension transmission lines, protective apparatus such as earthing devices, lightning arresters, water jets and choke coils, and a variety of fuses of the air and oil break types for low and high-tension lines. These various pieces of apparatus are made up in standard lines and in accordance with modern practice.

EDISON & SWAN.—We gather from leaflet A.3,096 that there is a reduction of prices upon Ediswan foolproof quick-make and quick break ironclad switches and switch fuses for pressures between 250 and 600 volts. This list will be found of interest to those contractors and central station engineers who are called upon to put down emergency power installations, more particularly for firms who have undertaken the manufacture of war munitions.

DONOVAN & CO.—A pocket price list (No. 1,515) is being distributed, and deals with the various electrical lines which are either manufactured or handled by this firm. Amongst the manufactures are "Barwick" starters and regulators, "Cornwall" fan regulators and "Safuse" distribution boards. The factored material includes mining bells and tappers, blasting machines, batteries, wires and cables, a variety of electrical wiring accessories, and a line of alternating and direct-current fans.

DRAKE & GORHAM.—Among their [illegible] line of separately heated electrical utensils, this firm calls attention to El Grilstovo, a table utensil loaded to 600 watts and suitable for toasting, grilling, frying and a small amount of boiling. This is offered as a useful selling line during the summer months.

BELLING & CO.—A circular is being distributed describing the new Belling boiler, which is loaded to 1½ kw., and is provided with three heat control switch, 2 yds. of flexible cord and earthing terminal. It is 12 in. by 12 in. by 4 in. high, the heating element being circular, with ample room on the stand to draw pans on one side for simmering purposes. The price is 37s. 6d. subject.

CARRON CO.—An attractive 90 pp. catalogue will shortly be available dealing fully with Carron electric heating and cooking appliances and also a line of separately heated table utensils. Cast aluminium pots and pans, and a line of porcelain casseroles, &c., known as "Cook's" ware, are also featured. Illustrations are given of a number of restaurant installations. We shall turn to this list again in a early issue.

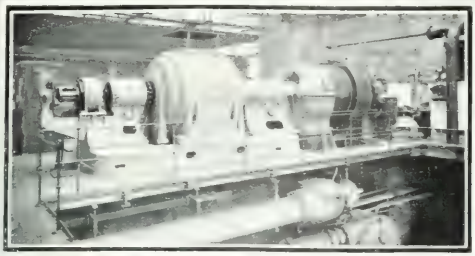
THE NO-CELL DYNAMO.

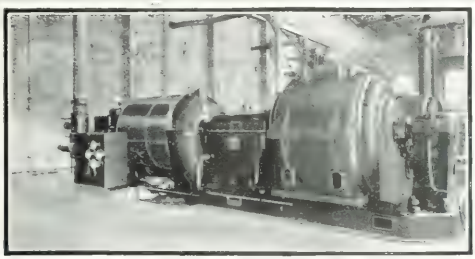
Some interesting particulars are being distributed in the motor-cy trade regarding a small dynamo set which is being offered for use o large and small cars for supplying a couple of headlight lamp while the engine is kept running. The use of this little dynam dispenses with the need for lighting batteries for supplying th headlights. The dynamo is of the permanent magnet type, and totally enclosed in a cylindrical case 5 in. diameter by 5½ in. long.

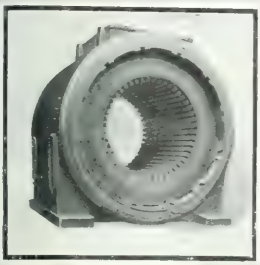


NO-CELL DYNAMO IN POSITION.

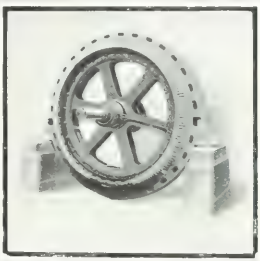
[illegible] one of the type will give a constant voltage when driven at a varying speed. There is a small friction pulley at one end of the dynamo shaft, and this is engaged with the periphery of the engine flywheel, the contact being regulated by a Bowden ratchet lever placed in front of the driver on the dashboard. The equipments are [illegible] complete with dynamo, two headlamps in brass, 10 in. diameter each, with a 10 volt 10 c.p. lamp, Bowden ratchet lever and the necessary fixing brackets. For light cars the equipment is similar, except that the headlamps are 7½ in. diameter, and are fitted with 6 volt 6 c.p. lamps. The dynamos are also obtainable [illegible] shortly. The propulsion headlamps are neat in appearance and







VICKERS Limited





RIVER DON WORKS, SHEFFIELD

ELECTRICAL EQUIPMENT
of every description





FERRY | FERROZOID | CONSTANTAN | CHRONIC

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:

MAKERS:

HENRY WIGGIN & CO., Ltd.,
George Street, Birmingham.

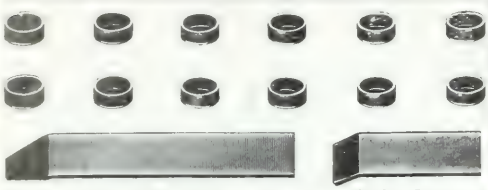
TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.



Drawn and Pressed Work of every description for Dry Batteries.

Sole Agent for the Electrical Trade:—
LIONEL ROBINSON, 3, STAPLE INN. LONDON. W.C.
TELEPHONE: Holborn 6323.

are so designed that the lamps occupy a correct focal position in relation to the reflector. In ordering these outfits, it is necessary to state the make and the year of manufacture of the car for which they are required. Full particulars of other G.E.C. motor-car accessories can be obtained by application from their latest catalogue, the 11th edition of which is just off the press.



DETAIL OF METHOD OF ATTACHMENT OF DYNAMO.

BENJAMIN HALF-WATT FITTINGS.

The adjoining illustration shows a new design of half-watt fitting (catalogue No. 4,407) which the Benjamin Electric (Ltd.) are now putting on the market. It will be observed that the reflector, which is of vitreous enamelled steel, finished white inside and green outside



THE BENJAMIN HALF-WATT FITTING.

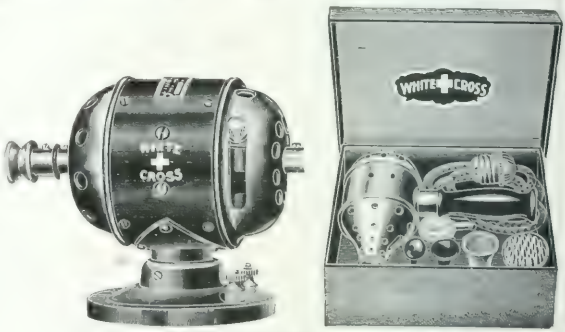
"WHITE CROSS" ELECTRIC VIBRATORS.

The value of vibration and vibratory massage for a number of ailments and diseases is now generally recognised by the medical profession. With the prospect of so many wounded and injured soldiers in our midst there should arise a greater demand than formerly for massage devices, and amongst them those which are electrically operated should meet with a popular reception. Several sizes of these machines have been made to many years



No. 22 VIBRATOR OUTFIT WITH RECHARGEABLE MOTOR.

past, and the development of the small electric motor on lines of improved efficiency and greater reliability has assisted in their manufacture at reasonable prices. The general availability of a public electricity supply is also another contributory factor to



SMALL MOTOR AND No. 21 VIBRATOR OUTFIT.

increased trade in such electrical accessories. We have been recently supplied by the Cameron Sales-Organisation, Southampton-street, Holborn, London, W.C., with particulars of White Cross electric vibrators, which are offered under a definite guarantee for one year in a variety of outfits. No. 21 is a small set for fixed vibration only. It gives a percussion stroke and a rubbing movement, but there is no regulating device. It is supplied with four applicators, and is complete with flexible cord and adaptor. No. 22 outfit is similar to the latter one, but is a rather more powerful machine, and is fitted with a regulating switch. There are several other outfits in this series, all of which are suitable for operating from alternating or direct-current mains supply mains. Portable outfits operating from dry cells are also listed. The pamphlet contains particulars in addition of a range of small motors rated at $\frac{1}{32}$ H.P. and $\frac{1}{16}$ H.P., absorbing 56 watts, and

FERRANTI LTD
Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

ROYAL EDISWAN

DRAWN WIRE LAMPS

FIRST

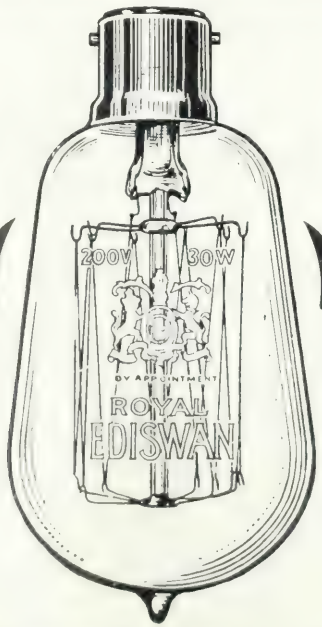
THE EDISON & SWAN UNITED ELECTRIC LIGHT CO., Ltd.

have longer experience of Incandescent Lamp making than any other firm, being Pioneers of the industry in 1883.

TO-DAY

"Royal Ediswan" Drawn Wire and Carbon Filament Lamps are benefiting by over 30 years' lamp making experience, and are made at

PONDERS END
MIDDLESEX.

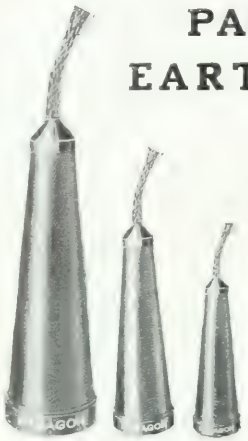


EDISWAN—EVERYTHING—ELECTRICAL.

A Good EARTH

THE

PARAGON EARTH CONE



is made of perforated copper and filled with small charcoal. It is easy to instal, is permanent, and makes a really scientific earth.

The Cone is made in various sizes for Lighting, Power, Tramways, Telephones, Telegraphs, &c

SCHOLEY & CO., Ltd.,

56, Victoria Street, London, S.W.

ARMORDUCT CONDUIT

■

Puts you on good terms with your Profit and Loss account.

■

Write for particulars and prices

The
ARMORDUCT
Manufacturing Co., Ltd.
Farringdon Ave., London, E.C.
Bathurst Works, Witton, B'ham



capable for 100-110 or 200-220 volt alternating or direct current. These motors and those fitted to the vibrators are all of standard size, with laminated armature and fields, former wound coils of double silk-insulated wire, mica insulated wide and deep commutators, phosphor-bronze bearings, tool steel shafts and self-oiling cups.

BRITISH INDUSTRIES FAIR.

After a round of the exhibits which the Board of Trade has collected at the Agricultural Hall and styled the British Industries Fair, 1915, we were unable to discover anything of essential and general electric interest. The main body of the hall is filled with a large number of stands, such as are not uncommon to the printing exhibitions which are held at Islington. What little there is to attract electrical men, both traders and manufacturers, may be found in the gallery and annexe. In the toy world the tiny electric motor is slowly coming into its own, and side by side with it increasing the popularity of the small dry battery. Where the penurious youth in the early days of steam working models spent all his allowance on methylated spirit, the modern electrically minded youngster hoards up his savings for investment in small dry batteries, wherewith to furnish energy for his electric railway or motor-driven workshop. No surprise need therefore be felt at seeing in the toy section of the exhibition a number of firms who call attention to the [illegible] batteries, or the small batteries, which they have used for lighting or small (very small) power purposes. Among the makers of these batteries who are exhibiting are the New British [illegible] Co., the Hyndson Co. and the Surrey Electrical Co. These firms show a variety of small batteries, pocket lamps, torches, hand lamps, reading and cycle lamps, motor car lighting sets, and [illegible]. The makers of toy electric motors are still very small, and amongst them we may refer to the stands of F. Darton & Co., Economic Electric Co. and Ward & Goldstone. These firms show typical examples of small permanent magnet and wound field motors, such as are suitable for stationary work in driving small models. There seems to be no attempt to standardise a line of compact machines for the driving of locomotives for model railways, &c. The tiny dynamo for small battery charging sets, or for country house lighting, is hardly yet producible in sufficiently large quantities to be standardised, consequently it is only to be seen in somewhat crude and expensive sizes.

An exhibit of some interest is that of Syrolit (Ltd.), who have succeeded in manufacturing a substitute for that excellent insulating material hitherto the exclusive product of the fatherland, and known as galalith. They have given the trade name "Erinoid" to the material, and we understand that it will shortly be available for electrical accessory material of all kinds. Specimens of bell pushers, tumbler switches and similar accessories are shown at the stand, but these do not by any means exhaust the applications in an electrical sphere to which the material can be put. "Erinoid" is the product of casein, and is non-inflammable, highly colourable and capable of taking a brilliant polish; it can be turned, threaded and worked in an exactly similar manner to ivory, bone or horn.

The complete rout of the German electric clock makers is emphasised by the presence at the exhibition of the Synchronome Co., an essentially British concern, which has done the bulk of the pioneer work with electric clocks in this country, and have been in business for the past 20 years. Not only is the Synchronome system (which we have frequently described) suitable for commercial and industrial installation but it is increasing in popularity in large domestic establishments to which it is, of course, equally adaptable. Maybe the future electric house will not be considered complete without its [illegible] of electric clocks, set and corrected each day from the local electricity works.

SLATE INIGO JONES & CO.,
Tudor Slate Works,
GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
SLATE WORK for ELECTRICAL ENGINEERS.

EDISWAN
EVERYTHING—ELECTRICAL

(See Adv. on page 47.)

[illegible] Printed at the Offices of Technical Publications, Ltd., 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, FRIDAY, MAY 14, 1915.

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—2,000 kw. at Bella-vista in London's latest hotel—the Regent Palace.

* * * *

The latest in hydro-electrics is Mr. Mauritz Serrander's pamphlet "Water-power Exertions in Sweden in 1915."

* * * *

In several electrical centres we learn that the British Industries Fair would be more appropriately described as the British Industries Unfair.

* * * *

The L.C.C. were congratulating themselves at the beginning of the war that they had no Tories to let the Government to commandeer. Now—

* * * *

The co-operative spirit which the war is disseminating must have descended on that ancient town of "bitter and burton," namely, Burton-on-Trent. Ald. T. E. Lowe, in moving the adoption of the report of the Gas *and* Electricity Committee, remarked pleasurably upon the rapid strides made by the electricity department. Possibly the gas department now represents the "bitter" in the famous beverage.

* * * *

According to "Sales Promotion," the "Sales Managers Association are as valiant a body of talkers as you would find anywhere in the kingdom. There's not a subject connected with the business on which they could not get up a full-dress debate at a minute's notice." To all of which, judging by the Association's recent discussion of the electrical trade, may be said "deeds, not words."

* * * *

An Edison man entered a saloon (which, being interpreted, is a public-house) to test the meter.

Publican: What are you going to test the meter for?

Edison Man: Your bills have dropped away down suddenly, and the boss thinks the meter is running slow.

Publican: Never mind testing the meter. I am not using the juice. Your lights are too bright for my pub, so I went back to gas. ["Edison Life."

* * * *

Engineers, so-called, are often selected for service in the Colonies and certain foreign countries, and are given charge of electrical plant of which they have not even the most elementary knowledge. A case is vouched for as authentic by a firm doing a large amount of constructional work abroad who had despatched a new man (with wonderful testimonials) to a job in the tropics. From this individual they received a cable worded somewhat as follows: "Complain dynamo makers' connections all machines reversed, trams running wrong way. Cable instruction—

In certain towns where the tramway authorities have refused to employ female labour on the cars the ladies have been dubbed insulators, otherwise non-conductors.

* * * *

The Primate has pleaded with the Premier that we shall not retort by the use of suffocating gases. He has forgotten that when one deals with gases, suffocating or otherwise (they are usually the former), one must retort! Eh, what?

* * * *

The latest lead battery slogan is "PEP." It is the new Ironclad Exide motto, and is variously translated as "snap," "vim," "full of life," "always on the job," &c. Finally, an advertisement states: "It's a live wire proposition with plenty of 'Pep.'"

* * * *

Thus a contemporary on marine electric propulsion: our italics:—

In due course of time the Admiralty will make a practical use of the experiences gained by the United States; and the ghost of Mr. Durtnall, engaged we presume in devising improvements in the equipment of the other world, will *look down upon* a House of Commons passing votes for electric battleships as a matter of routine.

We cannot conceive of Mr. Durtnall looking down (except from the deck of a Paragon aeroplane), and if he is to be engaged as suggested, in another clime, he will probably not be looking down.

* * * *

With the passing of Elbert Hubbard the commercial world loses the "double first" of its philosophers. "Fra" will not easily be replaced, for few men have his breadth of view, and certainly few men are actuated by the same lofty motives, commercial though they always were. He has left many devotees of the cult for which he stood, against criticism and even hardship, and it is to be hoped that they will, by example of precept, carry on the good work which his master mind conceived, and for which he laboured so consistently. He could not have met a worthier fate than that which was meted out to him: to die in the company of many another brave.

* * * *

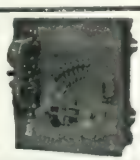
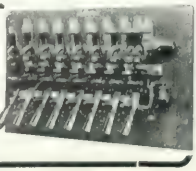
The Safety First campaign is going strong in the United States just now. Some of the mottoes of the movement read as follows:—

Be careful, boys.
Don't do dangerous things.
Avoid unnecessary risks.
It is better to cause delay than to cause an accident.
It is better to be always careful than always crippled.
Acquire the safety habit; it is the only habit that will never injure you.
Safety first is safety always.
Safety first.

Now we know why the Americans keep out of the war.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. E. R. Hill (Reading).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
(West Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).

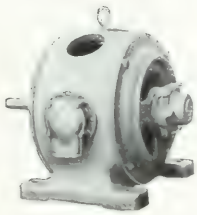
'IGRANIC'
FOOLPROOF STARTERS.
IGRANIC ELECTRIC CO., Ltd.,
147, Queen Victoria St., E.C.
No. 27 — Patent Inching Starter ... foolproof, only one handle and only one act, to operate it. The most careless operator cannot damage the motor or starter by inching, overloading or too rapid starting. Our Leaflet No. 27 describes it.

No. 10G — Foolproof Starter for large motors no sliding contacts, but a succession of circuit breaker type switches that can only be closed in the correct order. They are all magnetically held in the running position, but are released by overloads or voltage failure. See our Leaflet No. 10G.


SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams: "SIEMBRALDS, VIC, LONDON."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. NEWCASTLE—64and Collingwood Buildings.
CARDIFF—89, St. Mary Street. SHEFFIELD—22, High St.
GLASGOW—66, Waterloo Street. SOUTHAMPTON—4c, High Street.
Branches in Principal Towns Abroad.

ELECTRIC DRIVING OF SAW MILLS.

The application of the electric drive to the machinery installed in saw mills is one of the simplest problems with which electrical engineers are called upon to deal. Saw mill machinery comprises such plant as circular and band saws, planers, cutters, which, almost

Hill, Birmingham, three-phase power at 25 cycles 440 volts supplied from the mains of the Birmingham Corporation, is distributed from an ironclad switchboard to a number of "Witton" induction motors of the open type, varying in size from 50 H.P. downwards. These have been running for a considerable time, and have proved the success of the application of this type of motor to saw mill work. The mills are situated in one of the busiest parts of Birmingham, where space is at a premium. How readily the electric motor lends itself to compact design in a saw mill will be gathered from the accompanying illustrations. Two of the motors will be seen mounted

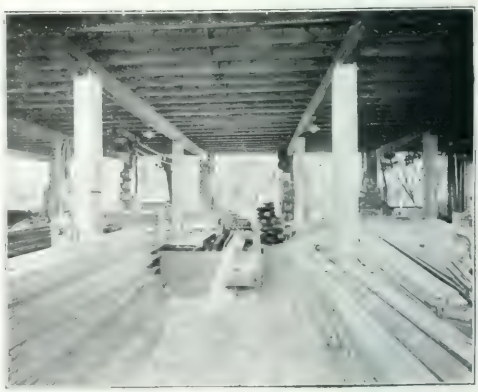


CIRCULAR SAWS DRIVEN BY THREE-PHASE MOTORS.

on the ceiling, one driving a cross-cutting circular saw, while the other drives a group of small machines consisting of band saws, saw sharpeners, grinders and spindle machine. The other motors are installed in concrete pits directly below the machines they are driving. One operates a circular saw, a second another circular saw, and a third a four-cutter machine, trimming the four surfaces of the wood at the same time. In each case the controlling switchgear is situated close to the driven machine. It will be observed that the whole of the floor space is available for the ordinary operations, and in no case is any room taken up by belting or shafting.

Invited to express his opinion on the performance of the electric drive, Mr. Shipway was emphatic upon its economy. One of the





CIRCULAR SAWS DRIVEN BY MOTOR IN CONCRETE PIT BELOW MACHINE.

valuable features was the ability to shut down those of the machines which were not required, and, in addition, to run one or more machines as desired through the breakfast hour or on overtime when a pressure of work make this desirable. The whole of the electric plant for this installation was supplied by the G.E. Co., and we are indebted to Mr. Geo. Shipway for permission to reproduce the accompanying illustrations, and to describe the installation in his mills.

The Electric & General Works, Ltd

15, Victoria Street, London, S. W.



Isolating Switches for Indoor and Outdoor Mounting.

Electrical Apparatus up to 80,000 Volts & 4,000 Amps.

Telephone: 5223 VICTORIA. Telegrams: "GABIONAGE VIC LONDON."

NEW "SIMPLEX" WIRING LIST.

The catalogue issued by Simplex Conduits are generally appreciated for two reasons. The first is, the matter is conveniently classified for easy reference and well printed, and the catalogue is a handy size for use either in the coat pocket or at the desk. These remarks apply to the latest edition of the Simplex wiring and accessories list, which deals with conduits, distribution boards and watertight fittings. The conduit section, in addition to giving full particulars and prices of light and heavy gauge enamelled steel conduits, also sets out in tabular form the various fittings such as couplings, bends, junction boxes, split tees, &c., which go to make up a complete system. The method of grouping the material in card bands for reference purposes. The Simplex grip continuity system is also referred to, and the particulars of the accessories are printed in red to distinguish them from the ordinary screwed or plain joint methods. The section on porcelain interiors is instructive in a way, in that it shows how intelligent use is being made of mechanical connectors which dispense with soldered joints and which also act as sectional points in the wiring system. Many of these connectors are made in circular form to drop easily into boxes of that shape, others are rectangular, and in certain types are provided with enclosed fuses. The various outlets for switches, ceiling roses, wall plugs, &c., are also specially dealt with, and attention is called to the Simplex conduit, a form of ceiling box with porcelain interior and porcelain cover which takes the place of the ordinary ceiling rose, and makes an extremely neat job of what would otherwise be a clumsy looking fixture. In this section something new is shown in the shape of Simplex sunk switches and plugs with protecting covers. These are recommended for use in situations in which the switch dollies or plugs are liable to damage from blows from packing cases, tools,





Views of Combined Switch and Plug Box and Plug Box.



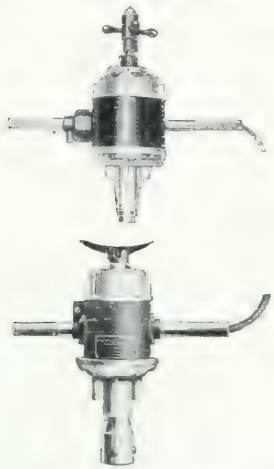


Two Patterns of Protected Switch Boxes.

[illegible] Ltd., Aston. Desirable these special boxes will now be widely [illegible] various industrial situations. The water-[illegible] are known to be quite complete. It covers an [illegible] fittings such as are indispensable where electric light is installed in damp or dusty situations and in gaseous [illegible]. A copy of the catalogue will be forwarded to any interested reader who makes application to the head offices of the company, Garrison-lane, Birmingham, or London or provincial [illegible].

PORTABLE ELECTRIC DRILLS.

There has always existed a ready and widespread market for the portable [illegible] machine. During the present period when metal and wood working tools of every description are being employed on the production of munitions of war the demand for such tools should be at its maximum. Our attention is called by the Armorduct Co. to their line of "Little Hustler" electric drills, which they have made for many years now, and which are suitable for operating on D.C. and A.C. circuits. We gather from a recently issued list that they are suitable for drilling on almost any class of work, the size of hole ranging from $\frac{3}{8}$ in. to 2 in. diameter. The motors of "Little Hustler" drills are of the air-cooled type, robust in construction, of light weight and high efficiency. The motor drum is a steel forging. Ball-bearings are fitted to take up thrusts on the drill spindle. The [illegible] of the drills is [illegible] and all gears are [illegible]



Little Hustler Drills.

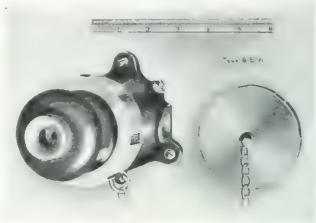
[illegible] hardened and run in grease. A switch or handle gives complete control over the machine.

The latest drill pattern is made for direct current only, 110-220 volts. It is a small handy type of drill for light work. Its drilling capacity is $\frac{3}{16}$ in. in metal or $\frac{1}{4}$ in. in wood. It is recommended for [illegible] holes. A small [illegible] chuck for [illegible] drilling. The machine runs [illegible] normally at 1,000 revs. per min.

Single and two-speed breast drills for direct and alternating current, 110-220 volts, are also made. The single-speed machine [illegible] capacity drills, built to stand hard service. The two-speed machine [illegible] capacity, running at 400 or 700 revs. per min., and speed can be changed while the drill is in operation by the simple adjustment [illegible]. Provision is made [illegible] for [illegible] different [illegible]. The machines weigh from 18 lb.

SWITCHGEAR AND ACCESSORIES FOR "WAR SERVICE."

We [illegible] Messrs. Reyrolle & Co. they are having their [illegible] to give prompt delivery of apparatus to firms who are [illegible] Ministry of Munitions generally pending [illegible] Government Work Service" orders. In some [illegible] to enable them to deliver more quickly [illegible] their special machinery [illegible] completed articles, parts [illegible] Government work only, they are able to build these parts together and thereby obviate delay in deliveries. The foregoing remarks apply to the 6,000 and 12,000-volt armoured switchgear, and 500 and 3,000-volt draw-out panels. Messrs. Reyrolle state that they have always made it a standard practice to manufacture only switchgear which is strong mechanically and absolutely safe and reliable in every respect. Further their designs are such that all the Home Office recommendations are embodied so as to ensure immunity from



Standard Watertight Well Plug.

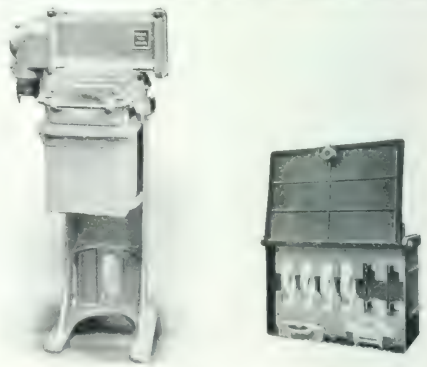
shock to the persons operating the gear. The designs are of robust construction, and made suitable to withstand rough usage, especially in such situations where unskilled labour is employed. To eliminate fire risks all current carrying parts are more than ample for their respective ratings, and all gear before despatch is subjected to a pressure test equal to three times the normal voltage on which the gear will be used.



H.T. Enclosed Switchgear.

The following additional features are worthy of comment: Reliable automatic operation under faulty conditions; freedom from risk of shocks or burns, especially during cleaning, inspecting or testing; freedom from breakdown under working conditions; costs of cleaning, testing and supervision reduced to a minimum.

The company's standard cast-iron distribution boxes can be supplied from 25 to 100 ampere ways. These boxes are described on



Enclosed Switch Fuse. Enclosed Distribution Fuse Board.

[illegible] No. 25, and the [illegible] the boxes [illegible] of a patented [illegible].

Watertight [illegible] are made [illegible] straight gate [illegible] and [illegible], and these can be supplied fitted with either two or three current carrying [illegible] and [illegible] earth attachment. A combined plug and socket [illegible] is [illegible] and [illegible] can also be supplied.

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LOUD-SPEAKING TELEPHONES.

In the ordinary way of business the gate-communication telephone is used or rather abused just because it may, for some particular purpose, be inconvenient or even annoying to lift a receiver from its hook and re-adjust oneself so as to speak closely to the transmitter. Various forms of telephone arms and similar expedients have been introduced, and they certainly answer their purpose well, particularly with heavy patterns of transmitters. The loud-speaking telephone is an instrument which should have a wide popularity when the simple features of its design and operation are better known. The

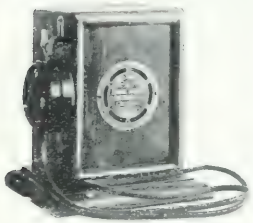


Fig. 1.—No. 1 Station.



Fig. 2.—No. 2 Station.

adjoining illustrations show the two stations of an office pattern of loud-speaking telephone designed to stand on an ordinary table. The instrument shown in Fig. 1 is used in the first place, and instrument (Fig. 2) is called up simply by speaking in a fairly loud tone; this is clearly reproduced in the second instrument and the person called replies in an ordinary voice without using earpiece or mouthpiece. If necessary a push button call, by which No. 2 can signal to No. 1, can be provided. The details and prices of these interesting instruments will be supplied on application to the General Acoustic & Dictograph Co., Southwark-street, London, S.E.

SOME ELECTRICAL FEATURES OF THE REGENT PALACE HOTEL.

For some two years past work has been proceeding upon a building site in Glasshouse-street, London, W., which only few realised would culminate in the opening of one of the largest hotels in Europe, and one planned on entirely popular lines. For the moment we will not dwell upon the remarkable value which can be got in the way of bedroom, attendance, breakfast, &c., for a very moderate outlay.

In the attainment of its "popular" ideals Messrs. J. Lyons & Co. have made generous use of the electric service, and in the present instance they have paid a remarkably high testimony to the recent advances in electric heating by installing modern electric fires in all the bedrooms and sitting rooms throughout the hotel. There are over 1,000 bedrooms, and in each of these is a 1½ kw. Belling fire, the pattern selected being that firm's "commercial" type of four heating bars mounted in a cast-iron frame and provided with two control switches. The energy supply for this record heating installation is given by two 0·8 sq. in cables, which are run directly and independently into the building from the sub-station of the St. James' & Pall Mall Co. in Carnaby-street, which is at no great distance from the hotel. These large cables are led into a special switch room in the basement, in which there is a large switch fuse board some 30 ft. in length. From this board some 56 pairs of 19/16 cable are led to the upper floors, and on each floor are distribution boards, whence sub-circuits, each controlling two fires, are led out. The sizes of the heating circuits and feeders have been worked out to provide for the whole of the fires being turned on at any one time.

The Guild Lamp Co.'s 60-watt gas-filled lamps have been installed, and the wiring has been laid out in two systems, to comply with the [illegible] regulations. The principal corridors in all the public portions of the hotel are supplied from what is known as the council main, which feeds two principal distribution boards. Convenient control for all the bedroom lights is provided—a fact which will add materially to the comfort of hotel guests. There are [illegible] A certain number of room and corner corridor lights are supplied from the opposite one of the two [illegible] supply is fixed. In this simple manner the important lights in corridors are not dependent on the same general circuit which supplies the bedrooms which are immediately adjoining those corridors. These special corridor lights are controlled by master switches at central points.

The general scheme of illumination is on the semi-indirect system and for this purpose a variety of designs of fittings by the Bromgrove Guild have been put up. In the dome of the winter garden a novel plan has been adopted of introducing opal bulls' eyes into the risers which support the glazing of the dome. Behind each opal is a 30-watt lamp. Around the dome cornice is a ring of lamps which are concealed from view at the floor level, but which throw a considerable volume of light upwards into the dome.

A complete electric bell system is installed on each floor and generally throughout the hotel. There are eight sections per floor, each with a large indicator, and by means of a four-point relay an indicator is operated in the service room showing which section has been rung up. An indicator is also arranged to be rung up in the night porter's office. The scheme adopted for the bells has dispensed with the use of multicore cable.

In addition to the heating and lighting circuits a considerable amount of wiring has been run for a number of motors driving ventilating fans and certain auxiliary machinery in different parts of the hotel: the same power service also supplies some 30 passenger luggage and service lifts.

The whole of the wiring, including that for the bell circuits, has been run in heavy gauge screwed Geekoduct, of which some 300,000 has been used. Of wires and cables of various sizes upwards of 1 miles have been run in. The whole scheme of the conduit lay-out provides for the easy withdrawal of any length of wire or cable without disturbing the plaster or cement covering in which the tubes are embedded.

We hope to give a more detailed description of this installation at a later date. Meantime we must express our thanks to Mr. Goddard of the engineering department of Messrs. J. Lyons & Co., for giving us the foregoing particulars. The whole of the electrical work was carried out by this department.

DISPOSITION OF REFUSE FROM WOOD-WORKING PLANT.

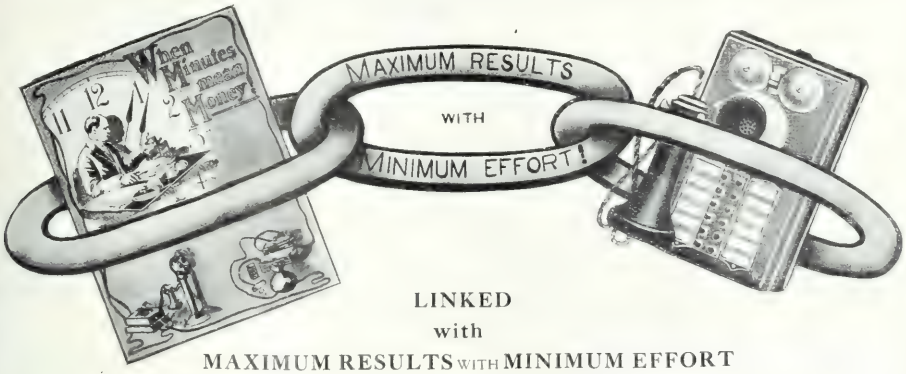
The Rood Box Co. at Columbus, Ohio, makes boxes of soft and dried wood in a fatory driven by motors using central-station service. An idea of the size of the plant can be gained from the fact that the aggregate rating of the motors used is 200 H.P. and the average monthly energy consumption is 8,500 kw.-hour.

To dispose of the by-products, sawdust, shavings and wood trimmings, at a price which makes it uneconomical to burn them under the boilers of an isolated plant, several ingenious arrangements have been worked out. Part of the shavings and all of the wood trimmings are burned under a boiler which supplies steam to dry kilns. This plant uses no kiln-dried lumber itself, but dries lumber for other concerns, charging $4 per 1,000 ft. of lumber dried. About 15 days are required for drying.

The excess shavings and sawdust are passed through a conical screen placed directly under a "cyclone" separator. The shavings and sawdust have a whirling motion imparted to them as they pass through this screen, so that the sawdust is forced through the mesh and the clean shavings drop down into a separate storage bin. The shavings are made up into bales of 80 lb. each, and the sawdust is sold by the wagon-load. The income from this sale of refuse amounts to $200 per month. About one-third of this amount comes from the sale of sawdust and the remainder from the sale of shavings.

It costs about 3 cents per bale to bale shavings, and they are sold at from 22·5 cents to 25 cents per bale. Breweries use a large percentage of the shavings for packing bottled beer in the winter time to prevent freezing. The sawdust, which sells for $2·50 per wagon load, is used by paint manufacturers for packing, by refrigerator makers for insulation, and by stablemen for bedding horses. Information regarding the operation of this plant was given before the Dayton meeting of the commercial men of the Ohio Electric Light Association.

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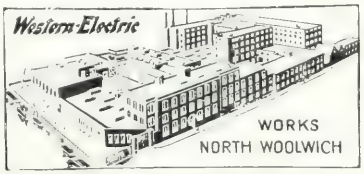
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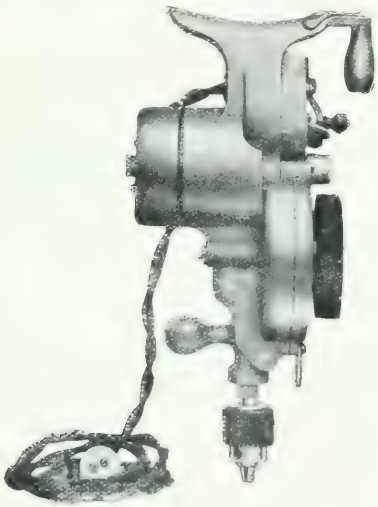
NEW "SUN" CATALOGUES.

Two new lists have just been received from the Sun Electrical Co., and they deal respectively with "Sunlite" porcelain enamelled reflectors for half-watt lamps, the Sun portable electrical grinder,



SUN ELECTRIC GRINDER, SHOWING HOLDER FOR SLIDE REST.

and the "Change Ad. sign. The "Sunlite" reflectors are made out of sheet steel, white enamelled on the under side and green on the outer side. They are listed in the extra extensive, extensive and



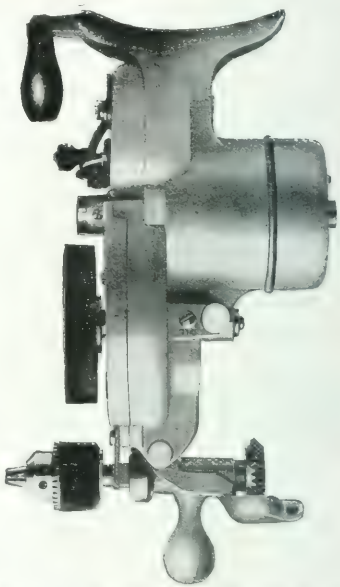
SUN ELECTRIC DRILL.

the floor. Characteristic light curves from each of the types of

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 35-37, NOBLE STREET, LONDON, E.C.

reflectors are given. In each case the reflectors are provided with enamelled steel canopies which, except for the 16-in. size, are detachable, and are complete with goliath holders and insulating suspension shackle. The latter provides for the entrance of the cables through the two swan necks, which effectively prevents the entrance of moisture.

The Sun portable grinder is a small machine which weighs 5½ lbs. and is provided with an aluminium frame. The motor develops $\frac{1}{12}$ H.P. when running at 1,000 revs. per min. It can be operated from any lighting circuit. It is recommended for use in tool rooms for accurate and quick grinding of centres, reamers, cutters, dies, &c. It is stated that it will work equally satisfactorily on internal and



SUN ELECTRIC DRILL, SHOWING METHOD OF LOCKING DRILL SPINDLE WHILE TIGHTENING DRILL IN CHUCK.

external jobs and will grind out holes up to 4 in. deep. A fixing arm is provided which is designed for fitting into the slide rest of ordinary lathes. The Sun portable electric drill is also fitted with a motor which will run on alternate-current or direct-current circuits. This machine weighs 11 lb. and has a drilling capacity up to ⅜ in. and tapping up to $\frac{3}{16}$ in. There is a single switch lever provided which starts, stops and reverses the motor. The machine is well ventilated and draught holes are so placed that chips of wood or metal cannot enter the casing, no matter what position the drill occupies. The drill point is always in sight of the operator. A grinding attachment is also provided, and can be adjusted in position in a few seconds. This enables the drills to be ground on the drill itself.

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EVERYTHING—ELECTRICAL
(See Advt. on page xviii.)

Printed for "The Electrician" Printing and Publishing Company, Limited, by Charles Alexander Addison, Printer Steward, in the City of London, Friday, May 21, 1915.

THE ROUND TABLE.

EVENT OF THE WEEK. The "triumph" of gas!

* * * *

Milestones on the road of gas progress—Hawick, Asgill, pres, Gretna!

* * * *

If a sitting hen casts no feathers, what may we expect of a ting cleat?

* * * *

Municipal electrical engineers are, we understand, inviting ggestions as to how they shall spend the two evenings "in wn" at the forthcoming I.M.E.A. (Half-what) Convention.

* * * *

The general regulations as to the installation and use of ectricity in mines, as given under the Coal Mines Act, 1911, id reproduced by W. T. Glover & Co. in a neat vest pocket ook, contain a number of definitions which have some military gnificance :—

"Live" means electrically charged.

"Dead" means at or about zero potential and disconnected om any live system.

"Earthed" means connected to the general mass of earth such manner as will ensure at all times an immediate disarge of electrical energy without danger.

No definition is given of "gas"; evidently it can speak for elf, or at any rate make its presence felt.

* * * *

The "Ford Times," the monthly organ of the "Chinese aimler," frequently breaks out into song. The following om the May issue is probably the product of a member of the ring department :—

WORK!

When living has lost all its savour,
And loving has lost all its charm;
When Destiny frowns such disfavour
No deeds you may do can disarm,
When creeds you have learned upon crumble,
And earth's one true guide is a mark,
Don't let yourself totter or tumble—
Work!

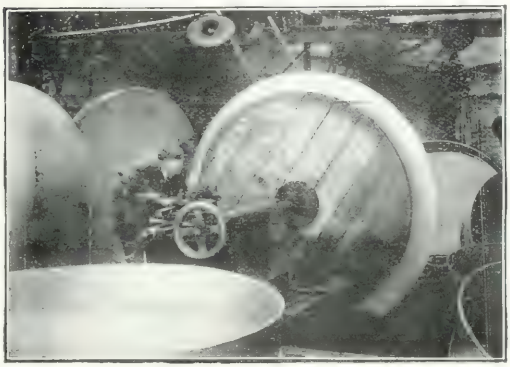
When yesteryear's errors return to
Vex you with ghosts of themselves,
And every last thing that you yearn to
Win out at is shoved on the shelves;
When lies stain your mail in the morning
And night hides untruth in its murk,
Don't sob or cry out; take my warning—
Work!

For he who has manstuff behind him
Will triumph and still pay the toll;
Fate cannot detain him or bind him
Nor Care crowd the size of his soul!
Life takes no excuse for soft natures,
And Death is ashamed of the shirk:
So stick to the "straight and the narrow"—
Work!

The Engineers' Club, Manchester, is to be congratulated upon its firm but fair treatment of alien members of the Club.

* * * *

A correspondent in Glasgow informs us that the fare collectors now installed on the trams in that city are not to be confused with mis(s)-conductors.



AT WORK ON A GIANT SPINNING

* * * *

"John Bull" seriously warns its readers that a bomb explosion in an under-river tube would let in the Thames and drown the passengers!

* * * *

THIRTY-SEVEN YEARS AGO.

FROM No. 1 OF THE ELECTRICIAN, Second Series, May 25, 1878.

TROUBLES WITH THE TELEPHONE. M. Allhaud gives an account of the use of the telephone established between the Observatory of Puy-de-Dôme and Clermont-Ferrand. The keeper of the observatory, with all his experience as a manipulator, worked from the first much more quickly with the telephone than with the telegraph. The wire of the telephone runs on the same poles as the telegraph wires. At the foot of Puy-de-Dôme is a post of artillery, and it is found that no communication can be made without being heard by the artillerymen. This phenomenon is even reciprocal up to a certain point. So the keeper is sometimes obliged to ask his correspondent at Clermont-Ferrand to wait a moment because the brigadier is singing, and his song disturbs the telephonic communications. Thus, in this transmission of sound by electricity, many phenomena remain still unexplained, since sound can reproduce itself without requiring the vibrating diaphragm, by contact with the line wire alone.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. E. R. Hill (Reading).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
West Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
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SIEMENS

ELECTRIC MOTORS

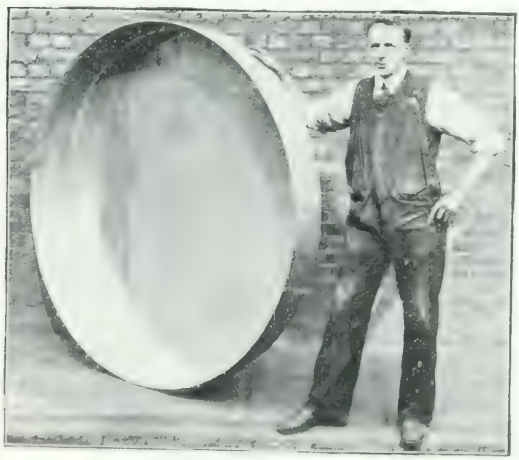


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SPINNING EXTRAORDINARY.

The Benjamin Electric Ltd. has always done a big business with metal stampings and spinnings, their most well-known product in this direction being the Benjamin steel reflectors and reflector fittings, all of which, we understand, are produced at their London works, 14, Rosebery Avenue, E.C. A large amount of special work



[illegible] View of Gear Spr[illegible]

[illegible] ing has been carried [illegible] from time to time by [illegible] and their [illegible] ation, [illegible] all by metal [illegible] ed in [illegible] [illegible] [illegible]

MOTOR CAR ELECTRIC LIGHTING.

Electric light on the motor car is becoming the rule rather than exception, and great strides have been made during the last few years in its applications to ignition, lighting, starting and heating of various classes of cars. Electric lighting particularly has made progress, practically all new cars are now being supplied complete with standardised equipment. The advantages of electric lighting over

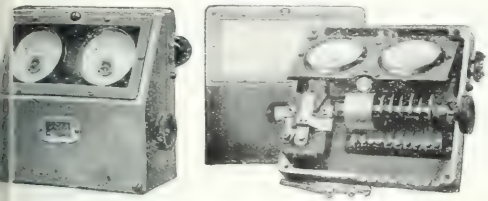


FIG. 1.—SWITCHBOARD, TWO INSTRUMENTS, TAIL LAMP, TELL-TALE AND AUTOMATIC CUT-OUT COMPLETE.

acetylene gas are well known to all who have had any experience of the latter systems. So far as electric lighting for cars is concerned, undoubtedly the introduction of the tungsten lamp is one of the leading factors in its increased use. We have already referred to the Mazda headlight lamp with its special helical point filament, and quite recently we described the latest advance in car lighting, the Mazda half-watt lamp, which is twice as efficient as previous lamps.

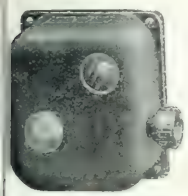


FIG. 2. SWITCHBOARD WITH CHARGING INDICATOR AND AUTOMATIC CUT-OUT COMPLETE.

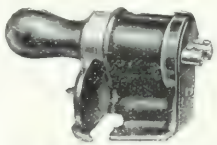


FIG. 3. PLUG AND SOCKET FOR USE IN CHARGING BATTERIES OF ELECTRIC VEHICLES.

The B.T.H. price list No. 10,780 on automobile accessories shows how widely electricity is used in the car. This list illustrates and describes switchboards and batteries, ammeters and voltmeters, lamps and electric horns, many kinds of fittings for interior lighting and lamps for garage use, &c., searchlights, sparking plugs, switches, leads, cable connections, &c. In fact, it takes a 20-page closely printed



FIG. 4.—"PARAMBO" TWO CONDUCTOR ALMOUR'D CABLE FOR AUTOMOBILE USE.

list to refer to the many useful and ornamental articles for car use available at Mazda House. This list will be of interest to those who own cars, and to those who have to do with the supply of accessories and repairs. Free copies will be sent if application is made to the British Thomson-Houston Co. (Ltd.), Mazda House, 77, Upper Thames-street, E.C.

WESTINGHOUSE AND WAR MUNITIONS.

We learn with interest that a movement has started in London by the engineering and other office staff of the British Westinghouse Electric & Mfg. Co. (Ltd.) to express in a practical form their patriotic feelings, and a proposal suggested by them to the management of the company that they should undertake in their spare time some additional work on munitions of war. This proposal was accepted by the management, and operations were commenced almost immediately. At the present time each man will work a 5½ hours' shift one night per week, commencing at either 6.30 in the evening or 12 o'clock at night. We understand that approximately 300 [illegible] have already volunteered for work on this basis.

WARNING

Statements are being circulated to the effect that GERMAN interests predominate in the Simplex Company.

As all such statements are absolutely false and devoid of any foundation, and as they can only have been circulated with the object of injuring the Company's position in the Electrical industry, immediate proceedings will be taken against any person using or repeating such libellous allegations.

We here repeat that SIMPLEX CONDUITS, Ltd., is entirely a BRITISH Company. The Directors, Shareholders, Staff and Employees are ALL BRITISH.

Admiralty Contracts of considerable magnitude are being executed in the Works, and approximately one-third of the Company's employees are serving with the Forces.

A Substantial REWARD will be given for any information which will enable us to strike at the root of these libellous statements.

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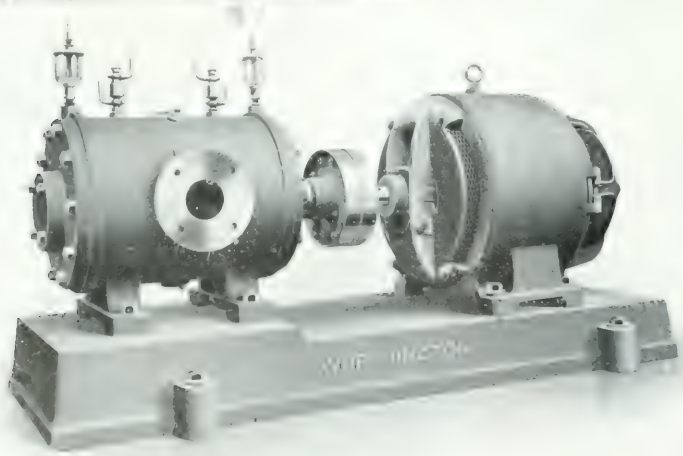
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DRY VACUUM PUMPS AND BLOWERS.

Appreciating the extent to which the vacuum principle is now applied in the development of modern industrial processes, and realising the importance of machinery to satisfactorily



These machines operate upon the principle of the rotating eccentric drum fitted with sliding plates or pistons, which open and close by the rotation of the drum. This principle has been known and applied for many years, but, in the forms hitherto manufactured, it has not been suitable for the high speed of revolution required to enable the pump to be direct coupled to an electric motor.

The older types have accordingly been abandoned and new designs developed having this end in view, with the result that, after considerable experimental work and protracted trials under actual working conditions, the Worthington machines now offered have proved reliable in service, efficient in operation, and moderate in first cost and upkeep. The simple form and small dimensions of this new design of vacuum pump or blower are well illustrated in a new Worthington catalogue, which shows a combined unit of vacuum pump and motor capable of handling 20,000 cubic ft. of free air per hour when running at 700 revs. per min.

The machine has been standardised in 10 sizes, and prices and particulars of larger machines will be gladly furnished upon receipt of inquiry, stating the nature of service and capacity desired.

The machine consists of a cylindrical body or casing, having the inlet and outlet branches located on opposite sides. Since the compression of air, or other gas, at high speed generates considerable heat, a water jacket is provided having connections arranged for the inlet and outlet of the necessary cooling water. The sliding plates or pistons are carried by a revolving drum arranged within the cylindrical casing and set with its centre eccentric to the centre of the casing. The sliding plates are made from tempered and polished saw steel, this material being employed to combine the necessary strength and durability with the minimum possible weight. In order to reduce friction to a minimum and permit of high speed of revolution, the sliding plates are not allowed to rub upon the inside of the casing, but are carried by hardened and ground steel running rings. This constitutes one of the essential features of the machine, and is of vital importance in overcoming the difficult problem of successfully combating friction losses and overheating, which are frequent source of trouble and annoyance in machines of this class.

In the Worthington machine the steel carrier rings are arranged to float, so that no rubbing friction is set up at this point. The steel driving shaft is carried upon ball journal bearings located in the end covers, and the packing necessary on the driving end (to prevent air leakage) has been specially designed to be as nearly frictionless as possible.

Experience has shown how essential to success is the elimination of friction in every form, and this feature has been considered in the design and construction of this interesting pump.

Ample provision is made for lubrication at all required points, and we gather that no expense has been spared to make these machines robust in construction and entirely suitable for continuous service. The offices of the company are at India House, Kingsway, and copies of the catalogue referred to can be obtained there.

The roto-drum pump is suitable for use as a dry vacuum pump for any service to which reciprocating machines are at present applied. Among other uses, may be mentioned the evacuation of close chambers for any industrial purpose to any desired degree of vacuum, paper mill work, preserving processes, chemical and dye works, manufacture of pa-

pared foods and medicines, evaporative processes, for use with vacuum cleaning, and disinfecting installations, and for exhausting gas from retorts, drying out telegraph and telephone culverts, charging centrifugal or reciprocating pumps of large capacity where the use of boosters is impracticable, &c. On a closed system it will maintain a vacuum of 28 in., with the barometer at 30 in. The roto-drum pump may be used in series when a very high vacuum is essential. An important feature of the roto-drum pump is that in cases where only a partial vacuum is required, a regulator can be fitted, so that the specified vacuum will never be exceeded, no matter how long the machine is kept in motion. This feature is of value in certain industrial operations, such as the application of vacuum apparatus to the milking of cows where any increase in the predetermined vacuum is liable to produce harmful and possibly fatal results to the animals. As a blower the roto-drum pump is applicable to all uses commonly served by reciprocating or rotary machines such as compressed air heaters, refrigerators, vibrating machines, sand blast blowers, for use with humidifying plants for textile mills, for smelting, annealing and other furnaces; for chemical work, paper, pulp and celluloid factories, &c.

For use as a compressor for pressures above 15 lb. per square inch we understand that special quotations will be submitted upon request.

TRAIN LIGHTING.

In view of the great amount of attention which the subject of the correct illumination of railway carriages has recently been receiving at the hands of the illuminating engineers of railway companies and others, the accompanying illustration is of interest. This railway carriage is one of a large number built by the Metropolitan Carriage,



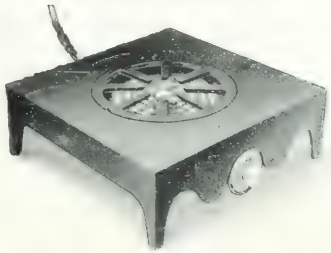
Holophane Lighted Train.

Wagon & Finance Co., Ltd., at Saltley, Birmingham, for the Central Argentine Railway. The overall dimensions of the carriage are approximately 66 ft. by 9 ft. It is divided into two compartments, each 25 ft. by 9 ft., and both compartments are installed with four 12 in. Holophane reflectors mounted [illegible] 40-watt lamps) down the centre of the coach, whilst on either side there are four Holophane pines with 40-watt lamps. The energy provided in this case is very liberal, enabling an illumination [illegible] of 6 ft. candles to be obtained uniformly over the whole working plane. Notwithstanding that the illumination intensity is so high, excellent diffusion and evenness are, we understand, obtained from the use of the Holophane glassware, whilst glare and shadows are obviated. The carriage [illegible] a lively and pleasing effect when illuminated, and the handsome furnishings are shown up to excellent advantage.

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A NEW PLUG TESTER.

An interesting form of patent testing device for motor-car sparking plugs is being put on the market by G. W. King & Co., Mermaid court, Borough, S.E. The adjoining illustrations show a detail of this plug tester (Fig. 1) and the method of applying this in practice (Fig. 2). It comprises a length of chain, with a large ring and a shorter length of chain terminating in an insulating handle. The device dispenses with the need for using a screwdriver to test the insulation of a sparking plug. The links of the chain take the place of this temporary expedient and leave the motorist's hands free to examine the condition of the plugs while the engine is running. The device also most conveniently removes all risk of shock during the time the test is being made. A sample set will be forwarded on receipt of P.O. or stamps value 1s. at the above address.



Fig. 1.



Fig. 2.

A USEFUL MINING PAMPHLET.

The revised edition of Glover's mining pamphlet is now off the press and is being distributed amongst colliery and mining engineers. We commented upon the contents of the original publication at the time of its first appearance. It will be found to contain the recently issued regulations with the Home Office memorandum thereon as revised to March, 1914. In order to distinguish these from the regulations issued in 1912, and which have since been withdrawn, the various headings of the latter are printed in red. The text portion of the book is divided into three parts. Part I. gives the general regulations as to the installation and use of electricity in mines, and covers such important items as earthing, portable apparatus, shot firing, signalling, locomotives, &c. In Part II. is given the memorandum on the regulations, and Part III. is devoted to illustrations and descriptions of Glover's mining cables and accessories designed to comply with the regulations. Glover's whipcord braided trailing cable is illustrated, also cab tyre trailing cable, Solbit & Cracore bitumen cable are shown in section, and instructive illustrations are those showing the application of sitting cleats for shaft cables, cone fitting for single suspension of shaft cables, horizontal and vertical joint and dividing boxes for shaft cables. Glover's patent straight-through mechanical connector for use where sweating is undesirable makes a sound mechanical job of a joint between two insulated or bare cables. This connector can also be employed for tee joints. It is also made up with a suitable lug which can be bolted to a 'bus bar or other joint-box fitting. Numerous other interesting illustrations are included showing the component parts of Glover's standard disconnecting link box, the method of sealing the ends of rubber or bitumen cables with guttaroid tape, Glover's patent cable cling, and an earthing device specially designed to comply with the regulations. There is a concluding section, in which the electrical units are explained and formulæ are given by which the sizes of cables can be ascertained.

We understand that W. T. Glover & Co., who have had an almost unique experience of mining cables, are prepared to advise upon any matters in connection with the use of cables and wires of every kind in colliery and mining work.

DUST AND WIND.

We have received from the General Electric Co. a neat card showing on one side the G.E.C. dust bellows and on the other a "Freezor" electric fan. The bellows are of the plunger type, and are made in two sizes, measuring only $21\frac{3}{4}$ in. long over all by $2\frac{1}{2}$ in. diameter, and $25\frac{3}{4}$ in. long by 3 in. diameter respectively. We understand that many thousands of these bellows have already been sold in this country and have given the greatest satisfaction. They are light and strong as well as being cheap and efficient. They are suitable for removing dust from inaccessible positions in office, storeroom, home or factory. The bellows are valuable for removing dust from pianos, typewriters, electric motors and machinery, as well as books, papers, fancy goods, china, glass, &c. On the other side of the card we are reminded that the advent of summer may be expected, and that "Freezor" fans are noted for efficiency, reliability, silence, steady running, low cost for current and upkeep as well as for first cost. The card is suitable for overprinting electrical dealers' and contractors' names and addresses, and, owing to its size, is suitable for sending out with correspondence, invoices, &c.

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CONCENTRIC WIRING.

The subject of concentric wiring is now being discussed at some length by American electrical men, and the following letter contributed to the "Electrical World," N.Y., by Mr. A. H. Seabrook is reproduced as being of interest :—

"The opportunity for concentric wiring here depends to a large extent on the distribution conditions encountered. Most British central stations furnish direct current, distribution being invariably by the three-wire system with the neutral grounded at the generating station only. In one or two isolated cases the authorities have permitted earthing of the neutral on consumers' premises, but in large distribution systems this method is considered inadvisable, as it makes the detection and correction of faults in mains very difficult. If both poles of a concentric wiring system have to be insulated, the advantages of the system in cost, and so on, largely disappear. The concentric system is therefore practically barred from the great majority of British electricity supply systems. By means of a motor-generator or converter a concentric installation could, of course, be isolated from the general distributing system, but the use of such a plant as this is obviously out of the question except in very special cases.

"Although not many British central stations furnish alternating-current service, there is not much difficulty in using concentric wiring with a grounded outer on such systems, since the tendency is now to ground the secondaries of alternating-current systems. In the case of private plants, which generally furnish a two-wire supply, concentric wiring can also be used to an unlimited extent.

"As regards cost, a concentric installation with grounded outer is less costly than any other system of wiring, excluding, of course, shoddy work, such as cheap wiring cleated to the wall or unprotected rubber wire. It is also cheaper than slip-joint tubing or wood casing. The lower-grade lead-covered wiring systems are probably as cheap as concentric, but they are not so safe or durable.

"One of the principal economies permitted by the use of concentric wire is the saving in cutting plaster and woodwork and in making repairs. Concentric wiring is so unobtrusive that it can be run on mouldings, and in many cases even mounted directly on the surface without being unsightly. This feature presents the great advantage that houses already built but not wired can be wired with concentric conductors at very low cost, a good reliable job being ensured at the same time.

"One of the largest electrical contractors in London reports that 70 per cent. of his business is now installed with concentric wiring, but it should be explained that this particular firm does a very large business in private plant equipments. A contractor whose business chiefly with municipal electric systems might report very different.

"It is now six years since the Stannos concentric system was first brought out, and from the manufacturers' returns this system must be rapidly gaining favour, as the yearly increase in the output of Stannos material is very great. Special fittings are not required, apart, of course, from the fixing plates for ceiling rosettes, &c. Even these are not necessities, but they are useful and economical.

"One large contractor, who uses a considerable quantity of concentric wiring, states that even if both wires have to be insulated, as on three-wire direct-current distribution systems, the cost of concentric construction is only about 10 per cent. greater than wood moulding, and is even 20 per cent. cheaper than screwed tubing.

"In England, as elsewhere, there is a growing disposition to substitute alternating-current distribution for direct current, especially where large cooking and heating loads have to be taken care of, and the increased use of alternating current for this purpose will undoubtedly have the effect of increasing the use of concentric systems of wiring.

"Although considerable opposition seems to exist on the part of electrical contractors in the United States to the use of cheaper forms of wiring, in Great Britain the same opposition does not exist, and some of the most enthusiastic users of cheap wiring systems are the wiring contractors. This is hardly surprising, because, obviously, the more cheaply an installation can be put in for the consumer the more wiring work the contractor is going to get, and although the profit on his individual job may not be so large, he will get many more jobs and consequently a bigger total net profit.

"In Great Britain central-station engineers are always on the look out for anything that will reduce the cost of electricity for the consumer, while at the same time maintaining a high standard of safety, for the disastrous results from cheap installations and apparatus are only too well realised."

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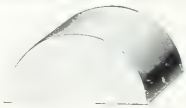
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CONVENIENT SERVICE BOARDS.

The [illegible] that will be described in connection with a pattern of house service board which has been put on the market by Messrs. Lundb[illegible]



turning down the metal edges of the board. We understand that the boards are made up without rivets, screws or welds of any description. The board is attached to the wall by four fixing screws, and the meter is secured in position by means of a number of tapped



METAL HOUSE SERVICE BOARD WITH METER, FUSES AND CONNECTING BOX COMPLETE

holes in the base plate. The position of these holes registers with those of the standard pattern of Landis & Gyr meter; when some other type of meter is employed adjustable supports similar to those shown in one of the illustrations are provided. The edges of the baseplate are partly cut away at the top and bottom, and a sheet of insulating material is inserted. A view is given of one of these [illegible] L. & G. meter in position, together with screw plug fuses and connecting boxes. Fuses up to 25 amperes capacity [illegible] on the line side of the meter suitable arrangements can be made for sealing them. It is claimed that by the use of these metal house service boards the connections from the incoming main to the fuses and meter are simplified, the theft of current is entirely prevented, and the fire risk is minimised, because the conductors are entirely surrounded by sheet metal. The arrangement will also appeal to central station engineers because it admits of the standardising of all house service boards. Fuller [illegible] can be obtained on application to the company at the above address.

Printed and Published by GEORGE TUCKER, at the Electrical Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON. FRIDAY, MAY 28, 1915.

THE ROUND TABLE.

Our names of the milestones on the road of gas progress, published last week, are in need of slight correction; they should read: Hawes not Hawicke, Aegon Ypres, Gretna. We make this correction "Lest ye forget."

While on the subject of gas, we are reminded that we have been asked by a correspondent why some attempt is not made to use E.H.T. electricity at the front. He forgets that electrical energy plays no part in methods of frightfulness: it exercises only a domesticating influence in the affairs of men.

Haydn T., whom we award a Hot Plate this week, is President of the Batti-Wallahs' Society. All B.W.s will feel that his appointment to H.M.S. "Vernon" is in no small measure due to that fact. Whether there is any connection or not does not matter much. The Society will be able to boast another of the few of its presidents who "have even been on the sea."

Aylesbury U.D.C. now has its electricity works, which were officially opened last week. A discovery of new electrical firms has evidently been made, for we read in the "Bucks Herald" that the engines, generators and electrical plant were supplied by Messrs. *Williams* & Robinson, Rugby, and the electrical plant was sub-let to the Electrical *Contraction* Co., Wolverhampton. Thus do the bucks make ducks (and drakes) of traditional nomenclature.

The following piece of verse by Bertram Dobell, the well known bookseller, is taken from "Sonnets and Lyrics, a Little Book of Verse on the Present War." It aptly summarises the attitude of the British commercial man to Germans and German trade:—

"To the Greater Profit."

Rivals we knew you in the art of peace,
And sometimes hated your ordered activity,
Which threatened to destroy our ancient lease
Of world-wide commerce threading every sea;
Yet we desired to be your friend, and for
And while I you grow in wealth and power more
Menace nor warning heeded, and were sure
To deem your enmity so deep and base
But clearly now unmasked, we see your pose
To strike a treacherous blow against our state
Mad lust! the hard is more than we forgive
But confident the issue we await:
No wile of yours can by our Empire be
That worthier foes have failed to overthrow.

K.V.A. has survived the smoking of a "Circeale" cigarette, presented to him with the best of intentions this week by the Record Electrical Co. Evidently the old saying about the "bourn from which no traveller returns" does not hold. Prospective callers should note this.

According to a new pamphlet on Trafford Park, a number of concrete buildings or "hives" have been erected for the use of small firms as works, warehouses, &c. Mr. W. Haslam Mills, in a lengthy preface to the booklet, rhapsodizes on these buildings thus: "Some of the buildings, for all their modern efficiency inside, have outwardly quite a cloistral, collegiate air." The air of the Ship Canal has been called some hard names, but cloistral and collegiate never! In any event, the air, whatever it is, is both inside and outside the buildings.

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, Second Series, June 1, 1878.]

IS THE BODY AN ELECTRIC MACHINE?

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—Allow me to bring the following (to me) strange phenomenon under the notice of your scientific readers. To many of them, doubtless, it will not be *strange*, and they will be able to account for it.

I have frequently observed during the past winter, on removing the innermost garment (a flannel vest), that its under surface has been *highly luminous*. Sometimes the light is of a pale phosphorescent hue, like winter or sheet lightning; but often it assumes an angry red, like the forked does, and in this latter case, when the house has been quite silent, I have distinctly heard that crackling sound identical with the electric spark.

Is it possible that our bodies resemble so many Leyden jars fully charged, and that the flannel acts like the silk "rubber" in producing electricity by friction on the person, and all this without any aid from Pulvermacher's apparatus?

Let me add that I have noticed the above phenomenon only on *dry, frosty nights*, and that on undressing I have *briskly* taken off the fiery vest and thrown it *briskly* to some three or four feet distance.

I shall leave it to some of your learned readers to account for all this. I can only assure them I was not mistaken, as I have often and closely observed it.

I hail with pleasure the appearance of your excellent paper, THE ELECTRICIAN.

Hoping some correspondent will enlighten me on the foregoing, I am, sir, your obedient servant, W. S. O. B.

Probably our correspondent has never heard of the effects of "laden jars" fully charged.

OUR HOT PLATES.

No. **198** to—

Mr. Haydn T. Harrison upon his appointment as full Lieutenant to H.M.S. "Vernon."

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).	Mr. H. Gray (Accrington).
Mr. H. F. Street (Southampton).	Mr. S. E. Fedden (Sheffield).
Mr. W. H. Cooke (Luton).	——— (West Hartlepool).
Mr. T. Roles (Bradford).	Mr. J. W. Beauchamp (West Ham).
Mr. A. S. Blackman (Sunderland).	Mr. A. H. Shaw (Ilford).
Mr. C. S. Davidson (Barnes).	Mr. C. Furness (Blackpool).
Mr. A. H. Seabrook (St. Marylebone).	Mr. C. M. Shaw (Worcester).
Mr. E. R. Hill (Reading). [bone).	Mr. H. A. Nevill (Wakefield).
Mr. J. W. Hame (York).	Mr. Frank Ayton (Ipswich).
Mr. S. T. Allen (Wolverhampton).	Mr. C. N. Hefford (Leeds).
Mr. F. W. Purse (Carlisle).	Mr. S. E. Britton (Chester).
Mr. W. G. Pickvance (Wrexham).	



No. 10A. Heavy Duty Motor Starting Switch for arduous service. Large renewable contacts, ample auxiliary carbon contacts, laminated short circuiting brush; every part more robust, both mechanically and electrically, than ordinary service requires. No-volt release always, overload release when desired.

'IGRANIC'

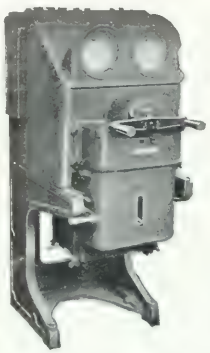
DIRECT CURRENT STARTERS.

IGRANIC ELECTRIC CO., LTD.
London and Bedford.

No. 38. Combined Motor Starter and Field Regulator, for starting and regulating the speed of shunt or compound wound motors in any ratio up to 4 to 1. Simple and mistake proof. The interlock is infallible, ensuring always full field at starting. Thousands in daily use with no-volt or no-volt and overload release.



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GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

"WITTON" MULTIPLE SWITCH STARTERS.

The face-plate type of starter serves well for starting small continuous-current motors, but for large continuous-current motors face-plate starters are not suitable on account of the heavy starting currents to be controlled. For this class of work the multiple lever starter has been employed, but with this type of starter the current may be broken on the current-carrying contacts themselves, and this will result in damage through arcing, with consequent increased

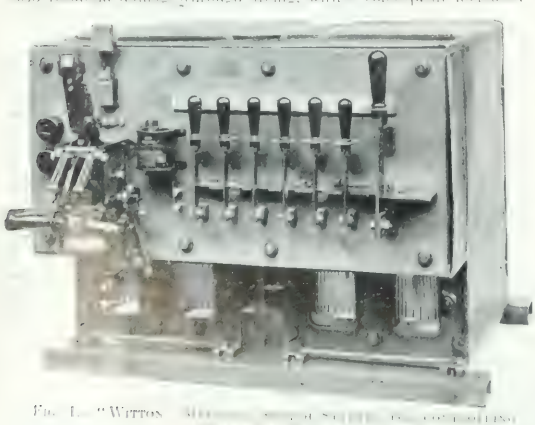


FIG. 1.—"WITTON" [illegible]

[illegible] and [illegible] of the contacts. To [illegible] this disadvantage a type of starter which is [illegible] has been [illegible]. Working on the principle that the best way to break [illegible] is by the use of the [illegible] [illegible] itself to the [illegible] has recently supplied a number of multiple switch starters, comprising a multiple break

starting switch, cutting out sections of the resistance in the ordinar way, and interlocked electrically with a circuit-breaker.

In starting up a motor controlled by such a multiple switch starte the circuit-breaker is first closed, and the switch cutting out the firs step in the resistance is then inserted. But should an attempt b made to insert either the switch that short-circuits the resistance o an intermediate switch on the starter, the attempt is frustrated b an interlocking bar. This bar is automatically moved along by th switches as they successively close, and precludes the closing of an of the other switches out of their proper sequence. Further, shoul the circuit-breaker trip due to an overload on the motor and a attempt be made to replace it—which would mean short-circuitin the supply—a special trip coil on the circuit-breaker is energise through contacts which are "shorted" when any or all of the switche on the starter are closed. The action of this trip coil locks the ci

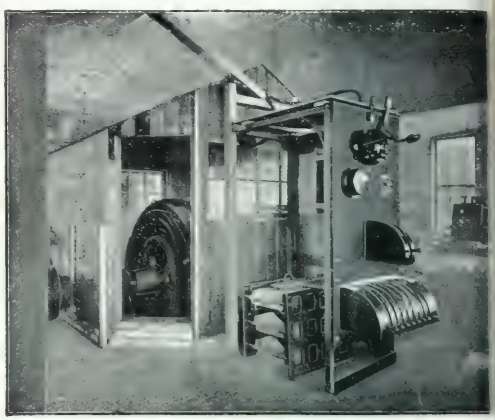


FIG. 2.—"WITTON" MULTIPLE SWITCH STARTER CONTROLLING 300 H.P. ROLLING MILL MOTOR.

cuit-breaker mechanism and prevents the breaker being closed The "Witton" multiple switch starter is, therefore, a mistak proof device, which has the following characteristics: (*a*) It is starter with a special device for breaking the current, thus preservin the ordinary current-carrying contracts from the effects of arcs. (*b* It includes complete mistake-proof arrangements which prevent mishaps to the motor through the motor being switched in with a or part of the resistance out of circuit.

The accompanying illustrations show a "Witton" multip switch starter for controlling a 100 H.P. motor, together with th necessary resistance and circuit-breaker, while a view of a simila device controlling a 300 H.P. "Witton" rolling mill motor is show in Fig. 2. In the latter case it will be observed that the switches ar provided with a suitable cover.

TRAFFORD PARK.

According to a booklet just issued by Trafford Park Estates, Ltd. Trafford Park possesses unique advantages for the establishment o works and warehouses. Sites are available with the most exception railway and deep water facilities, and large savings can be effecte in consequence. The estate adjoins the Manchester Docks, whic provide the nearest ocean terminals to about one-fifth of the whol population of the United Kingdom. The construction of the Man chester Ship Canal has made it possible to manufacture or stor alongside ocean terminals practically in the midst of the most thickl populated district in the world, resulting in considerable economy in transport charges.

Sites are available in Trafford Park with unique railway an shipping facilities. The purchaser can obtain the freehold of th land without payment of the capital sum by taking the land subject to an annual chief rent or ground rental. The conditions of sale are exceptionally favourable. With a view to provide for future extensions, firms taking sites in Trafford Park can obtain an option for short period over adjoining land.

It is interesting to note that the railway conditions in Trafford Park differ from those elsewhere, because the whole railway problem has been worked out in the interests of the traders in the following manner. Statutory railway powers were obtained from Parliament for the Trafford Park railways, so that the traders may not only

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obtain direct access with the statutory railway without any cost for signalling and other charges made with regard to private sidings elsewhere, but also on all goods dealt with that are not dealt with on their own railway sidings without any complications as regards terminals. The Trafford Park Company do not make any terminal charges unless they provide terminal services or accommodation, but simply receive out of the inland railway rate a small tonnage rate sufficient to cover their capital, maintenance and working charges. This tonnage rate is so small that the trader is generally enabled to obtain the same railway rates from his works as are paid in regard to

and obtains its revenue from the Ship Canal toll and wharfage charges. A railway business on a large scale has sprung up in connection with the railway sidings at over 90 works in Trafford Park, and over 1,000,000 tons per annum of railway traffic is already carried over the railways of the Trafford Park Company. Although for the most part only a single line of railway is in operation, and could deal with a much larger traffic than that which now exists, provision is made everywhere on the company's main roads for two lines of railway, and ample space is reserved for the necessary siding accommodation. The railway traffic is collected and delivered at the traders' sidings



Graphic [illegible] of the Advantages of Factories in Trafford Park.

railway traffic using the Manchester Docks. It is important to note that for railway traffic nothing is added to the railway rates just referred to. The Trafford Park Estates (Ltd.) own the shares of the statutory company, but take their benefits out of profits obtained by the disposal of their land.

The Manchester Docks railway traffic was developed on similar lines, under the same management, so that the Ship Canal Company does not earn its revenue out of its railway rates, but gives these (subject to an allowance out of the rate) as a facility to the traders

by locomotives two or three times a day, and hauled to or from one of the three sets of exchange sidings of the main line companies; there are no less than six main line railway companies competing for the same traffic—namely, the London & North Western, the Lancashire & Yorkshire, the Great Central, the Great Northern, the Midland and the Cheshire Lines Railways. We gather that experience has shown that each of the railway companies has to keep a much better supply of rolling stock for Manchester Docks and the Trafford Park traffic than even for their own ports, because in

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Bathurst Works, Witton, B'ham



[illegible] of shortage of wagons at any one company the trader [illegible] master of the situation. Instead of his traffic to another company, and the company for which the traffic was at first intended [illegible] through and preceding facilities.

The Trafford Park Company is bound to provide facilities for traders just the same as every main line railway company, but, in addition to this, every advantage to users can be rendered. It cannot be purchased by any of the large railway companies without Parliamentary powers being obtained and in such an event the public would see that their full rights and privileges were protected.

It is stated that special arrangement is in force under which all import and export traffic is hauled by rail, from or to alongside any ship wherever berthed in the Manchester Docks, to or from a works on Trafford Park, or the central [illegible] portion, including use of railway wagons. In the case of import traffic, arrangements can be made for the discharge of the goods direct from the ship in the Manchester Docks on to the railway wagons alongside, for haulage to Trafford Park, in which case the trader saves the charge for quay porterage. The cost of exchanging import and export traffic between a works in Trafford Park and steamers in the Manchester Docks shows large savings as compared with the costs to and from a works in any other location in the United Kingdom.

Facilities for distribution are offered by the frequent and regular services of steamers which operate from Manchester, including many coastwise services. It cannot be too much impressed upon any manufacturer laying out a works to-day that both raw material and manufactures are not received and shipped in full cargoes to advantage [illegible] are carried at much cheaper rates of freight as parts of general cargo [illegible]

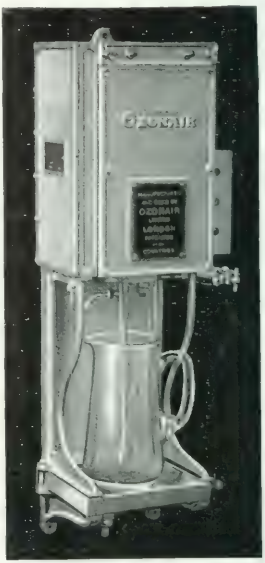
as available to and from most destinations. Manchester is the only one where land with such facilities is to be obtained.

There are sites available in Trafford Park with frontage to the Bridgewater Canal, which is in communication with all the important inland canals of the country.

We would refer interested manufacturers to the offices of the company, Trafford Park, Manchester.

DOMESTIC WATER STERILISERS.

Owing to the natural conditions obtaining in Great Britain, most of the water supplies attain unusually high standards of purity, but there are many which, on careful bacteriological examination call for immediate alteration and improvement. Many cities, villages, &c., depend on rivers, streams, and wells for their water supply. These sources under ordinary circumstances may be reliable, but during hot and dry seasons or in times of heavy influx of surface drainage water, are liable to become not only contaminated, but positively dangerous. Another and frequent source of water pollution is caused by the vegetable growth known as algæ. This



OZONAIR WATER STERILISER FOR DOMESTIC USE.

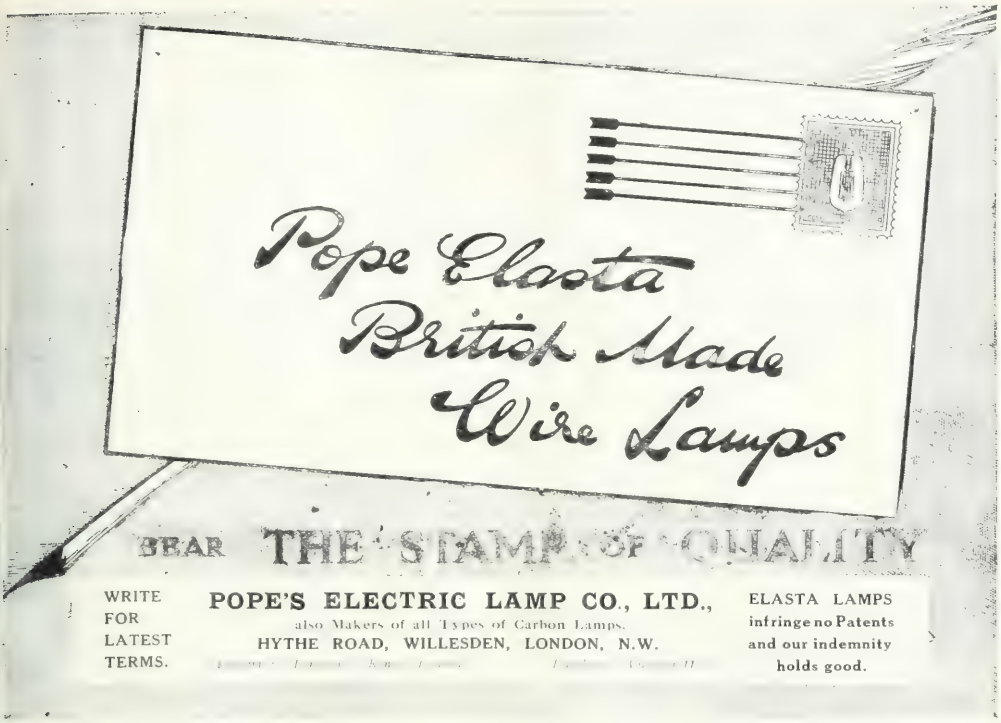
growth commonly occurs in large filter beds, and, although not dangerous, is unpleasant and alarming owing to the pronounced and disagreeable taste and odour which it imparts to the water. The occurrence of this trouble has been noticed many times in the water supplied to several districts in London, and frequently occurs in other cities.

In these cases the ordinary filtration method is practically useless. A good filter, sand or mechanical, will remove nearly all ordinary suspended matter, but no such filter will clear the water of its disease-bearing organisms. There are several methods at hand by means of which these defects can be easily and cheaply remedied.

The simplest and most certain in its action is sterilisation by ozone. Ozone is the ideal agent for water purification. It accomplishes its purpose without in any way altering the natural constitution of the water and at the same time leaves no trace of its presence. Water which previously was alive with dangerous organisms will, after proper subjection to ozone tre tennt, be in good condition for consumption. Moreover, its appearance and odour will have been improved, and it will have a sparkling brightness which, before the

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atment, as is absent. The water previous to treatment must be from all suspended matter, and purification by ozone should be arded as an adjunct to the filtration process.

The Ozonair system of sterilising water on a large scale for public nking purposes has been in use for many years, the plants being ed for capacities of from 100 gallons per hour upwards. A demand s, however, arisen for a small reliable apparatus of a capacity table for ordinary use in districts where the water of the public pply is not above suspicion from a bacterial point of view, or where uses derive their water supply from wells, streams or rivers which ay be contaminated at all or certain times of the year by sewage or ier impurities. The Ozonair domestic water steriliser is a simple paratus of small dimensions. It consists of a metal frame which is ined to the wall by three lugs. The upper part comprises a case hich contains the ozone producing apparatus, and the lower part nsists of a double bracket supporting a swivelling tray for holding receptacle, such as a jug, &c., for the sterilised water. The paratus is quite automatic in action, and all that is necessary is to ace the jug under the apparatus and to turn on the water tap, hich is provided as part of the apparatus. It is made to work on y kind of electric circuit, alternating or continuous, and for any ltage. It is also constructed to work on any water pressure from lb. to 50 lb. per square inch (0·8 kg. to 3·5 kg. per square centi-tre), which is the equivalent of 0·8 to 3·5 atmospheres. The case d metal work is neatly finished in aluminium.

The apparatus is merely mounted on a wall in a suitable position, eferably over a sink. Connection is made between the electricity pply and the terminals provided on the apparatus, and the water pply is connected to the tap fixed on the apparatus. In cases here it is not possible to fix the apparatus above a sink, it will be sirable to connect the waste outlet on the apparatus with a waste pe connection. When it is required to obtain a supply of sterilised ater, a jug or other suitable receptacle is placed on the swivelling ay and the water tap turned on. This automatically sets the paratus working, and when the jug is full it is only necessary to rn the tap off to stop the apparatus. The standard voltages are 0-120 and 200-250 volts, and the standard periodicities 40 to 100 cles per second. The apparatus measures 10½ in. by 7½ in. by in. Prices will be submitted by Ozonair (Ltd.), Victoria-street, estminster, S.W.

MOTOR INSTALLATIONS IN CARLISLE.

We reproduce the following from a pamphlet which is being circulated in his area by Mr. F. W. Purse, electrical engineer, Carlisle:

The total horse-power in electric motors now in use in Carlisle amounts to 3,635. It embraces a wide variety of industries, at one end of the scale being the tiny ⅛ H.P. motor driving a polishing machine, and at the other end installations totalling 480 for an engineering works, 639 for a print and dye works, and 746 for a printing and tin-box manufacturer. Nothing is too small and nothing too large for the electric motor.

The Carlisle Co-operative Society.—Electric power is used in the dairy cooling plant and also in the bakery. There are separate installations in different parts of the city, but by taking electricity from the public mains cheap power is secured in both cases. Cleanliness being of vital importance in dairy work and baking, the electric motor is ideal. The installation in the bakery is a very neat example of the "one machine, one motor" system of driving, which is so convenient and economical.

"Cumberland Evening Mail."—The installation shows how small is the space occupied by an electric motor driving several machines. The motor drives the shaft from which a newspaper printing machine and other small machines are run. The linotype machines are driven by a separate motor.

"Carlisle Journal."—In the office of this newspaper there is a large high-speed rotary printing press driven by a 40 H.P. motor placed in a pit below floor level, thus saving space. The small booster machine is for moving the machine during adjustment before printing.

Ferguson Brothers (Ltd.).—This firm manufactures cotton and similar materials on a large scale, and its works contain many electric motors. Here, again, the "one machine, one motor" system is employed, permitting each machine to be run quite independently of the others, thus abolishing waste of power. Electricity is conveyed to Messrs. Ferguson's mills by means of an overhead line along the riverside, the poles being fixed in the bed of the river, over which the Carlisle Corporation possesses rights.

Harbour Street, Ltd.—The large tin-box and coloured tinplate factory belonging to this firm has five storeys in one part, and by

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GUN METAL, MANGANESE BRONZE,
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Tubes, Sheets,
Rods, Wire, and
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BIRMINGHAM.

using electric motors all the long lengths of shafting and belting necessary with any other drive are avoided. Formerly the works had their own electric generating plant, but now they take current for power and lighting from the public mains.

Hurst, Nelson & Co. (*Ltd.*).—The work carried on by this well-known firm is the making and repairing of railway waggons. The installation shows typical applications of electric motors for driving shafting.

R. Todd & Sons.—In this installation there is a very interesting conversion to electric driving. All the mules used to be driven from a huge shaft. Now the shafting is split up so that each mule is driven by a separate motor, thus ensuring the highest economy. The mill is a seven-storey one, and is one of the most conspicuous factories in Carlisle.

Cowans, Sheldon (*Ltd.*).—This famous firm of crane makers uses electricity from the public mains for power and lighting throughout. In the fitting shop the motor is fixed high up in a corner of the shop, quite out of the way, and all the belts are on one side of the shop.

Carlisle Old Brewery Co. (*Ltd.*).—The refrigerating and other plant in this brewery are driven by electric motors.

Carrick & Sons.—This firm of hat manufacturers makes considerable use of electric motors for driving fans. The motors are direct coupled to the fans. Electric power is also used in other parts of the [illegible]

[illegible] Ltd.—The electric driving installation in these works, which are devoted to the manufacture of railway signal apparatus, provides good examples of "group driving," in which a number of machines which generally run together are conveniently driven from a short length of shafting coupled to an electric motor.

R. R. Buck & Sons, A. Morton & Co.—Both of these large and well-known firms, manufacturing "soft goods," provide examples of the excellent application of electricity. Their works cover a very large area, and, by reason of additions from time to time, it has not been possible to plan any main centre of power. The supply of electricity from the city has, however, stepped in and filled the gap. The current is taken right to the point where it is required, with [illegible]

[illegible] Ltd.—How would it be if we could know that at least one [illegible] realised the advantages of electricity as experienced by all other users, and has for many years been a large consumer of the city supply. In such a well-equipped and up-to-date [illegible] for [illegible] and motor must necessarily play [illegible]

TELEPHONES FOR USE IN MINE RESCUE WORK.

Telephone communication between the advance or rescue party and the outside of the mine, in the case of mine accidents, is one of the features of the daily demonstration of the United States Bureau of Mines rescue crew conducted in connection with the exhibit of the Bureau at the Panama-Pacific International Exposition at San Francisco.

According to the American technical press this exhibit is housed in the Palace of Mines and Minerals, and consists, primarily, of a model mine constructed under the floor of the building in which are installed various appliances, the use of which promotes safety and efficiency in mine work.

One of the features of this exhibit is the daily rescue drill by a crew of four or five men under the personal supervision of Engineer Edward Steidel, who is in charge of the Bureau's exhibit. Twice a day, in response to a telephone message to the effect that an explosion has occurred in the mine, the rescue crew in its especially designed motor car rushes through the exposition grounds and up to the entrance of the building, and, after putting on oxygen-helmet-breathing apparatus and Western Electric mine-rescue telephone apparatus, the members of the rescue party go into a glass-walled room located on the main floor of the building. This room is filled with smoke and gas fumes and demonstrates that the rescuers can actually breathe and work in the midst of thick smoke and poisonous gases. They then go below into the mine and bring out a supposedly injured miner to whom they administer "first aid" treatment. All the time the rescuers are in the smoke-filled room and in the mine they are in constant communication with the outside by means of the telephone equipment.

Each member of the rescue party wears strapped to his throat a small, especially designed transmitter and a watchcase receiver strapped to his ear. This apparatus is connected with a coil of flexible wire, which is carried by the chief of the party on his belt, which pays out as the party advances. The other end of this wire terminates in telephone equipment worn by the person in charge of directing the rescue work located at the rear or on the surface. The reason for this special equipment is that a man, wearing any of the different types of oxygen helmets which cover his mouth, cannot use the ordinary type of telephone transmitter. The throat transmitter furnished transmits speech practically as well as the standard type of telephone instrument and is very small and light and is provided with a soft rubber cup which assists in holding it firmly against the throat.

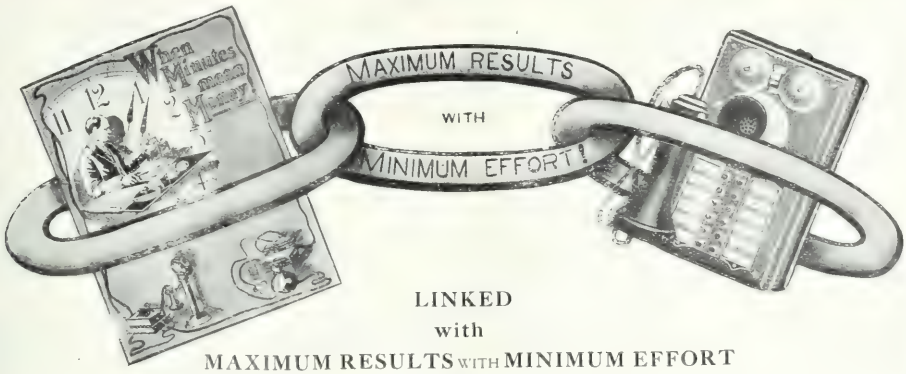
In the past, many losses of life have occurred to members of rescue parties which unquestionably could have been avoided, if there had been some means of communicating with the rear to advise when in need of aid which could easily have been given. Another feature of importance is that such an intimate and constant communication with another human being on the outside encourages the rescuer and prevents those sudden waves of overpowering fear which everyone is more or less subject to in times of great danger, particularly when in the darkness and alone. The mine-rescue telephone equipment demonstrated at the Exposition satisfies this need to the fullest extent and its development has been greatly assisted by suggestions and consultations with the Government Bureau of Mines and private mining companies throughout the country. In addition to the apparatus above mentioned, the standard Western Electric mine telephones of the iron-box underground type are installed and in operation throughout the model mine in typical locations.

SUBMARINE PHOTOGRAPHIC APPARATUS.

Apparatus has been developed by Mr. C. Williamson, Norfolk, Va., for taking either stationary or moving pictures under water. For this purpose a collapsible accordion-like submarine tube of waterproof canvas and rubber, 3 ft. in diameter, is used, braced at regular intervals by iron rings. By means of this construction a person can pass down the tube, while its flexibility permits it to be dragged along by a vessel. The top of the tube remains open at the [illegible], and the lower end extends down into the water, and is ex-

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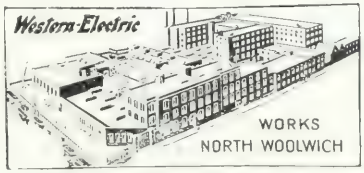


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THE LARGEST MANUFACTURING PLANT IN THE UNITED KINGDOM

panded into a chamber about 5 ft. in diameter, one side of which is provided with a observation window of heavy glass, through which the pictures are taken. The space in the chamber is sufficiently large to hold two men, one of whom operates the camera while the other controls the movement of the tube, which is effected by chains operated from the deck of the boat.

For illuminating the objects to be photographed, a battery of nine 2,400 c.p. Cooper-Hewitt quartz-tube lamps is suspended from the boat. The essential parts of each lamp are the quartz burner and the auxiliary. The former comprises the light-giving tube, its support and the enamelled reflector, while the latter consists of the necessary tilting mechanism and coils for starting and maintaining the mercury arc. In ordinary commercial use the burner is suspended from the lower part of the auxiliary, and is enclosed in a glass globe; but for submarine work the auxiliary is kept on board the boat, and the burner with its reflector holder is mounted in a casing which is placed in a frame and lowered into the water. Photographs and moving pictures have been made through the water by the method described for a distance of 100 ft. A photograph of a diver exploring an old wreck of a ship has been taken 50 ft. distant from the camera.—"Electrical World."

TRIBUTE TO ELBERT HUBBARD.

The following tribute to America's great commercial philosopher Elbert Hubbard is taken from our contemporary, "Electrical Review and Western Electrician":—

Elbert Hubbard was born in Bloomington, Ill., June 19, 1859. For a long time he made a more or less precarious living as a writer and as a printer of choice editions of the classics and his own quaint philosophy. He lectured a good deal, and later on established a printing and publishing plant at East Aurora, N.Y., which soon became the centre of an artistic community, and Hubbard, riding on a wave of personal success, soon found himself prosperous. He has been familiarly known as the "Sage of Aurora" and the "Fra." Many of his publications have reached a tremendous number in the editions that have been published and distributed. His "Message to Garcia" probably attracted more attention than any other single literary effort the world has known. It will be remembered that George C. Daniels, then general passenger agent of the New York Central Railroad, bought and distributed 1,000,000 copies of this little book. Hubbard was an ardent Boxton, and numbered amongst his close friends and acquaintances a host of electrical people. His passing will be particularly unfortunate, as the Royceroft institution, of which he was the inspiration and the main stay, will find it hard to in any way compensate for his departure. Mrs. Hubbard, who accompanied her husband, is also among those missing after the disaster.

EFFECTIVE HALF-WATT WOTAN LIGHTING.

The accompanying illustrations show Wotan half-watt lamps adapted to the lighting of scenery for a variety act and were taken at a Southampton theatre. The artistes are expert divers, and during the performance one of the ladies dives into the water and

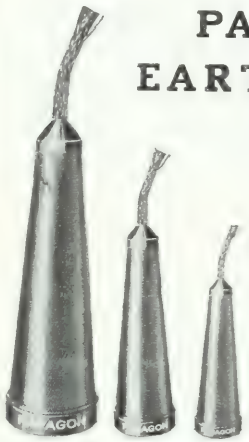


The Diver with Open-air Aquarium Scene illuminated by Wotan Half-watt Lamps.

A Good EARTH

THE

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is made of perforated copper and filled with small charcoal. It is easy to instal, is permanent, and makes a really scientific earth.

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A. REYROLLE & CO., LTD.,

HEBBURN-ON-TYNE.



[illegible] Lighting of Houses [illegible] Works [illegible]

[illegible] half-watt lamps (2,000 c.p.) only were employed, and were sufficient [illegible]

"ORWELL" ELECTRIC VEHICLES.

[illegible] stages, breweries and town transport of almost every description. The vehicles are designated and built on the Mossay system, and are quite simple as to the driving and controlling equipment. The forecarriage is made up of two direct-current motors of the totally-enclosed type, fitted with ball bearings and thrust bearings, and geared direct to the front wheels. They are bolted to swivel axles, and drive through helical gears on the armature shafts, which mesh within internal helical spur rings on the wheel hubs. We understand that these rings and pinions are made from high-grade steel, and are enclosed in dust and water-proof brass covers. The axis of the pivots about which the wheels turn when steering pass through the points of contact between the wheels and the road. The net result of this arrangement is that shocks between the wheels and the road are not transmitted to the steering wheel. It is stated also that there is no tendency for the front wheels to be deviated by unevenness of the road. In case of breakdown to any one of the motors, the vehicle can be driven by the other motor and will keep a straight course. A complete description of the machines is given in the catalogue, and priced and detailed information will be supplied on request to the selling agents, Mossay & Co. (Ltd.), Queen Anne's Chambers, Tothill-street, Westminster.

AUTOMATIC SIGNALLING.

[illegible] of the public interest which has recently been aroused by several disastrous railway accidents, the following note, taken from THE ELECTRICIAN of June 1, 1878, has a certain significance:—

"An Automatic Railway Signal apparatus has been invented by a Swede, and, it is said, enables the station officials to know the precise position of any train at any time; it gives sound signals to the engineer and at the station before the train enters, thus enabling switches to be closed and arranged in time to prevent accident. If two trains approach each other, whether running in the same or in opposite directions, the engineers of both trains receive signals in time to prevent collision, and the station people are at the same time automatically informed of the position of both trains. Any train may, by stopping at certain points on the road where "contacts" are arranged, open telegraphic communication with the stations at each end of the route, and two trains may in the same manner telegraph to each other."

Printed and Published by GEORGE PARKER, at the Electrician Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of London. June 4, 1915.

THE ROUND TABLE.

Thomas A. Edison has accepted the proposal of the Government to place his storage battery in the submarine E2.

"Over here" it would be the other way about.

* * * *

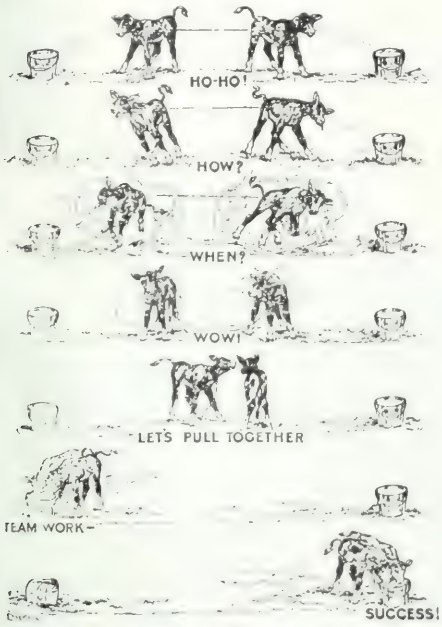
A Glasgow firm has acquired the sole British agency for Dumore "electrical appliances." As a result they have no doubt dun and will do more business.

* * * *

What's in a name? The following appears in an exhibition catalogue :—

The firm have also on their stand a very useful open fire hot air stove, the Marconi, which possesses many points of appearance.

Needless to say, it is not an electric fire at all; why? because it's wireless.



An American Idea of what the Electrical Industry in this Country is going to be.

All honour to those members of the staff of the St. Pancras electricity department who are putting several hours daily of their spare time in assisting Messrs. Bowden Wire (Ltd.) in the manufacture of munitions. Other electricity undertakings, please note.

FERRANTI LTD
Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "X"

A firm of lamp makers advertises that their product has been OK'd by the British public. The other lamp makers remark, sotto voce, "Sauce!"

* * * *

In all the electric tramcars in Manchester an appeal was made to Mancunians to play their part in the war. "Do something," shrieked the notice. A local correspondent informs us that the advice has been taken quite paternally.

* * * *

From "The Motor":

Taxi Driver (to driver of new car with very smoky exhaust): "Nah then, there, none o'yer asphyxiatin' gas tricks 'ere, guv'nor."

After this we may expect to hear that the petrol haze in the streets of London is another method of "frightfulness."

* * * *

In describing a miniature electric cooking range for children's use, one of our American contemporaries remarks :—

The range is well calculated to initiate the youngsters in the merits of electric cooking at an early age. It is absolutely safe, and therefore greatly superior to the plan of permitting children to practise cooking on a gas range.

Greatly superior? Why, sure! (Gas papers, please copy.)

* * * *

From "Punch":

"Merry month of May has played her dampest pranks, and the page of the calendar that ends on Monday will be indexed among those which are to be found among the superlative adjectives in the list of the weatherwise. Nature has contrived to crowd its most wonderful whims into the thirty-two days of the fickle month."

Smethwick Telephone.

Even at Smethwick, you see, *the telephone* cannot avoid its besetting sin, "wrong touch."

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), June 13, 1878.]

Cable Laying.—The telegraph cable between Tenedos and Constantinople has been successfully laid.

The Electric Light.—Information is now reaching us almost daily of contemplated experiments by public authorities in various parts of the country in regard to the electric light. The Chelsea Vestry, in view of the continued complaints with regard to the gas supplied to the parish, have also instructed their surveyor, Mr. G. H. Stayton, to report fully on the whole subject with permission to visit Paris, in order to inspect the system now in use in the French capital.

THE "POINT FIVES."

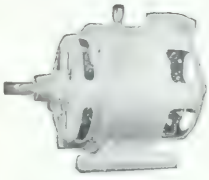
Mr. J. Horace Boaden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. E. R. Hill (Reading). [bone).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
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West Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
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Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).

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A. REYROLLE & Co., LTD. HEBBURN-ON-TYNE.

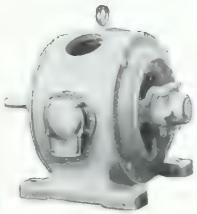
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For Direct Current.



For Three-phase Current.

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Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
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CARDIFF—85, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

"WITTON" HANDGUARD CUT-OUTS.

For many years the G.E.C. has been supplying a shielded cut-out complying with the Home Office regulations, but it has recently improved upon this design by the introduction of "Witton" handguard cut-outs, which are made in an extensive range, a few of the sizes being shown herewith. The object of this new design is to provide a complete protection guard to the hand, precluding the possibility of a live contact being touched while removing or inserting the fuse carrier.

As will be seen from the illustrations, the handle and carrier is composed of one porcelain block designed to enclose the contacts of

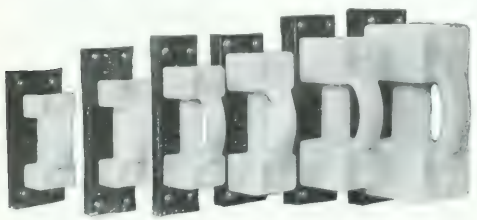


Fig. 1.—Range of "Witton" Handguard Fuses.

without interfering with its general rigidity. This freedom is adequate to enable the contacts to adjust themselves to meet any want of alignment in the clips.

A further feature of the hand-guard cut out is its adequate ventilation. As will be seen from Fig. 2 each contact is cut away at the

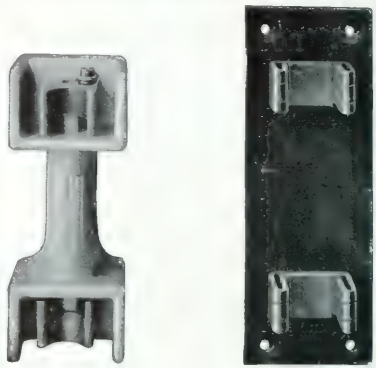


Fig. 2.—Contacts on Carrier and Clips on Base of "Witton" Handguard Cutout.

base so that ample facilities are provided for the access of air to the fuse wire. The latter is carried in the usual asbestos tube which passes through the tubular carrier. The cutout is made in a number of sizes, ranging from 15 to 600 amperes, and the G.E.C. has not changed the prices as compared with its older "Home Office" pattern.

THE ELECTRIC AS A HILL CLIMBER.

The accompanying picture disposes of a somewhat prevalent belief in some quarters that the electric vehicle is not reliable as a hill-climber. Our readers may recognise the famous London test hill,

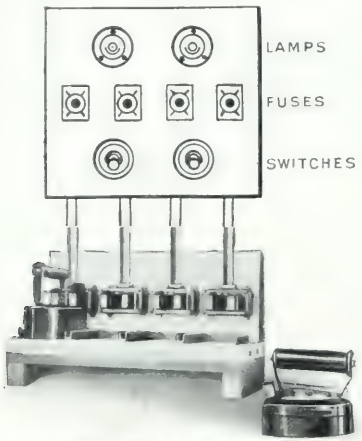


2 ton Dust Van Climbing 1 in 5 Hill.

leading up to Netherhall Gardens at Hampstead, an incline which varies in steepness from 1 in 8 to 1 in 4·5. The Edison Accumulator automatic tipping wagon, shown with a load of over 2 tons in our picture, successfully climbed this hill several times running, during the course of some experiments made with the vehicle in question by Mr. Wyld, the borough electrical engineer at Hampstead. The tests in question covered a wide area around Hampstead, and, we understand, demonstrated completely the ability of the accumulator operated vehicle, to cope with all inclines likely to be met with in every-day service.

INDUSTRIAL ELECTRIC HEATING.

The issue of a new catalogue of industrial electric heating appliances by the Dowsing Radiant Heat Co. appropriately follows our comments on this subject in our last issue. Our readers will remember that some little time ago the Dowsing Company took over the electrical department of Messrs. Eastman & Warne and incorporated it in their general business of electric heating specialists. The catalogue referred to deals with Hotpoint irons, "Eadisk" cookers, "Belenus" boilers, and a line of electrically heated branders. The Hotpoint iron is being extensively used in laundries and tailoring factories. This iron was initially developed in the ironing rooms and repair shops of Messrs. Eastman & Sons, the well-known dyers and cleaners. In its ironing rooms alone this firm employs over 300 hands and it was confronted with the problem of satisfactorily heating the large number of irons which these workers used and at the same time maintaining a cool and sweet atmosphere in all the rooms. During these experiments a number of test irons were made with the object of putting the maximum possible amount of heating wire and insulation into the iron, and of providing a free path for the heat from these elements to the soleplate of the iron, where it is, of course, required. We have described this iron in our columns upon various occasions, but we may recall the fact that the cast-iron sole is provided with a number of longitudinal slots which are lined with pure mica and contain simple elements consisting of strips of hard asbestos closely wound with wire. In the majority of hotpoint irons



DETAIL VIEW OF CORDLESS IRON STAND SHOWING CONTACTS

these slots are 1 in. in depth and spaced at about ½ in. centres. The actual length of wire in an 8 lb. iron is approximately 2,200 in. The bulk of the weight of the iron is in the sole, and as the heating arrangements of this are very efficient the mass of metal provides a very useful heat storage which admits of the iron being employed on heavy intermittent work with a low normal loading. This latter fact contributes considerably to economy in the running cost. Advantage is also taken of it to use a pure metal and not an alloy for the resistance elements. It is pointed out in the catalogue that pure metals increase rapidly in electrical resistance with temperature rise, a function which sets a natural limit to the final temperature obtained by an iron fitted with pure metal elements. We understand that irons of this pattern have been in constant workshop use for over five years without any cost for maintenance. In any event the elements are so readily accessible that they may be replaced when damaged at a purely nominal cost.

Full particulars are given of the various sizes of Hotpoint irons which are made for workshop and tailors' use. Special attention is also called to the "Belenus" system of cordless Hotpoint irons. We understand that these have been successfully installed in anumber of workrooms in the London area, including Messrs. Marshall & Snelgrove, Selfridge & Co., D. H. Evans & Co., Harrods (Ltd.), Hyam & Co., Reville & Rossiter, &c.

The workrooms of tailors, dressmakers, milliners, hatters and similar trades are usually so organised that six or eight or more workers sit at each worktable, and are mainly engaged in sewing and fitting. Each of the workers, however, requires an iron from time to time to press or finish off the goods. In many workrooms the irons are placed in slots or pockets in gas or oil stoves to be heated,



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PERFECT DESIGN
MECHANICALLY STRONG
COMPACT
WELL VENTILATED.

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R.1440
Copper Finger Tip



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Every description of Finger Tips, Connecting Pieces and Segments, made for Tramway Electrical work.

Sole Agent for the Electrical Trade:—

LIONEL ROBINSON, 3, STAPLE INN, LONDON, W.C.

TELEPHONE: *Holborn* 6323.

but in these stoves the irons get over-heated, and have to be cooled off by dipping them into buckets of water. This practice soon cracks the face of the iron and reduces its utility. The stove introduces a considerable risk of fire. It burns the air in the room, making it hot and unhealthy. In many cases, particularly in big workrooms, this is so much the case that the Home Office inspectors have insisted

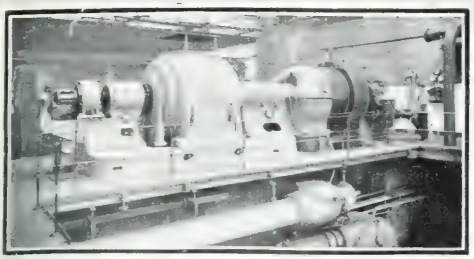
These disadvantages have led many workroom managers to try electric irons of the ordinary type with cords, or gas-heated irons with tubes attached; but it has been found that irons with these attachments are not so handy as the old-fashioned solid irons, because they could not so easily be used in turn by different workers.

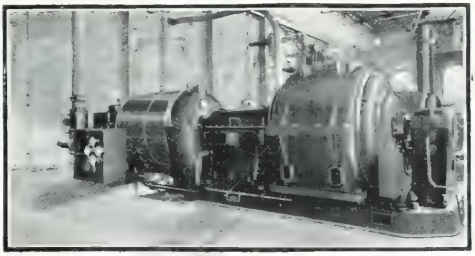
Test undertaken	No. of irons.	Cost of gas.	Cost of electricity.	Final result.
London	5	7 8½ per week	4 6½ per week	120 irons installed.
Newcastle ...	3	4 1 ,,	3 0½ ,,	46 ,, ,,
Brighton ...	8	18 5 ,,	13 4 ,,	12 ,, ,,

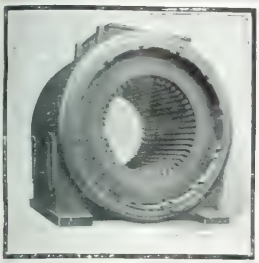
The unique heat storage capacity and automatic property of the "Hotpoint" irons have enabled electricity to overcome this disadvantage. These irons, when hot, may be disconnected from the source of current and used with the same freedom and convenience as solid irons. They are heated by being placed against substantial contact springs inside cast-iron housings. The housings are provided with guides similar to the guides in the hoods over gas stoves. They are usually mounted on strong fireproof shelves attached to the wall. As an alternative the contacts may be fitted at the bottom of inclined pockets attached to the legs of the tables as used in Messrs. Marshall & Snelgrove's workrooms, where 200 of these irons are installed. The system is doubly automatic. No current at all is used except when the irons are against the contacts, the irons then heat up rapidly, and as they warm up the current is gradually cut down to a nominal amount. The irons do not overheat, and there



CORDLESS IRONS IN USE IN ONE OF SELFRIDGE & CO.'S WORKROOMS





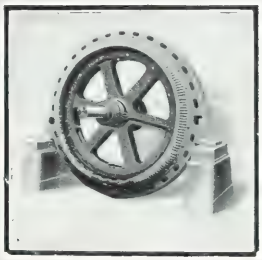


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CONSTANTAN | **CHRONIC**

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FOR ELECTRICAL PURPOSES.

NON-CONDUCTING

BEST QUALITY INDIARUBBER.



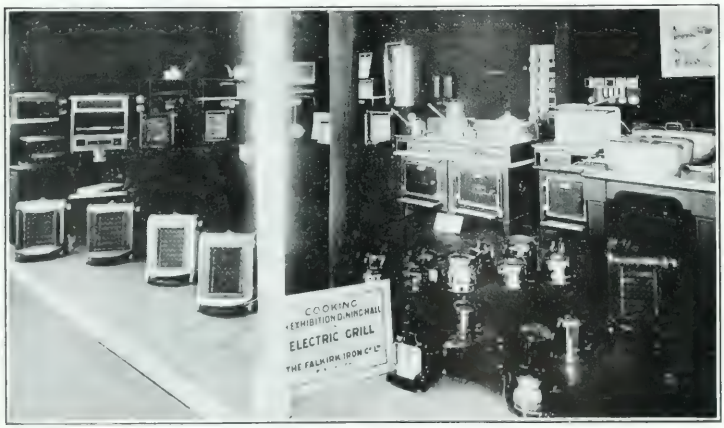
Made in ALL SIZES and ORDINARY STOUT SUBSTANCES to suit varying Voltages.

PRICES ON APPLICATION.

Manufacturers—
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ELECTRICAL APPARATUS AT THE IRONMONGERY EXHIBITION, MANCHESTER.

We briefly commented in our last issue upon the opening of an exhibition of ironmongery and hardware in Manchester on the 3rd inst., and of its continuance until to-morrow, the 12th inst. It has been purely a trade exhibition promoted by the Ironmongers' Federated Association, of which Mr. L. A. McGeoch (Glasgow) is the President for the ensuing year. We took the opportunity to visit the exhibition, and were somewhat impressed by the excellent display of electrical products of various kinds. Two large Scottish firms in particular included in their exhibits of coal and gas fires and ranges some interesting lines of electric cookers, fires and heaters, and we are informed that it produced a powerful impression upon ironmongers and hardware traders who visited the exhibition. They now seem to realise that electrical products of this class have come to stay, and



A Portion of the Falkirk Co.'s Exhibit.

[illegible] to be reckoned with as a legitimate part of their trading operations in the future.

Upon the largest display of electric cooking and heating apparatus is that of the Falkirk Iron Co., whose exhibit takes up nearly half of one of the long side aisles of the building. The electrical section, which is in charge of Mr. C. G. Nobbs, occupies about a third of the total exhibit. The "Falco" boxing electric fires are shown in a variety of patterns of the modern design, and they promise well as a [illegible] fire. The fire is portable, but is designed to stand [illegible] recess [illegible] being easily inserted over. The elements are of [illegible] ribbon, wound on flat former of best selected mica; the [illegible] are placed under a narrow strip of sheet nickel [illegible] terminal, and is pierced with a hole for the brass binding screw; the latter is only finger tight, the heating of the element giving rise to expansion which makes the terminal secure. The elements are [illegible] immediately in front of a [illegible] and either six or eight "bars" are used according to the size of the fire, 2 kw. or 2½ kw. The fire is completed by fixing the reflector and its elements in a perforated metal cover with ornamental cast iron ends, which also form the feet, and providing a substantial nickel-plated or oxidised trivet at the front; the control switch is of the Hart rotary pattern, and is recessed at the top corner of the fire, into the right hand cast iron end, where it can be reached without stooping. The elements of this fire are worked at a cherry red temperature, and are quite pleasing in appearance; the reflector throws the heat well forward, and its shape ensures that the top of the perforated metal cover always remains cool. These fires are offered in a variety of finishes, and are priced accordingly. A number of examples of modern Falkirk electric cookers are also exhibited. The "Compactum" breakfast cooker is a line which should go well. It is a combination of grill and hot-plate; the grilling space may be used as a small oven by raising the hinged fall down door. The hot-plate is entirely covered by the nickel plated iron top of the cooker, an arrangement which obviates troubles due to the spilling of liquids between the hot-plate and the metal frame. Two switches, mounted at the right hand of the cooker, give three heat control of grill and hot-plate respectively, the former is loaded to 1,500 watts (max.), and the latter to 1,250 watts (max.). These cookers are offered at popular prices. The design is slightly modified in other types in which the grilling space is increased in size, a rise and fall arrangement is provided for the grill pan, the number of the hot-plates is increased, or a hot cupboard is mounted above the grill. In one design two grills are combined with a hot cupboard over, this arrangement being suitable for a small restaurant or a tea room which does a trade in "grills." Several sizes of Falkirk domestic and restaurant ovens are shown. The domestic pattern is a combination of oven, grill and hot-plates. In one pattern the oven measures 18 × 18 × 14 in., the latter figure being the height of the cooking space; the company make a point of a shallow rather than a high oven space. The heating elements are of similar design to those used in the Falco fires, and are bolted to the sides of the oven at a point near the centre. They are protected by sheet-metal covers which are cut away near the top and bottom to form a flue around the element and promote circulation of the heated air. The top of the oven is a cast-iron plate studded with small projections, which increase the surface and store a considerable amount of the heat from the side elements; with this feature top heat in the oven is assured, and we understand browning of pastry can be done. The loading of the oven is 3 kw., each element having a three-heat switch.

(To be concluded.)

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INIGO JONES & CO.,
Tudor Slate Works,
GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
Manufacturers of every description of
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Masons, Turners and Enamellers.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON. Friday, June 11, 1915.

THE ROUND TABLE.

EVENTS OF THE WEEK.—Seaton was unable to make a speech and Mr. Bridges was also precluded from introducing the subject of bomb-throwing Suffragettes at the I.M.E.A. Convention.

* * * *

From a London evening paper placard :—

POISONOUS GASSERS IN LONDON.

Why cry stinking fish?

* * * *

Judging by the economical and progressive way in which Mr. T. H. U. Aldridge conducts the Shanghai Municipal Electricity Department, his initials should be altered to B.T.U.

* * * *

The vehicle parade on the Embankment yesterday was very apropos and all that sort of thing, but where were the exhibits of battery charging sets, of which there are many typical examples in this country, and of which, incidentally, so little is known?

* * * *

Ferranti Limited have issued a catalogue in Russian. Their name in that language looks like this :—

(Акц. О-во ФЕРРАНТИ),

and a portion of the catalogue has this appearance :—

Монофазный съ 2 проводниками.

1. Указанія: При каждомъ заказѣ вать слѣдующія указанія:

Типъ Ф2 или Ф3.
Интенсивность, нормальное напряж тока.

We understand that a new set of false teeth is supplied with each copy of the catalogue. Thankovitch!

* * * *

Apropos of the above, Mr. Schofield applied to Cooks for a Russian passport.

"What name?" said the attendant.

"Schofield."

"How do you spell it?"

"S—c—h——"

"Thank you, sir; you'll have to produce your birth certificate."

Thankovitch again.

* * * *

DEAR K.V.A.: I should like to call your attention to the following in your issue of June 11th, p. 363, line 22—*Radiations from Exploding Atoms*:

"In this way the had discovered 18 lines in the 'magnetic spectrum' of RaC."

We always knew the distinguished municipal electrical engineer with the above initials to be brilliant, but we never suspected this!!!—Yours, J. P. K.

A reproduction of Mr. Bowden's latest poster, circulated in the interests of the Poplar electricity department.

GAS
FOOD
COAL
EVERYTHING
DEARER
BUT
ELECTRIC LIGHTING IN POPLAR
CHEAPER
MAXIMUM RATE 4d. PER UNIT.
Reduced to 3d. to
3D. Nett.
Charges for Domestic Supply, under the Contract System, correspondingly reduced.
Apply at once for full particulars POPLAR BOROUGH COUNCIL ELECTRICITY SALES DEPT.,
Telephone No: East 1064. 121, EAST INDIA ROAD, E.

* * * *

We regret to record the death of Barclay Gammon, that versatile entertainer well known to, and appreciated by, Electro-Harmonists. Mr. Barclay Gammon was the first non-technical recipient of one of our hotplates.

* * * *

THIS WEEK'S CHESTNUT.—Into a first-class smoker on the District Railway a "buck" navvy, well "oiled," had strayed, and there being no seat vacant he had to strap hang. With his free hand he took out pipe and tobacco and finally his matches. After several vain attempts at lighting the pipe he called the conductor over: "Hi, guv'nor, come 'ere and 'old this strap while I light my pipe!"

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), June 22, 1878.]

NUMERICAL VALUE OF THE CONSTANTS IN WEBER'S FORMULA.—W. Voigt, in a mathematical Paper, proves that the ratio between the mechanical unit and the electromagnetic unit is $1 : 155{,}570 \cdot 10^6$ instead of $1 : 155{,}370 \cdot 10^6$, and that the constant C of Weber's formula is $440{,}010 \cdot 10^6$ mm., instead of $439{,}450 \cdot 10^6$ mm.

It sounds almost like making a man out a liar to the *n*th place of decimals.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. E. R. Hill (Reading).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
(West Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).



No 33
Double Pole Magnet ally Operated Clapper Switch for Alternating Current. Silent and Reliable. Suitable for starting A.C. Motors that can be thrown directly across the lines without starting resistances, for control by float switches or pneumatic switches, or for remote control of lights.

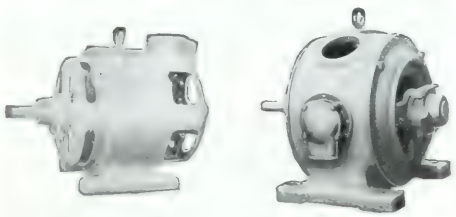


No 35
Self-acting Starter for polyphase Slip-ring Motor. Controls the starting by means of resistance in each phase of the rotor, equal sections being cut out simultaneously in each phase, thus preserving a proper balance in the machine at all times. For use with Pumps, Air Compressors, Lifts, Conveyors or any machine starting against full load.

'IGRANIC'
A.C. SELF-ACTING STARTERS.
IGRANIC ELECTRIC CO., Ltd.,
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STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for

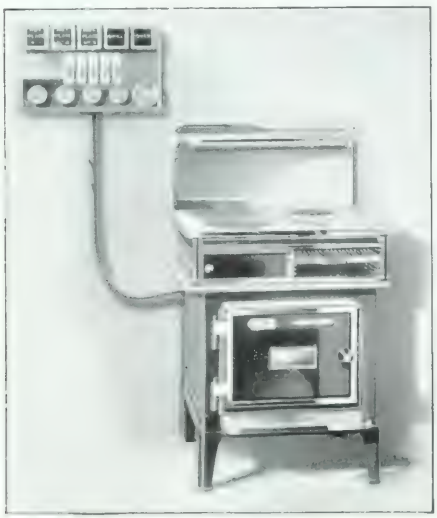
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Branches in Principal Towns Abroad.

ELECTRICAL APPARATUS AT THE IRONMONGERY EXHIBITION, MANCHESTER.

(*Concluded from p.* 78).

There is a 12 in. by 10 in. grilling space, a 22 in. by 12 in. hot cupboard and two 8 in. and one 6 in. hot plates. The grill is heated to



Dorman & Smith damper irons. The latter are specially provided with solid back connections so as to keep all terminals behind the control board. The indicating lamps are provided with "metalised" filaments of low energy consumption, and they also have the standard size bayonet cap, and not a special cap. A double oven range is also on view. A somewhat novel piece of cooking apparatus is a large four-vessel fish range for the deep frying of fish. The frying vessels are secured to a cast-iron table, and are heated from the underside by standard type mica pattern elements. The oil can be kept at a temperature which will cook the fish thoroughly and leave



FALKIRK WATER CIRCULATOR AND CALORIFIER.

it crisp and tasty rather than greasy and unappetising. This type of range has already done successful service in a number of works where it is installed in the men's messrooms. Another electrical exhibit of interest is the "Falco" calorifier and hot water circulator. The circulator is a concentric heater of small diameter, with unions top and bottom for its attachment to the existing hot water tank or



FALKIRK CALORIFIER, WATER AND STEAM CIRCULATOR.

cylinder. Water after passing through the circulator is discharged into the tank at 180° F. We understand that the standard size of circulator has a capacity equivalent to about 1·2 watts per 24 hour

The Electric & General Works, Ltd

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Water-Jet Lightning Arresters up to 50,000 Volts.

Electrical Apparatus up to 80,000 Volts & 4,000 Amps.

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day. The [illegible] 2 units per hour. Automatic temperature control apparatus can be supplied for use with these heaters if desired. All the grills in the dining room of the Exhibition were [illegible] Electroyl grill of the two compartment type, with large hot cupboard for plates below. The grill has been [illegible] during the Exhibition by a Manchester caterer, Mr. A. G. [illegible] and he informed us that he was delighted

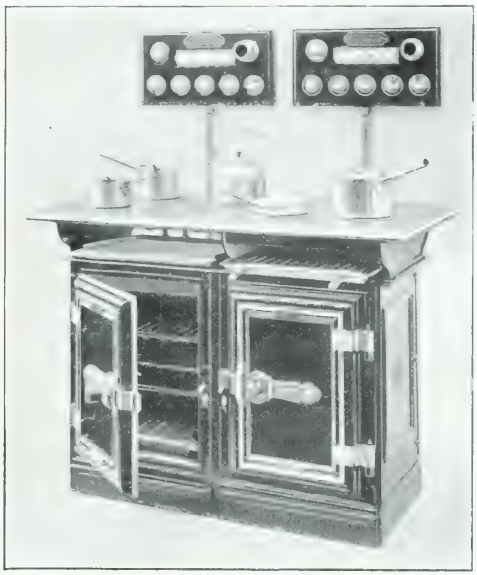


Electric Cooking and Domestic Grill and Hot Plate.

with the grill, and his customers spoke highly of its products. He stated that it had the advantage over coal or gas, that it did not need special attention, and could be looked after by the waiters themselves. The time taken to cook a grill [illegible] the public appreciated. Mr. [illegible] there was a good field for electric grills in Manchester.

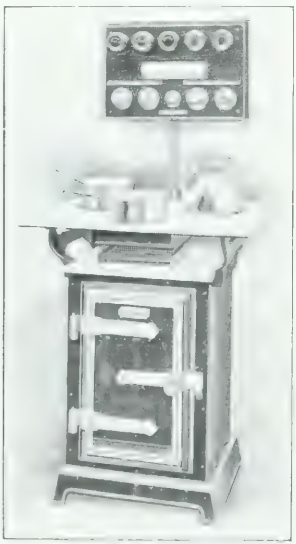
The other large exhibit of electric cooking and heating apparatus was that of the Carron Company, a firm which has done much pioneer work in this field. The exhibit was an island one near the centre of the hall, and was one of the principal attractions of the place. The electrical portion of the exhibit was confined to one end of the stand. The large piece in this section was a double oven range combined with grill and hot plates, all under the control of two distinct switch and fuse boards. The body is of cast iron, and each oven is double-cased lagged with non-conducting material, mottled white and grey porcelain enamel lined, and fitted with removable and interchangeable hangers, one sheet iron and two grid shelves, baking pan and meat hook. Standard Carron heating elements are fitted at the top and bottom of the oven. In the smallest size of this range the ovens measure 18 in. wide, 25 in. high, 16 in. deep. The width of the double range overall is 50 in., and the height 38 in. Another interesting Carron cooker on view was their Domestic type, which is made in four different sizes. In the smallest of these the height of the complete cooker is 29 in., the measures 13 in. wide, 18 in. high, 12 in. deep, and has a maximum energy consumption of 2,000 watts. Mounted above the oven is a table carrying one 6 in. and one 8 in. hot-plate, rated at 600 and 1,200 watts respectively. Between the top of the oven and the hot-plate table is a grill measuring 10 in. by 9 in., and rated at 1,250 watts. This size of cooker is suitable for a family of about six persons. The oven is fitted with top and bottom heat furnished by two standard Carron elements which are readily replaceable, and which can be withdrawn complete from the oven. Contact between the element and the fixed terminals is made through suitable pin connections. In each case, both the oven and hot-plates, 3-heat regulation is provided by rotary switches: heavy high, medium, low and off positions. The control board carrying these switches is also fitted with Zed fuses and indicating lamps. The connections between this board and the various sections of the cooker are protected by a heavy armoured flexible tube. In the largest sized the patterned

cooker the oven is rated at 3.5 kw. There are four hot-plates, one 6 in., two 8 in. and one 10 in., and the grill measures 14 in. by 10 in., being loaded to 1,500 watts. Examples of Carron breakfast cookers were also exhibited. The smallest pattern



Carron Double Range Cooker.

of these, which retails at a guinea, is a grill toaster and hot-plate which measures inside 10 in. by 5½ in. by 9 in. It is provided with a single heating element which is loaded to 1,250 watts, there being only one heat. A slightly larger size measures 17 in. by 12½ in. by



Carron Breakfast Cooker.

12½ [illegible] is fitted with a hot [illegible] grill. The [illegible] are carried out [illegible]

Considerable interest is taken in the "Abbey" series of Carron fires. A number of designs of these were exhibited and wired up, so that they could be seen in operation. These fires are of ornamental design, the metal framework surrounding the elements being of cast-



Carron Electric Fire.

iron finished either in art black, majolica enamel, armour bright or electro-brassed. The element consists of a spiral nichrome wire embedded in deep grooves in a fireclay block. This block is semi-circular in shape and of unit sizes, having five horizontal grooves. The elements are suitably supported within the frame, and the connections are brought to a three-heat control switch fixed in the base of the fire. The terminals are totally enclosed. These fires are designed to be set in a suitable mantle with tile surround and kerb.

The ironmonger has paid greater attention recently to the electric vacuum cleaner than he did a few years ago, a fact which is probably explained by the lower prices at which these handy little machines can now be retailed. The average householder will pay £5. 5s. for a cleaner, and the manufacturers are gradually approaching this convenient and attractive popular price. Several machines, which may be termed "popular models," were shown at the exhibition. Messrs. G. Gibson & Co., Wellington-street, Glasgow, are the agents for the "Doty" cleaner, a machine which, though diminutive in appearance, is powerful in action. Its principal feature is the placing of the motor inside the dust bag in such a way that it is kept cool by the air of suction. The aluminium housing, which also forms part of the cleaning nozzle, is made cylindrical at the point at which the bag is secured in position, and the motor body is concentric with this housing. Within the mouth of the nozzle is a rotary brush which is kept turning in both directions by the back set of vulcanite castors on which the machine runs; the drive from the castor-wheel spindle to the brush is by a small enclosed chain. The same firm exhibited a line of cleaners known as the "Dumore," but this is a larger machine and higher priced than the "Doty." This machine has a horizontal motor with its axis parallel to the suction nozzle. Two draught fans are fitted to the motor, one at each end of the armature shaft. The aluminium casing of the machine is divided near its centre, and the upper half may be removed to give access to the motor and the fan blades. As with the "Doty" machine, the motor, though small, cannot get hot, because it is placed directly in the path of the incoming air. Both these machines are fitted with self-contained push-bar switches, forming an integral part of the handle, and placed near its upper end. Messrs. Gibson & Co. are the British agents for "Dumore" electrical specialities, and apart from the vacuum cleaners, one of the most interesting of these is a self-contained motor-driving for sewing machines. It should go a long way to solve the rather troublesome problem of the electrical operation of the domestic sewing machine.

The outfit comprises a small motor $\frac{1}{16}$ H.P., to the casing of which is attached the bracket for clamping the machine to the sewing-machine table, a jockey pulley for the driving belt, and a switch within the motor casing actuated by a pull chain. The lever which operates the switch is so linked up with the jockey pulley that when the chain is pulled the motor is started, and the pulley puts the requisite tension on the belt to run the sewing machine. The pull chain is attached to the ordinary treadle of the sewing machine, the connecting rod for treadle operation being removed. There is sufficient play in the movement of the switch and jockey pulley



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THE LARGEST AND MOST UP-TO-DATE HOTEL IN EUROPE.

There are over 1,000 bedrooms, and in each of these a

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We make Electric Fires for all purposes.

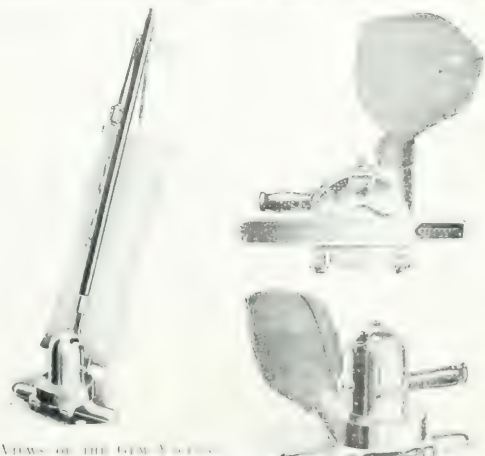
BELLING & CO.,
Electrical Heating Specialists,
Derby Rd., Edmonton, London, N.

...vers to admit of ... pose variations. As this is obtained mechanically and not electrically, the driving arrangement is much simplified. The average housewife is not attracted to resistance boxes and control switches, and it is useless endeavouring to supply her with anything electrical which is not absolutely simple. If Messrs. Gibson push this sewing machine motor it ought to have a big sale.



Domestic Sewing Machine with Motor.

A line of small vacuum cleaners ... contains a quantity of electrical apparatus by Messrs. E. O. Walker & Co., Cannon-street, Manchester. One of these, the "Gem," is a popular price machine, and is fitted with a vertical motor mounted over the suction nozzle casing. The air is drawn almost directly into the dust-tight collecting bag, taking only one turn round the casing itself. A separate brush with stiff bristles is placed across the mouth of the nozzle, and this is intended to remove threads and similar material from the carpet ... them into bag. The novelty of the machine lies in its light weight, and this is taken advantage of to dispense with the usual hose and attachments for cleaning furniture, &c. A small handle is screwed into the side of the machine, and with this it can be used in the hand and passed over the upholstery to be cleaned. The long handle is removed and also the large bag, the place of the latter being taken by a smaller bag, which is of ample size to collect the amount of dust which is usually met with in upholstery. An adjustable slide is provided for use over the nozzle of the cleaner when it is being used as a hand machine. The ... effectively used in corners. The ... larger cleaner, known as "the Bee" ... selling and technical interest.



Views of the Gem Vacuum Cleaner, showing Method of Using in the House for Furniture Cleaning, &c.

B.T.-H. STEAM, WATER AND AIR FLOW METERS.

We [illegible] No. 6,500 that the British Thomson-Houston Co. have developed a flow meter which, without the use of weighing tanks, orifice or other special apparatus, will accurately determine the amount of steam, air or other fluid flowing in a system of piping or closed conduits. These flow meters can be supplied to measure the quantity of steam, water or air flowing in pipes of any diameter and under any conditions of pressure or temperature encountered in commercial practice. These instruments are thus capable of furnishing information of great value in the economical management of any manufacturing industry or generating plant. The general principles of flow meters for steam, water and air are exactly the same, the instruments differing only slightly in their actual design to suit the physical characteristics of the three agents to which they are applied.

B.T.-H. steam flow meters are adapted for the measurement of steam generated by a single boiler or battery of boilers, steam delivered to any section of a manufacturing plant, steam consumption of turbines, reciprocating engines and pumps, &c. These meters facilitate the operation of equalising the load on individual boilers of a battery, and are also valuable in the detection of losses caused by leaks between boilers and the points of consumption, or leaks in the boilers themselves, which would be indicated by a large difference in the water input and steam output.

B.T.-H. water flow meters afford a convenient and accurate method of measuring output of a pumping plant, consumption of large waterworks, water turbines, condensers and boilers, slippage losses in pumps.

B.T.-H. air flow meters are also suitable for measuring the amount of air delivered to any section of a manufacturing plant and blast furnaces, mines, for operating drills or ventilation purposes, and are of considerable value in determining the efficiency of compressors and the various classes of compressed air machinery. These meters are also of assistance in detecting losses caused by leaks between air compressors and the points of consumption.

Flow meters can also be adapted accurately for measuring the flow of oil if desired. Information dealing with this type of meter will be furnished on request.

If the temperature and pressure of steam flowing through a pipe remain constant, then the quantity of steam passing any point in the pipe will be proportional to its velocity. A specially shaped pipe is inserted in the steam main, so that its two openings lie in the path of the steam. The leading opening faces against the direction of flow and the trailing opening faces in the direction of flow. [illegible] The two openings are connected by a vertical Ushaped tube containing mercury. It is evident that the steam, water or air when flowing through the main [illegible] the trailing pipe after the manner of a steam ejector. Due to the difference in pressure in each of the limbs of the U-tube, the mercury is deflected until the unbalanced column exactly balances the differential pressure. It is from the degree of unbalancing of the mercury columns that measurements are made of the amount of steam, water or air flowing in the main.

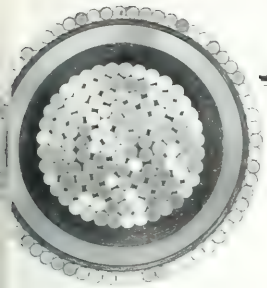


Normal Velocity Nozzle for Flow Meters.

A specially designed Pito tube, termed a nozzle plug, is used for the measurement of normal velocities, and is screwed into the pipe at the point where the steam, water or air flow is to be determined. This nozzle plug is composed of a double conduit tube extending across the pipe diameter, each conduit having a separate set [illegible]



B.T.-H. Nozzle attached to Nozzle Plug in Steam Pipe.



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BRITISH CABLE

for every class of installation is manufactured by the Western Electric Co., Ltd., at their works at North Woolwich. Western Electric Telephone, Telegraph and Power Cables are giving highly satisfactory service in all parts of the world.

You cannot do better than to refer all your cable schemes to our staff of engineers for expert advice in the matter concerning the choice of the most suitable cable for your particular purpose.

Our Cable Handbook will be gladly sent upon request.

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ARMOURED SWITCHGEAR, *6,000 to 12,000 volts.*
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„ SWITCH TYPE FUSES, *50 amps. single pole.*
SWITCHES *(Air or Oil Break Patterns).*
WALL PLUGS *(For PORTABLE DRILLS and LIGHTING).*

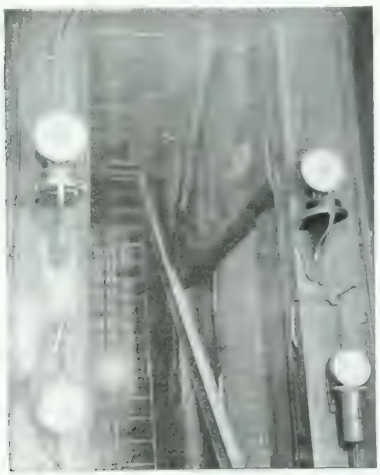
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BIRMINGHAM.



Indicating Pressure Flow Meter on Bracket.

the case with the Lonergan form of Pitot tube. The introduction of the nozzle plug in the mean causes no appreciable drop in the pressure, even at a high rate of flow. There are ribs on the head of the nozzle plug for radiating purposes. The same normal velocity



Recording Differential Steam Flow Meters.

pipes, the distance between the nozzle plug or orifice tube and mete being immaterial. All necessary valves and unions are supplie with the instrument. Under ordinary conditions, the only extr material needed for installation is the piping between the meter an its nozzle plug or orifice tube, which must be supplied by the customer

An installation of B.T.-H. steam flow meters is shown in one o the illustrations, which clearly indicates the facility with which thes meters may be installed and also the small space occupied by them.

ORDERLINESS AND ECONOMY.

"When seen make a note of" is always good advice, and the business man should make immediate record of the thousand and one items which occur to him and which at the moment he cannot attend to. The most unsatisfactory method, however, is to make a jotting on any piece of paper which lies handy—more often than not it gets mislaid. A scribbling block is always useful, but often owing to a false sense of economy, it is not as widely used as it might be outside the chief's office. A new line of pads, the "City Scribbler," is now obtainable at the moderate price of 17s. a gross (or under 1½d. each!), carriage free to any station. The size of the block is 8 in. by 5 in., and the quality of the paper appears to be excellent judging by the sample submitted to us. The business man should send for a supply to the makers, Elsworth Bros., Bowman-lane, Leeds.

WOTAN SALES.

The sales and advertising departments of Messrs. Siemens Brother Dynamo Works (Ltd.), incandescent lamp and fittings department Dalston, have now been transferred to 39, Upper Thames-street E.C. From this address the combined lamp and supplies business will in future be controlled. The re-arrangement has been made essential by the rapidly increasing turnover of Wotan and Tantalun lamps. Extensions in the manufacturing departments have been made from time to time, and it will be remembered that exceptionally large premises at Shacklewell-lane were occupied some three years ago to provide store accommodation for the large stocks held by the company. Although this released a certain amount of space and temporarily eased the situation, the introduction of new types of lamps, including gas-filled lamps, demanded that further extensions should be made. Accordingly, Dalston works will now be devoted solely to lamp manufacture, and the output correspondingly increased. Apart from these considerations, it is hoped that the centralisation of the lamps and fittings selling organisations will prove to the convenience of their numerous customers. All correspondence relating to Dalston material should be addressed to 39, Upper Thames-street, E.C.

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Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 35-37, NOBLE STREET, LONDON, E.C.

Printed and published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet-Street, in the City of London. Friday, June 18, 1915.

THE ROUND TABLE.

EVENT OF THE WEEK. Mr. C. H. Wordingham as the candid friend at the I.M.E.A. Convention.

* * * *

The I.M.E.A. Limerick :—

There once was a chief named Wordingham.
The - - -

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GLASGOW—65, Waterloo Street. | SOUTHAMPTON—46, High Street.
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A NEW TUMBLER SWITCH.

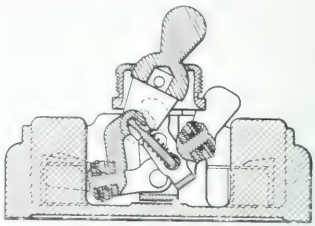
Various attempts have been made from time to time to introduce into the ordinary tumbler switch a positive quick make and break action, which it has proved fairly easy to apply to the lever pattern of larger size. We have received from Messrs. J. H. Tucker & Co., Birmingham, samples of a tumbler switch which is fitted with a distinctly novel form of action. It is a little difficult to describe, although in fact it is quite simple in construction. An ordinary pattern ball socket dolly is used, and the inner end of the dolly lever is U-shaped, with two pins projecting from the outer side of the arms of the U. These pins engage with a swinging link which is also



TWO-WAY SWITCH.

U-shaped and pivoted near its centre upon a couple of pins which project internally from the supporting saddle. This swinging link is provided on the under side of the pivotal point with a bridge, from the centre of which is a long pin which passes through a helical spring. The free end of this pin is loosely linked to another U-shaped lever which carries the moving contact of the switch, the current carrying [illegible] of the dolly lever.

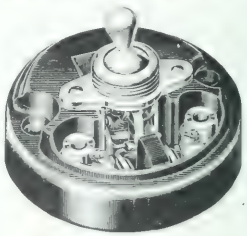
The movement of the dolly sets the swinging link in motion about its pivotal point, and puts the helical spring into compression, this [illegible] the spring [illegible] the flicking over of the switch arm. The net [illegible] of the spring is applied to the flicking over of the switch arm. The net result is that the swinging link the switch arm is rapidly carried into or out of the fixed contacts. We have vainly strived to arrest the position of the switch arm midway between the on and off positions. No matter how slowly the dolly is moved, it is quite impossible to make or break contact other than with a snap action. The illustrations give a fairly good idea of the switch movement, but we would recommend interested contractors and consulting engineers who have not yet



SECTION THROUGH TWO-WAY SWITCH.

received a sample switch to apply to Messrs. J. H. Tucker & Co. for one. The switch is of small diameter, the base being only 2¼ in., and the overall projection is only 1½ in.

In accordance with Messrs. Tucker's custom in producing new switches, they invariably test an ordinary sample by switching it on and off a number of times. In the case of this particular switch, we gather that it has been mechanically operated over 2,000,000 times without breaking down, either mechanically or electrically. We are



SINGLE WAY SWITCH.

asked to state that the switch is now ready for the market in both the one- and two-way patterns. We must certainly say, in conclusion, that the switch is one of the neatest and simplest that has been brought to our notice of recent years. The metal parts of the switch are all in best brass, and the helical spring is coppered to safeguard against rusting. The terminals are also of the looping-in pattern, with pinching screws set at an angle in the ordinary way.

GLASGOW SMOKE ABATEMENT EXHIBITION.

Preparations are now being made for an important Smoke Abatement Exhibition at Glasgow a few months hence, and this fact recalls the great success which attended the two previous enterprises of this kind held in this city. At the last local Smoke Abatement Exhibition no fewer than a hundred thousand visitors from various parts of Scotland passed through the turnstiles, and this amply proves the wisdom of the Glasgow Corporation bestowing their civic blessing upon such undertakings. The forthcoming exhibition will be under the patronage both of the Glasgow Corporation and of the local branch of the Smoke Abatement League of Great Britain, and it is anticipated that many of the leading firms throughout the country possessing specialities in smokeless fuel and combustion, as well as in heating and lighting, either by gas or electricity, will co-operate with the promoters in an enthusiastic desire to make the venture even better than any of its predecessors. We understand that the preliminary classification of probable exhibits embraces no fewer than 15 sections including smokeless fuels, domestic heating, gas stoves, gas heating appliances, electric apparatus of all kinds, ventilating fans, dust preventing contrivances, and shop window lighting specialities and already a considerable amount of the stall space has been taken up by enterprising firms. The exhibition will be held in the Exhibition Hall, New City-road, Glasgow, and we are asked to mention that Mr. James M. Freer, 38, Bath-street, Glasgow, who is acting as manager, will furnish any interested reader with any further preliminary information desired.

A MODERN ELECTRICALLY DRIVEN AND LIGHTED SHOE FACTORY.

Messrs. W. Edwards & Son have recently erected a three-storey factory in Norwich in which no points have been overlooked which would safeguard the health and welfare of their operatives, or enable them to turn out a greater quantity of a superior article, in the minimum of time with the least expenditure of effort. The building is of reinforced concrete and occupies the site of the ancient palace of the Dukes of Norfolk on the banks of the river Wensum. The windows are large so as to admit an abundance of light, and the ventilation and general hygienic arrangements have been so designed as to supply ideal working conditions and healthful surroundings. In addition, the flat roof of the building has been laid out as a garden to provide the employees with a recreation ground.

To the factory, mill, or workshop owner, the question of obtaining the necessary power to drive his machinery and to light his establishment is of vital importance. The way in which he solves this problem will enormously affect the operation of his works, and, in these days of keen competition, will make the difference between profit and loss. The modern manufacturer cannot afford to employ any but the most efficient and up-to-date methods, whether they refer to the[illegible] drive, lighting, [illegible] organisation or book-keeping.

Messrs. Edwards [illegible] to be congratulated in being able to secure their supply of electricity from the mains of the Norwich Corporation, whose charges are low, making it an attractive centre for boot manufacturers who are contemplating fresh fields of operation. The maximum floor space has been secured in their factory by placing the motors, which drive the machinery, near to the ceiling in non-



[illegible] Motors in Shoe Factory.

cradles, grouping the machines they drive so that the smallest number of belts and line shafts are required. As it is a function of the electric motor to operate equally well, whether placed on floor, pillar or ceiling, there has been no sacrifice in efficiency by placing the motors near the ceiling as Messrs. Edwards have done. Two sizes of motors have been standardised for use throughout the factory, viz., 10 B.H.P. and 15 B.H.P. with speed of 1,000 revs. per min.

It may be of interest to briefly summarise the advantages of the electric drive :—

1. The cost is always proportional to the actual work done.
2. Whether under or overloaded the electric motor is always highly efficient.
3. No attention and few and inexpensive repairs necessary.
4. Electric motors are easily and quickly installed, and require no special foundation or alteration to existing arrangements.
5. Electric motors are small and compact, and, if necessary, can be fixed to wall or ceiling. In any case only a negligible amount of space is occupied.
6. A single machine can be used at any time without stopping the whole power plant.
7. Electric motors are perfectly safe, and [illegible] obtain preferential insurance rates.
8. They create no fumes or dirt.
9. They are vibrationless and practically noiseless.
10. They can be started by simply throwing [illegible] switch, and an entirely [illegible] piece of apparatus.
11. Extensions to the factory can easily be made. There is no need to instal more power than is necessary at the moment. Additional motors can be installed as required without disturbing the original plant.

The entire factory is lighted, as previously stated, by electricity, Mazda lamps shaded by "Mazdalux" reflectors being used, and arranged so that the light is concentrated on the work, and not in the

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eyes of the operatives. In the case of special machinery such as consols, stitchers, pullover machines, &c., the lighting fittings are of the "Universal" type with Mazdalux reflectors, enabling the operator to place the light in the desired position. The present capacity of the factory is 1,500 dozens per week, consisting of ladies' and children's turn shoes, machine sewn and veldt-schoen, the greater proportion of the output being children's goods, in the manufacture of which Messrs. Edwards have specialised for a number of years. The equipment of the different departments consists of the [illegible] machinery supplied by the British United Shoe Machinery Co. Ltd., and the Singer Company.



Cutting Room Driven Entirely by Electric Irons being Used in Connection.

The Clicking Room, which contains double open-end presses, "Planet" sole rounder, "Acme" heel building machines, universal sluggers, and the usual complement of skivers, splitters and preparing machines, is driven by a 15 H.P. motor. The Clicking Room, which contains "Ideal" clicking presses, is driven by a 10 H.P. motor. In this room the electric flat-iron is used for "backing," as it has been found extremely satisfactory for this purpose. The Machining Room contains Singer closing machines, button-hole machine, hand-meshed folder, new power hammer and No. 4 edge cementing machines driven by the motor in the Clicking Room.

The Machine Sewn Making Room is driven by a 10 H.P. motor, and contains "Rex" power assembling machine, "Rex" pull-over machine, C.H.M. lasters, wire grip backer, "Rex" rotary pounding, up machine, "Blake" sole sewers, "Atlas" leveller, Channel closing and edge-raising machine and cementing machines. The Veldt-Schoen Department is driven by a 10 H.P. motor, and contains a veldt power assembling machine, C.H.M. laster, "Rex" rotary pounding-up machine, No. 2 rapid stitchers, "Goodyear" rapid stitcher, veldt trimming machines, wire grip tackers, channel laying and sleeking machine, tack pulling machine, universal slugger and channel opener.



Machine Room, showing Motors near Ceiling.

The Turn Shoe Department is driven by two 10 H.P. motors, and contains Boston lasting machines, wire grip tackers, "Goodyear" model "K" turn shoe sewing machines, "Goodyear" universal power channeler, "Goodyear" turn shoe reforming plant, universal slugger and lightning heel attacher. The Finishing Room, Heeling Department and Stock Room are driven by two 15 H.P. motors; the Finishing Room contains "McKay" heel trimming machines and [illegible] heel scourers, heel scourers, "Pearl" edge setters, Master bottom scourers, Expedite heel burnishers, Twin heel breast scourer, top moving machines and polishing shafts. The Heeling Department contains universal sluggers and lightning heeler; the Stock Room contains a "Regent" power monogram machine. The Driving Room is heated by elec



10 H.P. Motor in Veldt-Schoen Making Room.

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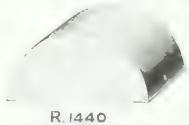
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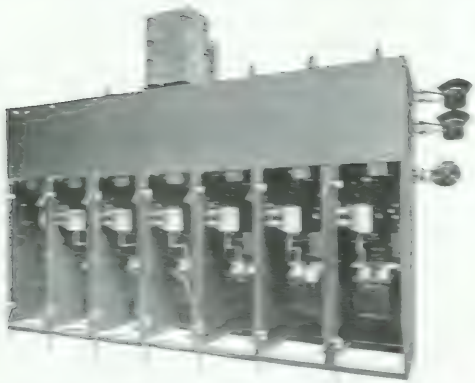
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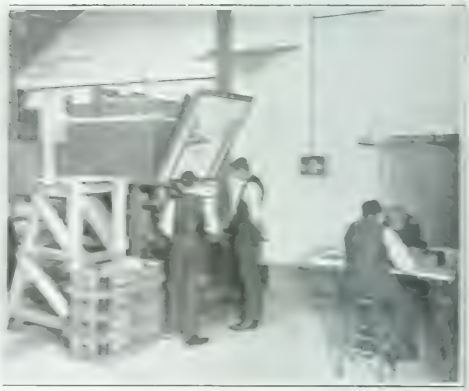
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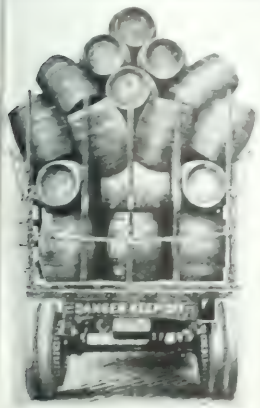
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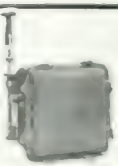
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In the June issue of the "Journal" of the Institute of Journalists, Mr. M. Powis Bale ventilates the subject of reviewing. He says, inter alia: "What I strongly object to in technical reviewing is that after an author has produced a book, which perhaps gives [illegible]



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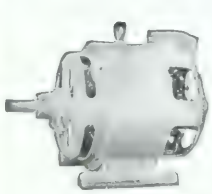
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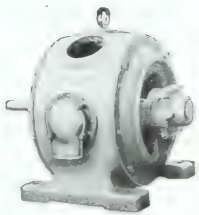
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RAILWAY STATION LIGHTING.

The lighting of British railway stations has not hitherto been particularly satisfactory either by day or by night. Especially do these remarks apply to the provision of artificial illumination; but the new half-watt lamps have tempted some railway companies to depart from tradition and to light their stations so that they present



Plan of the Entrance Hall to the Central Station, Glasgow

over from arc lighting. This station was originally lighted by 10-ampere open-type arc lamps with opalescent globes running four in series on 230 volts, the total number of arcs employed being approximately 120. Inside the main entrance containing the booking hall, offices, bookstalls and waiting rooms, the lamps were mounted at a height of about 22 ft., and were spaced from 60 ft. to 80 ft. apart. Along the platforms they were mounted at the same height, the average spacing being 80 ft.

These arc lamps have now been replaced by 500-watt Osram Atmos type lamps. These occupy the positions previously filled by the arc lamps. The result has, we understand, been more than satisfactory, as is exemplified by the fact that there is a reduction of



THE CENTRAL STATION, GLASGOW, BY DAYLIGHT.

300 watts on each circuit of four lamps, while at the same time the lighting of the station has been considerably improved by the more even illumination obtained from the new lamps. Also they require less attention. The horizontal illumination in the main hall, of course, is 2 ft.-candles maximum, with a minimum of 1·7 ft.-candles, while along the platforms the variation is between 0·8 and 1·6 ft.-candles.

The photograph which we reproduce was taken at night, solely by the light of the lamps, and gives some idea of the results obtained. A general view by daylight, showing the old arc lamp carcases, now containing the Osram Atmos type lamps, is also given.

DE LAVAL STEAM TURBINES.

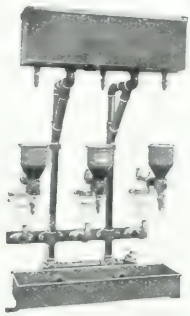
From a recently issued brochure we understand that de Laval turbines made by Messrs. Greenwood & Batley have been installed for electric lighting, power, and ventilation in over a hundred steamships of all sizes, from warships to tugs. Several recent battleships for the British Navy are equipped with them, and during the last year 12 of these turbines have been fitted in the new vessels of the Canadian Pacific Railway Company. In electric plants for towns and mines, and in pumping stations and factories of all kinds, the de Laval turbine is extensively used.

It is of interest to recall that in the de Laval turbine there is only one wheel and only one row of moving blades. The nozzles are so shaped that the steam is fully expanded in them; on leaving the nozzles the steam has expanded until it is at the condenser pressure. During the expansion in the nozzle the heat in the steam is converted into kinetic energy. Striking the buckets with a high velocity, the steam drives the wheel round by its momentum. The de Laval is a pure impulse turbine. To give low steam consumption, the speed of turbine wheels must be high—too high for direct driving. The de Laval turbine retains the high, efficient speed and introduces a double-helical gear to reduce the driving speed of the turbine to one-tenth or one-twelfth of the speed of the wheel. Both pinion and spurwheel have three bearings. This type of gearing first introduced by de Laval is now used in other styles of turbines thousands of horse-power in size. The loss in the gear is slight, and as the brake-horse-power of the turbine is measured on the slow-speed shaft this loss is discounted in all steam consumption guarantees. The de Laval steam turbine is the lightest, simplest and probably the most efficient of all the engines driven by steam.

It is made in standard sizes from 3 B.H.P. to 600 B.H.P., and of the following types: (*a*) High-pressure type, for taking steam at from 50 lb. per square inch upwards, exhausting to a condenser or to atmosphere. This type is specially adapted for town electricity works, hotels, factories, institutions, ships, mines, &c. Where possible a condenser should be fitted in order to obtain the best results. (*b*) Back-pressure type, for taking steam as for type (*a*), and

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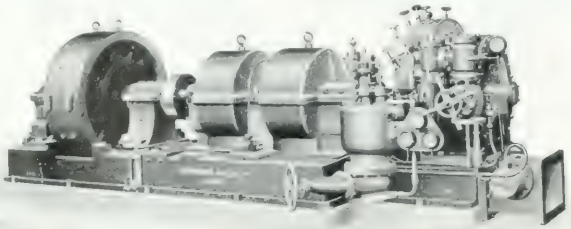
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exhausting against a back pressure. This type is recommended where steam is used for heating, boiling or drying. The turbine then serves as a reducing valve between the boiler and the works. (c) Low-pressure type, for utilising the waste steam from non-condensing engines. This type is widely used in mines and steel plants where there is generally a large quantity of exhaust steam going to waste. (d) Mixed-pressure type. In many cases the supply of exhaust steam is intermittent and it is necessary to switch over automatically to the live steam supply. This type is designed to meet these conditions. It may be necessary, or advantageous to fit a heat-accumulator in connection with turbines of type (c) and (d).

Since the de Laval turbine was first made many other types of turbines have followed. In all of these a compromise is made between a fast running wheel (necessary to get a good efficiency) and slow running generator (advisable in the case of direct-current machines to avoid commutator troubles). In the de Laval turbine, made by Messrs. Greenwood & Batley, we gather that the reduction that enables both of these conditions essential to economical working to be met. The blading of the turbine is simplicity itself. Owing to the special design of nozzle ring, in which there are many small nozzles, the buckets or blades are quite short. This is a distinct advantage and one which has contributed greatly to the long life of the blades. By the introduction of single gear and forced lubrication Messrs. Greenwood & Batley have made a notable advance in the design of the de Laval turbine in the direction of simplicity and higher efficiency.

The de Laval turbine has several important advantages over compound engines. By its simplicity, running charges of the plant have been reduced to a minimum; in the de Laval the cost of repairs, renewals, oil and attention is much lower than with reciprocating engines. Wherever exhaust steam is wanted for boiling or heating, a turbine has an important advantage as its exhaust is entirely free from oil. The cost of installation is less with the turbine. No holding-down bolts are required, there being no vibration when running. A full technical description of this interesting turbine is given in the brochure above referred to, a copy of which may be obtained from Greenwood & Batley, Ltd., Leeds.



De Laval Turbo-Generator.

ILLUMINATION FEATURES AT PANAMA EXPOSITION.

The glass dome of the Palace of Horticulture, the largest in the world, at the Panama-Pacific International Exposition will furnish, in an ever-changing series of spectral colour achievements, one of the grandest, most spectacular night-time lighting effects ever conceived. Such startling effects in shapes and colours are unbelieveable until a person has actually seen them. The entire lighting scheme of the exposition, fathered by one man and created in his laboratories, has proved one of the wonders of the wonderful exposition. The effects to be gained by the use of high-powered searchlight, seasting their beams upward through coloured revolving screens and lenses of various types to the dome, are beyond the power of expression. Moreover, it is the first public demonstration of what can be accomplished in dome lighting by spectacular effects. Mr. W. D. A. Ryan, in his efforts to produce unique and effective system of illumination, met with a great deal of scepticism. The entire lighting plan is radically different from anything previously attempted. His faith in the plan was unbounded from the beginning. The lighting of the large dome probably represents more intricate reasoning than any other form of illumination ever mathematically worked out. While it is but one unit of a comprehensive scheme for the entertainment and enlightenment of visitors to the exposition, it strikes the keynote of the whole plan.

The various spectacular lighting units of the exposition are the dome of the Palace of Horticulture, the Tower of Jewels and the scintillator of 48 searchlights placed on the water front. Coupled with this is an elaborate scheme of flood lighting for the facades of the exhibit palaces, a moonlight effect for the Palace of Fine Arts, lighting for the various courts, avenues and streets and the amusement district. The system used in lighting the interior of Festival Hall is a separate and distinct type of interior lighting, which is unique.

The Tower of Jewels under the concentrated glow from 50 search-lights, has proved a wonderful picture of light. Rising to a height of 435 ft. and towering majestically above the surrounding buildings, studded with many thousands of Novagems hung so as to swing with the slightest movement of the air, it presents at night a vivid picture of quivering, sparkling light. The interior of the large ball surmounting the tower and the colonnades about the various terraces, appear in relief in a blood-orange glow as a background for the myriad twinkling of the jewels. Such doors are used on the search-lights as will direct their rays on the tower without any waste light and without revealing the sources of illumination. The hanging of the jewels was completed considerably in advance of the opening date, and this gave time for making through tests.

The tower rises in eight receding stages, each stage except two being surrounded by a colonnade and being ornamented with various sculptured effects. These furnish the motif for the entire jew-



The Tower of Jewels at Night.



Entrance to the Court of Palms.

Many effects are possible in the dome lighting by the use of five sets of specially designed lens plates, in various combinations, and by the use of opaque sectors which cut off some and which permit some light from the searchlights to reach the screens where the beams are coloured and projected upward. Three-colour arrangements are always possible, a constant colour appearing as a general diffusion over the entire dome, a spectral series and an enlarged spot, mottled with rotating colours. One of the most beautiful effects is seen in a series of 12 ribbons of light, each a sixth of a revolution ahead of its [illegible] All [illegible] the dome. The colour [illegible] one colour for each ribbon, then the spectrum series, in which the whole ribbon assumes various solid colours, then a rainbow effect, each ribbon having one edge of [illegible] intermediate colours. Each [illegible] during a rotation and twice as a [illegible] the ribbon effect are seen rising out of the [illegible] together with spots appearing in [illegible] to seem revolving at from [illegible] about their own orbits. Twenty [illegible] have been worked out, and all have proved [illegible] The period of each operation is 40 minutes.

scheme. The jewels have been hung in strips and arranged in elaborate designs over the surface of the tower and the statuary to coordinate with the architectural plan. Each Novagem has a tiny mirror placed behind it to catch the rays of light and direct them through the facets, giving an indescribably beautiful effect of glittering, sparkling colours of every hue of the rainbow. The least atmospheric change causes them to swing as a pendulum, and it is this swinging that causes the various changes of colour.

The humidity of San Francisco atmosphere and the fogs which drift in through the Golden Gate close by aid materially in the spectacular displays by the scintillator. A dry, clear atmosphere detracts from the effectiveness of the displays. Smoke bombs bursting high in the air, the smoke and steam from a locomotive stationed nearby, are used for playing up marvellous colour effects on clear nights. The 48 searchlights, the largest of their kind, each equipped with six colour screens, can be used to furnish one great burst of light or 48 separate beams at the will of the operators. Fully 450 searchlights have been installed about the grounds, mostly in batteries on the roofs of the main exhibit palaces. Fifty alone are used for the Tower of Jewels. Four batteries are trained on the Palace of Fine Arts. A number are used for lighting up the various flag standards. Others are used in the Court of Honour for playing

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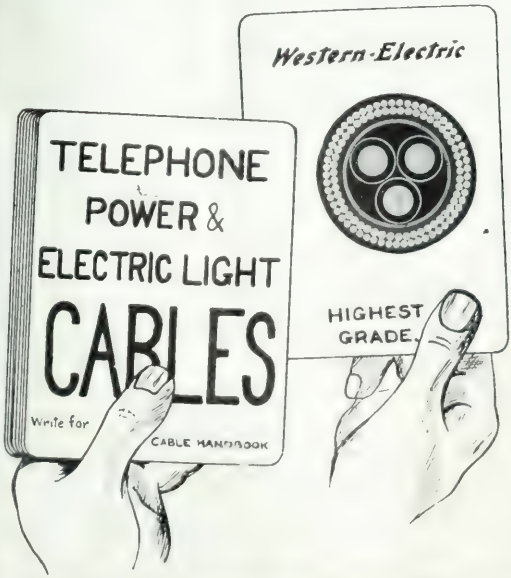
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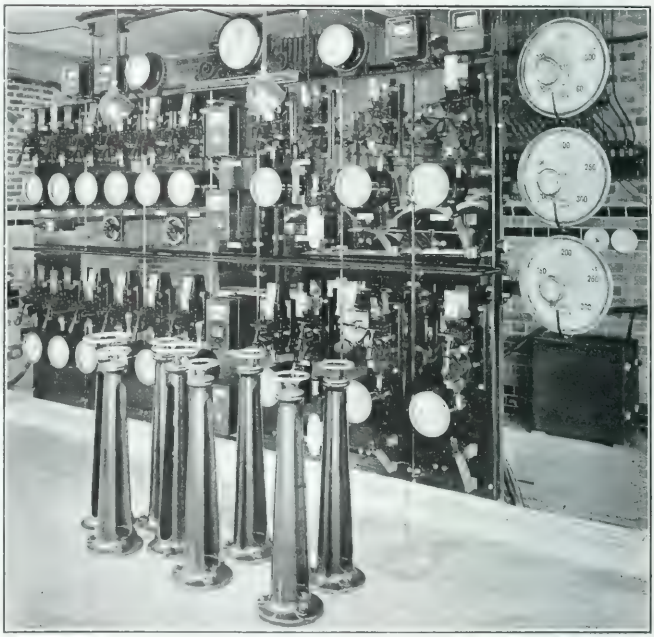
up the Novagems on the stat figures which adorn the balustrades about the court. The main intent of the lighting scheme has been to preserve to the sightseer all of the architectural beauties so evident in the daytime, in a beautiful night time setting, and to lose none of the exquisite colouring of the buildings.

The dome of the Festival Hall is lighted by 12 searchlights placed in a pit under the centre of the dome and arranged to throw their beams upwards to a large diffusing glass, sandblasted on the under side; the dome itself acts as a reflector. The facades of the various buildings are lighted by high-power arc lamps placed on lofty standards and surrounded on three sides by heraldic banners.

We are indebted for the foregoing matter and illustrations to our Chicago contemporary, the "Electrical Review and Western Electrician."

A "CIRSCALE" SWITCHBOARD.

The adjoining illustration shows the switchboard installed at the recently opened electricity works of the Wood Green (London) District Council. The board itself is of standard construction and controls two generators, one battery and booster, and three feeders. The framework is of angle iron, and the panels are all of black enamelled slate. They are divided horizontally near the centre by an enamelled slate shield; the top half of the board controls the positive circuits and the bottom half the negative circuits. The total length of the gear is 12 ft., and it is erected 6 ft. from the front of the engine-room wall, thereby allowing ample space at the back to bring up the connections and generally to give access to the terminals. The battery regulating switches are also placed behind the board. It will be seen from the illustration that all the instruments, which are of the "Cirscale" pattern and made by the Record Electrical Co., are readable at a considerable distance, and especially the main voltmeters. These latter are mounted at the right-hand side of the board on swing brackets. They are of the illuminated dial type. On the uppermost voltmeter may be read the 'bus-bar pressure, and the two lower instruments are coupled up to voltmeter [illegible] contact type, which enable readings to be taken of the volts at the various feeding points of the distribution system. The ammeters on the generator, feeder and booster circuits are "Cirscale" instruments, and so also are the battery voltmeters, which are of the pedestal type and mounted at the top of the board. For the purposes of paralleling, a portable horizontal pattern of voltmeter is provided, and this is fitted with plug contacts which can be inserted in the sockets on the panel of the incoming generator. The gear itself, which was made by the Electric Construction Co., is typical of modern flat back board practice, and the instruments contribute largely to the ease and efficiency with which the gear can be operated.



E.C.C. SWITCHBOARD WITH "CIRSCALE" INSTRUMENTS AT WOOD GREEN ELECTRICITY WORKS.

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EDISWAN—EVERYTHING—ELECTRICAL.

A SHOOTING MATCH.

A friendly shoot between the "Ediswan" Rifle Club and a team from Siemens Rifle Club was decided on the "Ediswan" Range last Saturday, the 26th ult. There was a good muster, and many well-known men from both firms were present.

Siemens put 17 men in the field, including Mr. Holmes (sales manager), Mr. Hicks (assistant sales manager), and Mr. Pryor (hon. sec. to the Club). "Ediswan" team were equal in number, and included Messrs. Child and Elliott (joint sales managers) and Mr. Corbett (hon. sec.).

The shoot resulted in a win for the home team by 1,254 to 973. Spoons were given for the highest score on each side, also wooden spoons for the lowest scores, and a Mystery prize completed the tropies.

The prizes in the team match were awarded as follows :—

Highest score	"Siemens"	Mr. Fowler.	97
	"Ediswan"	Mr. Black.	91
Lowest score (Booby Spoon)	"Siemens"	Mr. A. N. Other.	2
	"Ediswan"	Mr. Elliott.	48
Mystery	"Ediswan"	Mr. Swallow	87

After the "shoot" the party, of nearly 50, adjourned to the staff café for tea, and a vote of thanks to the hosts was proposed by Mr. Holmes, and responded to by Mr. Elliott, after which the latter presented the prizes. Having taken tea, another match of 6 a side was decided in favour of the "Ediswan" men by 518 to 492.

PROGRESS WITH ELECTRIC CLOCKS.

We hear from the Synchronome Co., Clerkenwell-road, that uniform and accurate time is still considered by some to be more in the nature of a luxury than a necessity, hence the industry of electric clockmaking has felt the pressure of war time, and this has made it easier for them to spare no less than 50 per cent. of their staff who are now serving H.M. forces in some capacity or another. Rapid extensions of their circuits of electrical impulse dials have, however, been required in munition factories and shipyards, such as the Atlas Steel & Iron Works, Sheffield, of John Brown & Co. (Ltd.), Vickers (Ltd.), Barrow, and John I. Thornycroft (Ltd.), Basingstoke, and in many buildings now used as hospitals. They are also extending the electric time circuits in Euston Station for the L. & N.W. Railway Co., at Waterloo for the L. & S.W. Railway, and at Port Sunlight for Lever Bros (Ltd.), and providing new installations of electric clocks in the Civil Service Commission, Burlington House, for the Office of Works, the new offices of the Western Union Telegraph Co. (Ltd.), Messrs. Pilkington's Glass Works, St. Helens, &c.

ERRATA.

In our issue of June 18, under the heading of the Ironmongery Exhibition, Manchester, we referred to the Falco standard water circulator as having a capacity equivalent to about 1·2 *watts* per 24-hour day ; this should have read "12 *baths* per 24-hour day."

The article in "Electric Vehicle Progress" last week entitled "Electric Vehicles and their Control" contained an obvious error. In the second paragraph, for "it is *im*possible to obtain five speeds forward or reverse," read "it is possible to obtain, &c."

NEW SWITCH-HOLDER.

The adjoining illustrations show a new design of switchholder, of which a sample has been sent to us by Messrs. G. St. John Day, Mumps Electrical Works, Oldham. This accessory is of interest because it is something of a departure from previous types in which some form or another of electrical contact making and breaking device has been introduced into the body of the holder ; as a rule this particular form of switch has been operated either by a pushbar, a key or a pull chain. In the present circumstances the inventors have adopted the simple expedient of making and breaking contact at the bayonet socket plungers which, in a normal lampholder, occupy a fixed position within the shell. In the Mumps holder these contacts form part of a moving member which is provided with a collar and which is a slack fit within the body of the holder, which is either of brass or moulded material as desired. This moving member is free to slide through a given distance within the shell, and is under the control of a fairly stout helical wire spring. In the position shown in Fig. 1 the circuit is broken, the moving portion of the holder being at its extreme outward point. In this position the plungers are some distance away from the contact plates in the lamp cap. If the shell is taken in the hand and the fingers of the same hand are used to press the moving member into the shell in the direction of the lamp ; at the extremity of its travel it is locked in place by a plunger catch which pushes forward a release button, which will be seen at the right-hand of the case. This action brings the plunger contacts against the plates within the lampholder cap, at the same time sufficient pressure is exercised to lock the lamp in position. The device, therefore, prevents the removal of the lamp with the current on. In order to switch off, the holder is again taken in one hand and the protruding button is pressed, therefore releasing the moving member and causing it to fly outwards under the action of the spring. The sample submitted to us is of the moulded material type, and has been designed specially to comply with the Home Office



Fig. 1.



Fig. 2.

A New Switch Holde...

regulations in regard to shockproof accessories for industrial situations, mines and similar installations. A sample of this interesting holder may be obtained on application to the makers, who will also furnish fuller particulars and prices. We may mention that the lamp plungers are provided with Day's patent form of contact, which enables the connecting flexible to be wired without the use of any tools.

TRANSPORT INEFFICIENCIES.

It is estimated that in the United States alone there is a grand total of 720,000,000 tons of goods every year which passes through the railway freight and transfer stations. The present lack of system in handling this freight and the tremendous amount of lost time involved represents a yearly loss of more than £16,000,000. With the existing antiquated and inefficient methods there is constant confusion and delay where thousands of conveyances endeavour to get served within a few hours. This causes the transfer mediums to be held up for several hours inactive with resulting losses. As the use of the "electric stevedore" increases, it is to be hoped that this will influence a further systematised manner of delivery. As their work becomes more thoroughly unified, the freight sheds and docks in many cases will operate on a 24-hour schedule. With the virtual freedom of city streets electric commercial vehicles operating silently will transport the goods by night to well-located centres from which goods may be distributed the following day and delivered when business houses are prepared for them. This seems to be the only way to solve the problem of congested freight piers in cities where increase in size of the termini is rendered impracticable for physical reasons, the cities in most cases having steadily built up around them. To-day the only hope for decreased congestion is increased efficiency, such as will enable street vehicles to discharge or receive their loads with celerity, and this must be effected by speeding up the movement of freight over the platforms, in using more efficient transfer means between the vessel holds or freight cars and the vehicle tail-boards, and in organising a system of distributing centres to supplement the cramped termini.

Printed and Published by GEORGE TUCKER at the Offices of the Publishing and Publication Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of

THE ROUND TABLE.

EVENT OF THE WEEK.—The coming of the new half watts. Not 'arf! (Small Schnapps, please!)

* * * *

The latest in transmission poles is the one-piece lattice pole. The recipe for this is "Take one H girder, make a number of staggered notches in the web and pull at the side members until the desired 'mesh' is obtained." Result, one-all-steel-one-piece-lattice-pole! Some pole!

* * * *

The latest Ediswan showcard is reproduced in miniature herewith. At the present time particularly the practice of economy is synonymous with the keeping down of bills; the



showcard is therefore patriotically appropriate. Wilhelm and the Crown Prince certainly look completely "overwilhelmed"!

Now that the summer has really arrived the thoughts of the industry are turned to holidays. A correspondent remarks upon this, and suggests that yachting even in these days of submarines has its pleasures as well as its perils. He asks us incidentally if it is true that the Tungsten Lamp Association is thinking of a cruise in the "Argon-naught." We cannot say, but we Pope so.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), July 13, 1878.]

It is but half a century ago that to circle the earth in 40 minutes became more than a poet's imagination. Since then improvements in the electric telegraph have come with something of its own speed, one following another almost before the public mind could realise the importance of what had already superseded. It was only yesterday that we were laughing at the very notion of the telephone. To-day we are opening our eyes at the microphone, uncertain as yet what to think of its extraordinary phenomena. And, from the sources that cannot be named here, comes information of experiments, the results of which already give reason to expect that we are on the eve of a still more stupendous electrical discovery.

A CIRSCALE SWITCHBOARD.

In the description of the above board at the Wood Green Electricity Works, published in our last issue, we omitted to mention that Messrs. May & Hawes were the consulting engineers for the entire scheme of the new electricity undertaking.

GLOVER'S ALMANAC.

The issue of Glover's almanac for the ensuing year has been compiled more or less in accordance with previous editions from "useful information contained in technical publications chiefly dealt with, which the busy engineer had not time to refer to in the ordinary way." Copious extracts are given from the "Proceedings" of the Institution of Electrical Engineers, from our own columns and from those of our principal home contemporaries, and from the "Electrical World." The editor is to be congratulated upon the quality of these extracts both in a textual and illustrative sense. The humorous side of the calendar is, if anything, more humorous than heretobefore. A few of the cartoons have been contributed by appreciative readers of the calendar who are at present serving with his Majesty's Forces in the trenches. We hope to reproduce a number of these from time to time, but meanwhile we feel sure that those of our readers who have been recipients of the calendar in previous years, and who may through some mischance, although we hardly think it possible, have been overlooked on this occasion, will take the opportunity of reminding Messrs. W. T. Glover & Co. of the oversight.

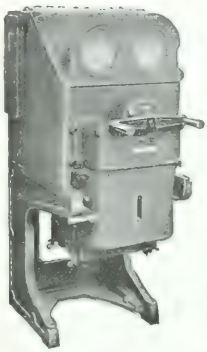
THE "POINT FIVES."

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AN INDIVIDUAL DRIVEN DOUBLING FRAME INSTALLATION.

At their new Arden works, Kings Cross, Halifax, Messrs. S. Thornton & Co. (Ltd.), after investigating the different systems of drive available, selected electric power, one of the determining factors being that energy is supplied by the Halifax Corporation at a com-



FIG. 1.—GENERAL VIEW OF THE DOUBLING FRAME INSTALLATION AT S. THORNTON & CO.

this installation are 12 ring doubling frames of 300 spindles; eight [illegible] 120 bobbins each; one 120-drum winding frame; one bundling press; one preparing machine.

The Halifax Corporation has installed in the mill a 100 k.v.a. three-phase 6,600-volt 50-cycle transformer to reduce the supply pressure to 220 volts, as this is the most suitable for small individual drive motors.

The electrification of the doubling frame installation was entrusted to the textile department of the General Electric Co. The problems involved in the individual driving of the doubling frames required considerable attention. Usually the tin-roller shafts on doubling frames are run at a speed of from 800 to 1,000 revs. per min., but in this case the frame makers required a speed not exceeding 880 to 900 revs. per min. As the nearest motor speed on a 50-cycle supply was between 960 and 970 revs. per min., direct coupling was out of the question. It was decided, therefore, to use 7 H.P. "Witton" squirrel cage protected-type textile motors with ball bearings, running at a speed of 1,450 revs. per min., the motors being fitted with machine cut double helical gear, made by the Power Plant Co. (Ltd.). The larger gear wheel is keyed directly to the frame shaft.



FIG. 2.—7 H.P. "WITTON" TEXTILE MOTORS DRIVING THE DOUBLING FRAMES.

The power at 220 volts is distributed to the machines from a compactly designed switchboard, enclosed in a sheet iron case, the cables being carried underground in conduit to a point close to the

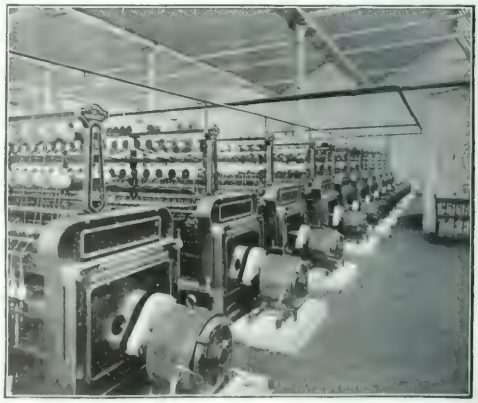


FIG. 3.—ANOTHER VIEW OF 7 H.P. "WITTON" MOTORS DRIVING THE DOUBLING FRAMES.

[illegible] motors. The motors are started by means of ironclad starters, a set of fuses, also in a cast-iron case, being included in the motor circuit when the starter is in the running position. A general view of the 12 motors driving the doubling frames is shown in Figs. 2 and 3, and a more detailed view of the motors and switchgear in Fig. 4, whilst Fig. 5 gives a view of the frames themselves.

Although this installation is on a small scale, it has, we under-

stand, thoroughly proved the claims made for the individual electric drive. It has shown that (*a*) the individual drive effects a considerable saving in power and space as well as in the cost of the buildings. An examination of Fig. 1, giving a general view of the installation, emphasises the changes wrought in the lay-out of a mill through the adoption of individual electric drive. It will be observed that the absence of belting and shafting has permitted the buildings to be of a lightly constructed type, and at the same time the illumination is very good. In this connection, Messrs. Thornton state that throughout the winter there was no occasion to light up on any day

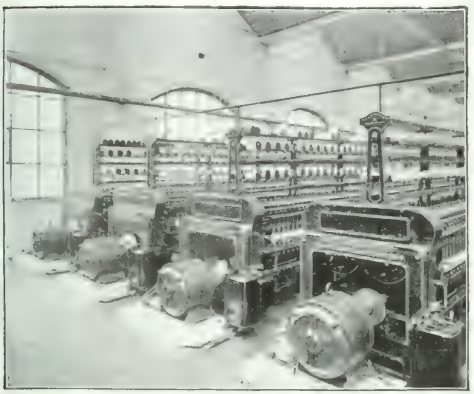


Fig. 4. Detailed View of the Motors and Starting Switchgear, showing Covers removed from the Gears.

until after 4:15 p.m. (*b*) Electrification has given an increased and improved production. (*c*) The machines run with great steadiness, and at the same time maintenance is reduced to a minimum. (*d*) The ability to run individual machines on overtime without keeping an engine room staff at work is a great convenience.

The buildings are lighted throughout by Osram Axial type lamps with an obscured reflector fitting close to the lamp. The illustrations show that the lights are arranged down the doubling frames, and the

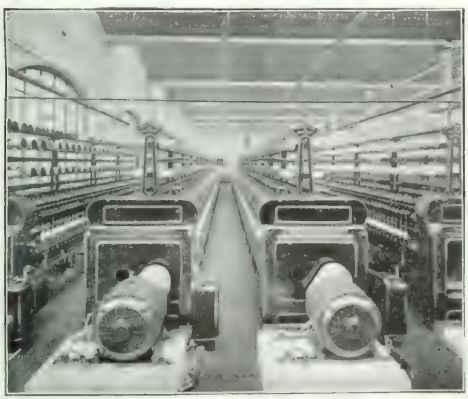


Fig. 5. A View down the Frames.

illumination thus afforded has, we hear, been entirely satisfactory. The installation has now been running nearly a year, and, although there is naturally considerable vibration, only one lamp has been broken, and that through being dropped on the floor. The sheets of coloured paper seen over the lamps are in no way connected with the illumination of the frames, but are due to the requirements of the Halifax Corporation for restricted lighting under war conditions.

We understand from Messrs. Thornton's that the installation has given every satisfaction, and that they are convinced of the efficiency of individual electric drive for doubling frames.

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NEWCASTLE—
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LEEDS—
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THE ELECTRIC HOME AT THE PANAMA EXHIBITION.

The importance of the electric service in the home is becoming more and more understood in the United States of America, a fact which may be attributed to the persistent publicity work undertaken by the manufacturing and central station elements in the country. Quite naturally, therefore, the Panama Pacific International Exposition, to quote its full title, has its electric house, in order still further to keep the domestic electric service in the public mind. Our contemporaries have all dealt more or less fully with this interesting feature of the Palace of Manufactures, and the following particulars are culled from the columns of the Canadian "Electrical News":—

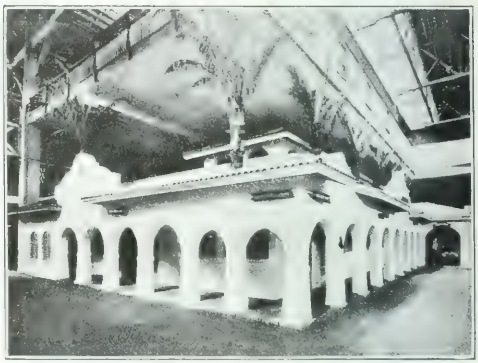
In this model home electricity is made to cook, wash, launder, sweep, dust and perform countless other domestic duties, as well as to heat, light and cool the house. The exhibit, conducted by the General Electric Co., is co-operative to the extent that it comprises a display of devices operated by this company's motors, the devices themselves being the products of other manufacturers, many of whom have no other representation at the Exposition. It is quite in contrast with the usual manufacturer's exhibit, because it is broadly educational, completely operative and required a considerable expense compared with the immediate return that might be expected through the sale of the electrical material exhibited. The idea governing the design of the exhibit was to popularise generally the use of electricity in the home.

The building itself is of Spanish California bungalow design and inexpensive cost, of grey stucco, with a long columned portico on two sides, and is roofed with red tile. The interior consists of a large living room, dining room with breakfast alcove, bedroom, nursery, sewing room, bath, kitchen, refrigerator room and laundry. There [illegible] and a small creamery. The [illegible] and attractively decorated, all in good taste.

The veranda is illuminated with lamps in suitable fixtures; the house number is an electric transparency, and electric bells are operated by transformers. The living room, spacious and appropriately furnished, is lighted with lamps placed in semi-indirect fixtures, the light being diffused and distributed by reflection from [illegible] of the luminous [illegible]. The electric piano player entertains visitors with either classical or popular selections.

Adjoining the living room is the dining room, also suitably furnished. This room is lighted by fixtures which provide direct illumination through tinted shades. It is heated by electricity, and the air is kept constantly stirred and refreshed by a small electric fan. The dining room is equipped with electric heating devices for the preparation of lunches and light refreshments. There is a radiant toaster, an electric coffee pot, a tea samovar, a disc stove for general cooking, a uni-set, a chafing dish for preparing hot soups or desserts, and an electric grill for broiling, toasting, preparing eggs, &c. If desired, a substantial meal can be cooked on the dining-room table. Another electrical feature is the warming cupboard at the entrance to the butler's pantry, where the food is kept hot between courses. To the right of the dining room is the breakfast alcove, cosily arranged and also equipped for "table cooking." Between the dining room and the kitchen is the butler's pantry. In it is installed a combination butler's sink and dish-washer for cleaning the light and valued wares. On a shelf there is a disc stove for making dressing and sauces, and a small electrically-driven buffer for polishing nickel and silver pieces. On the wall is the annunciator of the door bell system, which signals information to the maid or butler.

In the kitchen, which is the workshop of every home, electricity finds its greatest field of usefulness. An electric range, equipped with hot plates, broiler and ovens, is ready to cook the largest family dinner. A constant supply of hot water is ensured by an electric water heater attached to the usual kitchen water tank. The unpleasant odours of cooking are not noticed, as a household ozonator

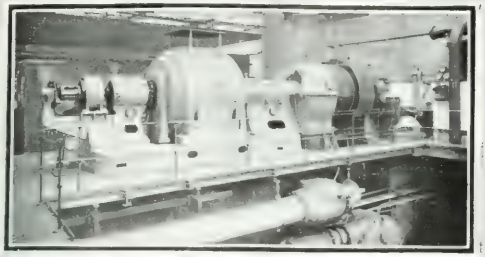
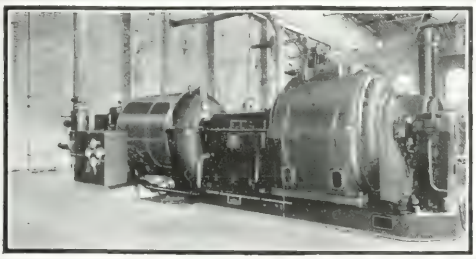
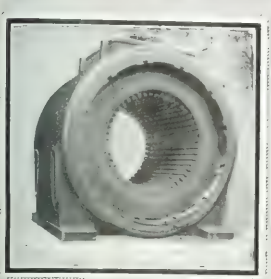
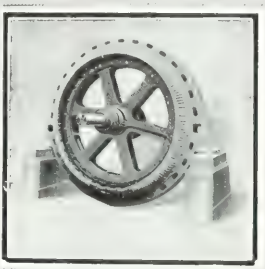


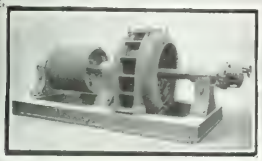
Exterior View of Electric House, Panama Exhibition.

and exhaust fan combine to remove them quickly and keep the air in the kitchen pure and fresh. Should the day be chilly, a portable air heater can be put into service by inserting a small wall plug. A new device, which does away with dirty and impure ice, is the electrically lighted and cooled refrigerator, where small cubes of ice also may be obtained. There is also an electrically-driven ice cream freezer, if home-made ices and creams are desired. A connection with the inter-house phone for saving steps is the final kitchen convenience.

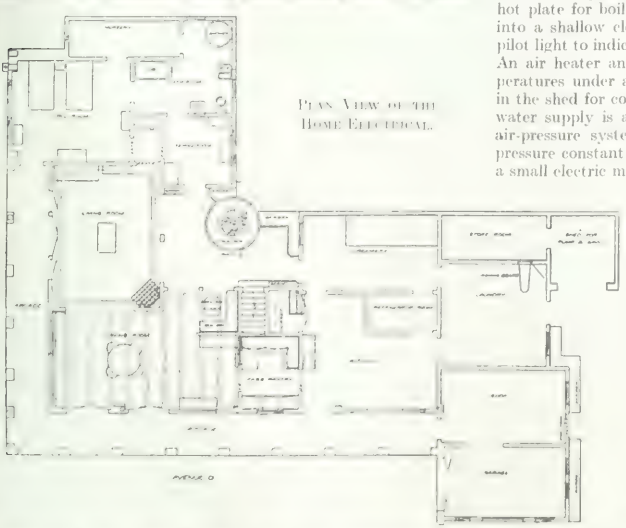
The bedroom contains many electrical conveniences and articles for the toilet, including an electric massage vibrator, electric curling iron, hair dryer and boudoir lamps. There is a heating pad to take the place of the old-time hot water bag, and a small electric water heater in case of sickness. The bedroom is heated by electricity in chilly weather and cooled with an electric fan when the nights are too warm. There is a connection for the vacuum cleaner. The room is also provided with a telephone connection to all parts of the house to save unnecessary steps. Most interesting of all the electrical appliances in the bedroom is the burglar switch, which when needed lights every lamp in the house. Near the bedroom is the nursery, with its electric toys and an electrical device at the window to keep the room supplied with fresh air without draughts. The nursery is heated by electricity, and there is an electric nursery outfit for preparing medicine, food, &c., in case of sickness. An electric heating pad is also provided to warm up cold hands and toes.

Every housewife visiting the "Home Electrical" takes great interest in the sewing room, with its electric appliances for sewing, mending and dressmaking. The sewing machine is operated by an electric motor controlled by the foot treadle. A 3 lb. and a 6 lb. electric [illegible] are located on a convenient board, and a small portable




VICKERS Limited


RIVER DON WORKS, SHEFFIELD

ELECTRICAL EQUIPMENT
of every description


acuum cleaner is used to pick up threads and scraps of cloth without effort. A connection to the inter-house phone saves many steps in ending to various household duties during sewing hours. A small



Plan View of the Home Electrical.

air heater and a fan keep the room warm and comfortable at all seasons.

The home is equipped with a complete electric laundry. There is a quiet-running washing machine and an electric mangle, which may be entrusted with delicate pieces; 3, 6, 8 and 12 lb. irons for any ironing and pressing which may need to be done, and a double 8 in. hot plate for boiling the clothes. A collapsible ironing board folds into a shallow closet, and the flat-iron switch is equipped with a pilot light to indicate whether or not the current has been turned off. An air heater and exhaust fan provide comfortable working temperatures under all weather conditions. Provision has been made in the shed for constant water pressure all over the house when the water supply is a well or spring. Here is installed an automatic air-pressure system connected to the water supply, keeping the pressure constant at any desired point. The air pump is driven by a small electric motor, controlled by a pressure switch.

Nearly every home has a workshop where the man of the house builds and repairs. This is, perhaps, more true of country places, and it must be remembered that the "Home Electrical" is by no means restricted to city folk. The shop is equipped for any ordinary repair or construction work, with a work bench, bench-type drill press, chipping hammer, electric riveter and grindstone. Then there is a buffing outfit, saw table, bench-type lathe and metal melting pot, all electrically operated; handy little electric soldering irons and an electric glue pot for repairing leaky utensils or broken woodwork. The air heater, of sturdy build and generous capacity, is ready at all times to ensure comfort in the shop.

In the garage is a light electric coupe, which is kept charged automatically by a mercury-arc rectifier. The lighting batteries are charged by a small valuator. A small portable search lamp, which can be operated on any electrically-lighted car, is used for close examination of any part of the car, and a portable electric tyre pump complete the car equipment. Connections are made to the inter-house phone in both garage and

workshop. An air heater is also installed in the garage. Of particular interest to the visitor from rural communities is the dairy. This is equipped with an electrically-driven cream separator, bottle washer and churn. In conjunction with these appliances is an automatic refrigerator and milk cooler, operated by a thermostat to keep the temperature of the cooling chamber at the proper point. More than anything else, the "Home Electrical" emphasises the fact that electricity is readily adaptable to all kinds of domestic service where light, heat and power are required. All these electrical conveniences are inexpensive, and most of them cost no more to use than an electric iron.

NEW HALF-WATT LAMPS.

The installation trade will be especially interested in the announcements made by a number of lamp makers regarding new types and prices of half-watt lamps. The complete range of half-watt lamps now available is set out in Table I. The heavier figures indicate either new types or new prices. It will be noticed that a 200 c.p. high voltage lamp is now available, and this size will probably be in the greatest demand, because there is a wide field of application awaiting it for interior lighting in conjunction with semi-indirect and indirect fittings. The fact that the lamp is only 6¼ in. long cap to pip, and but 3⅞ in. diameter, and, in addition, is provided with a bayonet cap of standard size, will also encourage its extended application for industrial and commercial interior illumination. The 150 watt and 200 watt are new types which will also be found most useful.



New Ediswan Half Watt Lamps.

Table I.

Voltage.	Watts.	Price.
25	**15**	4s. 6d.
	30	5s. 6d.
	60	6s. 6d.
	100	12s. 6d.
50 to 60	**30**	5s. 6d.
	60	6s. 6d.
	100	**12s. 6d.**
	150	**16s. 6d.**
	200	20s. 0d.
	300	25s. 0d.
	500	30s. 0d.
100 to 130	**60**	6s. 6d.
	100	**12s. 6d.**
	150	**16s. 6d.**
	200	20s. 0d.
	300	25s. 0d.
	500	30s. 0d.
	1,000	40s. 0d.
	1,500	50s. 0d.
200 to 260	**100**	12s. 6d
	150	16s. 6d.
	200	20s. 0d.
	300	30s. 0d.
	500	30s. 0d.
	1,000	40s. 0d.
	1,500	50s. 0d.

Turning to the lower voltage ranges, the smallest candle-power lamp now available is the 60 watt size, 100 to 130 volts. In this series of lamps the existing 100 and 150 watt sizes are both reduced in price. The 100 to 130 volt range of lamps also includes an interesting type of projector lamp, in which filaments of the grid pattern, either in a vertical or horizontal plane, are mounted; the former are the standard pattern of filament, and at an extra cost a portion of the bulb opposite to the filament is provided with a



Type of Mazda Half Watt Lamps.

FERRY | FERROZOID

CONSTANTAN | CHRONIC

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:
HENRY WIGGIN & CO., Ltd.,
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:
LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

...vily silvered side, which acts as a reflector and serves to assist ...he concentration of the light in the required direction.

...n the low voltage lamps, new 30 and 60 watt 50 to 60 ...t lamps are now offered, and the prices of the present 100 to 150 ...lt sizes have been reduced. An entirely new series of 25 volt ...mps is introduced for the first time, there being four sizes from ...0 to 18 watts. The railway companies ought gradually to take up ...latter, especially the smaller patterns, for use in the lighting of ...ir ordinary main-line trains, the dynamos for which are operated ...supply at these voltages. By comparison with present metal ...mps, the price is undoubtedly high, but for quantity lots it would be considerably lowered, and the increased economy would in time justify the outlay.

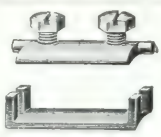
We gather from the literature which is being circulated on the subject that the new types of lamps are made in Holland and are licensed for sale in Great Britain; they are imported under a British Consular certificate that the lamps are of Dutch manufacture throughout.



Type "S" New Wotan Half Watt Lamps.

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.

TRADE MARK.


582 N. Earth Clip


505 L. Earth Clip

Every description of Finger Tips, Connecting Pieces and Segments, made for Tramway Electrical work.

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6323.

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May we send you our Catalogues?

BELLING & CO., Derby Road, Edmonton, LONDON, N.

The lamps are available from the British Thomson-Houston Co. (Mazda), General Electric Co. (Osram Atmos), Siemens Bros. Dynamo Works (Wotans), Edison & Swan Co. (Royal Ediswan), the Sun Electrical Co. and the principal traders and factors. We understand that the lamps can be obtained from stock or within a few days.

Table II.

Voltage.	Overall dimensions. Length. m/m.	Length. in.	Diam. m/m.	Diam. in.	Type of cap.
25	115	4½	64	2½	Bayonet.
	115	4½	64	2½	
	130	5¼	75	3	
	170	6¾	102	4	
50–65	115	4½	64	2½	Bayonet.
	130	5¼	75	3	
	170	6¾	102	4	
	170	6¾	102	4	Edison screw.
	205	8¼	121	4¾	
	270	10⅝	121	4¾	Goliath screw.
	300	11¾	145	5¾	
100–130	130	5¼	75	3	Bayonet.
	170	6¾	102	4	
	170	6¾	102	4	Edison screw.
	205	8¼	121	4¾	
	270	10⅝	121	4¾	
	300	11¾	145	5¾	Goliath screw.
	327	12⅞	168	6⅝	
	350	13¾	198	7¾	
200–255	170	6¾	102	4	Bayonet.
	170	6¾	102	4	Edison screw.
	205	8¼	121	4¾	
	270	10⅝	121	4¾	
	300	11¾	145	5¾	Goliath screw.
	327	12⅞	168	6⅝	
	350	13¾	198	7¾	

In order to indicate the general utility of the present range of lamps, we give in Table II. their overall dimensions and the type of cap with which they are fitted.

"INSTALLATION NEWS."

The second number of the quarterly edition of the new series of "Installation News" has just reached us. In the editorial column [illegible] is made for the late appearance of the issue, a fact which is explained by the shortage of labour in the various departments of Messrs. Simplex Conduits, who publish this interesting house organ, and [illegible] that a number of their staff and employees are [illegible] the forces. The reading matter of the number has been attrac-

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SWITCHGEAR, TRANSFORMERS, METERS, ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

tively set out, and the articles on the "Correct Illumination of Sh Windows," the "Illumination of Factories," and "Electric Lig Fittings for the Home" should be read with interest by the avera electricity consumer as well as the electrical contractor.

A description is given of the company's new Liverpool and distr show rooms which have recently been entrusted to the care of M E. P. Bennett, formerly a member of the London staff. We gath that these show rooms have been divided into three parts, each which has a definite colour scheme of decoration.

The subject of the design and construction and general utility American "socket hole" table cooking and heating utensils is d cussed with some vigour. The article is, in fact, a reply to certa criticisms levelled by our contemporary the "Electrical Times" British designs of subsidiary electric heating and cooking appa tus as far back as Feb. 25. The last paragraph of this article is some interest and we quote it in full :—

"Our critic goes out of his way to state that it is only quite recent that the English manufacturers have troubled to fit replaceal elements at all. This statement is grossly unfair. From the co mencement of the manufacture of such goods to the present day, would state that, taking cooking and heating apparatus as a who the English makers have had, and still have, more replaceal elements than the American. Flat irons have practically alwa had replaceable elements in both countries, but anyone who has h to repair an American water boiler or hotplate, and compared it wi any good English make, will quite realise the humour of the innocen of our critic. We wonder whether the 'Electrical Times' expe has ever tried to take to pieces and fit a new element to an Americ toaster, soldering iron or immersion heater. Ingeniously co structed certainly, liable to break down just as certainly, repaira by a novice—certainly not. No sane manufacturer objects to a f competition or reasonable criticism of his wares, but when th competition descends to the clap-trap of eternal guarantees, a criticism, to mere abuse of one's own countrymen, a few words protest may be permitted."

The "Selling of the Brilliant Vacuum Cleaner" and "Remarks Random" complete the text matter of the issue. We are asked state that copies of this interesting little publication will be forward gratis on request to the company at Garrison-lane, Birmingham.

HOLIDAYS!

The Great Central Railway Co. have just issued their new A.B. Guide to health and holiday resorts. Within an attractive cover included a description of the various resorts, and interesting inform tion is given regarding climatic advantages, bathing facilities, spor and entertainments, also a list of hotels, boarding houses and count lodgings, schools, &c. The book has been entirely re-written, is w illustrated, and any of our readers contemplating a short or lo holiday, either at the seaside or in the country, should obtain a co which will be sent free on application to the Great Central Publici Department, 216, Marylebone road, London, N.W.

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INIGO JONES & CO.,
Tudor Slate Works,
GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
Manufacturers of every description of
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Masons, Tunners and Enamellers.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, July 9, 1915.

THE ROUND TABLE.

EVENT OF THE WEEK. An electrical manufacturer in receipt of orders for munitions is asked to make round holes accurate to three places of decimals!

* * * *

After the exposure of Germany's gruesome methods of frightfulness, how will it be possible to use anything but electric lighting in the peace celebrations?

* * * *

We are breathlessly awaiting the news that Mr. W. P. Ertnall has "done his bit" in the war either in his Paragon electric submarine or his ditto ditto aeroplane.



COMPARISON IN ROTUNDITY.—Mr. G. Pepys Cockle and Wickham Cheek by Jowl—Cockle's Incomparable Pickles.

We gather from a pamphlet just issued by James Spicer & Sons, the famous paper makers, that they are introducing a new waterproof fibre. The gamut of its possibilities is most extensive, as the following paragraphs taken from the pamphlet show:—

"Our "Economic" was prepared [illegible] for the manufacture and supply of 60,000 pairs of trousers for the War Office. These were not ordered until many months after the [illegible] and during two months, both before and after [illegible] many alterations effected in shape, pattern and general quality.

Cablemakers, who usually treat the paper they use with their own solution, have in this article a material capable of standing a high voltage strain, and at any rate [illegible] would find it valuable.

The association of trenches, waders and cables is not at all inept.

The Tramways and Light Railways Association Congress, held to-day, includes three Papers to be read during the course of the morning. Fortunately the members have the option of doing what they please in the afternoon, or it is optional that they dine together in the evening. Doubtless they will select the latter.



CA VA SANS DIRE, MADEMOISELLE!

With apologies to the British Commercial Gas Association.

* * * *

THIRTY-SEVEN YEARS AGO.

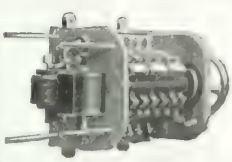
[From THE ELECTRICIAN (Second Series), July 20, 1878.]

THE ELECTRIC LIGHT. It is somewhat over two hundred years since the first public lantern was put up in Paris—a lantern enclosing a candle. This was in 1668. Louis XIV. was so pleased with this innovation that he ordered a medal to be struck, with the legend *Securitas mittor*. In our days the dazzling spectacle offered by the Avenue de l'Opera is that which most excites the admiration of strangers. The application of the electric light is in Paris daily extending. Many large workshops and other commercial establishments have adopted it, and it is to be found at the termini of several of the railways. Besides the Avenue de l'Opéra, the Place de l'Opéra, a portion of the terrace by the banks of the river at the Tuileries Gardens, the front of the old Chamber of Deputies, and the Place de l'Etoile, are illuminated by the electric light. Yet in London there is not one such light to be seen!

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. E. R. Hill (Reading).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
——— (West Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).

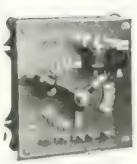
No. 41. Standard Motor-proof Starting Switch for Squirrel Cage 3-phase Motors. Robust construction, fitted with No-volt and Overload Automatic release. Handwheel rotates in one direction only during starting.



'IGRANIC'

STARTERS FOR A.C. MOTORS.

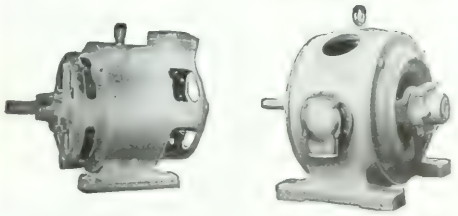
IGRANIC ELECTRIC CO., LTD.,
147, Queen Victoria St., London.



Rotor Starting Switch for 3-phase Slip Ring Motor. Has Automatic No-volt or Overload and No-volt Release. Renewable Contacts. Laminated Contact Brushes. All parts are interchangeable and the switch is very robust, without any of the faults of earlier rotor starters.

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STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for

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GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood
SHEFFIELD—22, High St. [Bldgs.
SOUTHAMPTON—46, High Street.

Branches in Principal Towns Abroad.

PRESSURE CONTROLLED SPEED REGULATORS.

The type of controller illustrated and described in pamphlet No. 628 is designed for use in connection with electric motors driving boiler-draught fans, boiler-feed pumps, gas-pressure blowers, hydraulic elevator pumps, &c. For mechanical draught systems the controller is arranged to adjust the speed of the motor and the blower driven by it to the number of revolutions per minute necessary to furnish the amount of draught required for a given demand on the boiler. So long as the steam pressure is constant the speed of the motor is not changed, but any variation in pressure above or below that for which the controller is adjusted results in a decrease or increase of motor speed, the draught being thus automatically regulated so as to maintain a practically constant boiler pressure.

When used in connection with a direct-current motor the controlling equipment may be designed to reduce the speed of the motor below its normal rated speed by inserting resistance in the armature circuit, or to raise the motor speed above normal by field weakening, or by a combination of these two methods, to provide for any percentage of speed variation within the limits of standard practice for motor speed regulation.

Alternating-current regulators are suitable for use with polyphase or slip-ring motors and with single-phase commutator type self-starting motors. When used with a polyphase slip-ring motor it takes the form illustrated in Fig. 1, in which speed regulation is obtained by inserting resistance in the rotor circuit, and any desired reduction in speed may be obtained. A magnetically operated double-pole switch is installed in the primary circuit, and this operates to open the stator circuit in two phases, and so stop the motor in case the pressure rises too high. When used with a single-phase commutator type self-starting motor a magnetically operated switch is not essential, but may be provided if desired.

The complete controlling equipment consists of two parts—viz., a rheostatic controller (which, as already stated, may operate by means of series resistance, or field resistance, or both), and a hydraulic cylinder whose piston controls the movement of the rheostat contact lever. The admission and exhaust port valves of the hydraulic cylinder are in turn controlled by the movement of a pressure-actuated diaphragm, one side of which is subjected to the steam, [illegible] pressure. The normal pressure on the steam side of the diaphragm is balanced by a weighted lever bearing upo[n] the top of the diaphragm in such manner that this lever will ri[se] or fall as the pressure rises above or falls below the normal pressu[re] for which the lever is counter-balanced. This up and down mov[e]ment of the lever operates a pilot valve controlling the admission [of] water to the hydraulic cylinder, and, due to this pressure, the pist[on] of the cylinder is raised and lowered, operating in turn the rheost[at] contact lever.

In the diagram (Fig. 2) it is assumed that the pressure is low an[d] the weight lever is pressing the regulator diaphragm down, and [the]

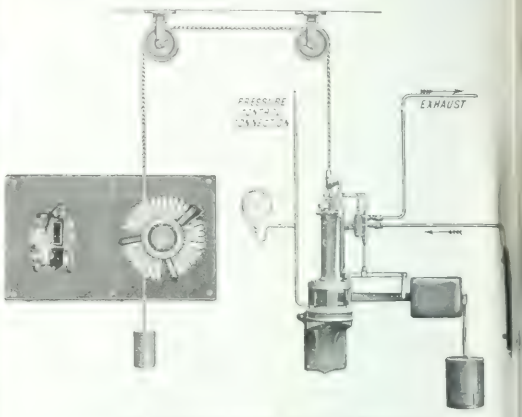


FIG. 1.—THREE-PHASE MOTOR REGULATOR.

same time depressing the pilot valve stem and floating lev[er] admitting water to the upper end of the cylinder, the piston rod which is shown in its lowest position. The contact lever of t[he] regulating rheostat is in the position it always assumes when th[e] pressure is low—namely, the maximum speed position—in which [all] armature resistance is out of circuit and (if field control is employe[d] all field weakening resistance in circuit.

Assume that the motor is running at maximum speed with weakene[d] field and all armature resistance out of circuit. The pressure w[ill] gradually rise owing to the high motor speed, until it reaches a poi[nt] at which the pressure is sufficient to lift the weight lever. This

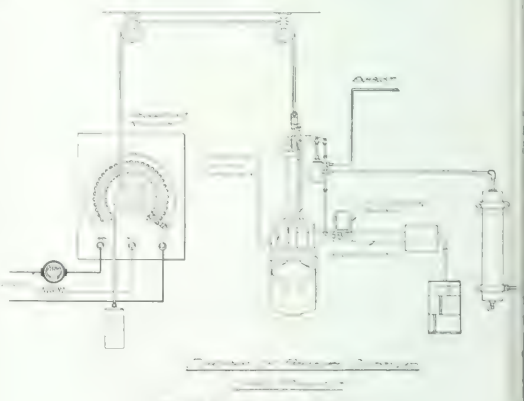


FIG. 2.—DC. MOTOR DIAGRAM.

turn will lift the pilot valve stem and floating lever, opening th[e] valves and admitting water to the cylinder through a differen[t] channel, the water being now conducted to the lower end of th[e] cylinder, so that its pressure is exerted to force the piston out of th[e] cylinder, this in turn moving the lever of the regulating rheostat so that it first cuts the field resistance step by step, bringing the motor down to normal speed and then (if the pressure is still above normal) cuts in the armature resistance step by step, decreasing the speed of the motor to the minimum. Should the pressure fall the series of operations just described is reversed. The diaphragm

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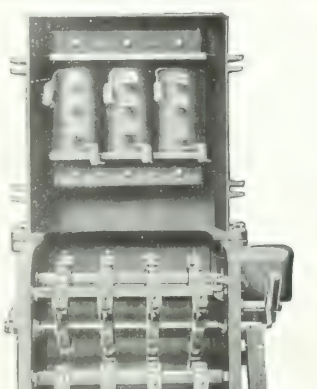
Telephone: 5223 VICTORIA. Telegrams: "GABIONAGE VIC LONDON."

ks, permitting the weight [illegible] to move downwards, and so turn ...ws down the inlet valve [illegible] lever. When [illegible] ...mitted to the upper end of [illegible] ...wing the contact lever of the regulating rheostat over the segments ...til the motor speed is again increased to maximum. Copies of ... pamphlet can be obtained from the [illegible] ...toriastreet, London.

DRUM TYPE CONTROL GEAR FOR A.C. MOTORS.

It is worthy of note that [illegible] ...nufacturers of motor control [illegible] ...sign for starting gear for squirrel-cage and slip-ring motors. The ...mer were usually of the double-throw knife switch pattern, while ...e latter have usually been of the face-plate type, similar to direct-...rrent starting switches. The causes for this dissimilarity are ...obably that the squirrel-cage motor was first introduced and used ... America, and for some years was objected to by English supply ...thorities owing to the large current taken during starting. Con-...quently, for some years the [illegible] ...untry, and the type of starting gear adopted for such motors ...llowed the lines of direct-current starting switches. When the ...uirrel-cage motor was finally taken up in this country a similar ...pe of starting gear was used to that which had been adopted in the ...nited States.

This use of two different types of starting gear presents certain ...sadvantages, as it is seldom that squirrel-cage or slip-ring motors ...n be exclusively used in any large industrial electric power installa-...on, such as a colliery [illegible] ...ctric shop. In such cases [illegible] ...d stopping of the machines [illegible] ...erators, and only a small electrical staff is employed for main-...ance purposes. The fact that two entirely different types of ...rting gear are used is likely to confuse these operators, and, in ...ddition, means the duplication of spare parts.



Type [illegible] Detail View of Drum Controller and Auto-transformer.

The Electrical Apparatus Co. inform us that they have decided to adopt a standard in motor control gear which could be used for any type of alternating-current polyphase induction motor. After

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careful consideration, they have adopted a drum type of switch as being most suitable for effecting the control required; in addition, it has been proved one of the most suitable for heavy industrial service. The design of the switch adopted is shown in Fig. 1; in Fig. 2 are depicted the details of the design and construction of the standard contact finger employed in all patterns of this gear. With this system the starters and controllers for both slip-ring and squirrel-cage motors are similar in appearance and starting is performed in the same manner, the action of starting up being a straightforward movement of the handle, with a compulsory pause at the starting position. The switch contacts will be interchangeable throughout the system for a given capacity of switch, and thus the necessary stock of spares would be reduced.

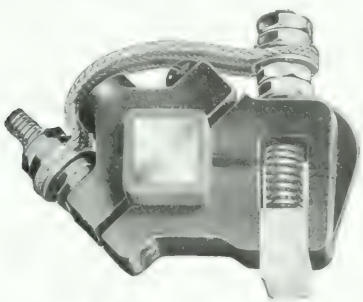


Fig. 2. Details of Contact Finger.

The starters can be supplied either non-automatic or with fuses, or, to meet the requirements of more recent practice, they can be fitted with no-voltage and overload release. (Fig. 3.) The construction consists of clamping the current-carrying parts on to mica-insulated steel bars; thus insulation failures are limited, and the starting gear is fireproof and will resist rough treatment. The gear is made in two types, and from a new set of leaflets recently issued by the company we give particulars of a number of the latter. It is stated that the re-design has resulted in better standardisation of parts, &c., which enable quicker deliveries to be made.

The two principal types are: (1) Air-break totally-enclosed starters; (2) oil-immersed totally-enclosed starters. (Fig. 4.)

The air-break starters are suitable for general industrial requirements; they are completely enclosed and fairly weatherproof. The range of totally-enclosed gear covers a small air-break switch arranged either to give star delta or series parallel starting connections, or suitable for switching small squirrel-cage motors direct on to the line. There is also a range of totally-enclosed air-break autotransformer (compensator) starters for motors up to 100 H.P. on 650 volts. This range provides control gear for any moderate size squirrel-cage motor, and is suitable for textile mill motors driving [illegible]. We understand that the company [illegible] for [illegible] operating [illegible].

[illegible] the transformer tappings as [illegible] and general inspection purposes is a good feature of the design of these starters. They can, if necessary, be fitted with no-volt and overload automatic releas trips with fuses, ammeters, voltmeters, &c. This makes it possibl for a complete self-contained motor control unit to be provided com bining everything necessary for efficient motor control. Fo instance, a control unit can be made up consisting of an auto transformer starter with no-volt and overload release or fuses, th starting switch being in the centre box, the transformer in the lowe box and the overload release in the upper box; an ammeter can b attached to such a unit if required, and would be of the pedest

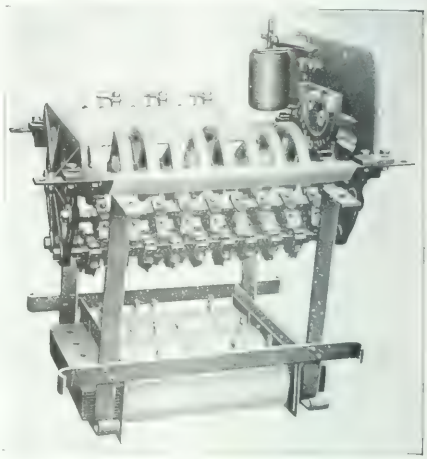


Fig. 3. Floor Pattern Auto-starter.

type, fitted to the top of the gear. The whole unit would then suitable for attaching to a wall, but it can be mounted on pedest suitable for standing upon the floor; the starters can be supplie with plain bushed cable holes, with holes screwed for conduit with cable sealing boxes where multicore cable is to be used.

In the oil-immersed gear the range covered is much greater. includes star delta starters, series parallel starters, or non-automat oil switches up to 125 amperes capacity at 650 volts, or auto-tran

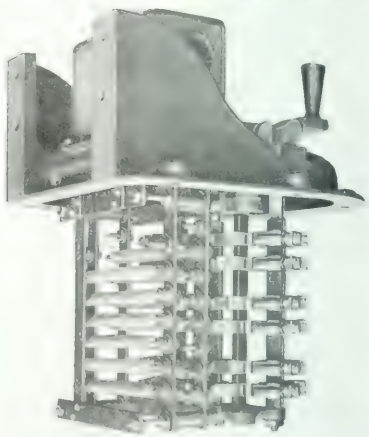


Fig. 4. Oil-immersed Drum Controller with Starting Resistanc

former starters up to 200 H.P. on 3,500 volts; also all types starters for slip-ring motors up to 100 H.P. It is thus possible for control equipment to be supplied for practically every duty and an type of induction motor, especially if used in combination with th high-tension automatic oil switches made by the company.

The range of oil-immersed gear being so much larger than that fo totally-enclosed air-break gear may occasion some surprise. Th reason is that squirrel-cage motors are now mostly used for high



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duties, where machines have to be accelerated infrequently or against light load, where constant starting and stopping is the duty slip-ring motors are usually installed. It follows that slip-ring motor starters have to withstand heavier duties than the starting gear for squirrel-cage motors, and it is the opinion of the company that it is preferable to have all starters with slip-ring motors oil immersed, as such switches have a larger starting capacity, and the wear and tear on the starter contacts is reduced if these are immersed in oil. The similarity of the internal construction is a noticeable feature of these gears.

From the foregoing it may be supposed that to obtain full advantage of the E.A.C. systems it is necessary to instal oil-immersed gear



Fig. 5.—Overhead Relay.

throughout. This, however, is not the case, as the contacts and detailed parts are interchangeable for a given capacity of switch between totally-enclosed air-break switches and oil-immersed switches. The oil-immersed switches can be fitted with similar automatic features, fuses or instruments, to the air-break switches, and cable outlets can be arranged in the same manner. A further advantage is that the former arrangement of mounting the various details of control gear on an angle iron panel is dispensed with, and the control gear is a complete self-contained ironclad unit.

The makers wish it to be understood that control equipments for slip-ring motors are inexpensive, as, in spite of the fact that the slip-ring motor starters are always oil immersed, an efficient motor control equipment for these motors can, they state, be supplied at a price competitive with the faceplate type gear. For large motors and high-tension machines the starters described above can be combined with drum-type oil switches.

The lists referred to above are now off the press, and can be obtained from the Electrical Apparatus Co., Vauxhall, London, S.E.

EDISWAN ELECTRIC SERVICE.

No. 2 of the first volume of this interesting Ediswan house organ is just off the press. The opening article deals with the extensions recently made by the company at their Ponders End works for dealing with the enormously increased demand for Royal Ediswan metal filament lamps. The merits of the Ediswan fan and particularly its use in conjunction with a dimmer switch for speed control are also pointed out. An illustration is given of an interesting trophy from the firing line sent in by Pte. H. Lacy and comprising a motor car headlight which was riddled with shot holes at the front. Needless to say the Ediswan lamp burning in the headlight survived this leaden ordeal. There is a useful article on artistic fittings, illustrated with bracket, pendant and floor standard types and the concluding page is devoted to the use of the Ediswan Imperial vacuum cleaner. The brochure is tastefully written and may with advantage be distributed amongst electricity consumers. Copies of this will be forwarded on request.

NAVAL COOKING EQUIPMENT.

Some 18 months ago the Falkirk Iron Co. established a special department for the production of electric cooking and heating apparatus to meet the demand within the last few years for electric cooking apparatus, both for domestic use and commercial use in restaurants, kitchens of public and private institutions. An equipment recently approved by Provost Hogg and members of the Falkirk Town Council is unique of its kind, being specially designed for catering for the needs of workpeople at Messrs. Armstrong's [illegible]. Some eight of these [illegible] equipments were installed in their Elswick and Walker shipyards, and we gather that they proved highly successful; hence a further order for dealing

with the catering needs of upwards of a thousand persons for the new naval equipment yard.

Amongst the pieces might be mentioned roasting oven, capable of taking 4 cwt. to 5 cwt. of meat at a charge; combination oven to cook 2 cwt. to 3 cwt. of potatoes, or the equivalent, at a charge; treble oven roasting and baking ranges, with boiling and simmering tables; electric grillers and toasters; some eight 10 to 12 gallon boiling pans for hot water, for tea making, soups, &c.; hot cupboards and carving tables for plate warming.

A demonstration was given showing the simplicity of operation for roasting, toasting, steaming, &c. It is estimated that the consumption of energy will be approximately ½ unit per person per day, and that with the saving of meat (there being less shrinkage, about 10 per cent. only as compared with 25 to 33⅓ per cent. in gas or coal ovens) will pay for all current consumed in cooking, and leave a large balance over to go towards the cost of installation of the apparatus.

Apart from this great advantage of the saving in butcher's bill may be mentioned a few of the other essential advantages with electric cooking: Hygienic working conditions, cleanliness and coolness in the kitchen, freedom from fire risk, small expenditure on the upkeep of cooking utensils, certainty of obtaining good results every time. This last advantage is caused by the fact that the heating value of electrical energy never varies; there are the same number of heat units in a unit of electricity at all times; absence of products of combustion. Electricity takes nothing from the air, neither does it add anything to it in the heating process. Better temperature regulation is afforded. There are no poisonous fumes, neither is there any soot, dirt or ashes.

The Falkirk Iron Co. anticipates that from this small demonstration members of the Council will come to realise the many advantages of electricity for cooking, and will employ it for its institutions.

GLASSHOUSE POT MAKING AT EDISWAN WORKS.

The adjoining illustrations should help to give some impression of an interesting industry which is little known to electrical trades, but is carried on by the Edison & Swan Co. at their Ponders End works. This industry is "glasshouse pot making." The pots are



Making "Vitrite" Lamp Caps.

made from a special fire-clay, and are used for melting the glass for bulbs and tubes in connection with the manufacture of "Royal Ediswan" lamps.

Owing to the limited space available only a few pots can be kept in the melting or furnace pots. The pots when filled hold 120 pots of a size suitable for the glass furnaces of the Edison & Swan Company. The clay of which the pots are made comes from the Stourbridge district, and is the finest mixture which can be procured for this class of work. It is delivered to the works in bags and dry state. It is taken in hand by skilled workers, who add the requisite amount of water, after which the clay is allowed to stand by for a time, when it is again taken in hand and tempered, being



A Number of Glasshouse Pots after Throwing on the Wheel.

trampled and trod by skilled men with their bare feet (see illustration) until it is in a sufficiently plastic state for the pot maker to start operations.

These pots require to be made at least 12 months before being used. The method adopted is to dry them to a state of hardness to allow of their being moved to a room where more direct fire heat is allowed to play on them until they are sufficiently hard or dried



Unloading Clay for Glasshouse Pot Making.

off, when they are transferred to the pot arch. They require at least 14 days to harden in order to temper them before being transferred to the furnace. They are then ready to be charged with the ingredients for the manufacture of the glass required for electrical work.

An illustration is also given of "Vitrite" lamp cap making at the Ediswan works. This picture should help to convince those who are unable yet to realise that "Royal Ediswan" lamps are entirely manufactured at Ponders End works.

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BOILERS AND BOILING PANS.

The issue of particulars of electric boilers and boiling pans by the Jackson Electric Stove Co. indicates that this type of culinary apparatus is not being neglected at the present time. We gather from Card No. 11 that the Jackson taped boiler has been designed for attachment to existing electric cookers, and also for use adjacent to



JACKSON BOILING PAN. JACKSON BOILER.

hygienic means to provide a constant quantity of hot or boiling water at short notice. The makers claim that this boiler will save its cost in a short period of time. Two pints of boiling water can be drawn from this boiler in four minutes; or a gallon of hot water in the same time. It will be appreciated that with a boiler of this type water can be supplied for filling up saucepans with warm water previous to its being placed on boiling plates for the cooking of vegetables, &c. The boiler is made in black iron with tinned copper interior, and is filled with ball valve for connection to the water main; a brass draw off tap is fitted. The dimensions are 17 in. high, 6½ in. wide and 10½ in. projection; to this latter must be added 2½ in. for the terminal box at the back, and 3 in. for the tap at the front of the boiler.

Some interesting particulars are also given in Card No. 12 issued by the same company on the subject of boiling pans.

These afford an economical way of cooking large quantities of vegetables, stews, &c., and the larger sizes are useful for boiling joints. They are strongly constructed in polished copper, heavily tinned inside, and have close rivetted bottoms, so that even if the pans are inadvertently left empty with current on no leak develops. The taps are provided with cleaning plugs and fitted with strainers. Nos. 180/2 are arranged for 3-heat control, giving full, half and quarter heat. Nos. 183/4 are arranged for 7-heat control, so that by means of one series-parallel and one on-and-off switch the following ranges in watts are given: No. 183: 3,000, 2,300, 1,950, 1,600, 1,400, 700, 350. No. 184: 6,000, 4,750, 4,125, 3,500, 2,500, 1,250, 625. These arrangements allow of fine regulation of heat, on all sizes, for stewing and similar purposes. The steamers are about 6 in. deep (15 cm.) and are arranged to fit the boiling pans; they are of substantial construction and form a valuable addition to the pans.

The whole apparatus is of sound construction, based on modern cookery practice; it will stand hard wear and is most useful in large kitchens.

The table below gives the principal dimensions and loadings.

Cat. No.	Approximate. Capacity.		Height.		Diameter.		Weight. Pans.		Steamers.		Max. loading.
	Gals.	Litres.	Ins.	Cms.	Ins.	Cms.	lbs.	kgs.	lbs.	kgs.	Watts
180	2	9·0	10½	27·0	12¾	31·7	16½	7·6	3¼	1·5	1,200
181	3	13·5	12	30·5	13½	34·3	21	9·5	4	1·8	1,700
182	4	18·0	12¾	32·5	15½	39·4	25	11·4	4¾	2·2	2,200
183	6	27·0	14	35·5	17	43·0	30	13·6	5¾	2·6	3,000
184	12	54·0	15	38·0	21	53·2	35	16·0	7¼	3·5	6,000

The knobs on lids add about 3 in. (7·5 cm.) to above heights: the taps project about 4½ in. (11·5 cm.) and the handles from 1½ in. to 3 in. each (4 cm. to 7·5 cm.) beyond diameters given above.

BENJAMIN POSTER STAMPS.

The value of an attractive "sticker" stamp on correspondence, invoices, circulars, &c., is now fairly conclusively proved, and when such aids to business are available from enterprising firms we think that contractors and electrical dealers should take advantage of them. The adjoining illustration is a facsimile reproduction of one of three "stickers" which Benjamin Electric Ltd., Rosebery-avenue, E.C., are sending out to the electrical trade. They call attention in a striking manner to the importance of paying attention to modern illumination material; and particularly to the Benjamin brand thereof.



We understand that these "stickers" are available from the company, and will be supplied to electrical contractors and station engineers who are interested in the pushing of modern reflectors and devices for the economical and efficient utilisation of electric light units, in industrial and commercial circles.

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THE ROUND TABLE.

EVENT OF THE WEEK.—Mr. Justice Joyce in "an atmosphere of steam and hydrogen."

* * * *

The very latest in illuminations is "LIGHT AS A FOOT.": vide Mazda lamp advert.

* * * *



This type of swit hboard attendant portrayed in an American dvertisement is now fast disappearing. Any station engineer who is keeping specimens of this class should hand them over to the nearest recruiting sergeant (but hasn't he got "some" ums and thews!)

* * * *

A correspondent says that his company recently had the opportunity of quoting an eminent Irish M.P., who is a K.C., for cooking and heating apparatus, but the gentleman considered that the prices were very much on the high side, and in view of this he stated that he is proposing to utilise, for the cater inquired for, his present boiler with wire wound round it o heat the water!

* * * *

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* * * *

Matter set up in type is usually pulled "for reading," and sometimes the "comp." is guilty of unconscious humour in the unread proof. The following is taken from the first proof of the evidence of one of the witnesses in the Pope *v.* Osram Lamp case, and is distinctly funny:—

"From his experience as a practical lamp maker, he said that there are not enough instructions in the specification to enable a filament maker to make filaments."

The motto of the T.L.A. now is "Gott strafe the glass blowers." (Why? Because they can't, of course!)

* * * *

By the end of 1915 there will be 15,000 half-watt street lamps in Chicago; and in London we shall still be groping in "half-darkness."

* * * *

We hear that the Volunteer Corps who wear the G.R. armlets have been dubbed by electrical men as the "Gaspipe Rifles." Not bad considering the dummy guns which they still are compelled to carry.

* * * *

Mr. A. V. Mason says:—

"Whistles given to motormen are much more effective in clearing heavy drays and steam lorries off the track than the ordinary foot bell. The vernacular also helps some."

Our motoring readers with an unlimited vocabulary much prefer the vernacular.

* * * *

A temporary service was recently run by the Birmingham Corporation Electricity Department inside a fence, the service including a 50-ampere 3-pole fuse and a meter board, with a wooden box as a covering. Two or three days ago one of the Birmingham Police conscables was walking down the street and saw a watch chain lying on the pavement. In the course of his duty, he picked up the watch chain and got no end of a shock. Subsequent investigation showed that the watch chain was fastened to a piece of insulated wire which was passed through a hole in the fence and attached to the live end of the service, the protecting wood box having been destroyed to give access to the connections! The constable is to be congratulated on carrying out his duties so successfully.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), July 27, 1878.]

CAPITAL OF CABLE OWNERS.—The capital of the companies (18) owning the cables (62,000 miles) as mentioned in our issue of the 20th inst. amounts to nearly 22 millions sterling. Government capital, which has constructed about 3,000 miles of cable, is not included in this total.

(Vide War Loan contributions 1915!)

TELEGRAPHIC CONNECTION WITH CYPRUS.—Mr. Pender, the son of John Pender, Esq., M.P., is announced to have reached Cyprus, where he intends to make the necessary preparations for connecting the island by means of a submarine cable with the other Mediterranean stations.

* * * *

OUR HOT PLATES.

No. 199 to—

Mr. A. V. Mason (Gen. Man., South Metropolitan Tramways) for his "Bread and Butter Tips" in his "Glimpses into the Obvious," at the T. & L.R.A. Conference.

THE "POINT FIVES."

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SIEMENS

ELECTRIC MOTORS

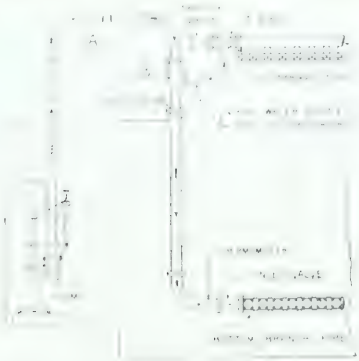


Part of small Motor Shop, Stafford Works.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, VIC, LONDON."
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GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

THE NATIONAL CIRCULATOR.

It is well known that if the feed water be delivered into an economiser at a temperature less than 100° F. a portion of the flue gases in contact with the pipes at this temperature condenses on the external surfaces of the pipes and sets up rapid wasting, involving [illegible] easily pipe renewals. Corrosion due to damp brickwork



[illegible] National Circulator.

[illegible] rapidly when the temperature of the feed [illegible] is low. To check this action [illegible] that the water should enter the economiser at a temperature above 100° F. It is claimed that this object is attained by the "National Circulator," the arrangement of which is shown in the diagram.

The [illegible] is in the feed pipe range "A" between the pump [illegible] pipe "C" connects the circulator to the top branch pipe of the economiser. The action of the circulator automatically draws hot water from the top branch pipe into the cold feed supply, thus raising its temperature and preventing the chilling effect of cold feed water on the economiser pipes. Access to the withdrawable nozzle in the circulator is obtained by removing the bolted cover "B." This cover can be removed, the nozzle withdrawn and replaced, and the joint remade in a few minutes.

The hot-water supply to the circulator should always be taken from the top branch pipe of the economiser. The hot water may be drawn either from the T-piece branch or from any part of the top branch pipe, such as cleaning cap holes or branch. The T-piece may be fixed with its branch in any position best suiting the position of circulator.

The old arrangement of taking a small pipe from the top branch pipe of the economiser to the suction side of the feed pump has frequently proved a failure, owing in some cases to the long distance between the feed pump and the economiser, and also because it depends on the attendant opening and closing a valve daily. This arrangement also increases the steam consumption of the feed pump 40 per cent. to 80 per cent.

We understand that the circulator as illustrated is in successful use, and below are given typical results.

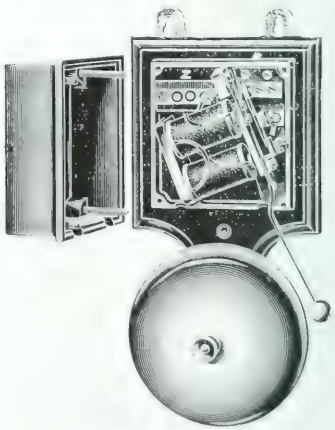
Temperature of feed inlet before fitting circulator.	Temperature of feed inlet after fitting circulator.	Temperature of outlet water before fitting circulator.	Temperature of outlet water after fitting circulator.
95° F.	140° F.	280° F.	280° F.
74° F.	145° F.	234° F.	243° F.
98° F.	125° F.	240° F.	245° F.

It will be seen that in the above cases the use of the circulator has led to the inlet temperature being substantially raised and in most cases with a rise in temperature of the outlet water to the boiler.

Full particulars and prices of this apparatus can be obtained from the National Boiler and General Insurance Co., Manchester, from whose circular on the subject the above description is taken.

ELECTRIC BELLS AND ACCESSORIES.

The modern electric bell requires as much care in its installation as the electric light, and electrical contractors who are disposed to believe that a bell installation can be hurriedly put up should obtain a copy of Section "L" of the General Electric Co.'s main catalogue. The size of this catalogue alone indicates what important pieces of

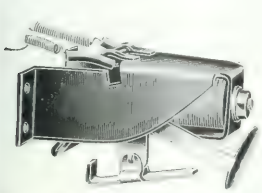


G.E.C. Line Voltage Bell.

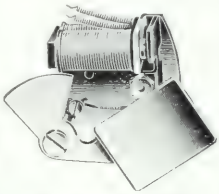
electrical apparatus the bell and its accessories are. The catalogue deals with all types of electric bells, with indicators of the pendulum and mechanical type, also ship and lift patterns, with relays, pushes and pulls, burglar alarms, batteries of every description, wires of all classes, mining tappers, switches, telegraph instruments, galvanometers and lightning conductors. In the bell section there is a considerable variety from which to select. In particular, the company draw attention to the watertight patterns of bells, which are

now available in a considerable number of designs and sizes. The popular pattern is the circular bell, which is offered in one size with 8 in. gong. The specification states that the bobbin is wound with silk-covered wire mounted on a frame carrying the armature, and the contact pillar is provided with a platinoid point and german silver spring, platinoid pointed. The complete movement is secured to the cast-iron base by nuts and bolts. The base is turned and well enamelled, and the bell is provided with a turned and lacquered gong. We illustrate a high voltage bell of the moulded watertight pattern. This is provided with bobbins wound specially to work off the electric light circuit at a pressure between 100 and 250 volts. This bell is made in three sizes, with 6, 12 and 14 in. gongs.

In the indicator section the attention of the trade is directed to a new design of indicator which, as the illustration shows, is fitted with a self-locking movement. The armature, which carries the indicating disc, is not affected by vibration, consequently this pattern of indicator movement can be used on lifts or other moving bodies. We also illustrate a double bobbin mechanical replacement movement, which is mounted on a solid brass base, the electromagnet having best Swedish iron cores and yoke drop made of stout brass controlled by a tension spring. All the carrying pillars are bolted to the base, and no parts are riveted except the plug on to the arm.



New Indicator Movement.



Flag Signal Indicator.

In the signal section interest attaches to the Admiralty pattern Morse lamp, which is of the portable type, and has already proved its value both in the Navy and mercantile marine. It comprises an oblong teak case fitted with a flashing louvre shutter, bayonet joint lamp-holder and sliding reflector, also 12 yds. of weatherproof flexible lead with plug adapter. The lightning conductor section is very complete, and contains particulars of finials, saddles, brackets, earth plates, tubular earths and coronals for roofs and chimneys.

AUTOMATIC LECTURES AT THE PANAMA EXPOSITION.

According to the "Western Electric News," one of the most original of the attractions at the Panama Pacific International Exposition is a model of the canal in miniature arranged in the form of an oval, over which passengers are taken in an endless train of slow-moving electric cars. Opera glasses are provided for studying the model, which is necessarily on a very small scale, as the track has a maximum diameter of only 430 ft. The most novel feature of the exhibit, however, and the most interesting to the engineer, is the means by which a lecture on the section over which the passenger is moving is delivered to him automatically through telephone receivers attached to the seats. As each set of three cars enters any of the zones into which the track is divided a phonograph is started at the central switchboard, which recites through the telephone a descriptive lecture referring to that part of the model. The Western Electric Company supplied the telephone equipment and designed the automatic starting and stopping switchgear, while the phonographs themselves were manufactured by the Thomas A. Edison Company.

The track is divided into 16 zones or districts. One of these zones is idle, so far as telephone communication is concerned, to permit of taking on and discharging passengers. There are 144 cars and the train is subdivided into 48 units of three cars each.

Assume that section or unit No. 1 of the train, consisting of three cars, has been loaded and enters zone B. A contact shoe, located on the first car of this three-car unit, touches a third rail, and instantly closes a relay on the switchboard in the telephone-phonograph central station, which in turn starts the motor of an Edison phonograph of the cylinder type. The phonograph starts instantly, and for one minute lectures into a transmitter mounted above it. The transmitter in turn talks through the telephone attachments at the seats of each of the three cars of the unit. Each telephone attachment consists of two telephone receivers. One transmitter talks into 42 receivers. As long as the phonograph is lecturing each passenger

We are Selfish.

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DEPARTMENT 4

Denzil Works, Neasden, London, N.W.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster General, etc.

receives a lecture on that particular part of the canal covered by his immediate vision.

Phonograph No. 1 will have travelled to the end of its record by the time the train reaches the end of zone B, and by means of an automatic switch is made immediately to return to the beginning of the record and stop, awaiting the first impulse to start the operation over again. As soon as the third car of the No. 1 section clears the beginning of zone B, the first car of No. 2 section enters the zone. The first lecture is then repeated, there being, however, another phonograph and duplicate telephone apparatus for delivering the lecture to the passengers of No. 2 section, this record being three cars behind the record of No. 1 section at its time of starting. Similarly, when the first car of No. 3 section comes into zone B, a third phonograph picks up the record, and at the proper interval of time repeats the first lecture, and by the time the last car of the third section has entered zone B the first car of the first section has entered zone C. Thereupon a fourth phonograph comes into communication with this three-car unit and delivers to the passengers the lecture covering the new zone they are entering.

In furnishing this equipment, the Western Electric Company provided an extra phonograph position and telephone equipment that would take care of any emergencies that might arise in any particular zone. Each unit of four phonographs that is, the three necessary to complete the three unit lectures and the emergency set—is mounted on a reinforced oak board of sufficient length and height to permit of access to the phonograph mechanism and the relays. A total of 15 switchboards of four unit telephone and phonograph outfits, 1,050 telephone sets, and 1,250 special receiver holders and head sets were made up and furnished by the Western Electric Company. The [illegible] and all other automatic equipment and specialities in the telephone circuits were the [illegible] by the company.

EXTRA COPIES OF

ELECTRIC VEHICLE PROGRESS SUPPLEMENT

[illegible]

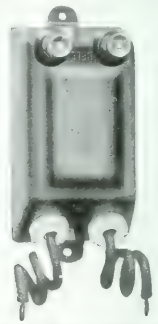
"THE ELECTRICIAN" PRINTING & PUBLISHING COMPANY.

LARGE CAPACITY STOKERS.

The 16-retort Erith-Riley Stoker, as built by Erith's Engineering Co., Ltd.), has, we understand, the largest capacity of any stoker in use. Four of this size are in use in one plant. Its normal capacity is no less than 4 tons of coal hourly, and it has 50 per cent. overload capacity. Each stoker is applied to an undivided furnace of a single water-tube boiler, 25 ft. wide. The capacity of this stoker is equal to that of a battery of eight large Lancashire boilers, occupying a site 100 ft. wide. The use of such large unit boilers is naturally confined to central electricity stations; but the entirely automatic working of the Erith-Riley stoker permits unlimited unit capacity. The stoker is of the inclined underfeed type, with the fires kept continually sliced and the ash continuously discharged by reciprocating tuyères and ash-pushers. The air for combustion is delivered direct to the tuyères by a suitable fan, and both air and fuel automatically respond to load variations. Each stoker consists of a series of standardised and inter-changeable retort-units; four boilers each with 4-retort stoker, or two boilers each with 8-retort stoker, will therefore give identical results to above-mentioned boiler with one 16-retort stoker. For mills, &c., using Lancashire boilers, the Erith stoker is employed, viz., each single-retort unit is applied to each internally-fired furnace; the capacity per retort remains the same and the combustion is equally smokeless and efficient.

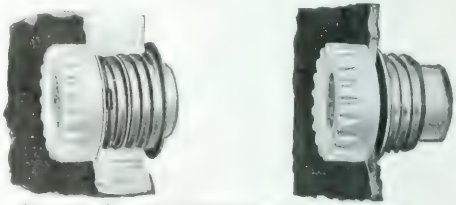
BELL RINGING TRANSFORMERS.

Our attention has been called by the Cameron-Sales Organisation to the "Junior" bell-ringing transformers which they are now putting on the English market. These transformers are of the iron-



JUNIOR BELL TRANSFORMER.

clad type, are fireproof and we understand may be short-circuited indefinitely, without affecting their efficiency. The "Junior" size has a capacity of 16 watts, which is suitable for the operation of any bells up to six bells 3 in. diameter; the outside circuit may also include a number of buzzers, electric locks and door openers, within its maximum capacity. The "Junior" bell transformer measures 5 in. by 2½ in. by 2 in., it weighs 2 lb. and has a maximum output of 16 watts. These are the standard voltages: 100-130, 200-260 at periodicities from 50 to 133 cycles. The standard size is listed at 10s. 6d. subject.



DETAILS OF PORCELAIN BUSHINGS FOR SLATE AND METAL.

The same company has on offer a line of porcelain clamp bushings which are illustrated herewith. The bush itself is made of one piece of high-grade porcelain; it is provided with two threaded metal sleeves one of which is permanently anchored to the porcelain body and the other is used for clamping the bush in position. The bushing and the sleeve are interchangeable; the loose sleeve can be reversed and the bushing can be used on a ½ in. thick wall or less, as the case may be. The illustrations explain this reversible feature.

ZOLAM LAMP

DRAWN WIRE.

BRITISH LABOUR.

BRITISH MATERIAL.



BRITISH CAPITAL.

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Large Stock. Liberal Trade Discounts.

THE IMPERIAL UNITED LAMP CO., Ltd.,
CAXTON HOUSE,
WESTMINSTER, LONDON, S.W.

The bushings is made in the following sizes:

Size.	Diameter. Inside.	Diameter. Outside.	Size.	Diameter. Inside.	Diameter. Outside.
1	$\frac{5}{32}$ in.	$\frac{7}{16}$ in.	4	$\frac{3}{4}$ in.	1 $\frac{1}{16}$ in.
2	$\frac{7}{32}$ in.	$\frac{1}{2}$ in.	5	$\frac{15}{16}$ in.	1 $\frac{5}{16}$ in.
3	$\frac{5}{16}$ in.	1 in.	6	1$\frac{3}{16}$ in.	2$\frac{11}{16}$ in.

Doubtless these standardised bushings will be found of use in electrical apparatus in which the connections need to be brought through metal or slate walls, but must be satisfactorily insulated therefrom. The bushings are offered at reasonable prices, particulars of which will be furnished on application to the company at 9-10, Southampton street, Holborn, London, W.C.

INDIRECT LIGHTING, ST. PHILIP'S CHURCH, RUGBY.

We have called attention from time to time to the successful application of semi-indirect and indirect illumination, and have reproduced many instructive illustrations of such installation Among these have been examples of church and chapel interior types of buildings which are extremely difficult to illuminate in manner which will furnish adequate lighting and at the same tin give comfort to the congregation. As a rule the use of the indire system *per se* is out of the question, and St. Philip's Church, Rugb is, therefore, probably a unique instance of its successful emplo ment. We understand from the B.T.-H. Co., whose "eye-rest system has been installed in this church, that it is the first ca which they have to record of indirect lighting in any church in th country.

The church is a mission church, and the building design has be evolved in an endeavour to use in a plain and straightforward wa such materials as were available. The total length is 100 ft. T



St. Philip's Church, Rugby. Illustration of Baptistery Lighted with Specially Designed Angle "Eye-rest" Fittings.



St. Philip's Church, Rugby. One of the Aisles.



St. Philip's Church, Rugby. General View of Interior.



St. Philip's Church, Rugby. View in the Nave.

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WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

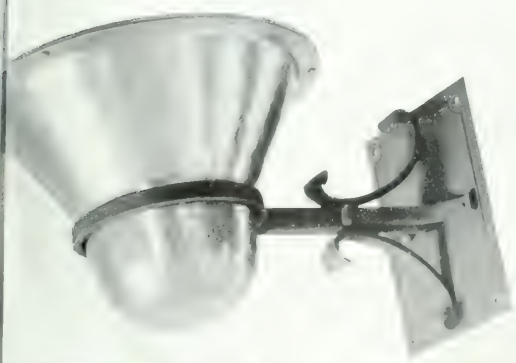
British-Made Resistance Materials

TO:—

MAKERS:
HENRY WIGGIN & CO., Ltd.,
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:
LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

...e is in five bays, each having a width of 24 ft., and the aisle 10 ft. ...e seating capacity of the church is 400. At the west end there is ...mall baptistery, and over it is a gallery for the accommodation of ...e organ and choir. The interior is plastered throughout with a ...gh surface formed with a felt-laced float, and is ceiled with a ...stered barrel carried on the under side of trussed rafters. The ...nstruction material is assisted in the use of the indirect system of



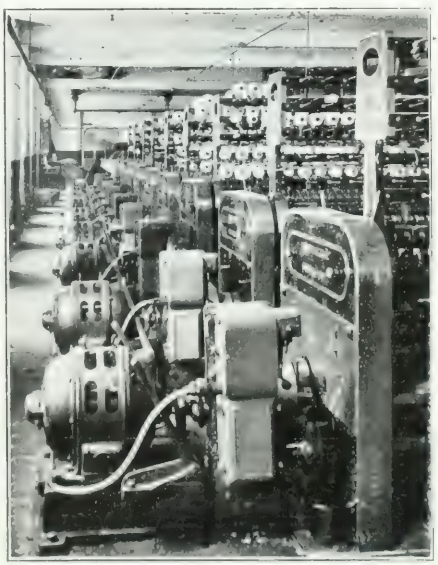
...r. Philip's Church, Rugby. Excelsior Enclosed Lighting Brackets Fitting ... the B...

...ghting. The effect of the lighting scheme is so successful that ...e make no apology for showing a number of illustrations of the ...hurch interior. All the bowl fittings are of simple design, and the ...netal portion is of hand hammered brass. Each fitting contains ...ne or more X-ray reflectors.

The architect for the building, Mr. H. Bulkeley Creswell, F.R.I.B.A., ...f Rugby, designed all the fittings.

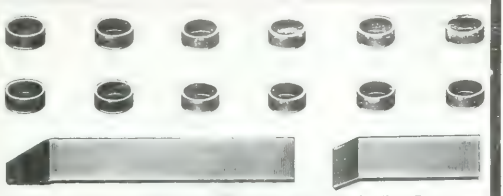
DRUM-TYPE AUTO-TRANSFORMER STARTERS FOR INDUCTION MOTORS.

In our last issue we referred to E.A.C. starters for induction motors. These are uniform in general design with the E.A.C. iron-clad switches and star delta and rotor starters. In every case the



Row of E.A.C. Drum Type Starters in Textile Mill.

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.



Drawn and Pressed Work of every description for Dry Batteries.

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Over 300 Corporation and Electric Supply Authorities have bought our goods for the last 3 years.

We endeavour to turn out strong practical articles for everyday use.

May we send you our Catalogues?

BELLING & CO., Derby Road, Edmonton, LONDON, N.

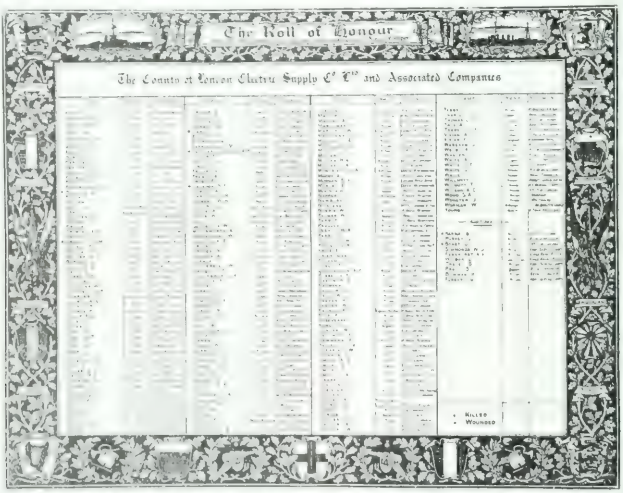
motor is completely [illegible] position so that a separate switch and fuse is not required. The contacts are self-aligning, with coil compression springs that do not carry current. The working parts are mounted on a good insulating material base, all live metal being clamped on to mica-insulated steel bars. The transformers are three-phase, with tappings giving approximately 40, 60 and 75 per cent. of the line voltage, unless otherwise specified. [illegible] tappings are required, a current density of 10 per cent. is made.

The air break form complies with Home Office Rules, and is recommended for use in textile mills and for similar applications (*see* illustration). [illegible] 30 second starts four times in an hour.

numerical form can be rendered flameproof, with ½-in. machine metal to metal joints, and is then suitable for use in the most dangerous positions. The construction is in any case very substantial. Mechanical clamps may be provided for the leads, so that no application of heat is required, for soldering or otherwise, and there is no obstacle to the installation of the starters in any position.

INDIARUBBER GOODS.

A four-page pamphlet is being sent out by the Silvertown Company to inform the trade of the great variety of indiarubber goods



Roll of Honour of the Staff and Employés of the County of London Electric Supply Co.

The [illegible] E.A.C. [illegible] on the pole [illegible] well [illegible] to the starting position. The transformer is mounted above the switch, [illegible] examination or removal.

The oil immersed form of starter is suitable for use in mines, and is recommended where the duty is severe and where bad conditions may prevail, such as excessive moisture or dust, or corrosive fumes. Both switch and transformer are oil immersed, and the coils are rated for 60 second starts six times in an hour. At a small extra cost this oil

manufactured by them. The publication is attractively got up, and contains illustrations of rubber flooring, belting, ebonite goods, such as pipes, rods, vessels, &c. Reference is also made in the text and illustrations to the immense variety of "Silvertown" products, ranging from heavy electrical machinery to delicate measuring instruments, wireless outfits, train lighting sets, battery trucks and delivery vans, primary batteries, carbons, insulators, cables of all classes and sizes, searchlight projectors and insulating tapes and jointing materials. A copy of the pamphlet will be sent on application to the India Rubber, Gutta Percha & Telegraph Works Co., Silvertown, E.

FERRANTI LTD
Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS, ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

SLATE
INIGO JONES & CO.,
Tudor Slate Works,
GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
Slabs and Tiles of every description of
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Mantels, Turrets and Enamelled

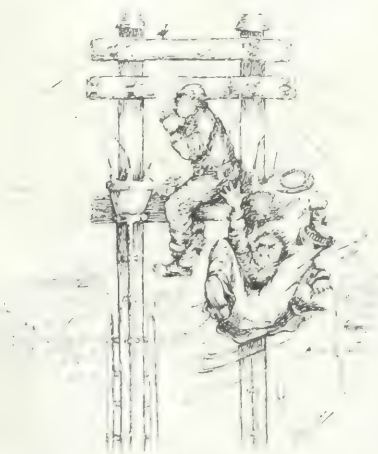
Printed and Published by [illegible] at the Offices of the Publishers, Nos. 1, 2 and 3, Salisbury Court, Fleet [illegible] in the City of [illegible], Friday, July [illegible], 1915.

THE ROUND TABLE.

"To deposit one *electrochemical* equivalent of silver, viz., 108 grms. of silver, requires 26·82 ampere-hours," say Messrs. Franklin & Barry MacNutt in "Elementary Electricity and Magnetism." One reviewer calls this a slip, certainly a slip-knutt!

* * * *

It is not often our esteemed contemporary the "Electrical World" makes glaring typographical errors. One of the few which have come to our notice in recent years is patent and also extremely humorous. The heading to one of the National Electric Light Association Reports is made to read "Grounding Secretaries." The report deals with grounding *secondaries!* (Same number of letters.) Many secretaries will not deny that they are "ground" between the upper and nether millstones.



[The Cheery Owl: Say, Bill, you can't drive long up some Diatrine tape. [From *Punch*'s *Almanac*.

* * * *

Sergeant E. C. Langston (E. Surrey R., who, before the war, managed the sales of Wotan and Tantalum lamps, is, we understand, now in the firing line, after many moons at home. E. C. L. will be remembered for his 6 ft. and over of brain, brawn and muscle, which have become "more so" with the two latter since he joined. As to the first named he is a crack shot and a highly expert bomb-thrower. He will throw from bulbs to bombs, but E. C. L. will place the latter with as great effect as he did the former, and more power to his elbow every time.

A correspondent writing of the merits of the electric battery vehicle says that he saw an Edison motor van in the street recently with a bold lamp on in broad daylight. Nothing like emphasising the fact that the vehicle is electric. Besides, it makes no noise, so something must be done to attract attention to it.

* * * *

Some seasons ago Ferranti, Ltd., distributed an advertising novelty in the shape of a circular looking-glass, and a calculator on its reverse side. Gunner J. R. Barrie Holmes, No. 480, of the 1/1st Warwickshire Heavy Battery, B.E.F., has written to the company as follows:—

"I hope you will pardon this somewhat unusual request, but have you got one of your advertising shaving mirrors you could spare? I had one which I had the misfortune to break, and it is rather awkward shaving with a polished tin as a mirror."

To this polite request the Company replied as follows:—

"We were extremely interested to receive your letter containing a request for one of our advertising calculator mirrors, and are glad to see that our products are equally appreciated 'somewhere in France.'

"We have run quite out of stock of this advertising novelty, but a member of the staff has given up the specimen he had, feeling that it will do better service in your hands than it is at present receiving.

"Wishing you the best of luck."

Is the gallant Gunner known to any of our readers?

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), August 3, 1878.]

GAS LIGHTING BY ELECTRICITY.—The system of lighting the public lamps by electricity on the plan invented by Mr. Lane Fox, recently put to the test in Pall Mall, does not seem to have met with the success that was at first claimed for it. At the last meeting of the St. James' Vestry it was officially reported that the system had proved an entire failure, and it was decided to request Mr. Fox to remove the apparatus at once.

DANGERS THAT BESET SUBMARINE CABLES.—Not long since an interruption occurred in a cable, and on examination it was found that it had been penetrated by one of the caudal spines of the sunfish. Even when the wire lies quiet at the bottom it is not safe, for a species of marine weevil attacks the gutta-percha and gradually destroys the conductivity. But the most curious instance of damage inflicted on a cable is that which lately befell the one from Portugal to Brazil. A fault having been found, the tests were applied, and the precise spot indicated. The wire was fished up and was discovered to be broken. In one of the ends was entangled a large whale. The monster was covered with parasites, and in attempting to free itself from its tormentors, had broken the cable, and then managed so to twist itself in the coils of one end that it was held fast as a prisoner, and, not being able to rise to the surface for air, was drowned.—*Galignani's Messenger*.

THE "POINT FIVES."

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Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
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Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
Mr. [illegible] (West Hartlepool).
Mr. J. W. Beauchamp (West Ham).
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Mr. H. A. Nevill (Wakefield).
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Mr. S. E. Britton (Chester).

No. 30B2 Diaphragm Type Pressure Regulator—a pressure-operated master for use with IGRANIC self-acting motor starters. This automatically starts and stops electrically driven Air Compressors, so that without attendance a constant supply of air at correct pressure is maintained.



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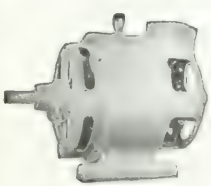


No 30B3. Float-operated Switch whereby (in conjunction with IGRANIC self-acting motor starters) electrically driven pumps can be made quite automatic, so as to maintain a constant supply of water, day and night, without requiring an attendant. Both of these devices are applicable to direct or alternating current.

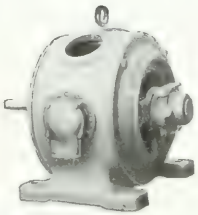
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Branches in Principal Towns Abroad.

B.T.-H AIR-BREAK Y-DELTA STARTING SWITCHES.

The Y-Delta Starting Switches included in price list No. 5,111 issued by the B.T.-H. Rugby, have been designed for use with three-phase squirrel-cage six-terminal induction motors up to 25 H.P. output, which are required to start up against light load only. The effect of the switch is to decrease the current at starting by lowering the voltage across the motor windings. The starting torque is at the same time reduced as the square of the reduction in voltage. The switch when in the starting position joins the windings in Y-connection, and when in the running position to delta connection. Thus at starting the voltage across each phase winding is only 58 per cent. of that when running delta connected. As a result the torque is reduced to approximately one-half of the full-load torque, and the current taken from the supply mains to about 1½ times to twice full-load current.

The switches are of the air-break drum type, provided, for inspection purposes, with an easily removed stout sheet-iron cover, which totally encloses all live parts and renders the switch sufficiently dust-proof for use in mills, factories, &c. The frame is of cast-iron adapted for mounting on a wall and has two bushed holes situated in the end remote from the operating lever, allowing the incoming line, the outgoing motor leads and the fuse leads to pass through for connection to the terminals provided. In cases where conduit is brought to the switch the bushes may be readily removed and the conduit secured by internal and external nuts. The contacts are renewable and all live parts are clamped to steel bars and shaft insulated by means of tough non-hygroscopic material.

The switch operating lever is attached to the projecting end of the drum shaft, and is moved forward into either the "starting" or "running" positions against a strong spiral spring. An automatic stop is provided in the "starting" position, which ensures the operating lever being held there for a period sufficiently long for the motor to come up to speed before it can be moved into the "running" position. The stop restrains the movement of the lever in the forward direction only and it is necessary to hold the lever in the "starting" position, otherwise it will return to the "off" position. On the lever reaching the "running" position a catch mounted on the [illegible] engages the lever and retains it there. When the [illegible] the lever to the "off" position the impact [illegible] by a check spring buffer fixed to the frame. The movement of the operating lever is limited by the catch in the "running" position and the buffer in the "off" position, thus it is impossible to damage the switch contacts by rough usage.

Switches fitted with no-voltage release can be supplied. This release ensures the starter being in the "off" position when the supply is resumed after an interruption. The catch previously referred to, which holds the operating lever of the switch in the "running" position, is made dependent for its action upon the maintenance of the current in the no-voltage release coil, so that when the supply fails the catch is released and the lever returns to the "off" position.

Protection from overload can be obtained by using switches provided with overload relays. The relays, two in number, are controlled by the current in two of the stator leads, and, on operating, open-circuit the coil of the no-voltage release and thus cause the switch to return to the "off" position. The action of the relays is delayed by means of a time-lag dashpot for a period inversely proportional to the severity of the overload. An overload, therefore, which is not sustained sufficiently long to damage the motor will not cause the machine to be shut down. The switches not provided with overload relays have terminals allowing fuses to be connected on the running contacts only. This permits the use of fuses graded to protect the motor from overloads, whereas if the fuses are in circuit during the first brief starting period they require to be of such a capacity as to make them of little value for protecting the motor.

The approximate shipping specification for these switches is shown in the table below.

	Nett weight	Gross weight (packed)	Case.
Switch without automatic features.....	35 lb.	55 lb.	4 cub. ft.
Switch with no-voltage release only	38 lb.	58 lb.	4 cub. ft.
Switch with no-voltage release and overload relays	55 lb.	85 lb.	4½ cub. ft.

ELECTRIC DRIVING IN CEMENT WORKS.

The extensive application of electric power for driving cement works machinery applies to the colonies just as much as to this country. A recent installation of electrical plant for this purpose is that of the Adelaide Cement Co., of Adelaide, N.S.W. Gas engines



FIG. 1. POWER HOUSE OF THE ADELAIDE CEMENT CO., CONTAINING TWO "PREMIER" GAS ENGINES DRIVING 275 K.V.A. "WITTON" ALTERNATORS.

were selected for the prime movers, the installation consisting of two 380 H.P. four cylinder horizontal gas engines running at 214 revs. per min., and manufactured by the Premier Gas Engine Co., coupled to 275 k.v.a. "Witton" alternators, supplied by the British General Electric Co. (Ltd.), of Sydney, and constructed at Witton, Birmingham. The gas producers were manufactured in South Australia by Messrs. Clutterbuck Bros., from designs prepared by their consulting engineer, Mr. W. S. Saunders.

Power is supplied to the works motors at 440 volts 50 cycles, and the generators are designed for a power factor of 0·725. There are several interesting features about this installation. In the first place, good parallel running has been successfully obtained, and the two units run in parallel without any trouble. Good parallel running is often difficult of attainment in gas-driven alternating-current plant, unless the engines are well designed. In this connec-

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ion it is of [illegible] to note that this is said to be the only plant in Australia in which three-phase gas-driven alternators are run in parallel. Not only do the sets run satisfactorily in parallel at no load as well as full load, but they run well when one of the cylinders is cut out.

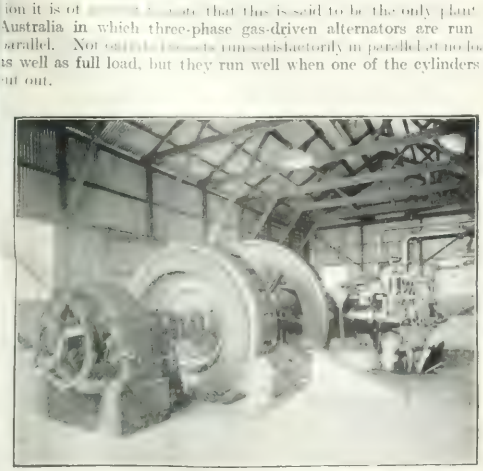


Fig. 2.—Another View of the Power House.

A second point of interest is the low fuel consumption. On the official tests, the weight of fuel consumed per B.O.T. unit (kilowatt-hour) was 1·221 lb., the fuel used being gas coke. This performance was nearly 25 per cent. better than the guarantee.

With regard to governing, during the official tests full load was thrown off the engines and then switched on again; in both cases the engines showed no appreciable variation of speed.

The electrical side of the contract was arranged and the plant installed under the supervision of Messrs. Colton, Palmer & Preston, who are the Adelaide agents of the British General Electric Co. (Ltd.).

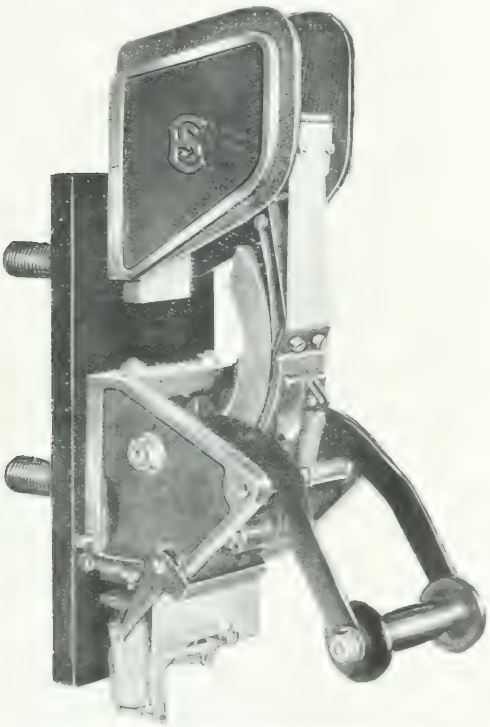
GARDEN PARTY ELECTRIC COOKING.

A garden party was recently given in the grounds of Lt.-Col. Kennard's (the chairman of the Falkirk Iron Company) house at Falkirk to the staff and employés, for the benefit of the families of the employés now on active service. Various sports were arranged for, and rifle competitions, for which a temporary range was erected. About 700 or 800 people were in attendance, light refreshments being provided on the lawn. The difficulty of providing for these people at a distance of about 250 yds. from the house was overcome by electricity. It was at last suggested that a squad of boy scouts do the carrying to and fro. However, some 3 to 10 gallon boilers of 5 kw. each and 3 kw. toasters were mounted on a table on the lawn; a supply of electricity was obtained by temporary connections from a 440-volt three-phase overhead line that ran near the garden. By this means ample supplies of boiling water for tea making and also toast were available.

Unfortunately the rain came on, but the electrical service "carried on" despite the drenching rain, and the people who were driven under the trees for shelter were comforted by ample supplies of hot tea, &c. It might be mentioned that the boiling urns and toaster grillers used for this outing were part of an order for electric cooking plant for an important customer, and an inspector who was present passed the apparatus with the remark, "As it stands this downpour, it is good for anything."

"EDISWAN" CIRCUIT BREAKERS.

The "W" type circuit breaker is of strong mechanical design, with simple and effective movements. It is made for any current from 150 to 6,000 amperes. The closing mechanism consists of a substantial toggle movement, so designed that a minimum of effort is required to close the circuit. The breaker is opened by raising the handle until the catch is tripped. By this means a quick break is secured. A "free operation" or "loose" handle is fitted, so that the breaker is free to operate electrically though the handle is grasped by the attendant, thus providing against the possibility of its being held closed on an overload, short circuit or reverse current. The magnetic blow-out is only of moderate strength, an inductive circuit is therefore protected from an abnormal rise of pressure, such as must occur with powerful magnetic blow-outs. The breaker is designed so that it will clear all ordinary arcs without any assistance from the magnetic blow-out. The result is obtained by arranging for a wide quick break. A special feature of the magnetic blow-out is that the magnetic flux is excited by the flow of current to the auxiliary contacts, no winding of any sort being used.



Large Capacity Ediswan Type with Circuit Breaker.

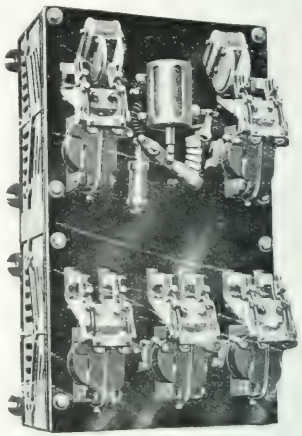
The main brush is composed of laminations of high conductivity copper strip, and is so constructed that when closing the circuit the contact faces are "wiped" by the contact edges of the strips and the face is thereby maintained electrically clean. The catch is mounted outside the body casting and is available for inspection and adjustment at any time. There is no danger of operation from vibration. [illegible] winding on any of these breakers, with the exception of the W. 1 (a) size, the operating magnetic field being excited in all other sizes by the flow of current in the main brush. The intermediate auxiliary contacts are of metal and can be readily removed, the final break is, in all cases, of carbon.

The time limit attachment is adjustable for time and current. It [illegible] operation on the event of a short circuit exceeding a predetermined value. The reverse release directly trips the breaker without the intervention of any relay. The principle [illegible] is based upon a purely polarity effect. The differential winding system, which has been widely used, [illegible] the event of a small and [illegible] reversal of current, [illegible] pressure such as occur with severe reversals. This failure is due to the excitation of the series winding wiping out that of the potential winding. By the use of purely polarity effect this danger is overcome, and the stronger the reverse current the more powerful is the operating force. Operation may also be relied upon when the "drop" accompanying reversal of current reduces the pressure to one-third of the normal. When both overload and reverse releases are required, the operation of each is arranged to be quite independent of the other. They can also be independently adjusted. No-voltage release can be arranged for when required.

Prices and fuller particulars can be obtained from the Edison Swan Co.

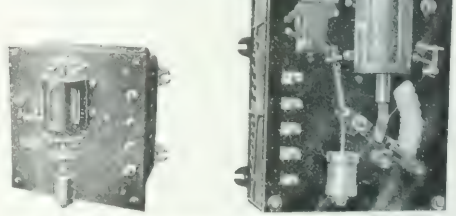
AUTOMATIC D.C. STARTERS.

Interesting particulars are given of a range of automatic direct current motor starters in leaflet H.25 just issued by the Electric Apparatus Co. These are made in standard sizes and are of the solenoid operated pattern. The acceleration of the motor is determined by an oil dashpot which is fitted with a valve having an adjustment which allows the starting period to be varied to suit the



Large Capacity Auto-Starter.

load. Size No. 10 starter is suitable for small motors driving centrifugal pumps and similar machinery representing comparatively light loads. The solenoid is provided with two plungers, the upper one of which is a disc which is pulled down quickly into contact, closing the main circuit and starting the motor. The movement of the lower disc is controlled by a dashpot, and its rate of acceleration is slower than that of the upper one. The starting resistance is therefore



Small and Medium Capacity Auto-Starters

slowly cut out. These starters should not be operated on control systems requiring more than six starts per hour.

Sizes 11, 12 and 12A are of the ordinary sliding contact type, the radial arm being moved over a series of face plate contacts when the [illegible] is drawn up into the solenoid. The movement of the arm is controlled by a regulable dashpot. The main circuit is made on

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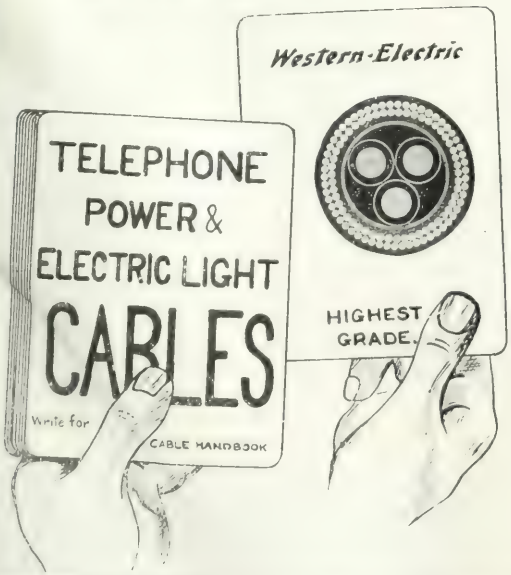
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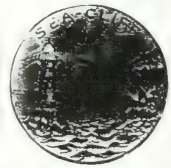


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broken by a separate contactor switch having a powerful magnetic blow-out. The contacts of this are of the laminated brush type. The size 11 starter is rated for 10 starts per hour. Size 12 is similar to size 11, but the resistance contacts are renewable from the front of the starter. Size 12x differs only from the foregoing in that it is provided with a second contactor which completes the circuit of the motor at the full on position.

Other sizes, such as 15A, B and C, are also made, and these are of the multiple contactor type. The solenoid of each contactor is energised from a master solenoid-operated switch. The first and last of the contactors are provided with powerful magnetic blowouts, and the rating of these starters is 12 times per hour. Particulars are also given of combined automatic starters and shunt regulators which are made for service where the motor must be brought into circuit and accelerated to any required speed automatically. This class of gear is employed in connection with ventilating and pumping installations. Copies of this pamphlet, containing particulars and prices, may be obtained on application to the Electrical Apparatus Co., South Lambeth-road, London, S.W.

ST. PHILIP'S CHURCH, RUGBY.

We omitted to mention in our last issue that in addition to supplying the "Eye-Rest" fittings for the above church, the B.T.-H. Co. also installed Mazda lamps throughout. Needless to say, these lamps with the fittings in question make up an ideal combination, and one which has assured the complete success of this the first church indirect lighting installation in this country.

"KINGOLITE" UPRIGHT CANDLES.

The attention of the installation trade is being called to the Edison "Kingolite" patent upright candle for use wherever electric candle fittings are employed. The chief feature of the device is its rigidity and its absolutely upright position. From the illustrations it will be observed that the fitting is made in three parts: (1) the connector, (2) the opal tube, (3) the lamp itself. The connector consists of a brass tube provided at one end with a bayonet connection, and at the other with an adjustable sleeve. On the same thread which carries the sleeve is a brass flange with milled edge, which serves to clamp the connector firmly into the candle sconce once it has been bayoneted into the holder. The lamp cap is of special shape, being provided with a long screwed extension, which is arranged to screw into the connector after the opal tube has been slipped into place. The sectional illustration explains how the bulb tightens up on the opal tube and holds the entire fitting rigidly in place, at the same time keeping the tube and candle lamp in a vertical position. The height of the lamp in relation to the opal tube can be regulated by raising or lowering the sleeve attached to the connector.

The candle lamps can be supplied with carbon or metal filaments, and three lengths are listed. Standard 4½ in., 4½ in. to 6 in. ar 6 in. to 12½ in., and special longer candles will be quoted for application. The opal tubes are made either white (wax) or primro (sperm) colours.

For the adaptation of candelabra for electric light the "King lite" socket is made. It is an Ivorine holder taking the place of t ordinary S.B.C. holder, and is used in conjunction with the "King lite" terminal connector. The socket is specially useful in cas where the nozzle is too shallow to admit of the ordinary holder bei



"KINGOLITE" CANDLE COMPLETE AND IN DETAIL.

used. It is recommended for use in the adaptation of candelabr appliques, and other fittings where provision is not made for wirin The "Kingolite" socket is stocked in all standard threads, and it ca be inserted and fixed rigidly either by screwing in or by a set scre through the side of the nozzle. Allowance is made for the wires t enter at bottom or side as required, and the interior of the nozzle no being entirely insulated, leakage is prevented.

The Edison & Swan Co. will furnish prices and particular

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Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, July 30, 1915.

THE ROUND TABLE.

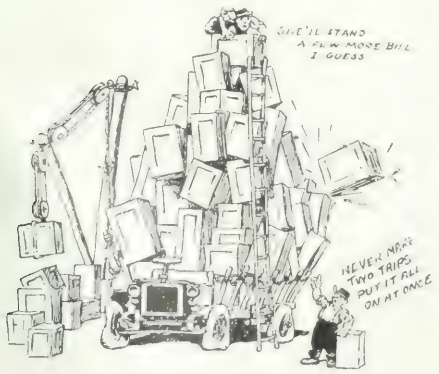
An enterprising electrical proprietor in Boston (U.S.A.) has placed a [illegible] at the entrance to his establishment. Result: No Flats. Fan makers and electrical contractors please note.

Commenting [illegible] "Courtesy by Utility Empowers," the "Electrical Review and Western Electrician" says:—

"Telephone companies have, perhaps, placed more emphasis upon the use of the word 'please' and similar evidences of courtesy than have the other utility companies. But there is no reason why the use of polite language should be limited to conversation over the telephone."

Our contemporary admittedly has no experience of the use of the telephone in this country. Unfortunately in war time our vocabulary of expletives must be kept to the English language; even strong [illegible]

The illustration taken from our overseas contemporary "Electric Vehicles" gives a true view, so we are informed, of the treatment of electric battery vehicles in the United States. We were [illegible] high speeds are not the feature of [illegible]



[illegible]

The following appears in several technical journals:—

"A full time instructor of experimental physics and mechanics, applied mechanics, electrical engineering, machine drawing and workshop practice is required by the Wimbledon District Higher Education Committee. Salary £160 per annum. Forms of application from the Principal, Mr. W. A. Hammond."

These latest lessons in [illegible] are to be [illegible] Ypres Journal": "Such men are better [illegible] at the front.

Capt. S. Utting, A.S.C., writing to K.V.A. from somewhere in France, remarking upon the recently reported death in action of Major Chapman, says:—

"True, he is only one of very many I have met who have 'gone under,' but his case brings home to me, more than most, the fact that many men are volunteering (and being taken up) who would be of greater service to the nation if they followed their ordinary pursuits at home, and, further, how unnecessary it would be for them to join the E.F. if the slackers, unmarried and with much less responsibility, would step into the breach."

Our readers will agree with Mr. Utting's sentiments, we feel sure.



She: What are those little prickly things?
He: They are her teeth.
She: So that's what the engineer meant when he said: She fairly eats the steam.

From *Ghost's Almanac*.

THIRTY SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), August 10, 1878.]

THE MICROPHONE.—The following important contribution to the controversy relative to the invention of the microphone has been addressed to our contemporary "Nature" by Sir W. Thomson, F.R.S.: "The pleasure with which those beautiful discoveries, the telephone, the phonograph and the microphone, have been appreciated by the world has been unhappily, and I must say I think unnecessarily, marred by one of the most disagreeable things that can be thrust on the public—a personal claim of priority, accompanied by accusations of bad faith, especially when made against anyone whose name and fame in the opinion of the public are concerned . . ."

THE REAL INVENTOR OF THE TELEPHONE.—An article in a recent number of the "Pekin Gazette," written by Chin Hoo, says Kung Foo Whing, a distinguished philosopher who flourished about the year 976, invented the telephone, which is known in China as "Thumthsein," in the year 968!

THE "POINT FIVES."

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Mr. W. H. Cooke (Luton).	Mr. J. W. Sparks (W. Hartlepool).
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STANDARD

ELECTRIC MOTORS



For Direct Current



For Three-phase Current

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

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NEWCASTLE—64-68, Collingwood Bldgs.
SOUTHAMPTON—4c, High Street.

Branches in Principal Towns Abroad.

MODEL ELECTRIC HOMES IN GLASGOW.

[illegible] only is it possible to point to any practical example in which the much-lauded benefits of an all-electric domestic establishment have been put to the test over what might be regarded as a reasonable period. One hears of central-station engineers who [illegible] with a house as a part of their remuneration and of recent years are furnished with electrical energy for all purposes without cost. In a few such cases it is possible to find that the cooking is done electrically, and also the heating of the occasional rooms,



SITTING ROOM IN GLASGOW MODEL VILLA.

but the cosy corner, the snuggery, the study, or whatever it is the particular engineer cares to call it, contains an ordinary coal fire. In the kitchen the heating of the water used at the sink, the wash basins and in the bath would also be entrusted to coal and (tell it not in Gath) to a gas geyser or some modern example of gas boiler. The "Proceedings" of the Institution of Electrical Engineers and the I.M.E.A. [illegible] numerable domestic exhibition [illegible] and small scale, in different parts of the country have without excep-





KITCHEN IN GLASGOW MODEL VILLA.

[illegible] the country, furnish records of opinions as frequently [illegible] every electrical engineer should practice what he [illegible] and live in an all-electric house. In the present stage of the development of domestic electricity supply, it is perhaps a little early [illegible] the head of men who, after all, although they are handling

dern electricity undertakings, have been [illegible] the
e true domestic conditions. Perhaps [illegible] they will
t mselves to be exempted from out-of-date [illegible]
ce.

ur readers may recall that [illegible] Dean, Dyce
ff at the last convention of the I.M.E.A. Mr. W. W. [illegible]
gressive city electrical engineer, Glasgow, gave some interesting
iculars of a number of [illegible]
the Utopian builder in his district. Mr. Lackie has been good
ough to furnish us with photographs showing the exterior and some
oms in one of these villas. We may recall the interesting fact
t the builder himself is so convinced of the merit of the all-electric
a that he decided to live in one of his all-electric homes for at least
period of 12 months. The [illegible]
d the heating and cooking [illegible]
water is also heated by [illegible]
al means. During the first year this particular builder was
roughly lavish in the consumption of electrical energy. He con-
ned no less than 16,000 units, which were charged up to him in
ordance with the special domestic [illegible] in the
sgow district. He paid for 150 units at 3d. and the balance at
.. and the total bill amounted to £51. 8s., or an average price of
77d. per unit. But, as Mr. Lackie points out, although the bill
y seem as it stands somewhat excessive, the builder was able to
spense with the services [illegible]



Bath Room with [illegible]

normal times would represent [illegible]
nd now that the war has appreciated female labour it may be put
own in the neighbourhood of £50 per annum. In these circum-
tances we are not surprised at Mr. Lackie's statement that the
uilder is perfectly [illegible] We [illegible] Mr. [illegible]
ending us the photographs, and we reproduce them as being of
xceptional interest at the present time. Mr. Lackie himself antici-
ates that the normal [illegible]
bout 10,000 units per annum for the electrical service for all pur-
oses.

PORTABLE SEARCHLAMP.

[illegible] powerful portable [illegible]
se is made of [illegible] 20 in. waterproof [illegible]
ocus-type nitrogen-filled lamp. The projector and Edison
attery are mounted on two wheels by means of trunnions, so that
he apparatus can easily be handled by one man. The outfit is
pproximately 5 ft. high, 3 ft. wide, and [illegible]
and is designed to operate [illegible]
The concentrated [illegible]
how objects half a mile away. By [illegible]
device the light may be spread out in the form of a fan for
ange work.



REPAIRS

to Electric Heating and Cooking apparatus cause no worry to sellers and users of Plexsim Goods—but there are others—for the benefit of whom we have established a repair department at our Works, where all kinds can be repaired or converted to Plexsim System, excepting certain of American manufacture, which experience has proved are difficult to satisfactory repair.

SIMPLEX CONDUITS, LIMITED,

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LONDON: 113-117, CHARING CROSS ROAD, W.C.
MANCHESTER: 16, CORPORATION STREET.
GLASGOW: 72a, WATERLOO STREET.
BRISTOL: 11, DENMARK STREET.
NEWCASTLE: 61-65, HIGH BRIDGE.
LEEDS: 6, WHITE HORSE STREET.
LIVERPOOL: 96, WHITECHAPEL.
SWANSEA: 14, HEATHFIELD STREET.
CARDIFF: 4, WESTGATE STREET.
ABERDEEN: 1, CRIMON PLACE.

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PERFECT DESIGN
MECHANICALLY STRONG
COMPACT
WELL VENTILATED.

ISENTHAL & CO.

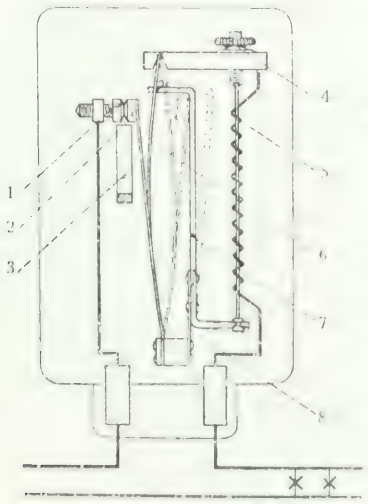
(DEPARTMENT 4

Denzil Works, Neasden, London, N.W.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, etc.

CURRENT LIMITERS.

Particulars are being issued to the electrical trade of a moderate priced current limiter, which is being offered by Lamble & Co.,



[illegible] when in position. The apparatus can be connected in either [illegible] continuous current or a single-phase circuit in the same way [illegible] meter. In the diagram the apparatus is shown as it [illegible] with the circuit closed, whilst the dotted lines denote the [illegible] taken up by the moving parts when the current exceeds the predetermined value.

The principle of the apparatus is simple, and consists of a length [illegible] wire which becomes heated and extended by the current and [illegible] tested bow-shaped spring carrying the moving contact of the [illegible] to be pulled over as soon as the current exceeds a predetermined amount.

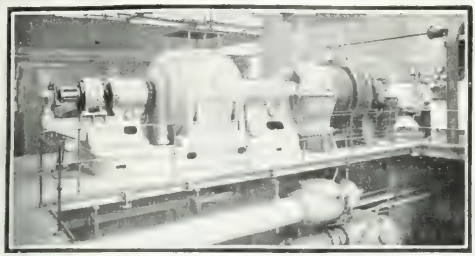
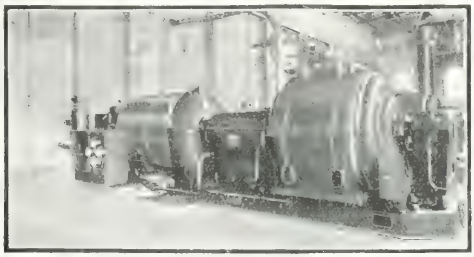
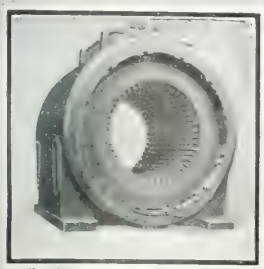
The action will be understood by referring to the drawing in which it is shown that the current flows from the left-hand terminal through the fixed contact 1 and the moving contact 2, upwards along the spring 6, across to the adjusting screw 4 and down the heating element 5 to the right-hand terminal and thence to the consumer's circuit. If the current taken exceeds the predetermined fixed amount, the element 5 expands and allows the spring 8 gradually to force the lever 7 into the position shown by the dotted lines. The motion of this lever 7 is at first against the action of the bow-shaped spring 6, but in the midway position the equilibrium of the latter becomes unstable and a small further movement causes it suddenly to spring over into the dotted position and at the same time to separate the contacts 1 and 2. Although the action of the contacts is a quick-break one, yet the small permanent magnet 3 is added in order to prevent the surfaces becoming pitted by sparking.



General View of Current Limiter.

Since the circuit is now broken and no current is flowing, the heating element 5 will begin to cool down and contract and at the same time pull the lever 7 into its original position, the spring 6 being likewise forced over so that the contacts come together and the circuit is closed. The cycle of operations will then be repeated unless the current consumption has been reduced in the meantime. The length of time during which the circuit is open is from 5 to 10 times as long as the period during which the contacts are closed, the latter being only a few seconds and varying, of course, with the current flowing. This time is too long to admit of heating or cooking apparatus being kept in circuit, whilst at the same time it is such as to cause the minimum of inconvenience from a lighting point of view. Another advantage is that the number of times that the contacts are called upon to open the circuit is small, and the wear is practically nil since the contacts have time to cool down.

The chief use for these current limiters is in small house installations where the cost of an ordinary meter is prohibitive. By employing the limiter, a meter is dispensed with and a fixed charge per month can be made for current, whilst at the same time the consumer cannot connect up additional apparatus taking current in excess of the predetermined amount. Similarly in hotels a limiter can be [illegible] each room or suite of rooms to prevent, say, a heater and a gas ring from being turned on at the same time although permitting each one to be used [illegible]

VICKERS Limited



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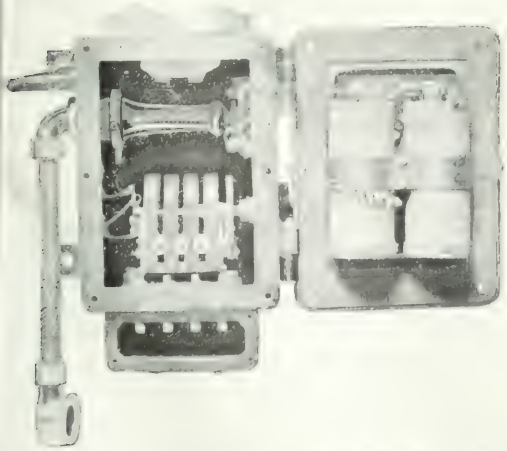


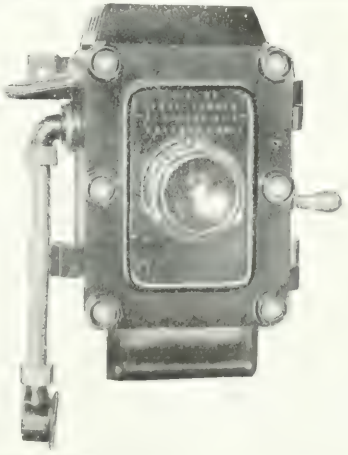

ELECTRICAL EQUIPMENT
of every description



G.E.C. FLAMEPROOF AND WATERTIGHT MINING TELEPHONE.

The need [illegible] means of signalling between the various parts of a [illegible] has been felt since the earliest days, and from time to time many systems have been [illegible]. Directly the danger of a complete telephone system were appreciated there was no irresponsible mining official [illegible]. For those premises where inflammable gas is unlikely to accumulate, telephone instruments have been designed to give satisfactory results. For use, however, in "fiery mines" specially designed instruments are necessary on account of the liability of inflammable mine gas to explosion by an electric spark, should such occur. At first the idea was to make the case of the instrument "gas and water tight" by employing packing between the joints, but this has not been found satisfactory for the following reasons. If the packing becomes defective inflammable gas may collect and the apparatus ever and become ignited, the





New G.E.C. Mining Telephone, Flameproof and Watertight.

A Good EARTH

THE

PARAGON EARTH CONE



is made of perforated copper and filled with small charcoal. It is easy to instal, is permanent, and makes a really scientific earth.

The Cone is made in various sizes for Lighting, Power, Tramways, Telephones, Telegraphs, &c.

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56, Victoria Street, London, S.W.

explosion, causing the packing to be blown out of the case to be shattered. In either event the flame will reach the outside gas and accumulations may be ignited.

Experiments and research have, however, established the fact that the products of an internal explosion cannot set an external explosion if they are below a certain critical temperature, so that if when an internal explosion occurs provision is made for the escape of the gaseous products in such a manner that they are effectively cooled to [illegible].

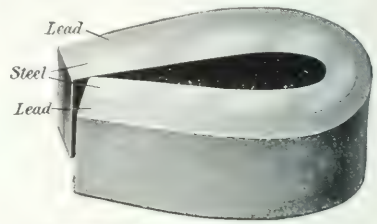
After a period of testing in actual practice there has been put on the market a flame-proof and water-tight telephone known as the G.E.C. Magneto Mining Telephone K8038, 1915 type. In the instrument it is very strong and well finished. The case is of cast-iron and the joint between the case and the lid is made by machined flanges 1 in. wide. When the lid is bolted to the case the joint is both water-tight and flame-proof, *i.e.*, any escaping hot gases are so cooled in passing between the flanges that they cannot ignite an explosive mixture outside the case even in the unlikely event of an internal explosion. The entire equipment is manufactured by the Peel-Conner Telephone Works (Ltd.), of Salford, England. The [illegible] is kept down to a minimum consistent with [illegible] the amount of [illegible] accumulator.

The telephone equipment comprises: A four-magnet tropical type generator with the armature wound to a resistance of 300 ohms, and [illegible] protected by a flame-proof and water-tight gland; a polarised bell movement wound with enamelled insulated copper wire to a resistance of 1,600 ohms and fitted with [illegible] bell gong, protected by a hot cover, long-distance speaking solid back transmitter fitted in an iron chamber on the front of the lid, the diaphragm of which is protected from wilful [illegible] by a [illegible] enamelled insulated copper wire, resistance of primary circuit 1 ohm, secondary circuit 25 ohms; a double-pole "bell" receiver wound [illegible] and fitted with [illegible] G.E.C. dry cells are fitted on the inside of the lid by means of a metal band.

Attached to the bottom of the cast-iron case is a chamber which contains strong and well-designed line terminals. Four lugs fitted on the inside and back of the instrument are provided for fixing. All mining requirements are met in the best possible manner and all Home Office Regulations are complied with.

PROTECTIVE LEAD COVERING FOR IRON AND STEEL SURFACES.

A new process introduced by the Homogenous Lead Coating Co., Old Pye-street, Westminster, S.W., enables cast-iron, wrought-iron and steel to be coated with pure lead or alloys of lead to any thickness up to ¼ in. or more, the lead being united to the iron or steel surface in such a way that it does not become separated when subjected to rough treatment or varying temperatures. We understand that the process can be applied to the lining of tanks, vacuum pans, condensers, autoclaves, pumps, taps, scrubbers, pipes, heating coils, &c. The prices vary considerably according to the size and nature of the [illegible] to be coated.



SPECIMEN OF STEEL WITH LEAD COVERING.

The following table gives the weight and cost per superficial foot for varying thicknesses of lead, the cost of applying the lead varying with the construction of the apparatus to be coated:

Thickness in inches.	Thickness in inches.	Weight per super foot.	Cost of lead per square foot at £25 per ton.
		lb. oz.	s. d.
1/64	0·015	0 14½	0 2·47
1/32	0·031	1 13	0 4·94
1/16	0·062	3 11	0 9·93
3/32	0·093	5 9	1 2·89
1/8	0·125	7 6¼	1 7·86
5/32	0·156	9 4	2 0·83
3/16	0·187	11 2	2 5·79

ELECTRICAL PROSPERITY WEEK.

We have received from the Society for Electrical Development, Inc., 29, West 39th Street, New York, a publication which sets out the plans of this Association for Electrical Prosperity Week, Nov. 29–Dec. 4, 1915. We have already commented upon the formation of this Society, and also noted the fact that the Electrical Development Committee of the I.M.E.A. is in close touch with it. The booklet comprises some 20 pp., of which the first 10 are devoted to an explanation of the objects of the Society, and the various organisations throughout the United States which have promised their co-operation. These include Central Stations, Electrical Manufacturers, Electrical Jobbers, Electrical Contractors, Electrical Dealers, Local Electrical Organisations, Non-Electrical Manufacturers, Department Stores, Non-Electrical Merchants, Public Schools, Women's Clubs, Electric Vehicle Association, International Association of Display Men, the Jovian Order and the National Electric Light Association. In the case of Central Stations, prizes are to be offered for the best illuminated stores or window displays; a local electrical show is to be inaugurated for exhibiting and demonstrating all kinds of electrical goods; the electrical manufacturers will call attention to the "Week" in all their national advertising, [illegible] distributing folders and leaflets urging upon their various [illegible] to co-operate and work with the object of making the week a success; salesmen are to be "primed" to talk and work for the week, and to enthuse retailers and jobbers, electrical contractors [illegible] with Chambers of Commerce, the Boards of Trade,

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AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

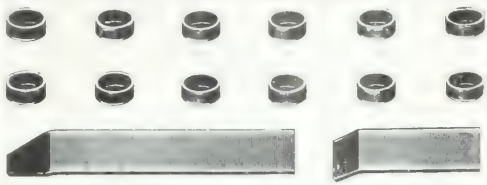
improvement Associations and City Councils, with a view to obtaining street lighting displays; electrical dealers will take special care with window displays, and use electric signs inside and outside their shops, they will also emphasise the "shop early" idea. Non-electrical manufacturers will bring out in their advertising the extent to which electrical energy enters into the manufacture of their products, how it makes them better, safer and cleaner. In such advertising in which home scenes are depicted these illustrations are to include electrical appliances. In public schools the subject of electricity will be introduced for special study during the week; demonstrators will show the uses of electricity in household work to domestic science classes, and lectures will be given in the evening to which parents will be invited. At Women's Clubs lectures on Electricity and Its Uses for Household Work will be given, and electrically-cooked food will be on sale. The Electric Vehicle Association has pledged its support, and there will be parades of electric vehicles on which decorated floats with special lighting effects and working exhibits will be mounted. There will also be endurance runs on commercial vehicles and sociability runs on electric coupés. In the case of the Jovian Order, which runs the slogan "Altogether All the Time for Everything Electrical," the members have pledged themselves to do anything in their power and in their immediate districts to further the objects of the Society.

One of the principal things which the Society will do will be to advertise in the principal American papers, and especially such magazines as "Collier's Weekly" and the "Saturday Evening Post," which have a circulation running into millions. Poster stamps, posters, showcards, window display bills, transparencies for shop windows, trains and tramcars, will be prepared and issued to non-members of the Society at practically cost. A special folder will be issued to the public explaining the objects of the week, emphasising what electricity has done for humanity and what it ought to be permitted to do. This folder will be written in popular language, and will be profusely illustrated. The Electrical Prosperity Week poster, 8 ft. 10 in. high by 6 ft. 8 in. wide, will be lithographed in six colours. The design is particularly striking. It comprises a large central figure of Electra appropriately draped, with her right arm raised closing a small switch, and with her left arm she is drawing back a curtain exposing on the right a view over a residential suburb brilliantly lighted at night time, and with electric automobiles running through the streets. On the left the curtain reveals a busy thoroughfare of a large city, the shops brilliantly illuminated, sky signs in profusion and electric vehicles plying up and down with goods and passengers. The subject-matter of the poster is provided with a suitable border, with a space at the foot for the name and address of the local electricity station, contractor or jobber, as the case may be. The motto of the poster is "Do it Electrically." This design will be worked out in transparencies, poster stamps, showcards, street-car cards and electrotypes for all advertisements. There will also be a special display of advertising in the American electrical trade journals and it is anticipated that many of these will produce special numbers to celebrate Electrical Prosperity Week. The same is expected of the popular magazines, and big Electrical Numbers will be produced by "Collier's Weekly," the "National Food Magazine," "Farm Machinery and Farm Power," "The Dry Goods Man," "Dry Goods Reporter," "The Jovian," and the "Signs of the Times."

In order to assist those who are organising the local campaigns the society is issuing a series of "How To" booklets. These will give specific information such as "How to Put on an Electrical Parade," "How to Put on a Demonstration," and similar instructions covering windows displays, slogan sign campaigns and co-operative lighting. A number of daily papers have arranged to produce a special electrical page, the reading of which will be furnished by the Society for Electrical Development. There will, of course, be co-operation from the advertising side between electrical manufacturers and the publishers of these newspapers. Last, but not least, the cinematograph shows, or as they are known in America, "Movies," will be brought into line, and special feature "reels" will be displayed throughout the country. It is expected that these will be seen by millions of people, because practically everyone in America goes to see the pictures at least once a week.

We feel that the foregoing information will be of interest to Central Station Engineers who are co-operating with the Electrical Development Committee of this country. As we have already stated, this Committee is in touch with the Society for Electrical Development, but in case specific information is required this can be obtained on application to Mr. J. M. Wakeman, the general manager of the Society, at the address given above.

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.



Drawn and Pressed Work of every description for Dry Batteries.

LIONEL ROBINSON, 3, STAPLE INN, LONDON, W.C.
6323.

BELLING

FIRES
BOILERS
GRILLERS
COOKERS

Over 300 Corporation and Electric Supply Authorities have bought our goods for the last 3 years.

We endeavour to turn out strong practical articles for everyday use.

May we send you our Catalogues?

BELLING & CO., Derby Road, Edmonton, LONDON, N.

ELECTRIC SUNSHINE IN FILM PRODUCTION IN CALIFORNIA.

To save approximately $200,000 a year in loss of actors' time and interest charges on equipment, one chain of theatres has been erected at Universal City, the large moving-picture plant in southern California, an electrically illuminated studio for taking pictures when the sun is behind the clouds.

Every type of lamp and diffuser was "tried out" in an endeavour to produce an artificial illumination which would give to the pictures the same character and colour quality as sunlight. The mercury-vapour lamp met this demand, although its size and shape offered some difficulties in adapting it to overhead lighting. The new gas-filled incandescent lamp, however, is well suited for such work, and by combining the two sources it is now possible to take indoor pictures that cannot be distinguished from out-of-door photography. The light from a gas-filled tungsten lamp has much the same quality as sunlight, and the useless orange and red rays are nullified by making the globe of blue rather than clear glass.

The studio is equipped with 2,000 c.p. gas-filled tungsten lamps equipped with metal reflectors suspended 2 ft. from the ceiling and 8 in. apart each way. Along the sides are banks of eight 400-watt 800 c.p. mercury-vapour lamps arranged one above the other with mirror reflectors behind each unit. The banks are mounted on casters, so that they may be readily arranged in position. Flood and spot lamps are used to illuminate the dark places. A scene in a [illegible] room, as it appears to the camera, and under average conditions requires a space at least 15 ft. square. The necessary lighting equipment usually includes 45 1,000-watt 2,000 c.p. gas-filled tungsten lamps overhead, four banks of mercury-vapour lamps on the sides and two flood lamps. The latter are of the double-arc type, equipped with prismatic glass to diffuse the light, and require 35 amperes at 110 volts. Thus for a single "set" there may be required approximately 100,000 c.p., representing an energy consumption of about 50 kw. The present electric lamp investment in this studio is $20,000, and this, the management has announced, it is proposed to double immediately. The energy for the plant is supplied by the Southern California Edison Co. — Electrical World.

THE GENTLE ART OF COLLECTING BILLS.

A good collector can [illegible] of nearly all our requirements [illegible] says Mr. George W. Hunt, office manager of the Haverhill Electric Co., Haverhill, Mass., in a recent [illegible] on modern methods of collecting and handling accounts.

He must be resourceful, diplomatic, courteous and withall capable of drastic, kind, severe, generous, relentless or [illegible] methods of dealing [illegible] the particular [illegible] of the case in hand when he undertakes to [illegible] accounts [illegible] A couple of [illegible] with [illegible] through courtesy and kindness with one man may with another result in loss of money.

"Collecting is the art of educating customers to make prompt payments—not the collecting of accounts after they are due. We, therefore, we train our customers to pay their bills promptly, the results will be advantageous to both the customer and the concern because if a customer can be educated to pay his bill within the discount period, he receives his service at the smaller cost and will be more satisfied than he would be if he had been hounded by notices and collectors."

DEVICE TO ELIMINATE ACCIDENTS DUE TO PHASE FAILURE AND REVERSAL.

When a motor driven machine starts off in a direction opposite to that which the operator is expecting, serious accidents are liable to happen. An elevator may be dashed to the pit or through the top of the shaft, and costly machines, pumps, cranes, hoists, &c., may be seriously damaged if the direction of rotation is unexpectedly reversed when the starting device is closed. With alternating current polyphase motors this may happen, due to reversing of the phases, and engineers have turned their attention to the problem of eliminating this source of accident. Failure of one phase may also cause burning out of the motor.

A new compact type of phase-failure relay has been developed in the engineering department of the Cutler-Hammer Mfg. Co. The device is similar to a vertical motor having a two or three-phase stator winding and a squirrel-cage rotor winding. The rotor shaft extends at the top, and to this extension a casting is secured, carrying contacts designed to close a pilot circuit which controls the motor starter. This phase-failure relay provides against abnormal drop in voltage, against failure of one of the phases and against reversal of the phases. If the supply voltage falls below about 70 per cent. of the normal, the relay opens the control circuit of the motor controller and keeps it open until the line voltage returns to at least 85 per cent. of normal. These limits can be adjusted before shipment to suit special conditions.

In case of phase failure caused by the opening of one of the supply lines at any point, the relay opens the control circuit if the motor is under appreciable load, and keeps it open until the fault is corrected. If the load on the motor is very light, so that no harm would result from its running single phase on account of the phase failure, the device may not operate until the load is increased or the motor shut down. If the motor is at rest at the time of phase failure the relay will act immediately. Thus the motor is allowed to run as long as no damage can result. In case of phase reversal the relay opens the control circuit immediately and keeps it open until the phases are [illegible] in the proper order. Accidents due to the motor running in the wrong direction when started up are, therefore, avoided.

FOR WAR SERVICE
DELIVERIES FROM STOCK
SWITCHGEAR AND ACCESSORIES.
A. REYROLLE & Co., LTD., HEBBURN-ON-TYNE.

SLATE

INIGO JONES & CO.,
Tudor Slate Works,
GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
Manufacturers of every description of
SLATE WORK for ELECTRICAL ENGINEERS
Slate Mantels, Turrets and Enamelled

Edited and Published by [illegible] at the Electrical Trading and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet [illegible], in the City of [illegible], Friday, [illegible], 1915.

THE ROUND TABLE.

A firm of resistance-net makers appeal to think that solvedge is an unusual word, and beg that the reason must be put in inverted commas and spelt "solvege."

* * * *

A correspondent seeks an answer to the following riddle: Which is the more objectionable, the hyphenated American or the abbreviated Briton. He says that so far no satisfactory answer has been forthcoming.

* * * *



AMERICAN ELECTRICAL PROSPERITY WEEK POSTER IN MINIATURE.

Mr. G. H——, the Utopian electric home maker, of Glasgow, has had to put up with plenty of chaff from his colleagues in the building world. During the winter he was frequently asked if he was "frozen out" of his electric house. His answer was [illegible] Frozen." You don't mean frozen, you mean roasted!"

* * * *

A traveller in [illegible] tells us that he was in the office of a contractor (sic) lately when the latter threw an old lamp into the w.p.b. The pip struck the wicker work and was broken off, when there followed a loud phitt-sh-sh-sh-sh-sh.

"Listen," said the contractor, "to the air rushing *out*"! Collapse of lamp traveller.

* * * *

A heading in a cross-Atlantic contemporary reads:—

WIRING OLD HOUSES BY SPECIAL INDUCEMENT.

A WIRING CAMPAIGN IN A STATE CITY SUCCEEDED IN SPITE OF A SATURATION FACTOR OF SEVENTY-FOUR PER CENT.

The saturation is gaseous, not liquid, because the "city" is situated in a "dry" State.

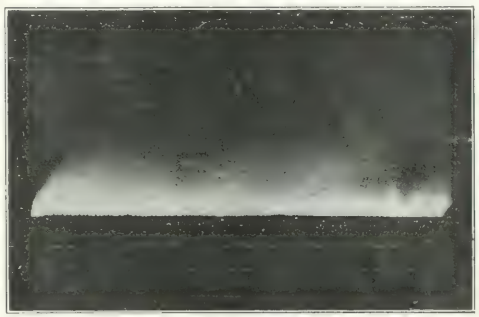
As a general rule, the names of authors of Papers presented to mechanical and engineering societies are quite out of keeping with the subjects of the Papers. An exception is, however, found in the case of "Four Years' Operating Experience on a H.T. Transmission Line," by A. Bang. We could not imagine those years to be anything else but that.

* * * *

A certain Volunteer Company, having the local electrical engineer (something of a nut) as lieutenant, was marching across a common, and getting no orders to wheel proceeded into a "labyrinth" of gorse bushes. The lieutenant, turning round, observed his mistake, and on the fringe of the gorse exclaimed: "I'm awfully sorry, you fellows, doncherknow. About turn. Quick march!"

* * * *

The world is full of contrasts. In Europe we read from the war area of "curtains of shrapnel," "curtains of fire" and "curtains of poisonous gases." In America they read of "curtains of steam" used at Lexington in a pageant to celebrate 100 years of peace between England and America. The steam curtain does nothing more terrible than hide the outdoor pageant stage from the view of the audience—while the scenes are being changed. At night the steam curtain is lighted by 1,000 25-watt lamps and its appearance (which might be familiar to a Tommy somewhere in France) is shown in the illustration.



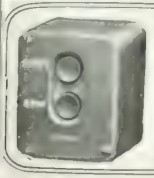
STEAM CURTAIN AS SEEN AT NIGHT.

* * * *

The smallest electric motor hails from Hillsboro', N.D., and is the work of Ivan T. Nedland, a jeweller. It weighs 5·5 grains! The commutator is 0·045 in. diameter, with four gold mica segments and the "main shaft" is 0·009 in. diameter. The armature is 0·09 in. diameter and has four poles wound with No. 40 silk-covered copper wire, the weight being 1·25 grains. The overall "dimensions" are 19·61 in. long by 11·61 in. high. Would be very suitable for driving a tie-pin fan from a pocket dry cell!

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Maryle-bone).
Mr. E. R. Hill (Reading).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
Mr. J. W. Sparke (W. Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).



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NEW PATTERN NILFISK SUCTION CLEANER.

There would appear to exist a definite demand among electricity consumers—domestic, trade and commercial—for a type of electric suction cleaner which is more powerful than the broom handle



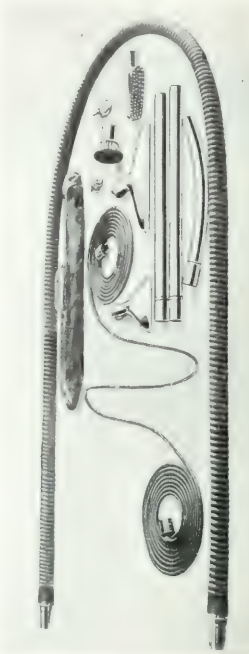
being covered by a perforated swinging grid. Here the smaller model differs radically from the larger, for these outlets are so shaped that they cannot receive the end of the tubing, and make the machine available for blowing as well as suction. It is, however, felt that there is less need for a blowing attachment among the class of prospective buyers for whom this type of Nilfisk cleaner is intended.

The motor is provided with ball bearings, and consumes only 300 watts at full load. A point worthy of note is the passage of the air of suction, after it has been freed of its dust, into the motor housing and thence into the surrounding air through the holes already referred to. So large a volume of air as is moved by the turbine fan serves admirably to keep the motor quite cool, even during long periods of running. Within the motor casing are the bearings and brush gear, but these are readily accessible through hinged metal covers provided for the purpose. The entire machine is of extremely neat appearance, and is finished bright all over, so that it is easily cleaned, and, being cylindrical, is not likely to damage furniture or wall decorations if accidentally knocked against them. The complete machine weighs 30 lb., and the list price is £15, including a large number of cleaning nozzles and attachments. An illustrated pamphlet on the machine may be obtained from Messrs. Gollespie & Beales, Amberley House, Norfolk-street, Strand, London, W.C.

built up with an eye to neat appearance, embodying in the complete apparatus the unit principle of construction, which makes for efficient operation and accessibility for inspection, removal of dust, &c.

In the first pattern of Nilfisk cleaner a vertical motor driving a two-stage turbine fan was compacted within a single housing, which could be detached from the cylindrical container forming the receptacle and screen for the dust removed by suction. The motor and fan were an independent and complete unit. This type of machine, with its accessories, has sold in large quantities, having been taken up by hotels, restaurants, large residences, flats, railway companies, cinema and ordinary theatres. Its price (a matter of 19 guineas) has rather militated against its very general use, and the makers have, therefore, decided to introduce a less expensive model embodying practically all the useful features of the first machine.

The adjoining illustrations show the general outlines of the new model, and the first noticeable difference from the larger machine is the "one piece" spinning, which acts as the housing for the motor. The height of the machine is also slightly reduced, a fact which is explained by the use of a single instead of a two-stage turbine fan. The outlets for the air of suction after it leaves the filter chamber are near the top of the motor housing, and are elliptical in shape



ACCESSORIES FOR NILFISK CLEANER.

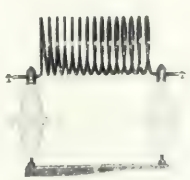


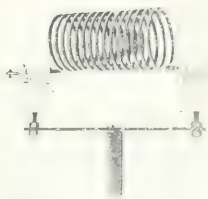


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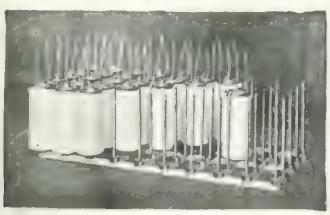
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HELSBY "POWER" TYPE CONDENSER.

The application of condensers on alternating current power circuits has been recognised for some years, but their high cost and the difficulty of making them reliable for all working conditions have kept them out of general use. After considerable experimental work British Insulated & Helsby Cables (Ltd.) have produced a "power" type condenser which we understand is suitable for use on alternating current power circuits; it is both cheap and reliable,



METHOD OF MOUNTING 50 OIL IMMERSED OUTDOOR CONDENSER UNITS EACH



BOX OF 50 OIL IMMERSED CONDENSER UNITS WITH PORCELAIN

and are arranged in connection with a reducing transformer or voltage on electromagnets and other electrical devices in high voltage circuits, and for certain uses in wireless telegraphy.

The condensers are manufactured by a special process which increases the dielectric strength while reducing the volume, and reducing the losses to a negligible quantity. Measurements of the losses made by the makers and by independent experts show that the efficiency of ordinary transmission and current supply exceed 99.5 per cent. The [illegible] used [illegible] when working

Power condensers are of the Manchester oil cooling type and are manufactured in two types, oil immersed and solid impregnated. The oil immersed type is recommended in cases where the working pressure exceeds 2,000 volts alternating and the condensers are continuously in circuit. The solid impregnated type is recommended where the working pressure does not exceed 2,000 volts alternating or where the use of the condenser is intermittent.

Helsby power condensers may be used for power factor improvement on alternating current circuits, for the suppression of

at their rated voltage and [illegible] frequency [illegible] 20 F. They are constructed in [illegible] and [illegible] suitable for a working pressure up to [illegible] Each unit is [illegible] connected in series [illegible] each number of units may be required to [illegible] exceed 50 mfd. in one such case. The cases of 50 mfd. each are again assembled in strong wrought-iron frames (or cast-iron cases for mining work), and provided with suitable switch and fuse gear.

Various [illegible] power factor improver,

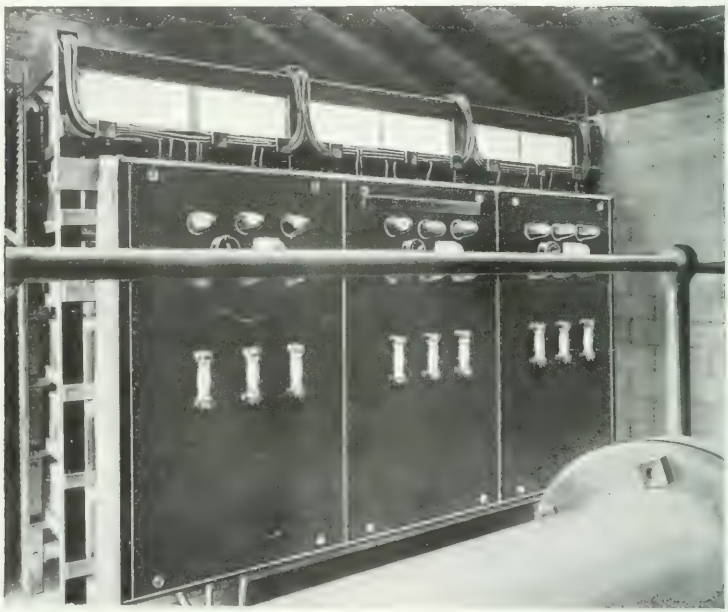
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mata, such as the installation of phase advancers, synchronous motors, vibrators, &c. All these entail the running of machinery, do not lend themselves to subdivision, are costly to instal, inefficient and costly to maintain. One advantage of the use of condensers

as such a circuit may be resolved into two components, one the energy component in phase with the E.M.F. applied to the circuit, the other displaced 90 deg. out of phase from that E.M.F., and hence, representing no consumption of energy and called "wattless." This latter component is due to the inductance of transformers, motors, &c. The product of the current component in amperes by the impressed E.M.F. in volts gives respectively voltamperes energy and volt-amperes wattless. The vector sum of both components gives the total or apparent load in volt-amperes. The ratio of the energy component to the total or apperent load is called the power factor.

HENLEY POSTER STAMPS.

Publicity by poster is a costly matter, and at the same time a doubtful expenditure, except for proprietary articles. Very few electrical firms indulge in it. But postering in miniature is a profitable and convenient method of reminding prospective customers of one's products. The box department of W. T. Henley's Telegraph Works are evidently of this opinion, for they have available for the trade a series of six coloured stamps, which may be affixed to correspondence, bags, envelopes or even inside the straw hat of some "prospect" as a reminder. They deal with street pillars and manhole covers, terminal boxes for poles, joint box compounds, colliery boxes and service cutouts. The colours have been well worked out, and the stamps are not unduly obtrusive. Try a set.



Helsby Oil-immersed Three-phase Condenser in a Colliery Generating Station.

for this purpose is that, if required, they can be supplied in small units and connected directly to those portions of the system which is carrying a low power factor, that is, a commercial can be connected directly to a transformer or motor, and can be switched on and off with the machine. This saves the losses in mains or feeders, the compensating being done exactly on the spot where it is required.

In an alternating-current circuit, if the current is in phase with the impressed voltage, the energy of the circuit is represented by the product of the current and voltage; but if the current is leading before or lagging behind the impressed voltage, the product of the current and voltage is called the apparent load, and the energy of the circuit is represented by the figure multiplied by a factor, the [illegible] always less than unity, and depending for its value on the angle of leading or lagging called the power factor.

In [illegible] distribution systems where alternating current machinery is employed, the current will lag behind the E.M.F., and it is these systems that are under consideration. The current flowing

A LARGE ELECTRIC RANGE.

We have frequently referred to products of the Brompton and Kensington Accessories Co. in the matter of electric cooking apparatus. In particular we may recall the complete installation put down by them for the Bradford Corporation in the Kursaal in that City. We now illustrate a large range which has recently been completed to the order of a home purchaser. The full rating of the range, "all on," is 22·5 kw., though the normal working rate is about one third of this capacity.

The construction follows standard B. & K. lines, there being a wrought-iron framework fitted with planished steel and panels of heating insulating board and suitable lagging. The interior of the ovens is lined with planished steel, there being three ovens, each measuring 24 in. by 18 in. by 18 in. In each oven, and fixed at the sides, are six heating units, three a side, each unit having a capacity of 500 watts or 3 kw. per oven. Surmounting the ovens is a large

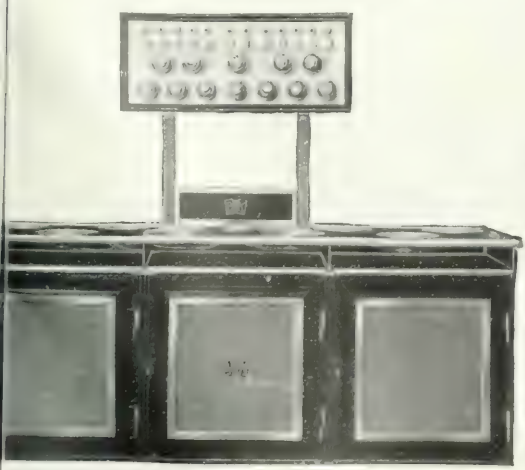
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THE LAMP WITH A LIVING IN IT

oiling plate which measures approximately 24 in. long by 24 in. wide. Fitted into this are nine standard B. & K. boiling plates, each 10 ins. diameter, rated full on, at 1·5 kw. each.

The control of the range is effected from a large separate switch



Front View of B. & K. Range.

and fuse board carried on two stout tubular steel brackets at the back of the range. The whole of the internal wiring is carried directly back from the hot plates and oven elements to the board in a manner obviating any point within the frame of the range itself. The connections are made at stout and accessible terminals in a special box, which will be noticed above the level of the boiling plates and between the standards carrying the board. This system of connections also makes it possible to remove any hot plate or oven element, by the simple disconnection at the terminal box, and the withdrawal of the part for renewal, repair or inspection. Three heat switches of the Hart pattern and dial fuses, also indicating lamps, complete the equipment of the control board.

ELECTRIC HOUSES IN GLASGOW.

In our last issue we published a number of photographs showing the exterior and interior of one of the electric houses which have been erected in a Glasgow suburb and equipped throughout with a domestic electric service for heating, cooking, ventilating and lighting. We have since had an interesting letter from Mr. George Hamilton, who has been locally christened "The Utopian Builder." Messrs. George Hamilton & Co., who have been responsible for the electric houses, are builders of nearly a half-century's experience, and the fact that they have come under the spell of the all-electric house idea is well worth noting by electricity supply engineers and electrical contractors generally.

Mr. George Hamilton in his letter to us refers to the year's bill of £51, this being the figure given by Mr. Lackie at the I.M.E.A. Convention. Mr. Hamilton states that the amount may appear excessive, but it includes the operation of the apparatus for exhibition purposes to many hundreds of people who visited the house, and quite naturally wanted to see how things worked. Also during the period Mr. Hamilton was unfortunate enough to have a considerable account of illness which necessitated the keeping of certain of the fires on circuit both night and day. Bearing all these facts in mind, Mr. Hamilton was surprised that the amount was no larger than it was.

We are sorry to hear that Mr. Hamilton has experienced a considerable amount of opposition from local electrical contractors, who personally ridiculed the scheme, both in Mr. Hamilton's presence and amongst the local residents. Probably they were labouring under an impression that an electric house is altogether too Utopian to be put into practice at the present day, and that anything in the nature of a premature attempt would be doomed to failure. We prefer to think

that their attitude was governed by these motives, rather than that they were deliberately opposed to the scheme. We understand that this unfriendly attitude on the part of the contractors ceased as soon as it was [illegible] that Mr. Hamilton had experienced no opposition of the scheme, and had remarked that it was perfectly feasible.

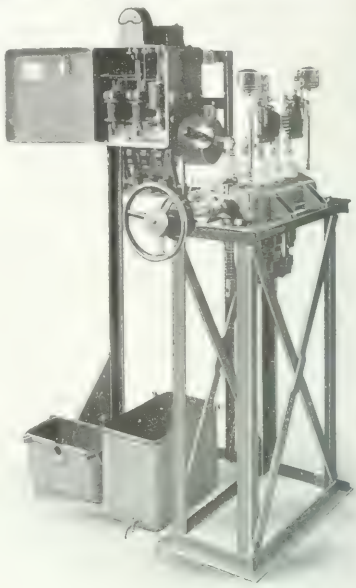
Mr. Hamilton has kindly given us a few figures based upon 12 months' working. He states that breakfast can be cooked very nicely in 16 minutes at the cost of ¾d. for electrical energy. A full breakfast of six courses has been cooked in 22 minutes, this representing the record for the house. The hot water apparatus, of the [illegible] type, furnishes hot water for a bath in 10 to 12 minutes, and a bath can be obtained in 20 minutes, the cost of energy being at the rate of 3 units per hour. The fires take ¾ unit on the low heat and 2½ units on the full heat, and, we understand, they are seldom full on after the first 20 minutes. In June the record for the first week was 8d. per person per week for lighting, cooking and heating (hot water); during the last week of June it was 4½d. per person per week.

We think the above figures are of considerable interest, and we are obtaining further information from Mr. Hamilton, which we hope to publish in due course.

EXHIBITION OF SWITCHING APPARATUS.

In connection with the issue of a new catalogue of electrical apparatus, the Electric & General Works, 15, Victoria-street, London, S.W., have arranged an exhibit at their show rooms. The large illustration adjoining gives an idea of the lay-out of the principal features of this exhibit. It comprises extra-high-tension, high-tension and low-tension fuses of the air and oil-break patterns; knife switches, one, two and three pole; automatic circuit-breakers; isolating switches for high-tension and extra-high-tension bus bars; lightning arresters, liquid resistances, choking coils, &c.

One of the oil fuses will be noticed at the right-hand of the vertical panel, which is shown on the left of the exhibit. This fuse is designed to blow in air under an aluminium hood, which is open at the front, and to finally break under oil. The oil is contained within the porcelain handle of the fuse, and the lower contact at the bottom of the oil bath is provided with a spring with a terminal at its free end, which is raised above the level of the oil for the attachment of one end of the fuse. This fuse is made in a range of sizes from 200 kw. to 2,500 kw. single phase, and voltages from 6,000 to 50,000. We understand that a [illegible] type of [illegible] is [illegible] the bottom of the oil receptacle, and that no cement or compound is employed for holding in the lower terminal. This is an important feature, because one of the principal troubles with fuses of this [illegible] in the past has been oil leakage and consequent [illegible]. We also



Enclosed Oil Switch and Switch Box.

illustrate an oil switch and switch box mounted on skeleton frame, which is also exhibited at the company's show room. The principal features of this apparatus are clearly shown in the illustration. The



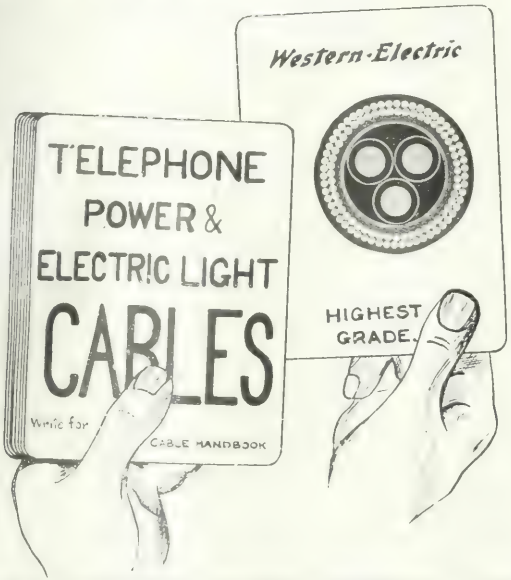
General View of Switchgear Assembly.

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provided with an adjustable pattern of air bellows time-limit device. The overload or short-circuits is immediately opened irrespective of the position of the hand wheel.

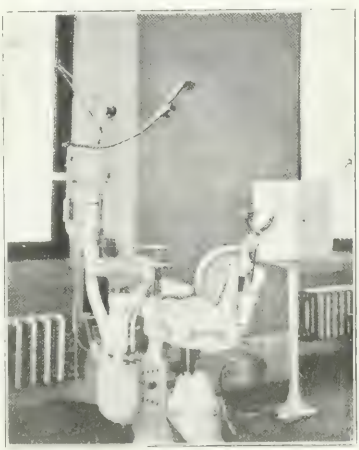
The dealing with the following classes of apparatus: (1) Low-tension high-tension ironclad switch boxes; (4) high-tension and extra-high-tension oil switches and instrument transformers; (5) high-tension and extra-high-tension horn-type line-sectioning switches; (6) high-tension and extra-high-tension protective apparatus; and (7) low-tension, high-

ELECTRICITY IN A DENTAL INFIRMARY.

The new [illegible] has been erected and equipped at a cost of £100,000. It provides gratuitous dental treatment for children of 16 years of age and under, and three treatments per annum can be given to 76,800 little patients: the ultimate facilities available will provide 381,600 treatments per year. This philanthropy is met by an endowment of £400,000. Apart from these matters the [illegible] is noteworthy on account of its electrical equipment. Energy is furnished during the day time by a private plant comprising three 25 kw. 110-220 volt three-wire generators, each driven by a 40 B.P. simple non-condensing engine. The night time service is given from the mains of the [illegible].

The main operating room is 160 ft. long by 70 ft. wide and contains 62 dental chairs, together with a number of accessories in the shape of [illegible]. Each chair is provided with an electrically-driven dental engine installed in the frame of the chair and controlled by a pedal switch which can be suspended when the machine is not in use. This switch [illegible] and [illegible] conditions. This idea is reproduced throughout the infirmary. The circuit [illegible]

Attached to each chair are four push button switches, one in circuit with an indicator board with 110 numbers, in the waiting room lobby, the second in circuit with the central stockroom, the third in connection with the instrument supply room, and the fourth for answering calls from the clinic room, in order to witness demonstrating operations. On a flexible bracket which is attached to the chair is a 40 watt lamp with a sectional reflector.



[illegible] Dental Infirmary, West Ham.

The arrangements for the sterilising of instruments are very complete. Metal trays mounted on a pedestal at the side of the chair are provided, and when patients are dismissed the trays are collected in trucks and removed to the cleansing and sterilising room. A tepid water supply for rinsing fountains and syringes at each chair

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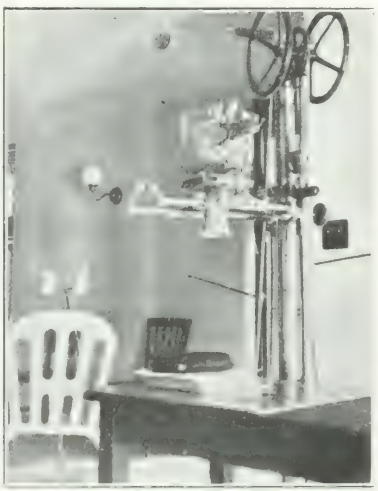
SWITCHES *(Air or Oil Break Patterns).*

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is accumulated by a 5 H.P. centrifugal pump operating in conjunction with a 600 gallon storage tank. The sterilisation of the instruments is accomplished by two gas ovens in the basement equipped with ½ H.P. fan motors which force hot air through portable racks of



Part Arrangement of Operating Theatre Equipment.

in the boiler room, a 3 H.P. ash elevator motor, and two 3 H.P. motors driving pumps supplying air washer shower heads.

Electricity is also used for deadening pain and generally adding to the comfort of the children during certain trying operations. A "galvanic controller" is used for this purpose and is operated on a 100 volt D.C. circuit. The process consists in forcing neurocaine into the nerves of sensitive teeth, gold or platinum foil being used to make the positive contact, the negative contact being made at the patient's wrist. For deadening a nerve a current of from 2·5 to 3 milliamperes is applied for one minute, and for pyorrhea the current is applied from one to three minutes.

The main infirmary room is lighted by 16 groups of four 100 watt tungsten lamps, each with 24 in. bowls installed 6 ft. below the ceiling and supported on brass tubing. This type of lighting is practically uniform throughout the building. On the mezzanine floor above the infirmary room is an X-ray department fitted with a complete apparatus and a regulating switchboard. The building is fitted throughout with standard time clocks, which for sanitary reasons are flush with the wall.

LANGDON-DAVIES MOTORS.

A new price list of single, two and three phase motors has just been issued by the Langdon-Davies Motor Co. The single-phase motors are made for 40 to 125 periods, and the polyphase machines for 25 and 40 periods. The motors are supplied either of the squirrel cage or slip-ring type; they range in output from ¼ H.P. to 120 H.P. The discounted prices of the various standard sizes of machines are set out in tabular form, the prices being readable at once owing to the use of letter type.

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

Printed and Published by GEORGE TUCKER, at the Electrical Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, In the City of LONDON, FRIDAY, AUGUST 13, 1915.

THE ROUND TABLE.

Some months ago we commented on the appearance of a B.T.-H. (Rugby) staff publication known as "The Asteroid." In self-defence, the staff of the B.T.-H. Willesden works have produced "The Wileroid," and the first copy has now reached us. The contents are chiefly of B.T.-H. interest, but a few of the items in the "En Réponse" (quite Willesden-esque) column are worth quoting.

STEVEN.—We understand that what you want to know is whether a certain reversing auxiliary switch *opens* when the main switch *closes*, and *closes* when the main switch *opens*, or whether it *closes* when the main switch *closes* and *opens* when the main switch *opens*. We have approached our apparatus engineer on the subject, and he says the answer is in the affirmative! We trust the matter is now clear to our friend, but would suggest that the safest way out of his difficulty would be to order up a double throw auxiliary switch every time.

SEVEN DAYS.—We are afraid you cannot get compensation. If you will go to Willesden Police Station, demand a sixpenny ticket and refuse to be convinced that the place was not a picture palace, what alternative could you expect?

SMALLHOLDER.—The "roasted meat squares" has nothing whatever to do with small allotments in Scotland.

ANXIOUS.—Your assumption is wrong. The term "phase splitting" is not a boxing expression. Possibly the error in spelling misled you.

SAMMY (London).—The solution should include potash bichromate, not "Potash and Permanate."

* * * *

In another column are described some new Ferranti electric fires. The firm is badly in need of a trade name for the fire marked with a cross (on next page). They have the Reflector, the Box and the Pedestal. Suggestions for the fire in question are invited from our readers, and we understand that the coiner of the most suitable name will be rewarded with one of the fires. Word twisters, get busy!

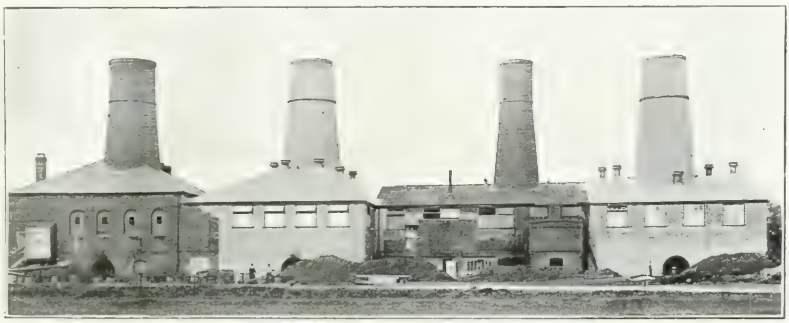
A correspondent calls our attention to the following paragraph in the "Evening News" (London) of the 11th inst. He thinks it takes the Hotplate :—

REMARKABLE DEATH.

Archibald Hemingway, 39, was cleaning a tramcar at Halifax to-day when he suddenly gave a scream, and soon after died.

It is supposed that the insulator was damaged in yesterday's storm, and that Hemingway touch a live part of the short circuit.

Mr. Gaster's attention should have been called to the "copy" before it was sent to press. It is errors of this kind that the Institute of Journalists is anxious to correct before they reach the printed page. Still, tramway managers might include in their car shed rules an item: "CLEANERS TOUCHING THE LIVE PART OF A SHORT CIRCUIT DO SO AT THEIR OWN RISK."



YET ANOTHER GLASSHOUSE AT EDISWAN WORKS.

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), August 24, 1878.]

"Suppose we admit that science at present is incapable of subdividing the Electric Light to any great extent, is that any reason why we should believe that science is to remain for ever powerless? She is nothing if not progressive, and what is deemed impossible to-day is laughed at as simple to-morrow. We shall hardly be accused of breach of confidence if we hint that we know more than one inventor who claims to have surpassed what his predecessors have done in the direction of electric lamps; and we have every reason to believe that, before these lines can reach the public eye, a new lamp, said to be almost perfect, which has undergone an exhaustive trial, will have arrived at that point when the requirements are clearly defined and the difficulties well known, and it will be a strange exception in the history of scientific progress if with such a case in hand we find ourselves at a standstill because Nature refuses any longer to answer inquiries."

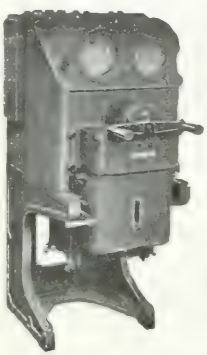
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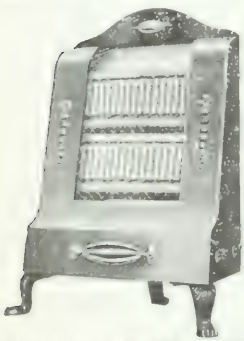
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NEW SEASON FERRANTI FIRES.

[illegible] engineers who have [illegible] operation [illegible] components to [illegible] electrical [illegible] will be [illegible] new heat-electric fires which [illegible] coming forward for the heating season. A complete file of the lists which deal with these fires, and also Ferranti [illegible] the makers.

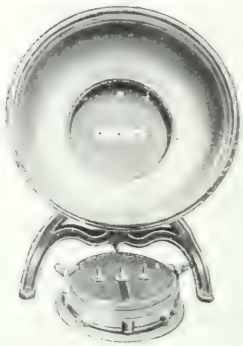




[illegible] Ferranti [illegible]

[illegible] reflector [illegible] be remembered. The [illegible] on all double-bar [illegible] and [illegible] The [illegible] from the [illegible] The [illegible] metal [illegible] edge [illegible] glow from it, a quartz disc was placed immediately in front of it. [illegible] with this pattern

of element, and the makers have now developed a cone type which is intended to replace it. It consists of a fireclay cone of small proportions and provided with a spiral path on which is laid the heating element, which is a helix of nickel cronium wire. This cone with its heating element is worked directly in air, but it is shielded from actual contact by a wire guard of fine mesh. The terminal arrangement of the cone and the general mounting in a circular metal case is identical with the old design. There are two live terminal pins and a central pin which is the earthing contact. The entire unit can be readily withdrawn, and advantage is taken of this fact to offer the new pattern in exchange for the old quartz design. We understand that a useful allowance will be made for the return of the quartz element. The new cone is rated at 1,000 watts, and is also surrounded with an ornamental ring. The heating spiral is guaranteed conditionally for two years from date of despatch, and if it fails under proper usage within this time a new spiral will be provided

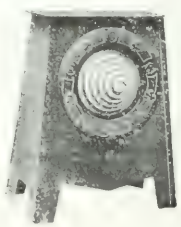


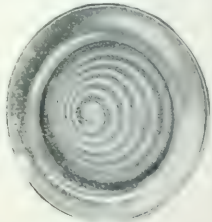


REFLECTOR FIRES WITH NEW CONE ELEMENT.

free of charge, and may be readily fitted by the customer. Illustrations are given of the reflector fires fitted with the new cone element.

A Ferranti fire which has not been [illegible] although it came on the market a little late it was, we gather, very well received. The heating element is a continuous spiral, which is held in place by a number of unit fireclay blocks supported on threaded iron rods. These latter act as terminals and are held in position in the frame of the fire by slotted metal strips, which are [illegible] These [illegible] are covered with heavy gauge, which is held neatly in position in the frame. One of the new patterns of 2 kw. bar fires with sloping ornamental front is illustrated. This is [illegible] type [illegible] design, which was put on the market last year, and which proved very popular. The sloping front type should have considerable vogue, because it is rather more pleas







NEW ELEGANT CONE ELEMENT AND PEDESTAL FIRE WITH CONE ELEMENT.

[illegible] temperature. It is provided with a copper reflector at the back of the heating elements, and there is a convenient handle, which is at the back of the frame and entirely out of range of the heat currents. It is therefore always cool. This sloping front design is also made for 3 kw. rating, and one of these fires is illustrated herewith. The [illegible] this pattern measures 16 in. wide by 9 in. by 21 in. high, and weighs 14½ lb. The 3 kw. one is 15½ in. wide by 9½ in. deep by 24 in. high, and weighs 17 lb. The frame can be either of black [illegible] enamelled ornaments or oxidised copper. We understand that a pattern of 2 kw. fire with cast-iron frame will shortly be available.

A word may be said with regard to the design of the lists in which these fires are described and priced. In the first place, the size is uniform, and a standard scheme of arrangement has been adopted. Each fire has a separate list, the article is illustrated and then follow (1) prices, in tabular form, (2) code endings for various voltages, (3) wattages, (4) construction, (5) guarantee, (6) instructions for wiring, (7) adaptability. The table of prices also gives code words, net all dimensions and weights, the latter being specified as net, gross and ocean tons. This scheme has been in operation for some time, and we are informed that it has proved of immense value in saving the time of customers and long-suffering buyers.

THE LIGHTING OF A PAGEANT BY PROJECTORS.

On the [illegible] June 21, 23 and 24 the citizens of Lexington, [illegible] gave an outdoor pageant commemorating 100 years of peace between England and America, the proceeds of the pageant being devoted to the work of the American Red Cross. According to the Electrical World, nearly one people in costume took part in the pageant alone, while including the workmen, the boy scout workers, etc., about 1,000 persons were necessary for the production. The pageant showed in episodes of dramatic form the part which the old town of Lexington has taken in the history of the American nation.

The pageant was staged on the property of the Twin Elm Spring Co. at Lexington, which afforded an almost perfect natural amphitheatre. In the centre was a level field, closely mowed and rolled, for the stage proper, 180 ft. long by 175 ft. deep. On a gently sloping hill facing the stage were constructed 6,000 seats for the audience. With the exception of the large orchestra, the entire pageant was lighted by projected light. Thirty-nine flood-lighting projectors, each containing one 500 watt tungsten flood-lighting lamp, were distributed around the grounds. The beams varied in spread from 6 deg. to 18 deg., depending upon the distance they were to "carry." The projectors were arranged in batteries and hidden from the audience either by natural screens, such as large rocks, or by clumps of cedar trees set out and at back of them for the purpose. From no part of the ground could more a score of lights directly visible.

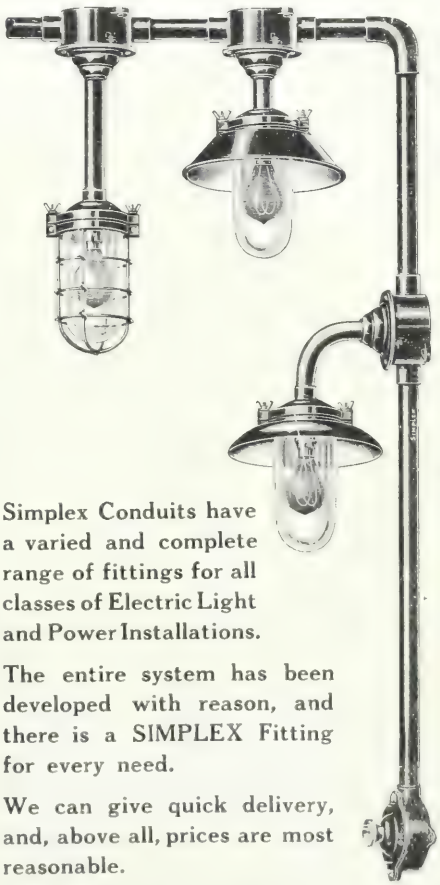
Supplementing the flood-lighting projectors, eight 20in. searchlamps, each containing a 750-watt focus-type tungsten lamp, were mounted 20 ft. above the ground at the rear of the audience. Six of these had their beams spread fan-shaped, covering the main stage and adjoining ground. The other two were focussed into spotlights, to follow the principal actors and actresses. The general flood-lighting was of such intensity that the "spots" did not give the effect of sharp-edged beams; yet they did raise the illumination on the objects on which they were trained to such a degree as to make them stand out prominently. Pale-blue and amber colour screens were used in front of both the flood-lamps and the searchlamps. Across the front of the stage proper was run a 2 in. pipe having 0·25 in. holes bored 2 in. apart. Live steam was supplied to this pipe under 15 lb. pressure from a 75 H.P. boiler. Just back of the pipe were placed 1,000 25-watt lamps in three rows—red, blue and amber, with some clear lamps mixed in. During the change of scenes the steam was turned on and changing coloured light was thrown on the stage from the 1,000 footlamps. The intensity was varied by means of dimmers, the lamps being controlled in three sections of 50 ft. each. The result was a beautiful steam curtain rising 30 ft. to 40 ft. in the air and constantly changing colour, intensifying and then fading away, suggesting colour without form. Not only was the effect exceedingly picturesque, holding the attention of the fascinated audience, but the curtain prevented the spectators seeing the changes of scenery. At the same time the steam curtain gave sufficient illumination without the flood-lamps to allow moving the full-sized three-story painted canvas houses and the other scenery off and on to the stage. All of the flood-lamps and searchlamps were also controlled by dimmers. By means of these the lights were brought up gradually after the steam was shut off, giving a very pleasing effect.

In wiring the various searchlamps and flood-lamps a balanced 110-220 volt three-wire system was used. The lighting was so arranged that no part of the stage was dependent entirely upon one group of lamps. Thus the failure of any current would not put any section in darkness. The wisdom of this provision was proved on the second night after Paul Revere's horse had become frightened at the firing and crashed through the foot-lamps and main feed wires, putting three circuits out of commission.

A 20 section [illegible] line connected the [illegible] of the apparatus with the switch house.

The following lamps were used: 1,000 25-watt lamps, 12 750-watt focus-type tungsten lamps, 60 500-watt [illegible] flood-lighting lamps, 6 100-watt tungsten lamps, [illegible]

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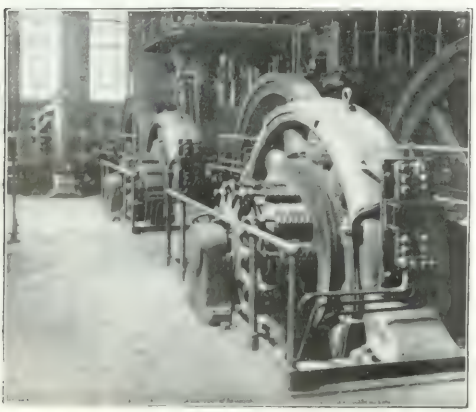
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300 candles. 8 20 in. incandescent searchlamp projectors. 56 flood lighting projectors. 25 orchestra music lamps. 25 pocket flashlamps.

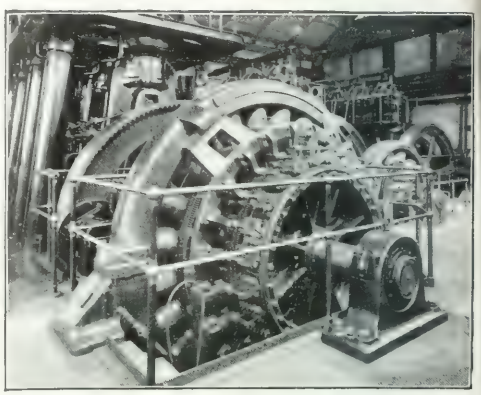
To make up the installation and operate the equipment required the services of 15 electricians for a week. The illumination for the Lexington pageant was planned by the engineers of the Edison Lamp Works of the General Electric Co., Harrison, N.J., and was installed under their direction by a corps of Harvard students.

ELECTRIC SUPPLY IN A BALL-BEARING FACTORY.

In the works of the Hoffmann Mfg. Co., Chelmsford, power is supplied for driving the machinery at 110 volts, and the generators are called upon to supply very heavy currents. The machines are driven by Diesel engines, and in the first installation comprised two 220 kw. Witton generators coupled to three-cylinder Diesel engines, having cylinder dimensions of 450 mm. diameter by 660 mm. stroke. A recent addition to the plant took the form of a 700 kw. Witton generator driven by a four-cylinder Diesel engine, with cylinder dimensions of 510 mm. diameter by 660 mm. stroke. This engine has water-cooled pistons and cylinders. Such a machine running at the low speed of 187 revs. per min. has large dimensions, and the problems involved in its construction can be realised by the fact that the full-load current of the generator is 6,400 amperes. Special care was taken in the design and construction of the commutator and brush gear, a split commutator being adopted to carry the heavy current. We understand that the generator runs continuously throughout the week without giving the slightest trouble. An interesting feature of the installation is the fact that the machines are equipped with "Hoffmann" roller bearings, which have, no doubt, contributed to their satisfactory performance. The generators for this installation were supplied by the General Electric Co.



The 700 kw. Witton Generator fitted with "Hoffmann" Roller Bearings and developing 6,400 amperes.



The 700 kw. Witton Generator fitted with "Hoffmann" Roller Bearings and developing 6,400 amperes.

SWITCHING UP-TO-DATE.

(An Imaginary Conversation between an Enterprising Contractor and an Appreciative Client.)

BY W. PERREN MAYCOCK, M.I.E.E.

CLIENT: Good morning! Mr. Allwatt. What is it you want to see me about? I understand you have been over the premises, and I was hoping you would find the specification I sent you clear enough to quote to. Anything vague?

CONTRACTOR: The specification is clear enough, sir, as far as it goes; but I want to make a few suggestions, if you don't mind.

CLIENT: Suggestions? Always glad to listen to any. But remember that specification of mine was drawn up by an electrical friend; and he and I went into the matter very thoroughly, especially as regards the lamp fittings. I think we have paid every attention to what he calls "efficient illumination."

CONTRACTOR: It isn't the fittings, its the switches I wanted to see you about, sir.

CLIENT: The switches! Why we have stated exactly what patterns we want, and have even marked the places on the walls where they are to be fixed, with stamp paper. We don't want the switches fixed with stamp paper though. He! He!

CONTRACTOR: But you have marked down single-way switches everywhere; and I thought you ought to know there are others much more convenient, before sending in my price.

CLIENT: I don't understand what you mean by single-way switches. I thought every switch was like a tap—it either turned on or turned off.

CONTRACTOR: It's rather a difficult matter to explain in a hurry, because there are so many things switches can do; but if you'll allow me to give you one or two examples, I think you'll see there is something in what I say, sir.

CLIENT: Some new development I suppose. Well, give me an example. Take this study for instance. Here will be my new light, and there is the place for the switch, by the door. Now what else could I want but that?

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TELEGRAMS: "FERRYDOM, LONDON."

Conductor. I should propose to fit two switches, one by the door here, and another on the desk, say about here. This switch would be connected with some of the ceiling outlets on the wall side. The other could be mounted away from the wall where [illegible] you would then be able to [illegible] the other.

Client: The [illegible] I couldn't have light in one switch [illegible] the other?

Contractor: Yes.

Client: That seems very worthless. Is it quite safe?

Contractor: There is nothing dangerous and nothing complicated about it, sir. You [illegible] to have [illegible] we call them, in most of your rooms. They cost a little more of course, but the extra cost is nothing compared with the convenience you get.

Client: Just let me see if I've got the thing again. Suppose I am sitting at the desk in the daytime, and it becomes overcast. I can turn the light on or off without getting out of my chair. Or I can [illegible] the other switch. Or I can turn it on at one place and off at the other. Is that it?

Contractor: Exactly.

Client: Well, I [illegible] Only you'll have to get used to the notion. Some new parts, I suppose?

Contractor: Yours old [illegible] nearly as old as myself. Only contractors won't fit these switches unless they are asked, and they seldom get asked as the customers don't know. That used to be the case at any rate, but things are better now.

Client: Well, I must certainly have some of these "controls"—as you call them—fitted up here. Some day I suppose we shall be [illegible] something at these [illegible] switches.

Contractor: I was coming to [illegible] I may be done already and I would suggest this arrangement in some of the large rooms, i.e. the passages, or the staircases, and in one or two places out-of-doors.

Client: Look here. We shall have to go over the place again in a day or two, and look into this switch business closely, for I want everything to be up-to-date. Meanwhile, have you anything else up your sleeve?

Contractor: There are all sorts of things that can be done, sir: but if I were to mention them straight off they would sound complicated. The best way is to consider one case at a time—if I might suggest it.

Client: Quite so. The [illegible] switches requires a little thinking out. Now take the Hall lights, do you mean to say that if we had a switch in the hall, one upstairs, one by the servants' door, and one in the front portico, we could turn the lights on and off at any switch?

Contractor: Yes. And if you wanted it you could have a special switch, to prevent the lights being turned out at the other switches, say, during the evening. A Master switch we call that.

Client: That is getting positively uncanny. Doesn't the electricity leak away, or overflow, or something?

Contractor: There is absolutely no danger at all, sir, in any of these switch arrangements!

Client: These hall-light switches will be grand. I am tired of having to go upstairs in the dark or with a candle after turning out the gas; and its a confounded nuisance coming down in the dark for something you've forgotten.

Contractor: I'm always pointing that out to my customers; and talking about gas, sir, I often think the gas people would make the most of controls like these if only they were possible. But of course they're not, that is—not with gas.

Client: But what about the electric[illegible] people? Don't they expect to supply something of the kind?

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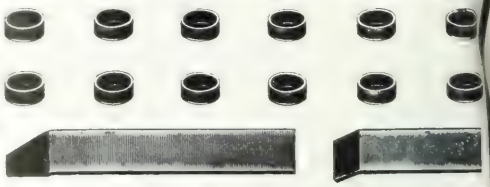
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Sole Agent to the Electrical Trade:—
LIONEL ROBINSON, 3, STAPLE INN, LONDON, W.C.
TELEPHONE: No. 611

CONTRACTOR: Not now, sir! They used to! That's the funny part of it. Although they have most complicated contrivances upon their works, their inspectors used to grumble at the simple "contraptions," as they called them, that I fitted upon some of my jobs.

CLIENT: Fancy electrical men objecting to electrical advantages!

CONTRACTOR: I think one reason was that they hadn't much time to spare, and it worried them to have to think out the wires. But things were altered after they refused to connect a job, and I had to get a lawyer to write about it.

CLIENT: How was that?

CONTRACTOR: The Chief was one of those who could bring his mind down to "small things." After he had heard of the trouble and had smoothed matters over he made all the inspectors go in for one of the Switching Competitions we have in some of our electrical papers, about every six months. There was no trouble after that, except now and then when a new man came along.

CLIENT: You must let me know about these things later. Now I have been thinking that two-way switch business would be the very thing for the bedrooms. One by the door, one by the bed. What!

CONTRACTOR: Just so, sir. That's where they generally are fixed. But as most people find more difficulty in understanding the uses in other places, I generally mention the other places first.

CLIENT: Mention another besides this study.

CONTRACTOR: Your workshop down the garden, sir. You've specified a lamp and an ordinary switch just outside the garden door, and the same outside the workshop.

CLIENT: Well?

CONTRACTOR: I would make the switches two-way and connect the lamps to work together. And you could have a third switch at the other garden door.

CLIENT: Good! I follow the idea. Anything else?

CONTRACTOR: I notice you have got two radiator sockets marked down for some of the small rooms as well as in the larger ones.

CLIENT: The intention is to have two or three radiators in some of the rooms, but only one in the small rooms. But in the small rooms we want to be able to plug in the radiator in either socket, and so get rid of some of the cord. Quite O.K. Eh?

CONTRACTOR: I should fix a switch to prevent anyone using two radiators in these small rooms, to prevent waste and to save the fuse.

CLIENT: Two sockets and one plug. Eh? Ha! Ha! What sort of a control would you term that?

CONTRACTOR: It's what we call a restrictive circuit. There are two or three kinds, and they are very useful for keeping down the consumption.

CLIENT: I shall have to look into these. Meanwhile, let's think of the kitchen quarters. I suppose you could fix up something to enable me to know if the servants had locked-up and turned-out the lights, without my having to go and see.

CONTRACTOR: A pilot circuit would do that, sir.

CLIENT: Great Jellicoe! You seem to be able to do anything with electricity.

CONTRACTOR: We can do most things if people like to pay for [illegible] arrangements are not so all [illegible]

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

CLIENT: It just struck me that when you have two or three switches turning lamps on and off you can't vary the light.

CONTRACTOR: Yes we can, sir. You can either use a varying switch or one of the "Marvel" circuits.

CLIENT: Marvellous!

CONTRACTOR: Quite so, sir. Ha! Ha!

CLIENT: Well it's very clear I shall have to get the specification amended, and meantime isn't there some book that I can get to tell me about these controls.

CONTRACTOR: You want this little sixpenny blue book "Lektrik Lighting Connections," and until I can send you a fresh copy perhaps you won't mind taking this one. Excuse the thumb marks. If I may mention it, sir, you will find my name among the Advanced-Certificate Holders on one of the back pages.

CLIENT: Indeed! That's good (*looking at the title page*)! I am sorry to see though, after all this talk, that we seem to be indebted to a wretched German firm for these special switches

CONTRACTOR: That's a mistake a good many people make. *Lundberg* is no more German than Smith or Brown. It's a Swedish name. But the firm is now English, and holds the Royal Warrant.

CLIENT: So I observe. And about those competitions.

CONTRACTOR: That "Booklet" will tell you something about them, and the results of the last are published in this week's issue of THE ELECTRICIAN.

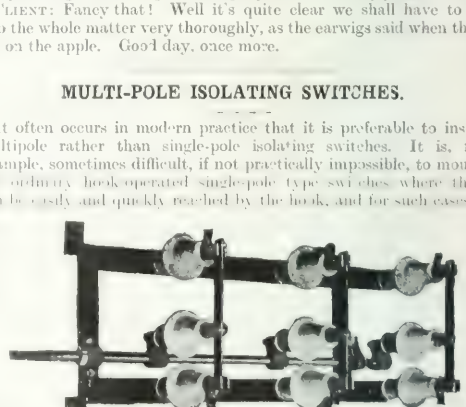
CLIENT: I'll look up that paper. And now my time's up. Will let you know when to call again Mr. Allwatt. Good day. Half a minute though. Supposing I wanted a switch to turn on all the lights in the house, say, when there was an alarm of burglars. You couldn't do that, I'm sure.

CONTRACTOR: That could be done, sir; and it's not a bad idea to fix special lights for burglar scare purposes, in a lonely place like this.

CLIENT: Fancy that! Well it's quite clear we shall have to go into the whole matter very thoroughly, as the earwigs said when they got on the apple. Good day, once more.

MULTI-POLE ISOLATING SWITCHES.

It often occurs in modern practice that it is preferable to instal multipole rather than single-pole isolating switches. It is, for example, sometimes difficult, if not practically impossible, to mount the ordinary hook-operated single-pole type switches where they can be easily and quickly reached by the hook, and for such cases a



multipole switch will be found particularly useful. This switch is provided with a pindle on which may be mounted a chain wheel for [illegible] mechanical control, by means of which the three poles may be switched in or out immediately with certainty and ease. These switches supplied by the Electric & General Wireless Ltd., of 15, Victoria-street, London, S.W., for any voltage [illegible]

Printed and Published by GEORGE TUCKER, at the Imperial Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET [illegible], in the City of LONDON, FRIDAY, AUGUST 20, 1915.

THE ROUND TABLE.

The adjoining photograph speaks for itself. "C. T. S." rooking cannot help being a versifier, but he has never had



any of his efforts published in such large type before or given such a "circulation." At least, we think not.

* * * *

A [illegible] parodies Longfellow's poem, pointing a moral upon the continental steel frauds which have so rigorously been exposed by our contemporary. The first and last three verses are reproduced below:

Tell me not in weekly numbers
[illegible]
That my cheek out-cools cucumbers,
And I am not what I seem.

* * * * * *

Lives of many smart men teach us
[illegible]
With the fate of doing time.

Time that's been done by another
In despite of all his skill;
Some misguided, botching brother
Languishing in Pentonville!

[illegible]
Doing someone every day.
Cheerfully the shekels wooing.
While the sun shines making hay!

* * * *

It is unofficially reported from our Zeebrugge office that Mr Durtnall passed over the Flemish coast, travelling east at a great pace. Evidently he is out trying his new thermo-electric (or thermo-syphon) flying machine. He is presumably testing it for [illegible]

The following wording of a recent Arrol-Johnston advertisement should be carefully digested by would-be manufacturers of electric vehicles in this country:—

EACH imported pleasure car bought now means so much actual GOLD shipped away.

THE while British motor manufacturers make munitions, and watch their markets, goodwill and sales organisation fall into greedily aggressive "neutral" hands.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), August 31, 1878.]

NEW APPLICATIONS OF THE ELECTRIC LIGHT.—A correspondent has written to the *Globe* suggesting the use of the electric light in tunnels. By so doing, he says, the carriages would not require to be supplied with oil or gas, much time and labour would be saved, and a uniform light would be ensured, not leaving, as is often the case, part of the train in darkness. The carriages would be cooler and less dirty, the driver would have a clearer view of the line, and the system would be less expensive than that at present in use. From France, we hear of harvest operations being carried on by the same light.

THE TELEPHONE IN THE FIELD.—According to the *Gazette de Cologne*, the telephone is about to be utilized in the German army. The regiment attached to the railways has been making with this apparatus some experiments, which are to be repeated by the infantry regiments. These will use the telephone for the advanced guard service. The experiments in question are facilitated by some new improvements in the telephone, which is provided with an alarum and an apparatus in imitation of the bugle, worked by a magneto-electric current. Some important reviews of the troops are to take place, and will give an opportunity for forming an opinion as to the extent to which the telephone may be utilised in military operations.



DRAUGHTSMAN: "GOLF STRAFE SCOTLAND."
[From the "Wileroid."

Study of a B.T.-H. (Willesden) draughtsman after uncovering his drawing board the following morning.

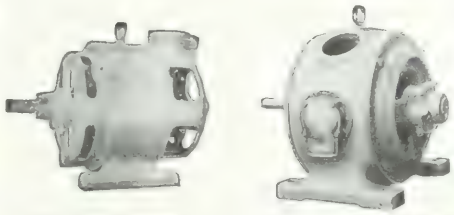
THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).	Mr. W. G. Pickvance (Wrexham).
Mr. H. F. Street (Southampton).	Mr. H. Gray (Accrington).
Mr. W. H. Cooke (Luton).	Mr. S. E. Fedden (Sheffield).
Mr. T. Roles (Bradford).	Mr. J. W. Sparks (W.Hartlepool).
Mr. A. S. Blackman (Sunderland).	Mr. J. W. Beauchamp (West Ham).
Mr. C. S. Davidson (Barnes).	Mr. A. H. Shaw (Ilford).
Mr. A. H. Seabrook (St. Marylebone).	Mr. C. Furness (Blackpool).
[illegible]ing).	Mr. C. M. Shaw (Worcester).
Mr. C. W. Spencer Hawes (Bexley).	Mr. H. A. Nevill (Wakefield).
Mr. J. W. Hame (York).	Mr. Frank Ayton (Ipswich).
Mr. S. T. Allen (Wolverhampton).	Mr. C. N. Hofford (Leeds).
Mr. F. W. Purse (Carlisle).	Mr. S. E. Britton (Chester).



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BRISTOL—30, Bridge Street.
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MANCHESTER—196, Deansgate.
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SHEFFIELD—22, High St. [Bldgs.
SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

FERRANTI ELECTRIC COOKERS.

The development of the domestic and restaurant types of electric cookers is proceeding steadily from the manufacturers' point of view, and the number of users of this class of apparatus is also increasing. Both electrical contractors and central station engineers are assisting the movement, the latter especially by furnishing electrical energy at rates which place the apparatus on a practical competitive footing with gas and coal. Considerable interest attaches to many of the designs of electric cookers which are described in a series of new st... issued by Ferranti Limited.

Fig. 1 illustrates a type of cooker which is suitable for prov... meals for 70 to 80 persons daily. It is a design suitable for restau... or hotel service. It is built on substantial lines, the main frame ... of cast-iron and the ovens, of which there are two, are suit... lagged. Each oven measures 22 in. by 22 in. by 22 in. inside, ... the maximum energy consumption is $4\frac{1}{2}$ kw. for each oven. ... mounting the oven on a cast-iron plate is a grill, which is divided ... two compartments, each measuring 21 in. by 15 in. The

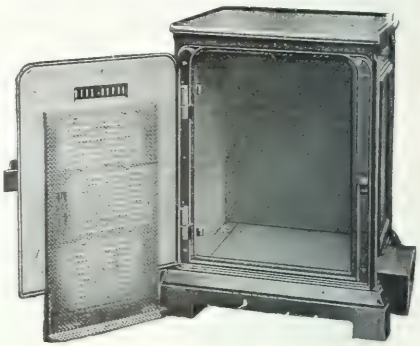


FIG. 3.—OVEN INTERIOR, SHOWING POSITION OF ELEMENTS.

energy consumption of the two grills is 11 kw. The finish of ... range is black enamel with polished facings, and, as the illustra... shows, it is a handsome piece of kitchen furniture. The contr... the various circuits is effected from a separate board, which is of ... cast-iron separate panel type, the fuses and switches for each cir... being grouped together and indicating lamps supplied in each pa... The connections between the control board and the range are carr... in flexible metallic tubing. A somewhat similar design of cooker ... a small restaurant is also listed. This includes a single oven 22 ... cube, with a maximum rating of 6 kw., a grill consuming 1,800 wa... and three 2-heat boiling plates, each rated at 1,150 or 350 watts. ... separate ironclad control board is also provided, this being of sim... construction to the range shown in Fig. 1. Fig. 2 illustrate...

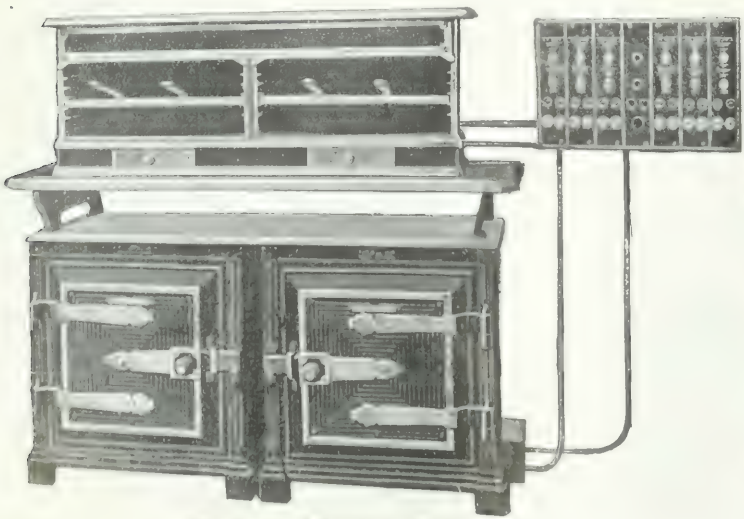


FIG. 1.—LARGE RESTAURANT COOKER.

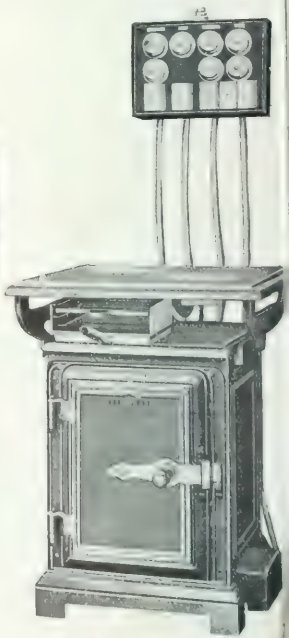
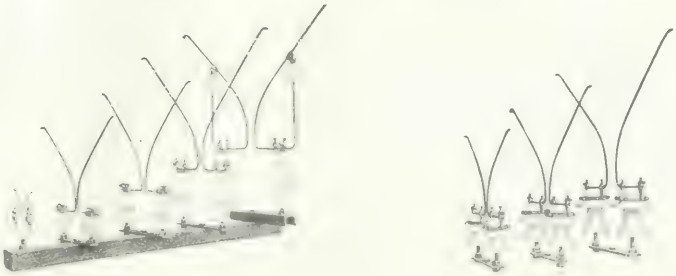


FIG. 2.—DOMESTIC COOKER.

The Electric & General Works, Ltd

15, Victoria Street, London, S.W.



Horn-type Lightning Arresters for Indoor and Outdoor Mounting.

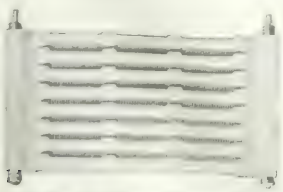
Electrical Apparatus up to 80,000 Volts & 4,000 Amps.

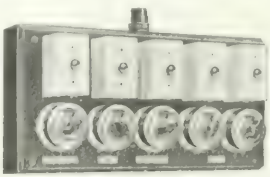
Telephone: 5223 VICTORIA. Telegrams: "GABIONAGE VIC LONDON."

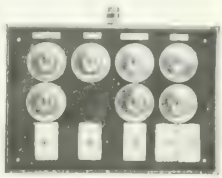
domestic [illegible] and boiling [illegible]. In the large size the [illegible] 14 in. by 14 in. by 23 in. The oven [illegible] in Fig. 3, are under 3-heat control, and having a rating of 3,300, 2,140 and 1,160 watts. The grill is rated at 1,350 watts, and the two boiling plates are 2 [illegible] 1,100 and 300 watts. In the intermediate size of cooker the cooking space in the oven is 13 in. wide by 13¾ in. deep by 19⅜ in. high. The oven rating is 2,500, 1,650 and 850 watts. The grill is rated as in the large size, and the hotplates are 850 and 300 watts [illegible]. A third heating [illegible] supplied if desired. In the large size of cooker the hotplates are 8 in. diameter, and 7 in. in the intermediate size. In all these cookers the elements are [illegible] arrangement admits of the easy removal or replacement of the elements. The design of the [illegible] to that employed in the Ferranti fire, [illegible] heavy-duty [illegible] and not [illegible].

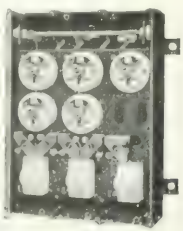
In Fig. 5 are shown the various patterns of control boards which have been standardised for use with Ferranti cookers. Type "W.M.T." is fitted with tumbler-switches and Zed fuses, and is offered in various sizes. Type "W.M.R." is designed for use with rotary switches giving 3-heat control and oblong pattern open wire fuses. The ironclad type, "I.C.," is fitted with tumbler switches and Zed fuses, and the interior of one of these boards is shown in one of the illustrations in Fig. 5. These boards are made up on the unit principle, and any number of ways can be provided for. The case is of black enamel cast iron with bright facings, and accommodation is provided for 'bus bars, switches, indicators and fuses. Suitable bushings are furnished for the incoming wires, and all live interconnecting parts are insulated from the case with porcelain.

The foregoing have been selected as examples of Ferranti cooking apparatus from the catalogue referred to. There are other cookers and kitchen apparatus, such as carving tables and hot-cupboards, rapid water boilers, separate grills, utensils in cast iron and cast aluminium, and such accessories as connectors, flexible cable and flexible metallic tubing. A copy of the catalogue, which also [illegible] issue, can be obtained from the company at their head offices, Central House, Kingsway, London, W.C.







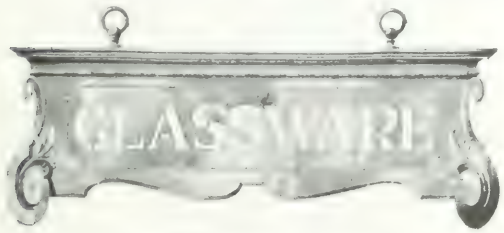


[illegible] [illegible]

G.E.C. FITTINGS ACCESSORIES.

The latest catalogue published by The General Electric Company (Ltd.) deals with "Electric Light Fittings Accessories, 1915." It is the most complete catalogue of its kind that has been issued and will be found a useful work of reference among electrical engineers, contractors, architects and others who have to select accessories, for electric light installations of all descriptions. It illustrates and describes all the established types of accessories, and a large number of novel designs. Cord grips, hooks, screw eyes, nozzles, ceiling plates, anti-vibrators, cord shorteners, galleries, shade carriers, tilters, ball fittings, counterweight fittings, chains, wire guards, switch plates, wood blocks, reflectors; these are some of the many things arranged for easy selection. The following notes necessarily refer to only a few of the designs, selected mainly for their novelty or for their usefulness to installation engineers in the direction where most business is now being done.

Glassware.—In addition to the now well known types of "Sterilux," "Holophane" and "Equiluxo" ware for the scientific distribution of light, the glassware section of the catalogue includes a list of cardboard, fancy silk and fancy glass shades, many of entirely new patterns.



Specific Window Advertising Sign

Chains.—This section, which deals with tubes, nurls and "S" hooks in addition to chains, has been enlarged by the inclusion, among other novelties, of a new pattern rectangular link chain, three patterns of Cash's ornamental patent chain and several fresh styles of "S" hooks.

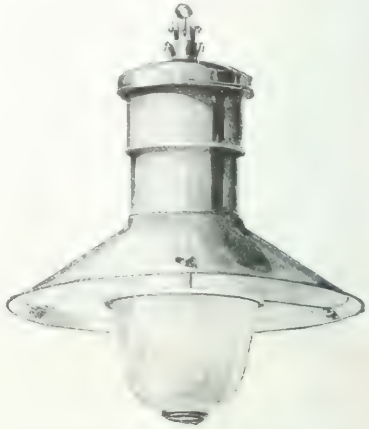
Reflectors.—One of the most useful divisions is concerned with reflectors for shop-window and show-case illumination. The special regulations for shop-window lighting in war time have made almost compulsory the adoption of what is in fact the best system of illumination—that of concentrating the light upon the goods displayed instead of allowing it to be thrown on the pavement and into the eyes of prospective customers. The catalogue describes new reflectors for "Striplite," and for standard Osram drawn-wire lamps



Conical Reflector with Metal Lens

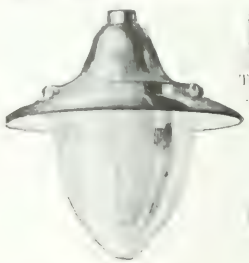
are to be used in conformity with the present regulations. These designs are supplied complete with chains and ceiling plates and are provided with an adjustable rod at the back. Different types of reflectors may be attached to this rod in order to bring about any desired distribution of the light, upwards, downwards and backwards. This design marks a considerable advance upon the old forms of solid box with mirror lining.

Lanterns and Posts.—The development of incandescent lighting with large units has led to a demand for special lanterns. Among those included in the new catalogue is a cheap industrial unit, known as the "Ordnance" lantern. This is designed to take Osram Atmos type lamps and gives an ideal light distribution with the lowest possible current consumption. For lighting workshops and other large spaces these are very cheap and effective. Osram Atmos type lamps can also be used with a new form of the "Highfield" lantern, fitted with a ventilated top and special wiring arrangements. Where a wide angle of illumination is required, as in side-street lighting, the "County" lantern with specially designed Holophane glassware, illustrated in the catalogue, is suitable. Easy access to the Goliath lampholder for wiring is provided by an outer top sleeve which can be lowered. The lampholder is also adjustable for focussing purposes. Many new designs of lamp-posts are shown, prominent among them being the "Whiteway Cluster" types which give an original decorative effect in main street lighting. Associated with this section is a series of iron brackets for clamping to poles or fixing to walls.



High C.P. Fitting with Diffusing Globe.

Ship Fittings.—An exceptional degree of ingenuity is displayed by the novelties among these fittings, which cover not only saloon, cabin, deck and bulkhead fittings and cargo clusters, but outside fittings suitable for docks, wharves, railways and ship yards. One of the new designs is a neat detachable casting for converting bulkhead fittings from one-light to two-lights at a trifling cost. All the cast iron fittings are now supplied so that one size is sufficient for either one or two lights, the change from one to two lights being made in a moment.



High C.P. Fitting



Two Light Adapter.

Special Handlamp.

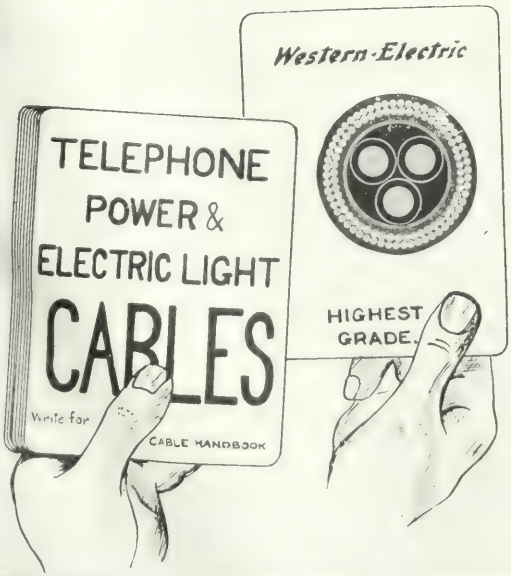
Hand Lamps.—Six new types of hand lamps are mentioned in the catalogue. Particular attention is drawn to the motor car type which has a handle of hard wood with a loaded base. Nothing could

POPE'S
Elasta
British Made Wire
Lamps

Make the most
of your opportunities and sell
ELASTA
BRITISH MADE WIRE
LAMPS

THE LAMP WITH A LIVING IN IT

SPECIFY
Western-Electric



BEAR IN MIND

They are giving satisfactory service in all parts of the world, having a reputation for durability and immunity from faults, even under the severest service conditions. Manufactured in one of the most modern equipped factories in the world, they are in every sense of the word

HIGHEST GRADE.

OUR ENGINEERS ARE AT YOUR SERVICE.

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Works: North Woolwich, London, E.

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Brass and Copper
Tubes, Sheets,
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PHOSPHOR TIN.
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TRADE MARK
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SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

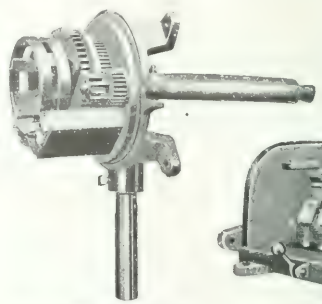
[illegible] variety of fittings and fittings accessories listed, but those will serve to indicate their up-to-date character. Copies of this catalogue [illegible] tion to The General Electric Company (Ltd.).

CRANE ACCESSORIES.

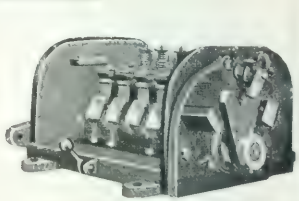
[illegible] brings the hoist block to rest within 2 in. of any given point. This [illegible] or speed conditions, and is not affected by any stretching of the hoisting rope. It cuts off the motor current and ensures quick [illegible] nor operated by a travelling nut, but is operated by a trip rope, so arranged that the hoisting block cannot fail to engage with it at the upper limit of travel. Having stopped the upward movement of the hoisting block, it leaves it free to be lowered by simply reversing the controller. The limit stop can then be easily reset by pulling on a hand rope. It may be used with any type of reversible crane controller, provided that the type of controller is stated when ordering. It was made in capacities up to 25 H.P., 110 volts and up to 50 H.P., 230 and 500 volts.

Another interesting crane accessory is an interrupted gear limit switch for automatically stopping electric cranes and other machines [illegible] predetermined limit of travel. It is arranged for mechanical connection to the operating shaft of the mechanism to be controlled, and must be electrically connected to a magnetic switch or shunt trip circuit-breaker. The limit switch can be used as a normally closed device in conjunction with a magnetic switch, or as a normally open [illegible] switches are designed for use with this limit switch in installations where no other magnetic switch is employed. If the controller itself is equipped with a magnetic switch a clapper switch is not [illegible] supported on a base casting, and totally enclosed by a pressed steel cover clamping a rubber gasket on the base casting, making a thoroughly weatherproof device. The interrupted motion is driven [illegible] for screwing into the end of the driving shaft. The connections to the limit switch are brought out through a chamber which is arranged to receive the incoming conduit. The interior mechanism of the switch is made accessible by simply removing the steel cover, thus [illegible] repair and adjustments. The range of adjustment provided is from a minimum of one-quarter of a revolution to a maximum of 36 revolutions. Unless otherwise specified, this limit [illegible] will be furnished as a normally closed device for use with a [illegible] switch.

The Igranic Electric Co. manufacture these crane accessories and also a number of patterns of lift controllers. We may mention a reversible controller for cellar lifts and short lift hoists. This equipment is self-contained, and consists of a drum case containing the line and reversing switch and resistance switch, with a space at the back containing the armature starting resistance. Only a single step of starting resistance is provided, and one current relay. The motor, therefore, is brought up to speed in two steps, one corresponding to the speed obtained with all resistance in circuit, and the other to the speed obtained with all resistance short-circuited. The motor is started, stopped and reversed by means of the drum switch which is usually connected directly to the hand cable. At the two limits of travel the lift may be stopped by buttons on the cable. The operating parts of the controller are enclosed in the drum case, and are thus protected from dust and dirt. The resistance is ventilated but enclosed. The controller is suitable for 110 and 220 volt circuits only.



Interrupted Gear Limit Switch. (Cover removed.)



Palmer Safety Limit Stop. (Cover removed.)

A small low-break drum reversing switch for high torque polyphase induction motors [illegible] is the type which may be thrown across the line, for use with electric lifts. This enclosed drum switch meets the demand for a reversing switch for use on small electric lift equipments. It is designed primarily for use with high resistance rotor squirrel cage polyphase induction motors, which do not take more than two and one-half to three times normal current when thrown across the line. It is three pole and disconnects all three lines of a three-phase, or two-phase three-wire circuit. On a two-phase four-wire system one lead is permanently connected to the motor. With lift equipments, the operating device in the car must be provided with a centering cable or similar arrangement. The maximum ratings are 5 H.P., 110 volts [illegible] H.P., 220 to 550 volts.

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Works: Dermody Road, Lewisham, London, S.E.

Printed and [illegible] at the Electrical Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of [illegible], Friday [illegible], 1915.

THE ROUND TABLE.

Regarded with the eye of the motorist the strategy of the Grand Duke must always remain as a marvellous example of the value and use of the reverse gear.

* * * *

First Shift Engineer: "What do you think of the new chief?"

Second Shift Engineer: "Well, he seems to think that what he thinks he knows he knows, but I know he knows what he knows he thinks he knows is ——"

(Main "breaker" comes out.)

* * * *

The recent L.N.W.R. accident near Stowe tunnel was attributed by one of the lay papers to the breaking of a "communicating" rod. The Railway Expert in the "Morning Post," however, felt that the opportunity was too good to miss, and delivered himself somewhat as follows:—

"The Irish mail was drawn by two locomotives, the 'Stewart,' a *non-pivot bogey* engine, and by the 'Euryalus,' with leading bogie wheels. . . . Just before reaching the point of passing, the *heavy steel rod* of the 'bogie' engine broke under the strain of the mighty blows it was delivering in its impact with the permanent way."

A method of railway traction by the "impact of a heavy steel rod with the permanent way" is a discovery, in the light of which the L.N.W.R. may regret having undertaken the electrification of its suburban lines!

* * * *

The latest half-watt lamp story is vouched for by a correspondent. A friend of his had installed a 200 c.p. 200-volt Wotan half-watt lamp in the dining room over his shop, the room overlooking a main thoroughfare. One evening he and his wife had left the house in charge of two boys (12 and 10), who commenced to quarrel as to whether the lamp should be turned on or not. A bright fire was burning in the room as it was a cold evening. The lads punctuated their disagreement by quickly switching the light on and off. The flicker of the fire light on the ceiling (the blinds were not drawn) alternating with the brilliant flashes from the half-watt lamp attracted attention in the street, where a crowd began to gather. Being early closing day, the effect in the upstairs windows was heightened by the surrounding darkness, and the rumour soon spread that So-and-So's shop was on fire. The shopkeeper was warned by telephone "that his place was ablaze, and a crowd of 3,000 people was doing nothing to put the fire out." When he arrived he found that the police were climbing into the house along a balcony from the adjoining premises. They discovered the two imps still flicking the light on and off, quite oblivious of the excitement they had occasioned!

The story should, of course, be concluded with the usual statement that, "in spite of the mental agitation to which it was subjected, coupled with the shuttling of 6,000 feet and the subdued hush of 3,000 people, the lamp is still burning!"



Electrical Terms Illustrated. A Shade Carrier. [From *Glover's Calendar*.

* * * *

The following extract from an American contemporary is appropriately phrased, as the italics, which are ours, clearly prove:

A piece of land in the heart of Pittsburgh *dammed* the flow of traffic across the city. Sewers, water pipes, cable ducts and conduits of all classes had to be lowered when this "hump" was cut down. The relocation of wires and cables for *thirteen* service companies in all the confusion of *blasting*, digging and hauling was accomplished with practically no interruption of service.

But there *must* have been some interruption in the language service, even in Pittsburgh!

* * * *

THIRTY SEVEN YEARS AGO.

[From The Electrician (Second Series), Sept. 7, 1878.]

Protection against Lightning.—All owners should follow Mr. Anderson's strong recommendation that competent persons be employed not only to erect but periodically to test lightning conductors at every point where they may be required. In Paris, he says, and other French towns, there exists a regular system of inspection and testing. Those who have the charge of our public buildings should lose no time in looking to this matter. The season of thunder-storms is not yet over, and as things stand now the Bishop of Peterborough, sitting on his episcopal throne, may any Sunday become the vehicle of an electrical discharge, struggling like a giant to reach its native earth by way of the verger's mace. We wish his lordship no harm; yet we cannot but recall Sydney Smith's celebrated dictum on the most effectual way of calling attention to a neglected danger.

THE "POINT FIVES."

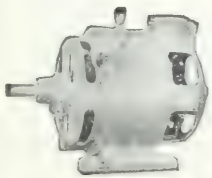
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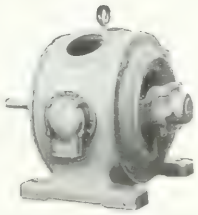
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SINGLE-TUMBLER DOUBLE-POLE SWITCHES.

The term single-tumbler double-pole switch is meant to convey that the device is a combination suitable for double-pole connection. Thus, instead of the usual coupling together of two separate single-way tumbler switches, the combination on one base of ordinary size is arrived at.

So far as we know, Messrs. A. P. Lundberg & Sons are the only manufacturers of switches of this kind, and their 10-ampere surface and [illegible] pattern are respectively shown in Figs. 1 and 2, the scale being two-thirds the actual size.

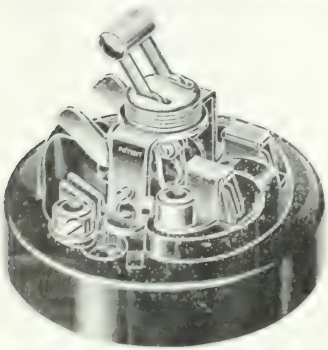


Fig. 1.—10-AMPERE SURFACE SWITCH.



Fig. 2.—10-AMPERE FLUSH SWITCH.

[illegible] patterns of cover (metal or porcelain) are available, the metal covers [illegible] in conjunction with some other type, for varying the number or [illegible] parallel, [illegible] pole with "Twinoh," double-pole with "all or part," and double-pole with special switch.

Although the details of these controls are decidedly interesting they are only of practical concern to designers and makers of electric heating apparatus, who should write for the firm's special list "H." The uses to which these switches can be put in lighting installations is a matter of more general interest, and two such uses are shown in Figs. 3 and 4.

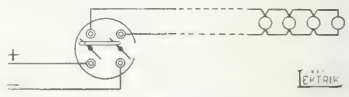


Fig. 3.

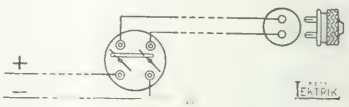


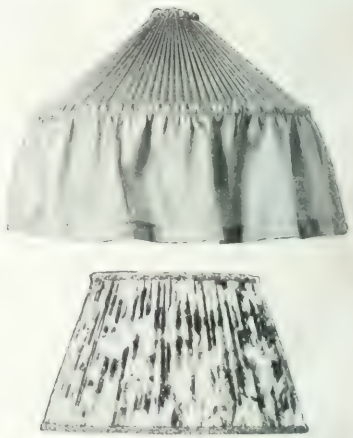
Fig. 4.

When a lamp (or group of lamps) is on an out-of-doors circuit, or in a cellar or other more or less damp place, it is decidedly better for various reasons, to break the circuit on both poles (as in Fig. 3) than to use a single-way switch. The same arguments apply also to the control of plug sockets (Fig. 4), an additional one being that there is no chance of shock at all if the socket is entirely "dead" when off.

It should be obvious that these compact forms of double-pole switch are also useful in laboratory, lecture and testing work, and on various classes of practical apparatus in wide use.

EDISWAN SILK SHADES.

The season is now approaching when the public will be improving their lighting arrangements, more especially regarding lamps and shades. It is doubtful if many new schemes will be introduced on account of the general feeling for "household economy," but new shades should replace those which have seen the previous season through. We have known for some little while that the Edison & Swan Company (Ltd.), Ponders End, have been doing exceedingly well in their silk shade department, but this is the first opportunity we have had of calling any special note to this important branch of the firm's manufactures. A neat little stiff-covered booklet of silks



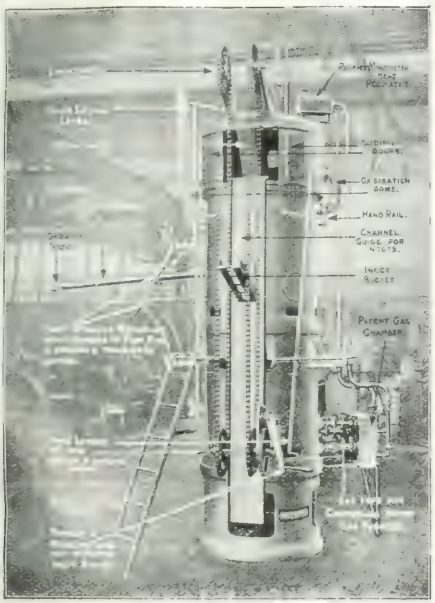
SPECIMEN ILLUSTRATIONS OF EDISWAN SHADES.

has been forwarded to us, which contains nearly 50 different tints of reds, greens, blues, browns, &c., with a large sample attached to enable a prospective buyer to test the quality. All shades can be re-covered in a similar fashion to match others, and old pattern [illegible] can be renovated. Illustrations are given of some of the work recently executed on stock lines, but it is also a speciality of this department to make for all individual requirements.

MONOMETER LEAD FURNACES FOR CABLE WORK.

A new gas-fired furnace specially designed for use with lead presses for covering electric cables has been supplied to the principal cable-making companies in this country by the Monometer Mfg. Co., Whitehouse-street, Aston, Birmingham. There are several interesting features embodied in this furnace, among which we may mention the device for automatically controlling the temperature of the melting pot, the prevention of oxidation, the means for charging the furnace, and the special form of flow pipe, through which the lead is conducted from the melting pot to the container of the hydraulic press.

The melting pot is arranged at a considerable height from the ground in order that the molten metal may flow by gravity direct; an ingenious billett charging device, comprising an ingot bucket, conveyor chains and gearing, enables a pig of lead to be elevated easily from the ground level, and automatically discharged into the melting pot by a strong youth, and thus much hard work for the operator is avoided. The sliding doors, which close the chamber above the melting pot, can be readily opened or closed from the ground level by special levers.



Monometer Lead Furnace for Cable Work.

The heating arrangements comprise a number of low-pressure gas burners of peculiar internal formation, by which a thorough admixture of gas and air is obtained, resulting in intense heat with a very low consumption of gas. The pressure and volume of gas supplied to each individual burner are equalised by feeding the inlet of the burners from a common circular pipe, which acts as a central reservoir. The temperature of the melting metal is prevented from exceeding a predetermined maximum by the use of an exclusive device known as the Monometer heat controller, which operates on the thermostatic principle and automatically reduces the supply of gas to the burners immediately the molten lead has attained the desired temperature. This pre-determined maximum is variable merely by turning an external knob, thus allowing the temperature to be set at anything within a range of 500° F.

As is well known, lead is most susceptible to oxidation, with a consequent formation of dross, and not the least interesting point of the Monometer furnace is the arrangement made for preventing this action, the inert gases from the burners being conducted by side flues to a closed chamber over the melting pot, which not only prevents oxidation but utilises the heat of the gas which would otherwise be wasted. By the combination of the heat controller and means for the prevention of oxidation the amount of dross made by the Monometer furnace is inappreciable, in fact one ton which

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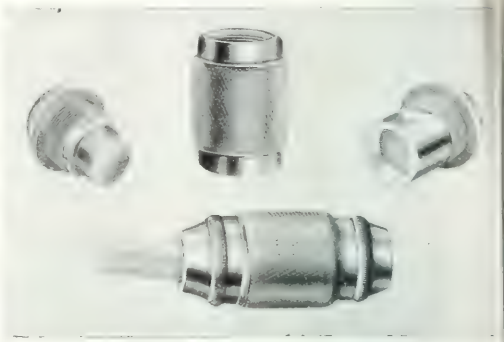
Contractors to the Admiralty, War Office, India Office, Colonial Offices, Postmaster General, etc.

has installed the furnace saves 1s. 1d. per ton in dross alone. The flow pipe for conducting the molten lead from the melting pot to the container of the hydraulic press is telescopic, so that when the container is full the flow pipe may be withdrawn out of the way to enable the ram to descend and extrude the molten metal.

B.T.-H. POLYPHASE INDUCTION MOTORS.

Alternating current is now universally adopted in modern schemes for the transmission of electric power, with the result that there is an increasingly large demand for A.C. motors suitable for industri purposes. The polyphase induction motor has been applied wit great success to practically every industry, a fact which is due to t simplicity, reliability and high efficiency over a wide range of load of well-designed motors of this type.

The great advantage of slip-ring over squirrel-cage motors is th they will exert full-load or over full-load torque at starting, wh taking current approximately equal to the full load or correspond overload current. This is effected by inserting resistance in



Details of Insulated Cable Coupling.

rotor circuit through the medium of the slip-rings. When the mot has run up to speed, the slip-rings, and consequently the starti resistance, are short-circuited. Speed variation can be obtained a slip-ring motor by running the machine with varying amounts resistance in the rotor circuit.

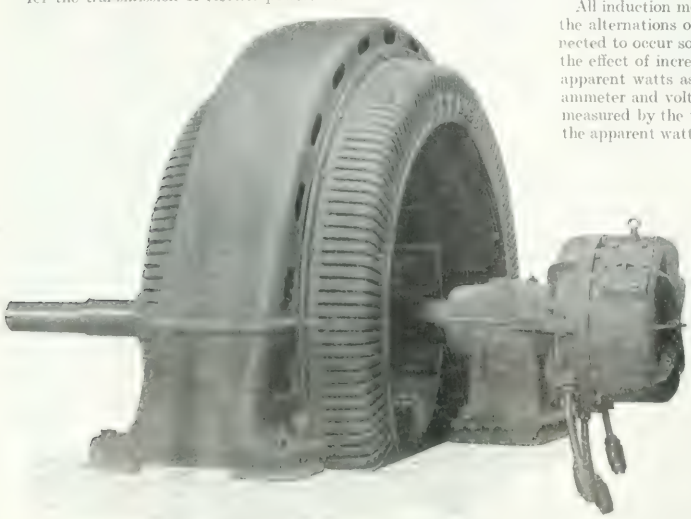
The British Thomson-Houston Co.'s two and three-phase indu tion motors are made in the following three types: Type I: For small slip-ring machines and for some of the small high-speed squirr cage machines; Type IR: for all small squirrel-cage machines wi the exception stated above; Type IX for all medium and large-siz machines both squirrel-cage and slip-ring.

These motors will carry the overloads given in the following tabl

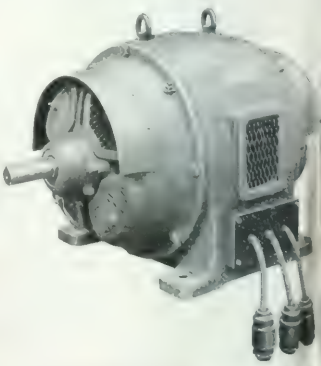
Listed rating of motor.	Overload.	Duration of overloa
Below 2 H.P.	25 per cent.	5 minutes
,, 25 H.P. and not below 2 H.P.	,,	30 minutes
,, 100 H.P. and not below 25 H.P.	,,	1 hour
100 H.P. and over	,,	2 hours

The motors will also carry a maximum momentary overload torq equal to that of twice full-load torque.

All induction motors give rise to a lagging current, *i.e.*, they cau the alternations of the current in the mains to which they are co nected to occur somewhat later than those of the voltage. This h the effect of increasing the current taken by the motor, causing t apparent watts as obtained from the product of the reading of t ammeter and voltmeter to exceed the power or actual watt-input measured by the watt-meter. The ratio of the actual watt-input the apparent watts is termed the power factor, and this is always l



B.T.-H. 100-H.P. Motor of the Flameproof Slip-Ring Enclosed Type.



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TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDUM, LONDON."

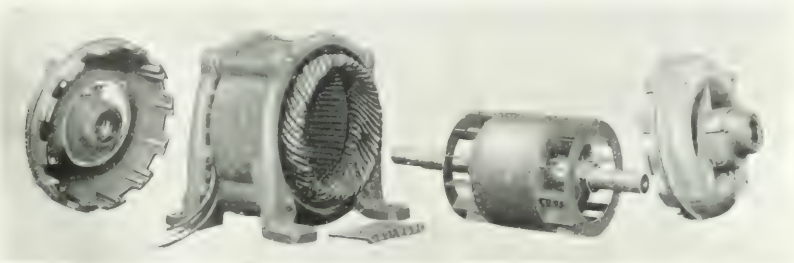
their unity. For example, a power factor of 0·9, or 90 per cent. as it is generally termed, signifies that only 90 per cent. of the current and consequently of the apparent watts is available for useful work in driving the motor. The idle current (*i.e.*, the remaining current of the example) represents no loss of energy beyond that absorbed in heating the conductors. A low-power factor, however, necessitates a heavier current in amperes for a given horse-power of the motor (thus requiring the use of larger cables); it may also seriously affect the voltage regulation of the supply system.

The commercial efficiency of an induction motor is the ratio of the work done, *i.e.*, the horse-power (equivalent watts) given out by the machine, to the actual watt-input as measured by the watt-meter. The product of power factor and efficiency is termed apparent efficiency. It is thus of great importance that motors should have an apparent efficiency of the highest possible value, and we gather that particular attention has therefore been paid to this factor in the design of B.T.-H. induction motors.

Speed variation can be obtained on slip-ring motors by inserting varying amounts of resistance in the rotor circuit. When an induction motor is run with resistance in the rotor circuit it loses its shunt characteristics and behaves like a D.C. series motor, changes in load causing corresponding variations in speed. Speed variation can also be obtained on both slip-ring and squirrel-cage motors by providing them with means for altering the number of poles. Both slip-ring and squirrel-cage induction motors can be run equally well in either direction. In the case of three-phase motors, reversal can be effected by interchanging any two of the three stator leads, and in that of two-phase motors by interchanging the stator leads of one of the phases.

The clearance, or air-gap as it is called, between the stator and the revolving face of the rotor of an induction motor requires to be small in order to keep the power factor high, and it is important for the satisfactory working of the motor that this gap be approximately uniform the whole way round the circumference of the rotor. Owing to wear in the bearings, which may take place in course of time, the rotor may not remain quite central with the stator, thus resulting in an air-gap of varying dimensions.

All B.T.-H. motors, with the exception of the Type IR machines, have adjusting screws provided in the end-shields, enabling the rotor to be re-centred when required, and consequently a uniform air-gap to be maintained. Accurate adjustment of the air-gap may be most conveniently carried out by using a set of feeler gauges which can be supplied if desired. These gauges consist of a number of steel blades of different thicknesses, varying from 0·002 in. to 0·035 in., and



B.T.H. Three-phase Squirrel-cage Motor, Dismantled.

enabling any clearance within these limits to be measured accurately. In order to keep induction motors in the best possible working condition, it is desirable that periodical inspections of the air-gap should be made. In this connection the B.T.-H. Co. will supply special record sheets on which details of successive inspections may be entered. Such sheets will serve to indicate the amount of attention the motors are receiving.

Both two and three-phase motors are provided with three slip-rings, which are mounted on a cast-iron sleeve, the rings being insulated from the sleeve by means of mica. The sleeve, while securely keyed to the shaft, is readily removable, thus rendering the renewal of slip-rings an easy matter. The slip-rings, when situated outside the bearings only, are provided with totally enclosing covers, which are removable. The brushes, in the case of motors supplied with slip-ring short-circuiting device, are composed of carbon, and those for motors without the short-circuiting device usually of copper-carbon.

A device for short-circuiting the slip-rings of motors when up to speed is supplied when required. The device is operated by means of a handle or lever, which causes contact clips to short-circuit the slip-rings and the starting resistance connected to them. The inclusion of this accessory is desirable whenever feasible.

Two-phase motors have four terminals and three-phase motors three terminals. When a two-phase squirrel-cage motor, however, is required to be started by means of a series-parallel switch or a three-phase squirrel-cage motor by a Y-delta switch, the number of the terminals must be increased to eight or six respectively. The different types of terminals with which the various sizes of motor are provided are as follows:—*Type IR.*—The stator windings are connected to flexible leads, which are brought out from the motor through bushings and terminate in brass connectors provided with fixing screws. *Type I 32 to Type IX 54.*—The stator windings are connected to terminals, which are mounted on a slate base, fixed to the motor and protected by means of a gun-metal cover. *Type IX 56 and Larger.*—The stator windings are connected to flexible leads, which are provided with insulated cable couplings. These couplings are completely enclosed by a tough insulating material, thus preventing accidental contact with live parts.

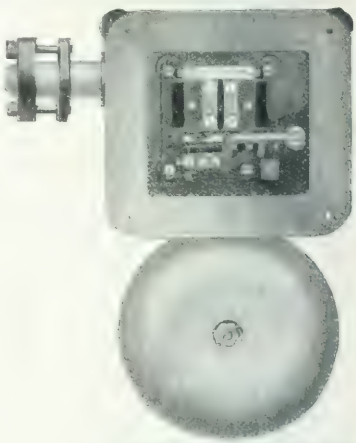
The Home Office Regulations applying to the use of electricity in mines state that, where motors are used underground, all cable armouring or pipes enclosing cables must make good metallic contact with the apparatus to which they are connected, so as to ensure continuous earthing. B.T.-H. motors can be supplied with either of the following accessories, enabling this regulation to be observed. (1) Stator and rotor trifurcating boxes can be supplied for all except the smallest sizes of motors. The stator box can be attached to the motor in one of four alternative positions, so as to accommodate leads brought to the motor from above or below or from either side. The boxes are of cast iron, all bearing surfaces being accurately machined. An inspection cover is provided, and also a clamp, by means of which the end of the cable armouring can be secured to the box. (2) Enclosed stator and rotor terminal boxes can be supplied for the types IX 52 to IX 74, frames inclusive, and enclosed stator terminal boxes only for the types I 42 and I 44 frames.

The foregoing notes are taken from descriptive list No. 2142A, a copy of which may be obtained from the B.T.-H. Co., Rugby.

NEW G.E.C. FLAME-PROOF AND WATERTIGHT BELL FOR MINES.

The progress of electricity for signalling in mines and collieries has been most marked, but until recently there was not available a bell quite suitable in all respects for "fiery mines." As pointed out in our columns recently when we described the new 1915 type G.E.C. magneto mining telephone (K. 8,098), all apparatus in which sparking may occur must be so designed that the products of an internal explosion are effectively cooled before they are expelled from the case into the surrounding atmosphere. The new G.E.C. flame-proof and watertight mining bell illustrated here meets every possible mining requirement, special attention having been given to the design and construction, so as to comply with the Home Office regulations. The bell action is enclosed in a cast-iron flame-proof case. The lid is secured to the case by a sufficient number of bolts, and contact is made between machined flanges 1 in. wide. These provide sufficient surface to effectively cool any hot gases expelled in the event of an



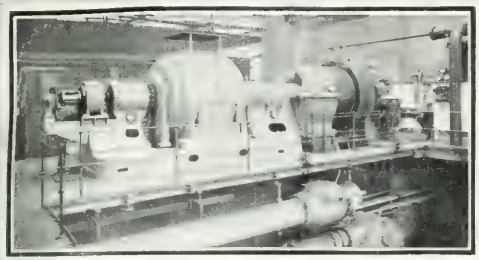


G.E.C. Flame-proof and Watertight Mining Bell with Cover Removed.

B.T.-H. Vertical Type Trifurcating Stator Box.

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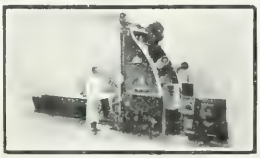
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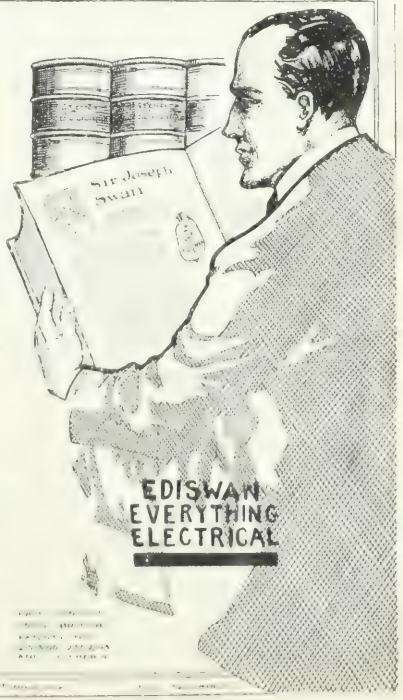
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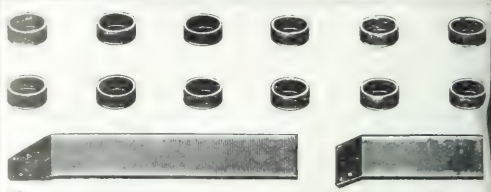


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automatically explosive. The case is water-proof, and the casting is varnished to prevent rusting. The internal unoccupied space is kept down to a minimum, so as to limit the amount of explosive gas which may accumulate.

The hammer is connected to the striking lever by a shaft which passes through a gland 1 in. long in the bottom of the case. It is situated under the gong, and is thereby afforded additional protection. A flame-proof gland is also fitted to the case. It is designed to take an armoured lead-covered twin cable.

The bell is made with two sizes of gong, 6 in. and 8 in. respectively. The 6 in. bell weighs 14 lb., and requires a pressure of 6 volts across its terminals to work it satisfactorily, while the 8 in. bell weighs 16 lb., and requires 10 volts. The resistance in each case is 25 ohms, and the current taken is just under 0·1 ampere. For further information concerning these mining bells, as well as others, relays, complete mine signalling systems, &c., application should be made to the manufacturers, the General Electric Co. (Ltd.), 67, Queen Victoria-street, London.

COMMENTS ON CANADIAN CONTRACTORS.

Even "on the other side" the electrical contractor lays himself open to criticism. Quite recently he has been taken to task on several occasions, and by his own confrères too. Mr. C. A. Walker in "National Electrical Contractor" argued for co-operation among contractors and the cultivation of more contented spirit, particularly with the work and problems which belong essentially to the contracting business. He spoke in parables during the course of his "sermon," and there is a lot of truth in the examples which he selected to illustrate his point. We reproduce the stories herewith.

"Is it not possible that the electrical contractor is spending too much time in bemoaning the conditions which exist in the electrical business, and looking longingly at some other fellow's business, and overlooking the opportunities which may lie right at his feet. I remember seeing somewhere, a long time ago, two pictures which I have never forgotten. One was of two cows, each in her own pasture, and one had her head through the fence eating the grass out of the other pasture, and the other cow had her head through the fence eating the grass in the pasture, not her own. The other was a companion piece. Two men were sitting on the opposite banks of a stream, which was apparently about 40 ft. in width, and each had his line thrown full across and was fishing close to where the other fellow was sitting. The question was, 'Why is the grass sweeter on the other side of the fence and why the fishing better on the other side [illegible]

"I remember well, a little incident in my own career. I was fishing along the Elk River in Kansas. I had caught several nice [illegible] I noticed, however, a place almost directly across the river from me, where there appeared to be an eddy around some willows, and it looked like the place ought to be alive with bass. The enchantment was too much for me, and I picked up my tackle and string of fish, and [illegible] I waded in and [illegible] and every fish I had [illegible] I looked back to the place from whence I came, and wondered [illegible] how I could have been foolish enough to have left it.

"What I am trying to show, is that it is an easy matter to overlook the opportunities which are right at our feet, and to imagine that somewhere there is a place where success will come without effort; where customers will always be eager to buy; where central stations will meet us with open arms, and where the general contractor will cease from troubling. Some of you, no doubt, have heard Russell Conwell in his lecture on 'Acres of Diamonds.' A farmer owned land which was not very productive. He struggled hard to make it pay. One day a travelling priest came that way, and stopped at the farmer's house over night. He related a story of a recent discovery of diamonds. Men were finding diamonds and were getting rich in a day. After the priest had gone, the farmer came to the conclusion that he was foolish to stay at the barren farm, when he also might be picking up diamonds, and become independent. He sold his farm and went in search of the diamond fields. The man who purchased his farm, was down at the spring one day, dipping up some water, when he noticed a peculiar looking pebble at the bottom of the spring. He dipped it up and it proved to be a diamond of great value. Other diamonds were found on the same farm and the owner became wealthy. The previous owner had left the farm in search of the very thing which lay almost under his feet, and which he had probably seen a hundred times and not recognised.

"These stories are told, believing that if the electrical contractor will look closer about him, he will discover that there is something more in the electrical business than he has found. That most of the obstacles about him are surface obstacles, and that if he would go a little deeper, even some of these obstacles might prove to be blessings in disguise."

REALISM IN A HOT-WEATHER WINDOW DISPLAY.

In the show window of the Western Electric Company at Cincinnati, Ohio, a bushel of white paper confetti, a thermometer and a few fans were used recently to make a most realistic snowstorm scene. The fans were so placed as to create a continuous current of air in the window, which kept the "snow" in constant motion, eddying rising, falling and whirling about in the inclosed space. A sign displayed read, "Remember this when the weather is warm." To add the last touch of realism to the scene a large thermometer previously drained of part of its mercury column, was placed in the foreground. Many observers, noting the low temperature indicated by this instrument, placed their hands against the glass to see if it was really cold.

ELIMINATING FUMES WITH ELECTRICITY.

The Duquesne Reduction Company, Pittsburgh, Pa., employs a high-voltage discharge to remove copper from the fumes emitted by its plant, and so does away with nauseous gases in the neighbourhood. A [illegible] three-phase motor-driven 500 volt direct current generator, the output of which is stepped up to 62,500 volts by an induction coil. On the motor shaft is a rectifier switch which converts the [illegible] current discharge into a unidirectional flow. The ungrounded side of the rectifier leads is run to an electrode from which the high-voltage corona discharge takes place. This discharge precipitates the copper from the fumes and causes it to fall to the bottom of a tank from which it can be removed.

THE ROUND TABLE.

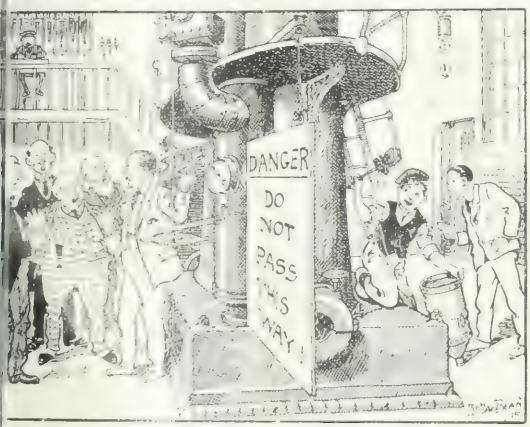
In the [illegible] rumour that the B.E.A.M.A. will shortly open a school of languages.

* * * *

[illegible] Arthur Schuster read his Presidential Address.

[illegible] West-End fire was recently reported as being due to the dropping of a cigarette end down a grating!

Mr. [illegible] sketch. With the coming of the steam turbine some other



[illegible]

subterfuge than hammering on an empty oil drum will need to be adopted. [illegible] Government Board Inspector.

* * * *

[illegible] beneath notice. There seems to be no hope of bringing the two industries together. Cannot Welsbach or somebody bring out an "electric mantle?"

[illegible] in the hospitals the Indian troops were frequently in danger of [illegible]



[illegible]

The problem perplexing the American Navy at the moment is whether the greasers shall watch the dynamos or the electricians shall watch the greasers watch the dynamos, or the electricians who have a knowledge of machinery shall watch the greasers watch the dynamos or the greasers who have a smattering (sic) of electrical knowledge shall watch the dynamos or the greasers with electrical knowledge shall watch the dynamos *and* the electricians on watch in the switchroom.

As the Irishman once said, "The answer's a lemon."

THIRTY-SEVEN YEARS AGO.

[From "The Electrician" (Second Series), Sept. 11, 1878.]

[illegible] 1877 [illegible] 6,158 of which 7 per cent. were complex lines, 7 per cent. [illegible] 26 per cent. were [illegible] 15 per cent. to telling tackle or earth slips, 3 per cent. to [illegible] 3·10 lbs per cent. to the [illegible] The remaining 7·10 lbs per cent. could not be accounted for. The troubles were 1,708 broken wires, 2,284 [illegible] 1,114 deranged insulators, 2,706 [illegible] The [illegible] 37,264 km. of line, revolving 136,801 km. of wire.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
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Mr. A. H. Seabrook (St. Marylebone).
Mr. C. W. Spencer Howes (Bow).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
Mr. J. W. Sparks (W. Hartlepool).
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Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
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Mr. Frank Ayton (Ipswich).
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GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

INDUSTRIAL ILLUMINATION.

During recent years a great deal of attention has been paid to the subject of the economical and efficient lighting of factories, workshops, mills, &c. Recent reports of H.M. Chief Inspector of Factories have contained frequent references to lighting, and in 1913 the recognition of its importance led to the appointment by the Home Secretary of a special Departmental Committee on Industrial Illumination.

The legislation of many countries contains requirements regarding "adequate lighting," and it is important to understand what is

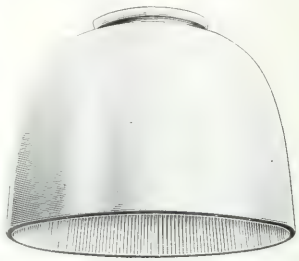


[illegible] Arc Lamp Fitting.

conveyed by this term. Speaking generally, there are three special points which should receive attention at the hands of the person planning a scheme for industrial lighting to obtain an entirely satisfactory result. (1) The illumination must be sufficient for the [illegible] (2) The illumination must be free from [illegible] particularly the glare from imperfectly shaded lights. (3) The posi- [illegible] in order to avoid [illegible] shadows. These [illegible] mill and similar buildings results in bad or spoiled work and the slowing down of the output, whilst in cases where dangerous machinery is employed, they often are the cause of serious accidents. All these defects can be remedied by the use of reflectors specially made for the purpose, and to this end the Holophane line of scientific reflectors has been designed.

Extensive investigation over some 80,000 work-shops of one kind or another prove that accidents and spoiled work occur mainly in the twilight hours, and it is estimated that of the 200,000 accidents [illegible] occur annually in English workshops, a large percentage is due to imperfect illumination. The elimination of imperfect illumination means, as has been proved in actual tests, an increased output of 11 per cent., a higher degree of efficiency and fewer accidents. When this result is compared with the cost of installing an efficient system of illumination, there is no field of investment or speculation which shows a better return on the money expended.

Some few months ago Holophane Limited put on the market a small reflector for local industrial lighting. This met with such a pronounced success that in response to numerous requests from the owners of all classes of workshops and factories, Holophane Limited have designed several new types of industrial reflectors. From the



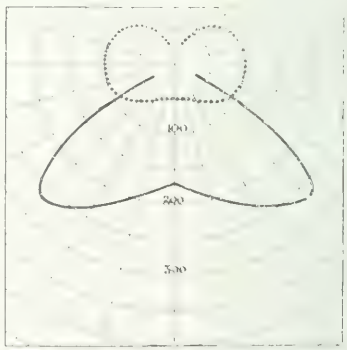
EXTENSIVE (E) TYPE REFLECTORS.



GOLIATH EDISON SCREW LAMPHOLDERS.

special pamphlet which has just been published dealing with these reflectors, it will be seen that there is a sufficient variety of shapes and sizes to meet every requirement of industrial lighting, whether local or general or for low or high candle-power lamps up to 2,000 c.p. half-watt lamps.

This new Holophane industrial list contains much information which will be found of use to illuminating engineers or to anyone entrusted with the lighting of factory premises. This information has been prepared in such a manner that it can readily be understood by the layman. As the Holophane industrial reflectors are composed of prismatic glass reflectors over which aluminium cases



PHOTOMETRIC CURVE.
LAMP ALONE. LAMP WITH REFLECTOR.

are spun in such a manner that they completely seal up both ends of the glass, the following advantages are claimed for them:—

1. The scientific light reflecting property of prismatic glassware [illegible] by the polished surface of the metal cover.

2. They are easy to clean, both the inside and outside surfaces being smooth.

3. The reflecting surfaces do not turn black after contact with the air, [illegible] always retaining its entire reflecting properties.

4. The glassware is secured from breakage owing to its protective metal cover.

The Electric & General Works, Ltd

15, Victoria Street, London, S.W.



Iron Choke Coils for Indoor and Outdoor Mounting.

Electrical Apparatus up to 80,000 Volts & 4,000 Amps.

Telephone: 5223 VICTORIA. Telegrams: "GABIONAGE VIC LONDON."

7. The [illegible] bolting holts are provided [illegible] expansion while the fixed [illegible] the same.

6. Spoiled work and accidents are eliminated.

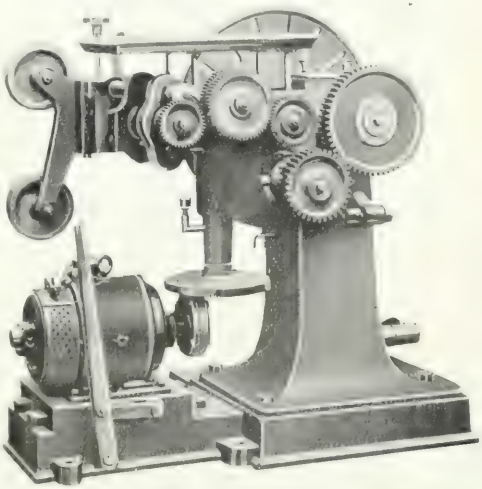
7. The [illegible] considered with his machine [illegible] works more effic[illegible] heat dissipation.

The pamphlet referred to is obtainable from the [illegible] Carteret-street, London, S.W.

SPECIAL WINDING MACHINERY.

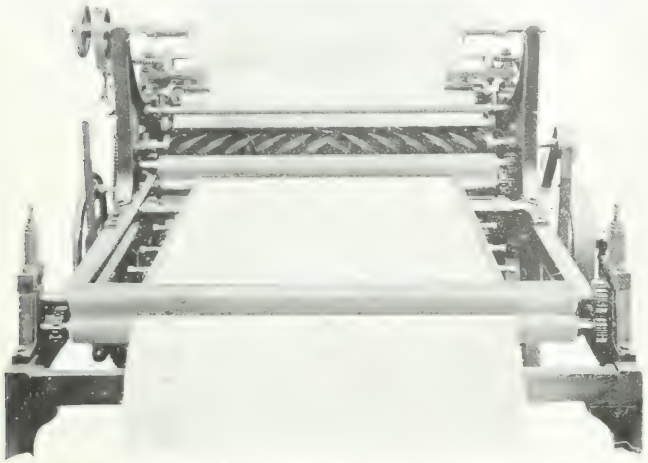
We have just received a copy of an interesting catalogue from Neville's (Liverpool) Ltd., in which full particulars are given of a variety of coil-winding machines, vacuum drying and impregnating plant, armature binding lathes, taping machines, hydraulic presses, pipe-bending machines and cold metal sawing machines.

The coil-winding machines are made in a variety of sizes and types. The "G" size machine illustrated herewith is fitted with a motor drive through friction pulleys and worm gear. A brake band clutch controlled by a pedal is provided, and it enables winding to be instantly started and stopped. A counter is fitted which registers in four figures the number of turns. A face plate and mandrel for holding the coils are included. With the motor-driven machines either raw hide gearing or friction disc drive can be fitted. The feeding of the wire can be done either by hand or automatically. In the latter case there is a considerable saving in wages, as less expert winders can be employed, and the finished product is guaranteed accurate. The device comprises a carriage having tension pulleys for the wire, the carriage travelling backwards and forwards on a screw spindle by a combination of change gears driven from the main spindle. The carriage of the "D" and larger-sized machines has a differential slide to compensate, without any interruption of the feed, for unevenness in the thickness of the wire insulation. If an automatic reversing motion is fitted, one winder can tend several machines. For long and heavy coils the machines can be supplied with a centre for carrying the [illegible] end of the coil mandrel. In the



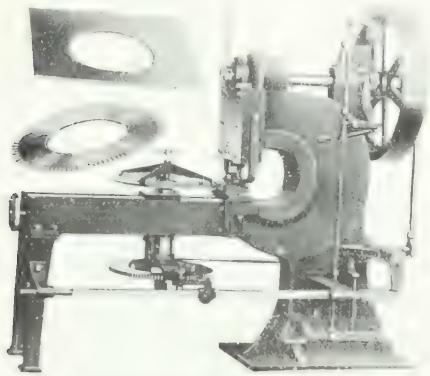
"G" Size Motor Driven Winding Machine.

of suitable size for introducing one side of closed armature bars or



Large Size Taping Machine.

applied on a continuous bench, with driving shaft extending the entire length of the bench, each machine having a separate clutch for independent operation. Standard driving equipments for motors ranging from $\frac{3}{4}$ H.P. to $1\frac{1}{2}$ H.P. are described. An illustration is given of one of the No. 2 size machines.



notched with one handling. The cutting speed is 200 cuts per minute. The machine is started by pressure on a foot pedal, and stops automatically when the last notch has been completed. An attachment can be fitted for notching the inner side of the rings. The gross weight of one of these machines is 20 cwt.

The details given of vacuum drying and impregnating plant, of vacuum pumps and condensers, of pipe-bending machines, of universal angle bending machines, and of cold metal saws, are of considerable interest. Those of our readers who require further information regarding this class of machinery should apply to the company

SWITCHES AND FUSES.



Two Patterns of Switch Fuses.

FERRANTI LTD
Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "F"

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 95/97, NOBLE STREET, LONDON, E.C.

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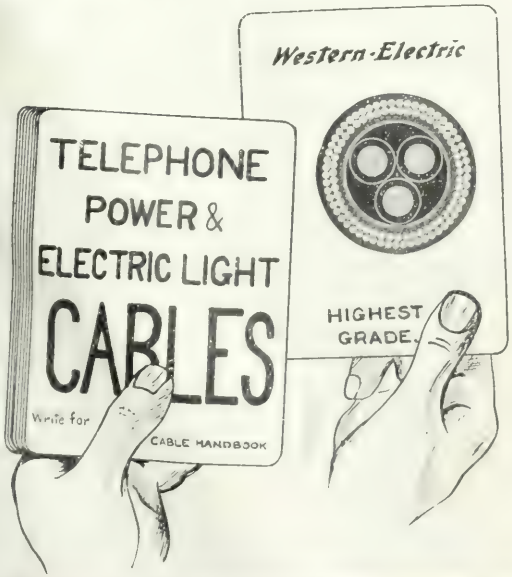
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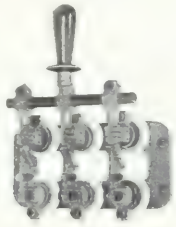
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Works: North Woolwich, London, E.

BIRMINGHAM. GLASGOW. LEEDS.
CARDIFF. MANCHESTER.
SYDNEY. JOHANNESBURG. BUENOS AIRES.

[illegible] and [illegible] of the type [illegible] provided with porcelain insulators and cast-iron base, thus rendering them suitable for mounting direct on a wall or on ironwork, or for building up "skeleton" switchboards. This special adaptability will suggest many uses to engineers, and the fact that all connections are on the front and quite accessible will increase their usefulness in certain



TRIPLE POLE SWITCH

spheres. All current-carrying parts are dull nickel-plated, these parts being thus protected against corrosion. In fact the switches are thoroughly suitable for mounting in dusty and damp premises These switches and fuses are supplied by the Electric & General Works (Ltd.), 15, Victoria-street, London, S.W., who will be pleased to show samples and give any further information to interested readers.

INSTALLING A COMPLETE SERVICE IN FIFTEEN MINUTES.

As one of the features of the annual field day and outing of the Commonwealth Edison Company of Chicago, service gangs from each of the company's three overhead districts competed in a service installation contest. The crew representing each district had previously been selected by elimination contests conducted in regular service-installation work during the two weeks preceding the field day.

Before the day of the final competition a pole line carrying primary wires on single arms was erected on the field. A platform on which three sections of brick wall were mounted was also erected at a distance of 75 ft. from the poles. Above it were placed three regular service outlets connected to 2 lamps of lamps. Each gang consisted of a foreman, two linemen and a groundman. The foremen were not allowed to do any work. Sitting in their trucks, which were loaded with standard tools and equipment, the men awaited the signal to start.

CONDITIONS OF THE CONTEST.

The rules of the contest required each crew to do the following work: Cut a gain and bore a hole for a buck arm on the pole; instal the buck arm with braces and primary cut-outs; hang a transformer; connect the transformer to the primary circuit and to the service drop; instal a bracket with three Pierce bolts on the brick wall; run a 75 ft. two-wire service from the pole to the bracket, and connect the service to the outlets. All joints were to be soldered and properly taped. The last thing to be done was to insert the primary plugs to light the lamps above the outlets, indicating that the work had been completed. Any failure to complete the job according to the company's standard practice was to result in a penalty equal to three times the time it would ordinarily take to do that part of the work. Any violation of the company's safety rules was to result in disqualifying the whole gang. Three judges with stop watches took the time and observed the work as it proceeded.

THE PRIZES AND THE WINNERS.

In addition to the prize money offered to the winner of this contest [illegible] each man in the winning crew, an added bonus of 2 cents for each second under 20 minutes was provided for each man in the winning crew. The result of the contest was as follows: Northern [illegible] 15 minutes, 192 seconds. Southern District, Foreman Neilly, 16 minutes, 30 seconds; Central District Foreman Crawford, 18 minutes, 44 seconds.

None of the gangs was disqualified for violating the company's safety rules. The winning crew was, however, penalised 15 seconds for spilling solder!

EFFICIENCY.

BY J. MACREADY.

There is a strong call for efficiency just now, and as a nation we shall need all we can get of it for many years to come; but the word itself is being used a lot too much—in fact, it is being exploited. I have seen it so much lately and in such questionable company that I have grave fears that it is losing caste. Whenever it appears at the top of an article, or in the title of a book or periodical, I have come to suspect it, and instinctively draw closer the mantle of scepticism.

I can't help the feeling that, when a man is sidling up to me with the word "efficiency" on his tongue, he is about to sell me something, regardless of whether I really need it or not. I have the fear that he may also be trying to sell *me*.

He gives me about the same feeling that I get when a needy-looking literary hack rushes up to me in Fleet-street, effusively shakes me by the hand, suggests adjournment to the nearest hostel, and commences to tell me a funny story—all in one "movement," as it were. The greeting is too sweet to be genuine; I know he can't afford to pay for the drinks, and the tale is often a "chestnut," therefore one cannot mistake what it is all leading up to. He's going to have me for something, sure enough, before he's done—it's our old friend the confidence trick again!

If these people made the fortunes for other folk which some of them profess to have made they would not have to shout their wares so loudly. On the contrary, they would daily dispense their wisdom in a throne room and would never be seen out of doors without their £1,200 motor car and fur-lined overcoat.

Now, it stands to reason that when a business man has spent most of his lifetime trying to save himself trouble—and which of us has not?—he will look upon it as a kind of affront when a fellow human being come along and insinuates that all is not right with him, whatever he may think to the contrary; that if he would only stir himself more, worry more about things and grow grey hairs in the process, he—this good, kind efficiency expert—will come and live with him for a time and help him to plunge deeply into the very trouble he has always tried to avoid. All he promises is that, having worried through greater tribulation, you shall find greater rest. And you are to pay him for persecuting you!

The efficiency man may have been a lawyer, an accountant or a navvy, for aught you may know, but he is invariably good at talking, especially about himself. He generally commences by telling you how he got the ear of this man or that man—he doesn't say how many times he got the "boot" as well, oh dear no! Although he has never been engaged in your particular line of business, has never been inside your works, and may never have seen you before, he will soon warm up to his subject and gleefully express his willingness to come into your establishment, turn it inside out, exorcise the devil of inefficiency and leave you "swept and garnished!" all for a consideration, of course. If you take such a man at his own inflated valuation, and let him loose in your affairs, it is just likely that it will not be many days before you are longing for a return to the com.

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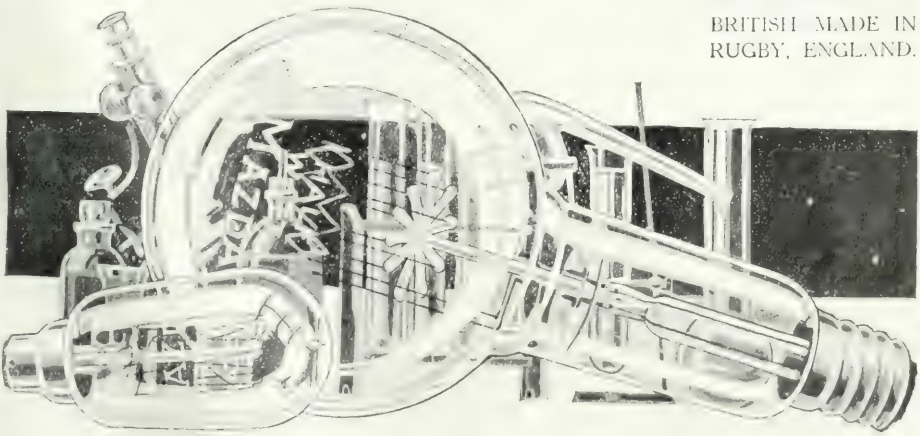
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If it were not for the continued research of patient men most of the things we accept as a matter of course would never have been. For example: Research evolved the locomotive and the steam turbine out of a steaming kettle; Research evolved the aeroplane out of a kite. So in the sphere of electric lighting, research—*my* research—has developed a lamp possessing the qualities of unsurpassed economy, brilliancy and durability in the place of one that was wasteful, dull and fragile. All the improvements in electric lighting are embodied in my glass bulb—Use and recommend me—I'm Mazda.

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potative [illegible] object you previously enjoyed, because of the "seven other devils worse than the first" which have stealthily taken under the cloak of the efficiency man.

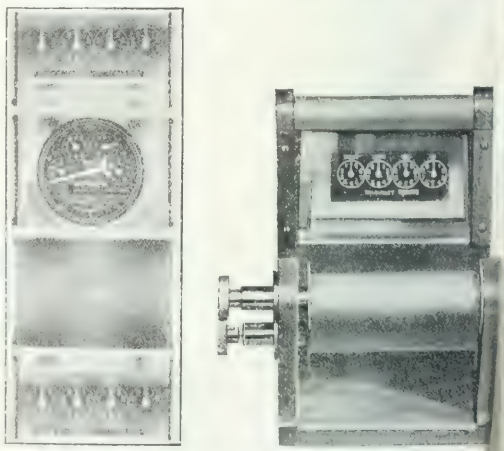
No efficiency is like [illegible] that comes from the inside not from without. From "The Pressman."

A CAMERA FOR READING CUSTOMERS' METERS.

A special camera has been developed by the Folmer & Schwing division of the Eastman Kodak Company, Rochester, N.Y., for the use of meter-reading companies, whereby they can bring into the office at the close of the day's work photographic evidence of the position of the dial pointer on the meter of the customer visited. To "take" the reading the meter man simply holds the camera [illegible] the meter dial. A small push-button, which automatically opens the shutter for a definite period and at the same time lights four small battery-operated lamps to illuminate the meter dial. After each exposure is made, the shutter is locked and cannot be operated again until the film roll has been advanced to the position [illegible]. The film is [illegible] and cannot be [illegible] without opening the shutter.

[illegible] The "film" on which the pictures are taken consists of an emulsion on opaque paper, which is backed up with a white coating that [illegible] graphic record of the condition of the customer's meter and avoid all [illegible]

[illegible] and exceed 0.5 cent per exposure. The camera weighs [illegible] Preliminary experiments with the meter-indexing camera have been conducted on the lines of the Rochester (N.Y.) Railway & Light Company, and the latter is employing these cameras on several of its regular meter-[illegible]



Film and Roll Stand for Examining Meter Readings.

[illegible] 1915.

THE ROUND TABLE.

From an Australian postal directory catalogue:—

A gasolene [illegible] it does [illegible] dry out on a long water run, can be [illegible] known by [illegible] number of signals of distress such as leaking and smoking; but a storage battery must struggle along without a sign or sound until it literally dies.

Respectfully, the question is: Which would you rather be?

* * *

The new pattern [illegible] Ferranti Ltd. [illegible] stood at a table [illegible] by the [illegible] screen is [illegible] forward.



I have already [illegible] the Company will [illegible] one of the fires [illegible] course) to the [illegible] cord twister who will furnish [illegible] that they consider the best [illegible] name for it. Dora [illegible] Ypres," or "Hot [illegible]" or "Kritter" or "Ali Baba" or anything else which signifies "hot stuff." Just a [illegible] letter [illegible] name for a fire, you know, and your idea to Ferranti Ltd., Kingsway, W.C., by the end of this month.

* *

"The camera cannot lie," according to an old saying. The [illegible] believe it to be true, according to George Washington, therefore they use the camera to record the read-



Electrically Lighted Camera for Recording Meter Readings.

ings of electricity and gas meters. The illustration shows the instrument which may or may not be [illegible] Australia in the near or distant future.

The following definition of salesmen of steam turbines or any old electrical thing has been taken from G.B.S.'s "Man and Superman," and sent to us by a correspondent who considers it very apt:—

They are not beautiful, they are only decorated.
They are not clean, they are only shaved and starched.
They are not virtuous, they are only cowardly.
They are not vicious, they are only frail.
Not intelligent, only opinionated.
Not generous, only propitiatory.
Not disciplined, only cowed.
And not truthful at all—liars everyone of them, to the very backbone of their souls.

* * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), Sept. 21, 1878.]

NICKEL.—This substance loses all its magnetic properties when alloyed with about 10 times its weight of zinc.

WHEATSTONE'S DEFINITION OF ELECTROMOTIVE FORCE.—The cause which originates *current* in a closed, and *tension* in an unclosed circuit.

THE MARINER'S COMPASS.—Many people look upon the compass as an introduction of the fifteenth century, but it seems to have been well known in a primitive form in the twelfth and thirteenth centuries. In one of the popular songs written in the time of King John it is said that the sailors who go on long voyages to Friesland or to the East know their way by observing the *tramontaine*, or polar star: but when the sky is covered with clouds and they could no longer see the stars of heaven they had a contrivance which was this: They took a needle of iron and put it through a piece of cork, so that one end remained out, which they rubbed with the loadstone, and then they placed it in a vessel full of water, and whichever way the end of the needle pointed there, without any doubt, was the polar star. This formed a primitive but fairly perfect mariner's compass.

* * *

Our Encyclopædia.

Contributions to this section (in the shape of definitions of well-known electrical objects) are invited from the witty members of the industry. Hot plates will be awarded from time to time for the best efforts.

INSULATION TEST.—A gross [illegible] dishonesty. (See *also* Cutting Pliers.)

AUTOMATIC CIRCUIT-BREAKER.—An apparatus which is usually "tied up."

JOINT BOX.—A receptacle with a marked affinity for coal gas.

RESISTANCE.—"Ohm Sweet Ohm," a song without words (except in the mains department).

C.M.A.—A body of manufacturers which, although it [illegible] is not a trust, though a combination is not a combination, though existent is yet non-existent (and whosoever buyeth not C.M.A. cable shall be eternally damned). (*See also* Non-Association Cable.)

THE "POINT FIVES."

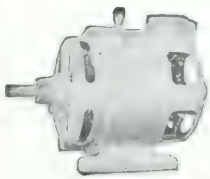
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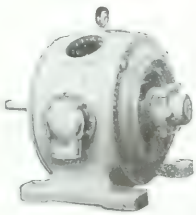
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MACHINE TOOL DRIVING.

At the present time, to increase the output of machine tools to an extent which will repay outlay, and avoid overtime, the [illegible] push button system of electric control has proved a most effective help. There are three ways of increasing output, viz.: Speeding up the machine, speeding up the man and reducing the idle periods, *i.e.*, the periods during which the machine is not turning out work.

[illegible] speeding up the workman [illegible] the speed control easy and quick. When the method of changing speed is cumbrous and slow (as mechanical gear changes always are) the tool cannot be set to run at its maximum speed. It must instead be set to work at a safe average speed: a speed which will not be too high for any condition that may arise during the progress of the job. If the method of changing speed be quick and easy, as in the push-button system, the speed can be varied as the job proceeds, to suit the varying conditions. Thus while the work is straightforward and the quality of the metal suitable, the machine can be kept running at top speed. When a hard spot in the metal is encountered (as, for example, when turning railway wheels) or for any other reason a lower speed is required, it can be quickly obtained by merely pressing a button. Just as easily and quickly the former high speed can be [illegible] increases the over all speed of the machine, but obviates damage to the cutting tools, and thereby reduces maintenance cost.

[illegible] so easy that he doesn't have to think about it. Under these conditions the workman (who is not an electrician) is relieved of the necessity of worrying about electrical matters, or indeed anything except the work in the machine. He need not think about the [illegible] pressing a button and it will obey. Consequently he concentrates [illegible] better. Time is saved because he doesn't need to leave his normal place at the tool to effect any desired change. The push button box is so small that it can be mounted on the machine itself, where it is [illegible]

portable so that the workman can conveniently carry it in one hand and press the buttons with the thumb or fingers of the same hand. Or it can be slung round his neck so as to hang in front of him and leave both hands free. The tool is literally "under his thumb" and its control becomes instinctive.

Reducing the Idle Periods.—The idle periods of a machine tool are when it is being set up for a job: when the cutting tools are being changed, or when either the tool or its motor are undergoing repairs.



FIG. 1.—PUSH BUTTON BOARD.

The most expensive idle period is that of setting up, for then not only is the production suspended, but the time of an expensive workman is being consumed. Furthermore, the setting up process occupies the major portion of the life of many machine tools and consequently any shortening of this process is an important economy. Push button shortens the setting up period by making the management so flexible that the machine can be "inched" as much as the process requires, without damaging either the switchgear or the motor, and

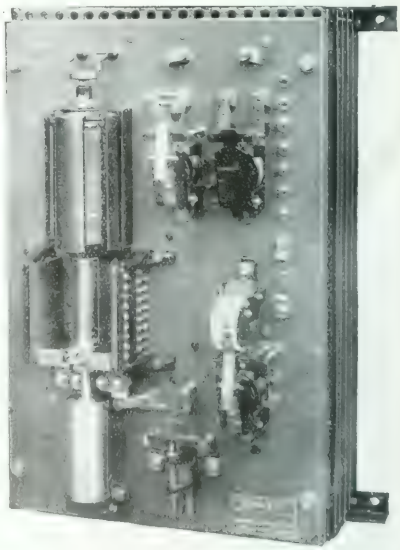


FIG. 2.—OPEN VIEW OF SWITCH CONTACTOR.

started and stopped with delightful speed and facility. The changing is less frequent with push button control. The tools last longer without re-grinding, because the workman can so easily "humour" them. Similarly the motor less often requires repairs because it is not subjected to the injurious stresses of hand control. It is never overloaded by being accelerated too quickly: never fitted with a workshop rabbit and is not called upon to drive the tool

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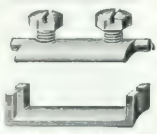
The Cone is made in various sizes for Lighting, Power, Tramways, Telephones, Telegraphs, Lightning Conductors, &c.

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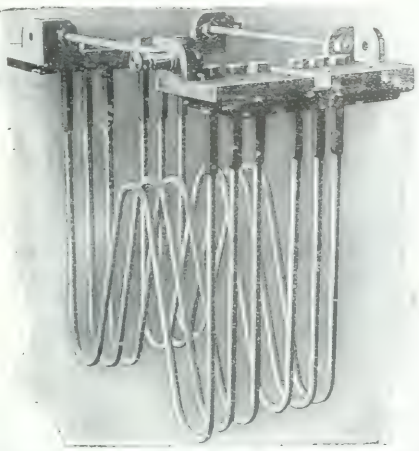
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Only the push [illegible] by the workman or mounted on or near to the tool. This is robust in [illegible] and self-explanatory. Nothing is easier than to press a button and all that [illegible] inscriptions) the button that will serve his purpose. The other piece of apparatus, shown by Fig. 2, is entirely automatic and never needs to be touched by the workman. It can be mounted out of harm's way on any convenient wall or pillar where it can easily be inspected and kept clean. It is not much more than two years since this system of control was introduced to the market, but in the interval it has been adopted by many of the principal engineering works, including railway workshops, locomotive builders, ordnance factories, shipyards, ammunition works, machine tool makers and many others.

Fuller details may be obtained from the Igranic Electric Co. (Ltd.)

THE LIGHTING OF FILM PICTURE STUDIOS.

[illegible] lamp, as well as the improvement and economy introduced by mercury vapour lighting, have materially changed the practical [illegible] the film itself and of the camera, and also the projection machinery, [illegible]

Mr. W. A. D. Evans deals with the employment of mercury vapour [illegible] Eastman Company's original studio in New York. Since that time [illegible] considerable efforts have been made to apply this form of lighting on a large scale, and the results seem to have been very successful.

[illegible] Hewitt lamps is particularly desirable for this class of work on account of the great actinic power of the light, for equal illumination it being about the same as daylight. Also the fact that the light comes from a long tube in place of being concentrated in a small point ensures thorough diffusion of the light, and gives a lighting effect similar to daylight. The light blends with daylight, and where used in a daylight studio can gradually be added as the daylight decreases. Even with 200 or 300 lamps on a stage there is very little glare, and no harmful effects are produced on the eyes of the actors. Furthermore, even with this large amount of light, the temperature of the stage is only slightly raised above the surrounding atmosphere. This is a most important point to be considered in taking pictures, and especially in fairly long scenes, as the fatigue produced by an excess of light will prevent the players from putting forth their best efforts.

Lamps are frequently arranged in skylights for hanging from the ceiling to provide top light, and floor stands are added to take care of the side lighting and reinforce the lighting at special points to obtain the best effects. By properly arranging the lights around the sides of the stage and overhead, modelling effects can be produced which do away with flat pictures, which are apt to result from improper lighting. As an instance of the manner of lighting a studio for large stage work, we may take a stage about 32 ft. deep. In a typical installation of this type there are 208 tubes, 136 for overhead lighting and 32 for high side lighting, with 48 mounted in floor stands for moving about to throw the light from one side and towards the front.

The overhead lamps are arranged in the following manner: Eight tubes in two banks are hung at approximately 8 ft. over the front line at an angle of about 30 deg. inclined toward the stage; back of these lamps are hung three banks of eight lamps, each at the same angle, and this idea is carried out so that at the back line there are four banks at about 18 ft. above the stage, this fan-shaped method being essential to cover the stage.

On one side are four hanging banks which are inclined 45 deg., throwing the light in on the stage. No lamps are placed opposite to these, for the reason that if the illumination was equalised the picture would photograph flat. The floor stands are placed at various positions to get light in on the stage to light up spots where the top and side lighting do not reach and to produce artistic modelling. The overhead lamps in the studio may be suspended from a trolley system which permits the lamps to be moved from one end of the studio to the other, and cover in this manner different stages. By this method scenes can be set up on two stages while pictures are being taken on the third, and no time is lost between the taking of the scenes.

In addition to Cooper-Hewitt lamps, a studio should have four or five large arc lamps, which can be used in conjunction with the tube lamps for spot lighting effects. Moreover, arc lamps are used for fireplace lighting, table lamps and other special lighting effects. A large studio may consist of as many as four stages completely lighted with Cooper-Hewitt lamps. Each stage is completely lighted, and no trolley system is needed for changing the position of the lamps. In other words, four different sets can be photographed at the same time, or while one or two sets are being taken, others can be set up, which eliminates lost motion, and there is no waiting for light at any time.

The main advantage of lighting a moving picture stage with Cooper-Hewitt lamps is, primarily, the fact that pictures can be taken at the proper speed and at any time, day or night, with lighting effects that are equal to daylight. Moreover, the camera man never has to make any change whatsoever in the aperture of his lens during the taking of a scene, as the quality and quantity of light is always the same. Passing clouds and the many changes in daylight values do not occur in an artificially lighted studio, and pictures taken under Cooper-Hewitt light always show the same degree of clearness and detail. Sometimes, in taking outdoor pictures, the same scenes have to be taken over and over again, due to the fact that the light was not just right. "Retakes" are not necessary in a studio with artificial lighting properly installed.

In figuring on the total illumination for a stage it will be found that proper lighting can be produced by Cooper-Hewitt lamps with an expenditure of current of about 100 watts per square foot of floor space; that is, a small stage can be lighted with about 30 kw., a medium size stage with 45 kw., and a large stage with about 75 kw. Stages lighted under these conditions will have a floor illumination [illegible] candles. These figures serve as a useful guide for estimating purposes; it should, however, be borne in mind that, just as illumination intensities in domestic and industrial lighting vary over relatively wide limits, so they may also in the studio.

As the Cooper-Hewitt lamps used for this work require no carbons [illegible] and the only cost is for replacing the tubes, which have

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TELEPHONE: 6400 CENTRAL
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

an extremely long life, the maintenance cost is extremely low, the [illegible] for renewing tubes for this work averages from actual experience 6s. 7d. per tube per year.

on for about two hours, would amount to 31s. 6d. for current and 6s. 3d. for maintenance, or a total of 38s. for 1,000 ft., whereas the entire cost of the film may have cost from £200 to £800, depending



General View of Cooper Hewitt Lamps Installed in Cinema Film Studio

On a large stage the cost of lighting for taking 1,000 ft. of film, which would mean about two days' complete work with the lamps on the subject. In other words, the best lighting can be obtained on the average for less than ½ per cent. of the entire cost of the film.

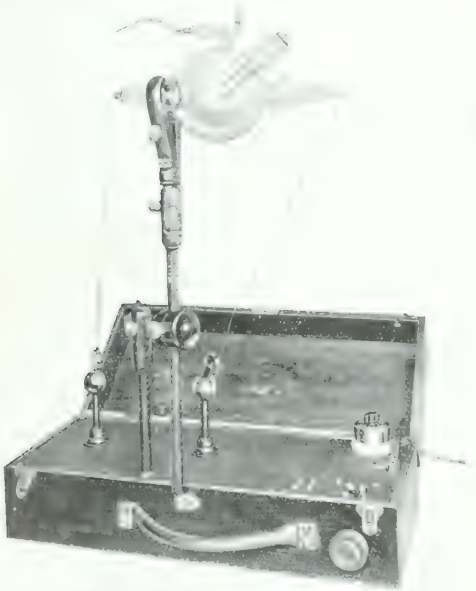
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in reducing the total cost of the film.

The Westinghouse Cooper Hewitt Co., Newcastle, Kent, will supply further details to interested readers.

PORTABLE X-RAY APPARATUS.

X-ray operators and practitioners have felt the need of an equipment which should be complete in itself and sufficiently portable to dispense with the large and heavy spark coils, battery outfits, &c., hitherto essential. The "Dubilier" apparatus described in pamphlet 1921, issued by the General Electric Co., can be connected



direct to any ordinary lighting main either continuous or alternating current. It can be used in the consulting room, and if desirable can be conveyed to the house of the patient with ease. It is also suitable for special classes of hospital and infirmary work, on account of the readiness with which it may be transferred from one ward to another

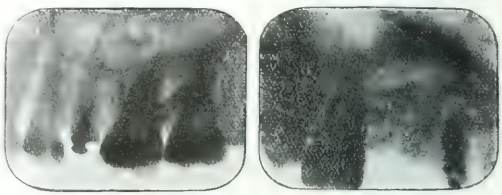
[illegible]

[illegible] weighs under 1 cwt. and is somewhat small when compared with that of the larger machines generally in use.

Fluoroscopy and radiography are equally practicable, and considering the size and simplicity of the apparatus, the results are excellent. Examples of radiographs taken in actual practice under different conditions are shown herewith.

There is only one switch and regulator; the manipulation is simple, and no knowledge of electrical science is necessary, although an acquaintance with X-ray work and the usual precautions to be observed are naturally of advantage to the operator.

The complete apparatus (catalogue No. 200) is suitable for all classes of X-ray work, &c., and operating with a 6 in. tube on continuous or alternating current of normal voltage. It is provided



Dental Radiographs taken on 110 Volts Continuous Current.

with double-pole switch, spring tube flexibles (avoiding use of various lengths of wire and facilitating connecting and focussing of tube), socket and flexible for joining to supply at any lampholder or wall-plug. A polished teak case, with convenient handle for carrying is supplied. The outfit measures 24 in. by 10 in. by 7½ in. deep and weighs 43 lb.

RADIAL DRILL FOR SWITCHBOARD WORK.

A light radial drilling and tapping machine is being introduced by G. Swift & Sons (Ltd.), Halifax, and is intended for electrical engineers for drilling the holes in marble slate and similar switchboards, &c. When placed in the centre of a large circular work table, on which several boards are being fitted up it can readily be swung through a complete circle to operate on anything within its range. The maximum radius is 4 ft. 9 in., minimum 12 in., and it admits 4 ft. 6 in. from the floor to the spindle. The arm bears on a conical pillar having a 2 ft. square base, revolves on roller and ball bearings and may be locked in any position. A projection cast on the arm carries the eight-speed, three-lever, positive clutch, gear box, and mounted on this is the 3 h.p. electric motor which drives the gear box by chain, provided with a guard. A brass plate gives all positions of levers and spindle speeds. The carriage runs on rollers and is traversed by rack and pinion. The 2 in. diameter balanced spindle is bored No. 4 Morse taper, and equipped with ball-thrust washers at both ends. It has hand feed, quick advance and return, and reverse motion for tapping, the traverse being 10½ in. The balance weight slides up and down a rod at the rear, to keep it in position. The machine weighs about 27 cwt.

SLATE
INIGO JONES & CO.,
Tudor Slate Works,
GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
SLATE WORK for ELECTRICAL ENGINEERS.

FERRANTI LTD
Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

[illegible]

THE ROUND TABLE.

EVENT OF THE WEEK.—A Government Department engaged on war work advertises for "Civil Engineering Draughtsmen accustomed to steel constructional work" at a salary of 6s. 6d. per day. May they long continue to advertise.

* * *

BON MOT OF THE WEEK.—"This gradual welding together of large Associations aiming at a common object cannot but mean good for all concerned, and is in the interests of Municipalities as a whole." (Alderman H. Linsley, J.P., Presidential Address, M.T.A.) Welding is right. Let it be electric and permanent.

* * *

ON THE 'PHONE.

FEMALE VOICE.—You the Electric Co.?

MALE-DITTO.—Yes, miss.

F. V.: Have you any fans?

M. V.: Yes, we have all kinds.

F. V.: Have you any that osculate?

M. V.: Well, yes—but I'm quite busy now. I'll transfer you to the Appliance Department.

[*Edison Life.*

* * * *

It is most trying to talk to a man who will call them electric veHicles. You feel up to your knees in dropped aitches.

* * * *

Edison Accumulators inform us that they are frequently the recipients of strange communications regarding their batteries. Here is a recent one written on a Post Card:—

"Kindly let us have, per return, full instructions for ... the accumulator which we purchased from you *twelve* ..."

The italics are ours, and the conclusion to be drawn is obvious: at any rate it is one way of writing a testimonial.

* * * *

The "bird" shown in the illustration tried conclusions with a 44,000 volt ... transmission line—way down upon the



Tennessee River. ... depicted appears to ... that it failed to make good. The bird is a hawk which measures 5 ft. from wing tip to wing tip. Some hawk!

The drastic changes in the postage rates will stamp the present as the "Point Five" Budget. There is some talk of a vigorous protest to the Chancellor of the Exchequer from the Secretary of the Association.

* * * *

We hear that a prominent illuminating engineer has given up his residence in the Metropolis on account of the greatly increased illumination from the planet Jupiter.

* * *

The following records the results of a shooting match at the Ediswan miniature range between the B.T.-H. and a home team. The shooting was 10 shots at 25 yds.

Ediswan Team.	1st shoot	2nd shoot	Totals	*B.T.-H. Team.*	1st shoot	2nd shoot	Totals
*E. Winterflood	92	98	190	*Redfern (2)	84	78	162
S. Smith	88	92	180	Redfern (1)	71	82	153
Harrington	89	87	176	Bush	62	72	134
W. Golding	87	87	174	Danton	67	65	132
E. Ralph	83	89	172	Abel	78	50	128
T. C. Black	78	90	168	Burton	30	67	97
A. J. Corbett	85	77	162	Butcher	34	54	88
†A. E. Davis	72	85	157	†Gowan	27	39	66
	1,379				960		

* Winners of silver spoons presented by Ediswan Rifle Club.
† Winners of wooden spoons, suitably illuminated for the occasion.

Mr. Elliott (Ediswan joint sales manager) was in the chair, supported by Messrs. Child, Pakenham and Cooke. Mr. Abel, on behalf of the B.T.-H. Co., responded to Mr. Elliott's welcome. Messrs. Anderton (Ediswan) and Abel (B.T.-H.) were captains, and the place of official scorer was filled by Mr. W. B. Clarke. The B.T.-H. team on the return journey was entirely devoid of "glare"—at least, so we understand from a member of the illuminating engineering department.

* * * *

THIRTY-SEVEN YEARS AGO.

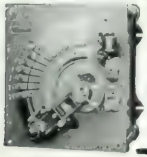
[From THE ELECTRICIAN (Second Series). Sept. 28, 1878.]

PROPOSED INTRODUCTION OF THE ELECTRIC LIGHT INTO THE NORTH BRITISH DYEWORKS, PERTH.—Several experiments were made with the electric light last week in the extensive dyeworks of Messrs. J. Pullar & Sons, Perth, for the purpose of introducing the same into some of the rooms instead of the ordinary gaslight. The experiments were very successful, and we believe the electric light will soon be introduced into the works, which are the most extensive in the kingdom.

LADD'S ELECTRO MAGNETIC MOTOR.—According to M. Deprez, this machine gives very good results, and has been too much lost sight of. A curious peculiarity presented by this machine is that, if the commutator be placed in the position which, theoretically, should render all movement impossible, the machine will, nevertheless, rotate indifferently in either direction. The velocity is even much more considerable than that obtained with the commutator in a rational position.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. G. W. Spencer Hawes (Regd.).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
Mr. J. W. Sparks (W. Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).



Heavy Duty Type.

'IGRANIC'
HEAVY DUTY STARTERS
IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street, London.

Multiple Lever Type.
Motors. Robust and toolproof, each section of grid resistance



SIEMENS

ELECTRIC MOTORS

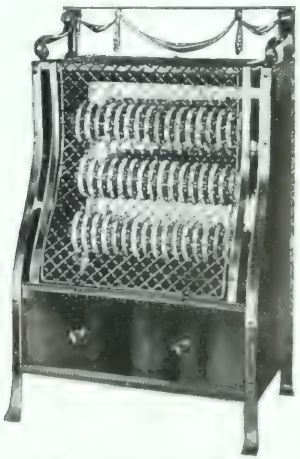


Part of small Motor Shop, Stafford Works.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams: "SIEMBARLOS, VIC, LONDON."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

THE "QUEAD" ELECTRIC FIRE.

There is no absolutely new principle involved in the element of the "Quead" fire, but an improvement in the arrangement of well-tried principles. It combines the experience of many years and



3 kw. Portable "Quead" Fire.

tires [illegible] ment have been proceeding hand in hand to discovering the form of heating best suited to domestic requirements, and that form is undoubtedly—radiant heat. Also for the rapid radiation of heat some form of fireclay has been found to be the most useful and practical agent.

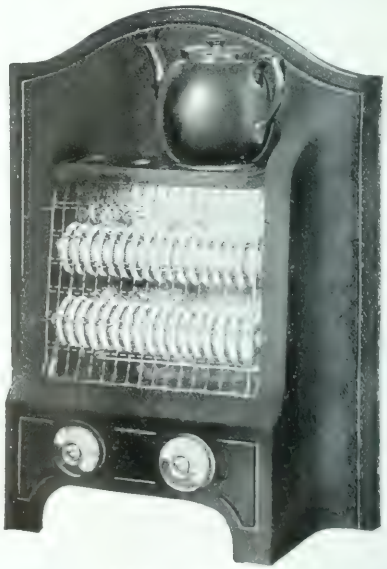
The "Quead" heat unit consists of a number of fireclay pieces of a special composition, which precludes the possibility of chemical trouble with the resistance wire at red heat, and which are built on a steel rod around a spiral of resistance wire so that the latter is sunk into the surface of the fireclay but is still visible. Thus, when the current is connected the spiral immediately becomes red hot and this in turn heats the fireclay. The result is a glowing mass, cheerful in appearance, and intense in its radiant effect. The method of sinking the wires into the surface of the fireclay has the effect of quickly making the latter red hot, but it also protects the wire from damage.



DETAIL OF "QUEAD" FIRE UNIT.

the result is that the "Quead" is a robust unit which can be roughly handled, removed, replaced or packed for transit without fear of damage. Its simplicity is another point worthy of notice—it can be built from its component parts in a few minutes by a novice.

The "Quead" elements are guaranteed for a period of three years from date of sale to work satisfactorily when used under proper conditions, *i.e.*, correct voltage and in "Quead" apparatus. Should any breakdown occur within this period, elements are replaced or repaired free of charge, provided the faulty element or apparatus is returned, carriage paid, for examination. This guarantee is limited to the "Quead" fires, and does not cover any consequent loss caused by such breakdown. The "Quead" elements are standardised at 1 kw. hourly consumption and the standard fires are all fitted with one element per kilowatt. Each element measures $10\frac{1}{2}$ in. long, and has a diameter of $2\frac{1}{8}$ in.

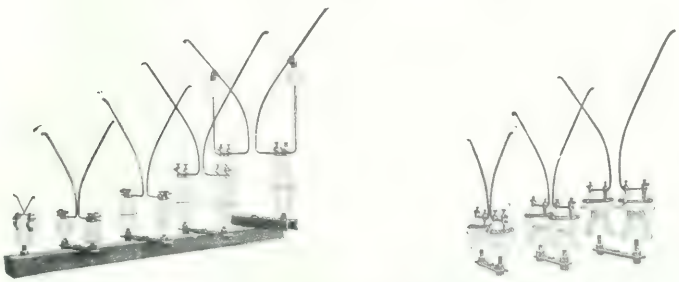


2 KW. "QUEAD" FIRE.

[illegible] "Quead" fires are not heated to excess by the [illegible] of radiation as do some fires, burning in the [illegible] Our [illegible] and fires generally are ga-

"Well, the element right, it is possible for the makers of the "Quead" to put on the market a range of electric fires which are sound, robust, reliable, guaranteed and entirely beyond the experimental stage, and

The
Electric & General Works, Ltd
15, Victoria Street, London, S.W.



Horn-type Lightning Arresters for Indoor and Outdoor Mounting.

Electrical Apparatus up to 80,000 Volts & 4,000 Amps.

Telephone: 5223 VICTORIA. Telegrams: "GABIONAGE VIC LONDON."

in the issue of a new list will be found illustrated a selection of electric fires of useful size and kind, for every condition and requirement, and at a range of prices which should suit everybody.

The "Quead" fires give red heat equal in appearance and effect to any coal or gas fire. They are arranged for convenience and utility, and the artistic side has been well considered in their production. One of the utility features is the provision for keeping liquids or food warm. Some of the patterns have detachable shelves for this purpose, while others are constructed so that their tops may be used in a similar manner. All of the fires, with the exception of the cast-iron patterns, which are not intended to be portable, are fitted with handles, and these are so arranged that they are kept cool even when the fires are running at full heat. Guards are also provided to all fires.

In spite of the many advantages of electric heating, there are many who will never reconcile themselves to the abandonment of the coal or log fire entirely, but are quite ready to welcome an arrangement by which the labour of coal fires may be reduced to the minimum. "Quead" fires successfully meet such a requirement. The coal fire may be laid, cleaned, &c., at the most convenient time, and for all emergency heating such as early morning, &c., the "Quead" fills the breach. Thus particular tastes and natures may be catered for.

The makers recommend that fires of ample capacity be installed in all cases, so that a good reserve is available for emergencies. It is found from experience that it is more economical to heat a room quickly with a higher consumption of current than to heat the same room slowly with a smaller consumption. It is found that, if from 1,500 to 2,000 watt heating capacity be installed for each 1,000 cubic ft. required to be heated, the reserve is equal to any emergency.

The catalogue referred to can be obtained from Ikin & Eads, Marylebone-lane, London, E.C.

A NEW DIRECT-COUPLED PETROL-ELECTRIC SET.

Those who have the opportunity of looking through the advertising pages of American magazines and a certain class of monthly engineering publication issued in the United States, will be struck with the very considerable number of small petrol and paraffin engines which are offered at comparatively low prices. These little power units are evidently purchased in their thousand by farmers and others in rural districts, not to say prairie regions, on the very fringe of civilisation and probably many score miles from the railway. Builders of these engines have evidently always had in mind the prospective demand for a combination unit which would convert the energy of petrol or paraffin into electrical energy, both for lighting on a useful scale and for heating and power in a small way. The horizontal engine is principally favoured by the makers of the "farm hand" type of plant, and, as a rule, it is built up complete with fuel and oil tanks and with thermo-syphon cooling system as an integral portion of the engine and bedplate. When employed in conjunction with a belt-driven dynamo and a small set of accumulators, these outfits are extremely useful and we believe are still in constant demand.

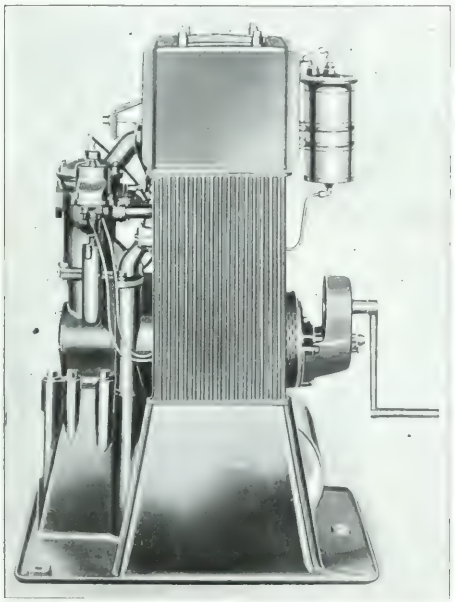
There exists, however, a market for an electric generating set which will furnish energy at a steady and constant pressure for lighting purposes, and also have a capacity which will admit of the use of a few domestic appliances such as irons, toasters, vacuum cleaners, &c., in addition to the lighting load. In order that a unit of this type may be attractive to the prospective buyer, the dynamo should be direct-coupled to the engine, and the combination set should be light and fairly portable. On Thursday last we were given an opportunity of inspecting on test at the Electrical Standardising and Testing Institution the Uni-Lectric petrol dynamo, which is now being introduced into this country. It comprises a high speed four-

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GUN METAL, MANGANESE BRONZE,
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Tubes, Sheets,
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CASTINGS.
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INGRAM'S
Indiarubber Gloves & Gauntlets
FOR ELECTRICAL PURPOSES.
NON-CONDUCTING
BEST QUALITY INDIARUBBER.

Made in ALL SIZES and ORDINARY STOUT SUBSTANCES to suit varying Voltages.
PRICES ON APPLICATION.
Manufacturers—
J. G. INGRAM & SON, Hackney Wick, LONDON, N.E.

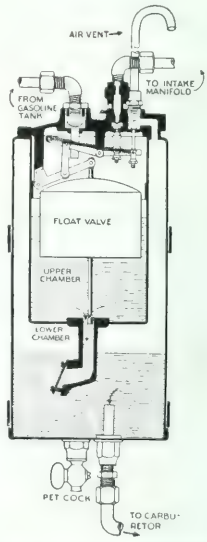
cycle engine direct-connected to a fan cooled direct-current generator, having a normal capacity of 500 watts and an overload capacity for a short period of 750 watts. As will be seen from the adjoining illustrations, the plant is entirely self-contained. There is a specially shaped bedplate, which is a clean iron casting, carrying the engine and dynamo and a pair of ribbed uprights which support the cast-iron thermo-syphon cooling tank. The uprights act effectively as radiators for the cooling of the circulating water. Immediately below the tank, and in some measure protected by it, is the small generator, which is semi-enclosed and supported by a long outboard bearing. The commutator is accessible through openings which, when the set is running, are covered with perforated sheet metal.



Side View of a Uni-Electric Petrol Dynamo.

The electrical end of the plant calls for no special comment, the shunt wound dynamo being of the Wagner Co.'s standard construction with a deep commutator and carbon brushes.

The principal interest attaches to the design of the engine. This is an ordinary four-cycle machine with overhung and balanced crank. The piston is specially shaped and reciprocates in a sleeve which is provided with ports, and which acts as the valve mechanism of the engine. The sleeve rotates within the cylinder itself, and in the walls of this inlet and exhaust ports are cut. The sleeve rotates at half the speed of the engine, and turns always in one direction. It is kept moving by a special form of skew gearing, which is entirely enclosed within the extension of the crank case, which is specially shaped to the housing. This half-time shaft, the sleeve and the main bearing are lubricated by an oil pump, which circulates lubricant from the crank chamber at the rate of 1 gallon per hour. This oil system ensures free and constant lubrication of the principal



Sectional View through Vacuum Fuel Chamber.

One, Two & Three Phase MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 139, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 35/37, NOBLE STREET, LONDON, E.C.

POPE
Elasta
British Made Wire
Lamps

You Need More Business and More Profit in War Time

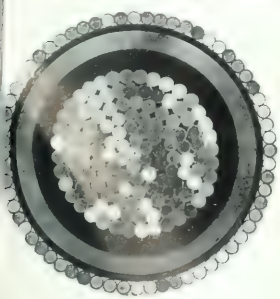
And the Way to Get It
is to sell

ELASTA
BRITISH-MADE LAMPS

Our Lamps are renowned—our terms are generous. Your enquiry will receive prompt attention

THE LAMP WITH A LIVING IN IT

Adct. of Pope's Electric Lamp Co., Ltd. Manufacturers of Carbon and Tungsten Lamps. Hythe Road, Willesden, N.W.



Western-Electric

Works:—
N. WOOLWICH,
LONDON, E.

HIGHEST GRADE
BRITISH CABLE

for every class of installation is manufactured by the Western Electric Co., Ltd., at their works at North Woolwich. Western Electric Telephone Telegraph and Power Cables are giving highly satisfactory service in all parts of the world.

You cannot do better than to refer all your cable schemes to our staff of engineers for expert advice in the matter concerning the choice of the most suitable cable for your particular purpose.

Our Cable Handbook will be gladly sent upon request.

Western Electric Company Limited.

BIRMINGHAM GLASGOW LEEDS MANCHESTER
JOHANNESBURG SYDNEY BUENOS AIRES

SPECIAL ATTENTION

FOR

WAR SERVICE.

STOCKS IN HAND
for SPEEDY DELIVERY

OF FOLLOWING GEAR:-

IRONCLAD DISTRIBUTION BOXES
AND **SWITCH FUSES.**

VENTILATED FUSES AND
ARMOURED SWITCHGEAR

FOR

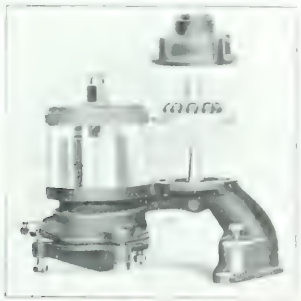
600, 3,000 and 6,000 VOLTS
THREE PHASE.

A. REYROLLE & CO., LTD.,
HEBBURN-ON-TYNE.

working parts of the engine. The normal speed is 1,950 revs. per min., at which the engine will deliver 2½ maximum power.

Other interesting features of the plant are an automatic voltage regulating governor, and the vacuum feed petrol and vaporiser system.

The petrol supply is maintained by a vacuum system, which consists of an upper and a lower chamber connected by a passage normally closed by a flap valve at its lower end. The upper chamber



Characteristics of Electric Power Distribution

[illegible] connecting pipes—one to the intake pipe of the engine and the other to the petrol tank. A [illegible] intake pipe connection is operated by a float as shown in the upper chamber. There is also an atmospheric valve and an overflow pipe controlled by it, and this atmospheric valve is also operated by the float. The lower chamber is connected by a pipe to the carburettor, and is provided with a drain for removing sediment or water. This petcock is therefore an additional safeguard against a clogged petrol supply. There [illegible] the upper chamber, and [illegible] the petrol has got been well strained before it is poured into the tank.

This governor consists of a solenoid connected in parallel with the [illegible] coil and the mercury tube, is cut a small rack, which meshes with pinion attached on the end of the shaft carrying the butterfly valve of the engine throttle. The flotation of the mercury tends to push the rod upward and open the throttle, while the action of the coil is to pull it downward to close the throttle, the upward and downward movements being exactly balanced at 110 volts, or proportionately higher to allow for a slight drop in the line.

When one or more lights are turned on, the voltage in the main line instantly drops, less current passes through the coil, and its downward pull thus being weakened allows the mercury float to rise and open the throttle. The engine immediately responds, and as it speeds up the voltage again rises until it reaches the 110-volt mark, or whatever point has previously been determined. More current passes through the coil increasing its pull until it again balances the upward push of the mercury and the throttle is prevented from opening further. The voltage will remain constant regardless of the load from no-load to full-load 500 watts (½ kw.) and up to 50 per cent. overload or 750 watts in all.

It will be observed that the voltage of the set has been fixed at 110, a pressure which will enable the user of the unit to employ standard subsidiary electrical appliances such as irons, toasters, heating utensils, vacuum cleaners, &c. Where the supply to a country installation is given at 25 or 50 volts, the circuits can only be used for lighting purposes unless the other devices are specially wound, and even then in the case of the heated appliances the current required is excessive, and large section conductors must be used. The voltage of 110 also admits of the employment of the newer types of half-watt domestic pattern lamps in a few of the larger rooms where plenty of light is needed.

It is claimed that the regulation of the unit is so close that a set of accumulators is not required. Starting is also an easy matter, a sharp pull up on the handle provided for the purpose being all that is needed to get the engine away. The ignition is by high-tension magneto of standard design, and is fixed. It is stated that there is nothing to choose between the lighting from one of these units and the supply given from a public central station; that is, the lamps are quite steady in burning, a feature which is often absent from belt driven units. The full load can be thrown off and on with very little voltage or speed variation. We saw this done at Faraday House.

Fuller details and prices of this interesting set can be obtained from Walter D. Fair & Co., 43, Leicester-square, London, W.C.

NEW EDISWAN "AD." SHADES.

The electrical contractor and the central station engineer with a showroom at any rate should not have the least occasion to be hauled over the coals by the police for infringing the lighting regulations, that is if they apply early to the Edison & Swan Co. for the neat and effective lamp shade shown in the illustration. We under-



Ediswan Advertising Lamp Shade

[illegible] to us the company that these shades are being distributed throughout the trade, and may be obtained free on application with trade card. Since the risk of aircraft attack by the enemy is likely to be greater during these dark days than the summer nights the regulations upon lighting should be strictly observed. Advertising assistance to this end should be welcome, especially when an artistic effect is produced.

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THE ROUND TABLE.

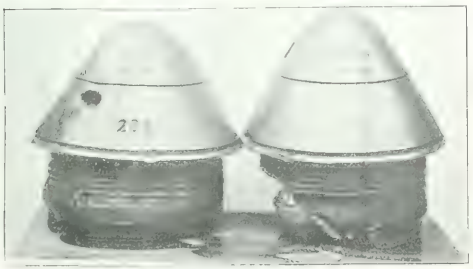
BON MOT OF THE WEEK.—Obviously the technical Press, as represented by the "Electrical Review," would do well to include on its staff at least one member not utterly devoid of a sense of humour.—"Daily Chronicle," Sept. 30, 1915.

* * * *

Now that the Municipal Tramways Association have discussed the problems of female labour we may expect the Institution of Electrical Engineers to consider Papers on "Eugenics," and the Illuminating Engineering Society on "Hysterics," while the I.M.E.A. and the E.C.A. might conjointly argue about "Polytrics."

* * * *

A correspondent sends us for reproduction a photograph of the "noses" of German shells bearing the initials of well-known firms not unconnected with the production of electrical



[illegible] apparatus. They make us wonder whether any of our own shells bear initials of the engineering firms who produce them, and the noses thereby convey little reminders to those who may "receive" them.

* * * *

A man [illegible] raging into the office of an electric light company and declared that one of the company's wires had killed a pet tree on his premises.

"That tree," said he, "has been standing there for 20 years and we regarded it as one of the family. My children played under it when they were babies, and it is associated with some of the pleasantest memories of my life. When it began to die we all mourned, and we could not imagine what ailed it until yesterday when I noticed that a wire was lying right across a branch. My tree has been killed, and I feel as if murder had been done in my home."

Considerably moved, the agent of the company went to view the scene of the tragedy. When he came to trace the wire he discovered one end nailed to the roof of an old barn and the other twisted round a discarded pole. It had been cut off for two years and forgotten.

The agent made the following report:—

"Tree alive, wire dead. Wire evidently killed by tree. Bill enclosed."

Edison Ltr.

The "Sunday Times" recently complained of realism in the nursery, and instanced an actual case in which a mother found her youngest son tied in a chair near a gas bracket which his brothers had deliberately turned on. "Oh, he's a German," they explained to the distracted mother. "He's been guilty of frightful atrocities to pussy, and we thought of hanging him, but came to the conclusion he ought to be gassed." Next we shall read of a barbed wire entanglement charged from the house-wires and stretched across the garden to waylay "daddy."

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), October 5, 1878.]

At the half-yearly meeting of the Harrow District Gas Co., held at the Guildhall Tavern on the 26th ultimo, Mr. James Glasher, F.R.S., the chairman of the company, presided, and in the course of his remarks, in moving the adoption of the report, said: "In Paris, as you all know, gas is sold at a high price, and so far as I have been able to collect information, the electric light costs a great deal more. At the present moment there are four carbon candles in each lamp, and it is a question to my mind whether throughout the whole of the coming winter, when the nights will be so long, the electric light will be continued in Paris. Only two lights can be used on each wire, as if there is a third or fourth light the wire is fused, and all of them are put out. . . . Viewing it in every way, I will not part with a single gas share I possess."

SOMEWHERE IN FRANCE.

"Quite a good story has been told here. The facts of the case must be known to the enemy by now, so I presume it is giving nothing away for me to mention the details. The time dates back to the occasion when the Germans first occupied Lille while our troops held Armentières.

"On entering Lille the Germans soon discovered the electric light works, and, of course, were not long in getting them into operation. They supplied themselves with electric light, and, naturally, such an asset they made the most of, for in a war area such a commodity must be 'some' capture.

"Thus they went on for two or three months, in utter ignorance of the fact that, in addition to facilitating their own work, they were obliging the British military authorities, for Armentières was supplied with electric light and power from the same works. In point of fact, a farmhouse adjacent to the end of one of our communication trenches was so supplied until the Germans found out their colossal 'bloomer'; but I have no knowledge of electrical engineering, so I cannot say to what use or uses the power might have been put in that locality."

THE "POINT FIVES."

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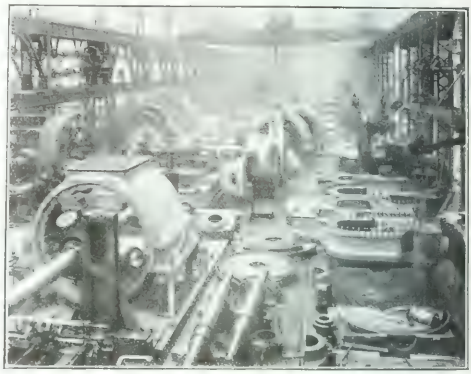
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ESSENTIALLY BRITISH ENTERPRISE.

Many people to-day consider that Dick, Kerr & Co. are mainly, if not solely, an electrical manufacturing concern, whereas in reality this branch of their business is comparatively modern. At one time they were chiefly a contracting firm, and it was only some 15 years ago that they became manufacturers of electrical apparatus, so as to facilitate the carrying out of large tramway contracts then in hand, both at home and abroad. The contracting side of the company's business naturally declined as the demand for tramways tended to fall away, and the manufacturing side increased in importance and for a time assumed first place. But the policy adopted some years ago resulted in the extension of the contracting department in other directions, and at the moment the work carried out by the firm may be considered as consisting mainly of two sections of equal importance, though differing essentially in character.

Some idea of the extent to which the contract department has been developed at home and abroad in recent years may be gathered from the fact that the company has recently completed the construction of 90 km. of railway for the Government of Portuguese East Africa, and has now in hand work on a large reservoir near Staines for the Metropolitan Water Board. This reservoir has an area of approximately $1\frac{1}{2}$ sq. miles, and the enterprise is estimated to take 6 years to complete. Amongst other interesting contracts now in progress may be mentioned a water supply scheme and hydraulic power development in the Canaries.

In addition to the contracting and manufacturing sections of the company, which may be said to represent the main business of the company, there is a third section to which reference may be made. This department is concerned with the supply of general and electrical engineering material manufactured by the company, which the experience enables them to place at the disposal of their clients. Regarding the electrical manufacturing side of the company's business, the company possess large and extensive electrical works which are situated in Preston, Lancashire, which are equipped with modern machine tools and appliances for the production of electrical machinery of various kinds.

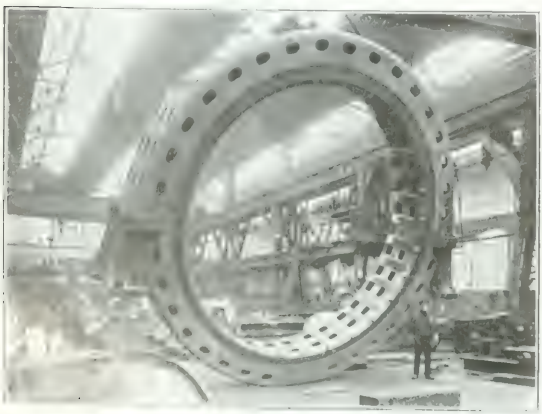


ONE OF THE MACHINE BAYS AT PRESTON WORKS.

During the last three years an important extension to the works at Preston has been made in the shape of a large and up-to-date factory for the production of metal filament lamps. This factory, which is known as the Britannia Lamp Works, is capable of turning out 8,000 lamps per day. The lamps are subjected to a rigid system of supervision and testing throughout all stages of manufacture, and are entirely made under the company's patent. Over 20,000 Britannia lamps were used at the Earl's Court Exhibition during 1913, and the lamps have a considerable vogue in domestic, commercial and general service.

In addition to the electrical works at Preston, the firm also have general engineering works at Kilmarnock, N.B., where narrow-gauge steam locomotives, electric locomotive bodies, contractors' tipping wagons and such like material are produced.

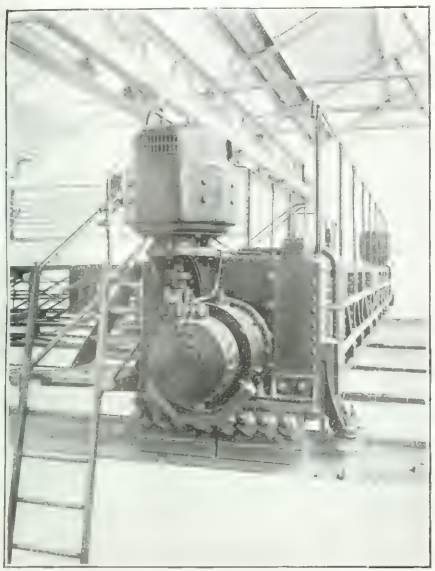
At the Preston works the following electrical products are turned out: Heavy electrical machinery, comprising generators of all types from 1,000 kw. upwards, motor generators, rotary converters, static transformers, &c.; steam turbines for use with either high pressure, exhaust or mixed pressure steam; complete electrical equipments for railway motor coaches, locomotives and tramcars, electric motors



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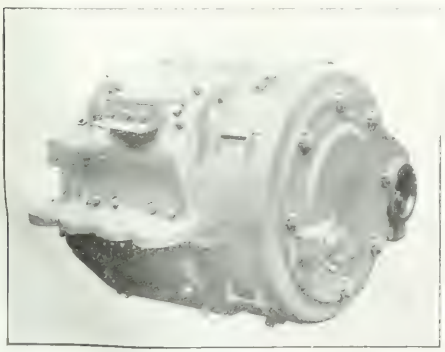
for industrial purposes, starters and controllers for motors, switchgear, &c.

The company has also manufactured and supplied numerous turbo-alternators in conjunction with steam turbines constructed by other makers. Of considerable interest is the large alternator supplied to the Inawashiro Hydro Electric Power Co., which is a 7,775 k.v.a. three-phase machine, designed to run at 375 revs. per min.



Dick-Kyle Motors Driving Carriage in Experimental Tank, National Physical Laboratory.

The manufacture and supply of electric traction equipments for both tramways and railways forms a large part of the business of the company, and a number of equipments have been supplied to tramways and railways both at home and abroad. An outside view of a typical 250 h.p. motor, designed to operate at either 575 volts or



A Dick-Kyle 240 h.p. Motor.

1,650 volts direct current, according to the type of winding employed, is shown. These motors are essentially "robust," and specially suitable for cases where hard work and trying conditions are encountered. Considerable numbers of traction motors have been manufactured and supplied by the firm; but as there is not much difference in external appearance between one traction motor

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and another, space does not permit of entering into the details of design and manufacture.

The firm not only supplies equipments for motor coaches and cars, but they also produce complete electric locomotives.

Dick, Kerr & Co. are well known as electric traction engineers, and no detailed description of their work in this direction is necessary. Reference may, however, be made to a branch of the Lancashire & Yorkshire Railway, in which certain features are of interest. The line in question is a short length, under 4 miles long, between Bury and Holcombe Brook, Lancs, and this has been electrically equipped on the overhead system, catenary suspension with single messenger wire being employed. The line is supported on bracket arms attached to lattice poles, but in a few cases light bridges spanning the track are utilised. This line is noteworthy from the fact that it is operated by high-tension direct current, the voltage between trolley and earth being 3,500 volts, which is, we believe, the highest voltage ever employed for the operation of a direct-current railway anywhere in the world. The motor cars are equipped with four motors permanently coupled two in series, and the usual series parallel control is used. No difficulty has, we gather, been experienced in the use of continuous current at this high pressure, and the operation of the line over a lengthy period has completely demonstrated the practicability of what may be regarded as extra-high-tension direct-current traction.

At this juncture we may remind our readers that Dick, Kerr & Co. are the manufacturers under licence of all classes of "Thury" series motors and generators, the essential working principle of which is the

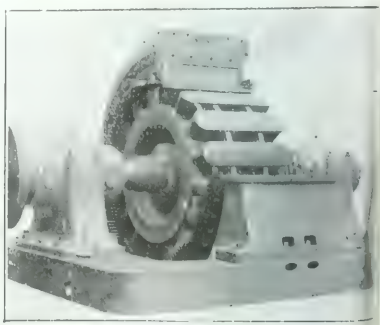


A Corner of the Britannia Lamp Works, Preston.

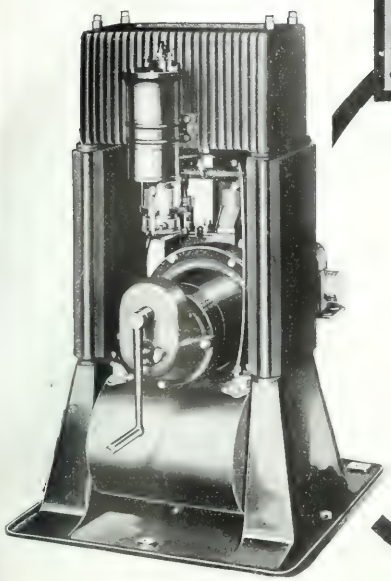
employment of a continuous current of constant value, with a variable voltage. This system is suitable for the transmission of power over long distances, but the principle has also been successfully employed for the electrical operation of winding and haulage gears for collieries, &c. One of these electrical winders was supplied to Messrs. Wm. Baird & Co. at Auchincruive. The Thury motor has an output of 275 H.P., and is controlled by varying the position of the brushes on the commutator. The motor being series wound and the current maintained constant under all conditions, but with varying voltage, it operates with constant torque and varying speed, which is what is required for this class of work. Several installations of this kind have been done by Dick, Kerr & Co

The foregoing information and illustrations have been taken from an admirably printed and profusely illustrated publication which the company has recently completed. In the space at our disposal we have only been able to briefly outline the work which the company undertake, but we would commend the publication referred to to the notice of our readers. We understand that only a limited distribution is possible.





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Standard 110 volts direct current automatic voltage regulation by potential governor. High tension magneto ignition. Petrol lubricating oil and water reservoirs self contained no piping necessary. Automatic correct lubrication. Thermo siphon cooling system. Automatic carburettor. High efficiency engine.

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Here is what the thousands of people have wanted for years. A complete electric lighting plant for use where central station supply is not available. Complete in one compact unit—engine dynamo and governor—delivering standard voltage direct to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use. This is the first successful system to produce such a result without the use of complicated switch boards and costly storage batteries requiring constant expense and care.

Turn on one or 50 lights just as you choose. Nothing to look after but the small high speed engine that works smoothly and silently while the lights are on—giving the same clear, steady, non-flickering light you get from a central power station.

Pour in oil, petrol, and water once a week, or as needed—that is all the attention required.

The perfect plant for country house, farm, garage, yacht, etc. Low priced, economical, easy to instal, simple to operate. Good for many years of constant service.

WRITE TO-DAY FOR COMPLETE DESCRIPTION.

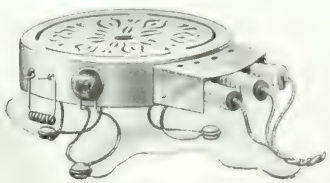
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PYRO-RING AND PYROSTOVE.

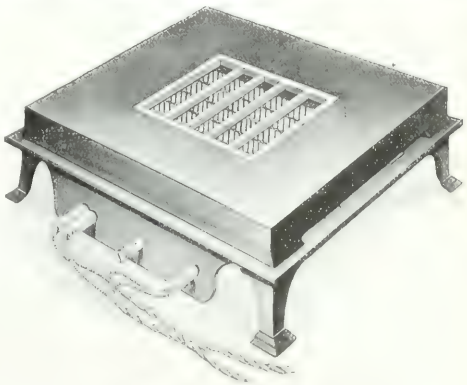
If the activities of the makers of electric heating apparatus are any criterion, the electric boiling ring is rapidly increasing in popularity. Many restaurants, snack bars and saloons experience a demand for hot drinks, and with an electric service available they are becoming more than ever attracted to some form of boiling ring. The use of this apparatus under such conditions proves a useful advertisement, and at the same time affords operating conditions which test the design to the utmost.

We gather from the new season list of Bastian heaters, which is now available from the Bastian Electric Heating Synd., Wardour-street, Oxford-street, W., that the quartzalite pyro-ring and pyro-stove are meeting a distinct want in the heating field. The pyro-ring is an extremely neat form of circular heater 6½ in. diameter, loaded to 500 watts with three-heat control. The regulation is effected by the use of three separate porcelain cased connectors. The latter are corrugated, so as to afford as large a cooling surface as possible. The weight of the ring, which is provided with a cast aluminium body, is only 3 lb. The feet are specially shaped, of a stout brass wire with porcelain knobs, which are quite smooth, so that the stove can be put down on a polished surface without fear of scratching. Coiled wire swing handles are provided, one at each side of the ring, for lifting purposes, and as these are well clear of the heating element they are unlikely to get hot, and may be used to lift the ring when it has been in circuit for some time.

We also illustrate the pyrostove, which is the big brother to the pyro-ring. This is a rectangular apparatus, and is provided with a central rectangular well, under which is a curved polished aluminium reflector. The outside measurements of the working surface of the stove are 12 in. wide by 13 in. deep. The maximum loading in this case is 2 kw., and the heat rises in a concentrated column from the heat well in the centre of the hob plate. Three-heat control of the elements is afforded by pin connections, and considerable regulation is possible by reason of the width of the hob plate; over this the utensils in service can be moved either nearer to or further from the heating space. The weight of this stove is 22½ lb. It will be seen from the illustration that an earth terminal is fitted.



The Bastian Pyro-ring.



The Bastian Pyrostove.



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D.C. MOTOR CONTROL PANELS.

We gather from Price List No. 3260, just issued by the B.T.-H. (Rugby), that type C D M, form P, motor control panels combine in a convenient form the apparatus required for starting and controlling stationary continuous-current motors. The equipment consists of a sheet steel base supporting a starting rheostat and a switch fuse. The whole apparatus has been designed to comply with the Home Office rules for the use of electricity in factories. There are no exposed live parts, neither can the starter nor the switch fuse be left in partial contact. The panels covered by the list are suitable for motors up to 7½ H.P. on circuits between 100 and 550 volts.

The base on which the apparatus is mounted consists of plain sheet steel of sufficient thickness to ensure rigidity. This base is fitted with a tubular beading and lugs suitably drilled for wall mounting, the whole panel thus presenting a neat appearance. All holes for bringing the leads through the base plate or through the switch and starter cases are fitted with insulating bushes. Connections between the switch fuse and the starter are not supplied with the panel, as these can conveniently be made when the panel is being wired up on site. The apparatus mounted on the base plate consists of: One totally-enclosed D.C. starting rheostat, type P B, form D, and one ironclad D.P. switch fuse, type E K, form A.

The switch fuse is of the double-pole quick-break type, enclosed in a cast-iron case. The fixed contacts are recessed in substantial porcelain bases, and the movable parts are attached to the hinged cover, the handle being so arranged that the cover cannot be opened while the switch is in the closed position. The fixed contacts are bridged in the closed position by bomb-type fuses, which are attached to the movable parts in the cover. These switch fuses are fully described in a separate list which may be obtained from the company. The starting rheostat consists of a switch and resistance mounted in a totally enclosed cast-iron case having a glazed opening for the inspection of the switch and contacts.

"HERCULES" DRY CELL.

[illegible] the dry cell bearing the above trade name are being distributed by the Silvertown Company. These cells are made in three sizes—large, medium and small. The large size is 3½ in. diameter by 8 in. high, and weighs 5½ lb.; the medium size is 3 in. diameter by 7 in. high, and weighs 3½ lb.; and the small size is 2½ in. diameter by 6 in. high, and weighs 2 lb. Both carbon and zinc are provided with screw-down terminals. We gather from leaflet No. 48 that tests were made on three cells taken at random from a batch in stock. The particulars of these tests are set out below:—

	Large.	Medium.	Small.
[illegible]	1·56 ...	1·55 ...	1·54 volts
[illegible]	0·12 ...	0·11 ...	0·12 ohm
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1 Dec. ...	201 ...	154 Dec.
Equals ampere-hours	131 ...	67 ...	17 ...

[illegible] low internal [illegible] be supplied on application. It [illegible] to the fluctuating [illegible]

A NEW LAMP LIST.

At the present time, when many firms are working continuously day and night, the question of artificial lighting is highly important. The new Mazda lamp list just issued will, therefore, be of interest. The cover is a fine example of beautiful colouring and pleasing design. Some idea of this may be gathered from the reproduction herewith; but it is, of course, not possible to show the magnificent blue, yellow and orange colour schemes of the actual list. The information pages



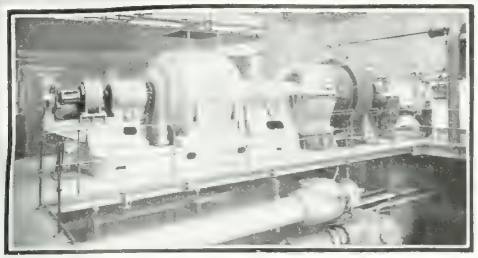
are well planned, and the illustration of the characteristic light distribution of Mazda lamps is an innovation in lists of this kind. All the standard Mazda lamps are illustrated and priced, and a two-page sheet dealing with Mazda half-watt lamps is pasted on at the end of the list. Copies may be obtained on application to the B.T.-H. Co., Mazda House, Upper Thames-street, London, E.C.

EXTRA COPIES OF

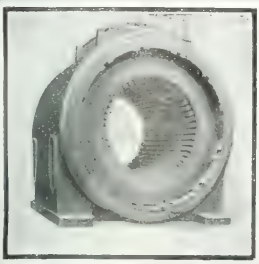
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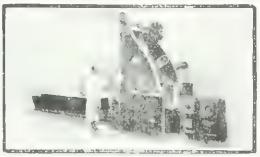
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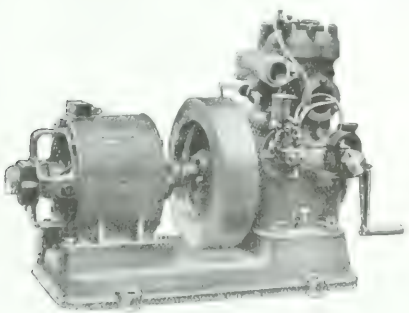
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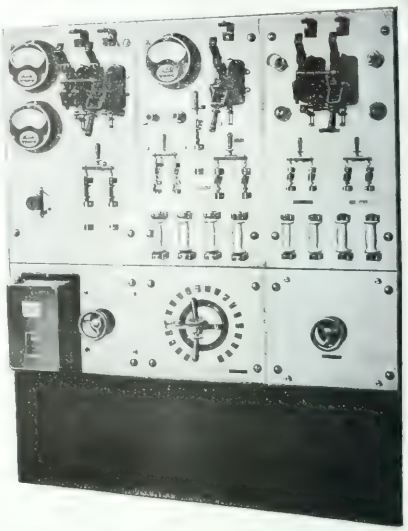
"SILVERTOWN" ELECTRICAL ACCESSORIES.

In publication No. 47, the India Rubber, Gutta Percha & Telegraph Works Co., Silvertown, set out particulars of their electrical accessories, which include ordinary and switch lampholders, goliath



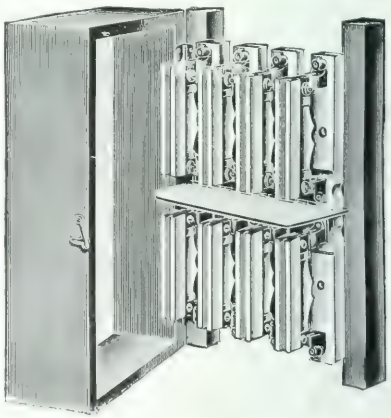
[illegible] Pattern Distributing Box.

[illegible] plug adapters, switch ceiling roses, tumbler switches, [illegible] switches and radial installation material. A line of insulated lampholders which conform to the Home Office requirements [illegible] being fitted [illegible] suitable for [illegible] and ordinary bayonet holder with cord grip. We illustrate one of the distribution [illegible] with end [illegible] three, four, five [illegible] front or with the wire at the back. The poles are divided by a fireproof slab. A line of distribution boards similar in electrical design to the foregoing is also offered, but the fittings are put up in cast iron cases. These cases are secured with wing nut fastenings, and are asbestos lined. These are also offered in sizes from two to six ways,



Silvertown Switchboard for Small Plant.

with or without switches. The list contains illustrations of the Silvertown petrol-dynamo set, and also an example of the Silvertown direct-current switchboard, which is typical of the class of work which the company is prepared to do in this direction. These latter illustrations are reproduced herewith.



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A copy of the catalogue in question may be obtained on application to the company, either in London or at their home or Colonial branches.

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Number FIFTEEN

ELECTRIC VEHICLE PROGRESS







THE QUESTION OF SPEED.

The motor vehicle user, especially in commercial srrvice, has been educated into taking his ideas of a power waggon from the petrol vehicle industry. The propagandist work of makers of commercial petrol vehicles is conducted with a considerable amount of vigour and the distribution of large quantities of printed matter. It is also accompanied by a certain number of trial runs, during which the attention of the prospective purchaser is called to the maximum speed at which the machine can be driven. This feature, together with the general information given in the printed catalogues, is usually greedily absorbed by the prospective purchaser. While the constructional features of the car will leave little or no impression upon his mind, he will invariably remember that the vehicle is a fast one, and he will automatically select this as a standard of comparison by which to judge any other machines, petrol; steam or electric, which are brought to his notice. He will not stop to analyse the effects which fast running will have on the tyres, chassis and the body-work of the vehicle. Obviously, the salesman will not bring these inevitable results into prominence. The vehicle user must find them out for himself. As a rule, the problems of operating and maintenance costs are, he considers, no particular concern of his. In a vague kind of way he will explain that the machine can be run for so much a mile "all in." It is true the highly organised condition of the motor-car industry has enabled him to collect technical data and information based upon trials taken under test conditions and everyday conditions, but there is nothing to show that the averages which are struck from these figures are sufficiently reliable to apply to specific classes of motor service. Herein lies the risk to the vehicle user of purchasing a machine on the principal recommendation of speed.

It is the mission of the electric vehicle pioneers, whose work is now being steadily carried on in the field of commercial transport and passenger carrying by motor 'buses, to remedy the ill impressions which have become current on the subject of the speed of power-driven road vehicles. They are advocating the employment of vehicles in a class of service in which high speed is of comparatively little importance. In contradistinction, they are able to offer to the users of power-driven vehicles a machine which will give a satisfactory average speed for town delivery work, and operating and maintenance costs which are superior to those obtainable with steam or petrol. The task which the petrol vehicle industry has thus imposed on the electric vehicle manufacturers of converting the commercial motor public to a new idea is certainly not a light one. The old proverb that first impressions are lasting impressions is as true in the commercial world as it is in the social world. Speed is an intangible something which appeals to the lay mind. Even engineers are not insusceptible to its fascinations. There is about it an inexplicable mental stimulation which can only be paralleled with the indiscretions into which youth is always ready to plunge. Speed is, however, not the only factor with which the purchaser of a commercial vehicle has to reckon. Quite aside from the problems of road wear which it introduces, and which would but for this war have assumed national proportions, speed is responsible for excessive maintenance costs of chassis and propelling mechanism, and an altogether disproportionate amount of wear upon the tyres, disproportionate having regard to the class of service—namely, town delivery work—upon which so many power-driven commerical vehicles are now employed. The commercial electric vehicle provides for this class of transport service a means of conveyance which furnishes the user of the vehicle with a well-balanced sheet of operating costs. Fuel, chassis, tyres and maintenance costs appear in this sheet as proportionate items, a fact which may be attributed to good average rather than high maximum speed in the vehicle.

OPERATING RECORD OF A POLE TRUCK.

An example of the successful operation of electric trucks in heavy hauling is given by the Electric Vehicle Association of America from the report of the Chief of Transportation of the Philadelphia Electric Co., showing in significant figures the record of a truck employed in transporting telephone poles. On Dec. 23 this truck hauled five heavy 45 ft. poles for the Bell Telephone Co. from the Philadelphia Electric Co.'s pole yard at Seventeenth and Ledgeley avenue to Newton-square, Pa.

There is nothing remarkable, reads the chief's report, in the statement as it stands, as we have made this trip frequently of late, but significance does lie in the fact that the trip was made by our No. 14 electric truck in the good time of 6¾ hours, leaving the pole yard at 6:30 a.m. and arriving at Newton-square at 11:30 a.m., and arriving back at 1:15 p.m. after leaving Newton at 11:45, making the total time for the round trip 6¾ hours and using 305 ampere hours. The poles hauled were above the average size, the entire load approximating 8 tons, the capacity of the truck being 6 tons. This fact, together with the hilly country travelled, caused the truck to use in some places three times the amount of current ordinarily required. This was particularly noticeable in the run over a distance of a little over 2 miles, taking one hour's time, and using 55 ampere hours. In addition to the above, I desire to call your attention to the difference in the cost of hauling these poles by horse team. The cost of the trip made by No. 14 truck was 6¾ hours at 6s. per hour, £2, when the horse team took 20 hours at 5s. per hour, or £5.

OSRAM Drawn Wire Lamps
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IGRANIC
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For the smallest or largest garage. Built like a filing cabinet—always complete but never finished. Fully standardised. Quite mistake-proof. Prevent all usual mishaps
IGRANIC ELECTRIC Co LTD London and Bedford.
A Single Complete Unit. One or more such units form a Switchboard. Units can be added at any time.

COMMERCIAL VEHICLE WITH TWO-MOTOR DRIVE.

A 3-ton electric truck, having two motors and concentric gearing, has recently been developed by the Commercial Truck Company of Philadelphia, Pa. The construction of the wagon is similar to that of 1-ton and 2-ton trucks made by the above company, two motors being employed to operate the truck. The battery consists either of forty-two lead cells or sixty Edison cells; for the former the pressure

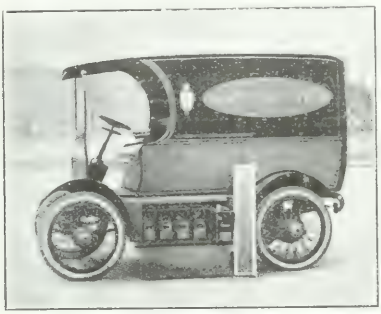


FIG. 1. WANAMAKER ELECTRIC TRUCK.

is 85 volts and for the latter, 60 volts, the current in each case being 12 amp. and 17 amp. A mileage of 40 to 60 miles is obtainable, depending on the battery equipment. The gears are completely enclosed and run in oil, double reduction being obtained. The front axle has a [illegible] box section and the rear axle is of the dull



FIG. 2. DETAILS OF TWO-MOTOR DRIVE.

[illegible] type of the double channel [illegible] type. The frame is of channel irons and is trussed and thoroughly [illegible] at the corners. A [illegible] type of controller is employed which is at the base of the steering column. There are four points for forward speeds and two points for reverse speed. The front tyres are 2·5 in. by 36 in. and the rear tyres are 3 in. by 36 in. The brakes are of the internal expanding type. In Fig. 1 is shown a truck of the above type, built for John Wanamaker of Philadelphia for use by the jewellers and silversmiths' department. Although this truck is equipped with wire wheels and pneumatic tyres, use is generally made of solid tyres and wheels similar to those shown in Fig. 2. Fig. 3 illustrates the arrangement of gears and the

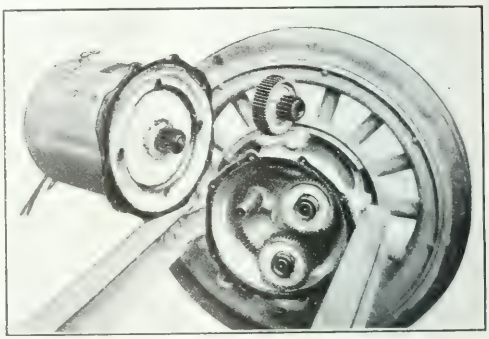


FIG. 3. GEAR DRIVE OF TWO-MOTOR EQUIPMENT.

method of connecting the motor to the wheel. According to the manufacturers, the following advantages accrue to the two-motor concentric-gear type of electric truck. It is well adapted for climbing hills; traction chains for slippery and snowy roads are unnecessary; the arrangement of motors is simple; in case of trouble in one motor it can be disconnected and the truck may be operated temporarily on the other motor.

ELECTRIC SHOP TRUCKS WITH TURNTABLE.

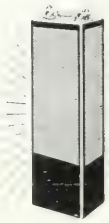
The illustration shows an interesting type of shop trailer built by the Waverly Company, Indianapolis, Ind., for the repair shop of the United States Navy Yard at Bremerton, on Puget Sound, Washington. The tractor used in connection with this trailer and the trailer itself, are designed for conveying plates and angle irons from places of storage to the machines and from machine to machine. The construction of both cars is very substantial, wheels, axle frames and turntables being of heavy steel. The wheels are equipped with 24-in. solid tyres. The tractor is provided with a structural-steel bumper which is braced for protecting it from head-end collisions. The wheelbase of the tractor is 66 in., and the platform of the car is 5 ft. by 11 ft., the principal overhang being in front of the front axle. The driver's seat is offset from the body of the tractor so that the entire

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TUDOR Accumulators

FOR ELECTRIC VEHICLES.

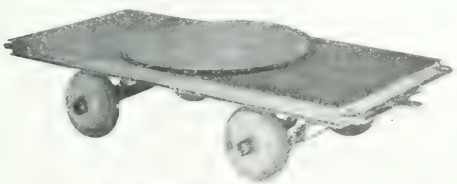


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About 16 Electric Omnibuses have been in regular service for the past six years, and TUDOR Accumulators have been employed exclusively.

THE TUDOR ACCUMULATOR CO., LTD.,
3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.
Works: DUKINFIELD, near MANCHESTER.

surface of the platform can be utilised for loading. Energy for operating the tractor is obtained from a thirty-cell, twenty one-plate lead battery, and a mileage of 30 miles on a single charge can be obtained. With both cars fully loaded a speed of 5·5 miles an hour is developed. Mounted on the platform of each car is a turntable 5 ft. 2 in. in diameter running on rollers and operated by hand spikes for the quick and convenient unloading of the heavy plates



ELECTRIC TRACTOR WITH TRAILER.

or beams it is designed to carry. A single motor is used, and the power is transmitted to the rear axle, by means of worm-gear-shaft drive. A 50-ft. cable connects the trailer to the tractor, giving ample room, it is declared, for the longest beam that could be carried on an ordinary flat car.

ELECTRIC VEHICLES ON MILEAGE RUN.

A popular fallacy in regard to the electric passenger automobile is that it is slow and of such limited mileage that it is impracticable for general use. To correct this mistaken idea the Electric Vehicle Association of America gives one example of the actual running power of the electric in a test run recently made by 14 electric pas- [illegible] much as a wrench had to be applied to a single car. An electric service wagon carrying a 1,500 lb. load accompanied the cars, and made the trip without a hitch and with power to spare. This run was made by the Beardsley Co., who offered a silver medal to any owner who made 90 miles on one charge, and a gold medal to any one who reached 100 miles. No one won the silver medal, because every one qualified for the gold one. The speedometers were sealed at the start, and were not opened until the batteries were exhausted, which was at about six o'clock the same evening, when it was found that the cars averaged 100·1 miles each, first place being taken by a car which made 112·1 miles, and was driven by a lady. Several of the drivers were elderly people, and some were new to the part, as was one young lady, who was unfamiliar with the car, but who made a score of 100·1 miles. Some of the records ranged as follows: 106·5, 105·8, 104·1, 103·9, 101, 100·3, which are some of the best ever scored by electric vehicles, but which might have been even better under favourable conditions, for the tour lay through hilly country, over roads with several heavy grades, and the return was made through the city, over pavements which were exceedingly slippery. It is to be noted that all these cars, which, besides the truck, included broughams, roadsters and victorias, carried from two to three passengers, and were stock models not driven by experts, but by the owners themselves.

BATTERY-DRIVEN WATERING VEHICLES.

Some interesting particulars were recently published in the American technical press of the results of an extended experience on the part of the Calgary municipality with a number of electric battery vehicles. Some eight machines in all have been purchased, and these comprise three 1-ton trucks, used by the electric light department, two 3-ton trucks in the service of the sanitary department, and two 5-ton trucks employed by the street-cleaning department. The last named are street-watering and drain-flushing vehicles. Each sprinkler does the work of three horse teams, and the flushers of two horse teams.

During the summer these cars are worked in day and night shifts of nine hours, sprinkling by day, and eight hours drain flushing by night. The mileage covered averaged 38 each day for the sprinkling period and 17 for the flushing period. It is claimed that these vehicles show a daily saving alone of £5 as compared with the horse-drawn machines previously employed. The sprinkler truck is of the 5-ton type, and has a capacity of 1,200 (U.S.) gallons. The tank, which is cylindrical, measures 160 in. long, and has an internal diameter of 51 in. At the forward end is a compressed air compartment 25 per cent. of the tank volume, worked at 65 lb. pressure. The total weight of the tank is 3,600 lb. The tank is filled by a $2\frac{1}{2}$ in. water intake valve in the centre of the rear drum head of the cylindrical tank. The main outlet of the flushing tank is an $\frac{1}{2}$ in. standard pipe and on the sprinkler tank a $4\frac{1}{2}$ in. standard pipe.

Having regard to the increasing interest in this country in battery driven public service vehicles, the experiences of the town of Calgary are of value. The authorities are so satisfied with the results that they have decided to increase the electrical equipment in the transport department until horses are entirely dispensed with.

Not the least important feature of the watering vehicle mentioned above is the ability to remove the tanks during the winter months and replace them with a box-type body which will carry 6 cubic yds. of refuse.

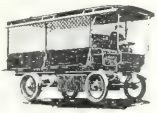
The vehicles themselves are of the standard G.M.C. type, single-motor drive through countershaft and side roller chains to the rear wheels, battery in large box behind the driver's seat, and controller gear under small and easily accessible bonnet at the front of the car. The controller is operated by a rod, concentric with the steering column, and terminating in a large lever which is above the steering wheel and is radial to it. The sprinkler and flushing cars cost £2,288 the two, complete with battery, but the type of the latter is not mentioned.

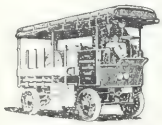
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ELECTRIC VEHICLE PROGRESS



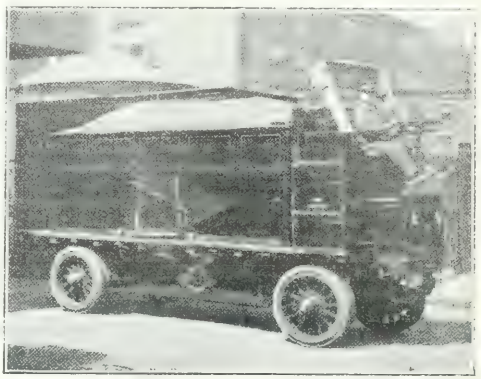

THE ECONOMY OF ELECTRIC VEHICLES.

By replacing horse-drawn vehicles used for hauling rolls of paper, waste paper, coal, mail and freight by electric trucks with demountable bodies and adopting efficient means of loading and unloading, the Curtis Publishing Co., Philadelphia, publisher of the "Ladies' Home Journal," the "Saturday Evening Post" and the "Country Gentleman," effected during the year 1914 a saving of $12,648, or 13·6 cents per ton, the total tonnage for the year being 93,000. The costs include all overhead expenses, interest on investment at 6 per cent., and depreciation at 10 per cent., and have been compared with the rates previously obtained from teaming contractors. The "Electrical World," which makes these facts known, states that prior to August, 1912, the hauling of paper to the company's plant at Independence-square from its warehouse at South Eleventh-street and Washington-avenue, the hauling of its periodicals to the Broad-street station of the Pennsylvania Railroad, to the post office on Market-street, and to wharves along the Delaware River, the removal of baled waste paper from the plant, and the hauling of coal to the plant, were done under contract by a local teamster.

Although the horse-drawn vehicles were always able to maintain the mailing schedule, six horses sometimes being used on a two-horse truck in blizzard weather, certain members of the Curtis Publishing Co. were of the opinion that the haulage bills could be reduced by the use of motor trucks operated by the company, and they were able to induce the directors to make extensive tests with different sizes and types of motor trucks in the hope of demonstrating that an expenditure of about $30,000 for trucks and a garage would prove a good investment. The electric truck proved to be the most economical. The maximum efficiency of the petrol-driven types of truck could not be obtained owing to short hauls averaging about 1·1 miles in the most congested parts of the city.

The four-motor, four-wheel driven type of electric truck manufactured by the Commercial Truck Co. of America, Philadelphia, was selected as being best adapted to the conditions. The first truck was of 7 tons rating and was purchased in August, 1912. This was followed first by a 0·5 ton two-wheel driven truck for carrying money, and later by four-wheel driven trucks for various purposes, until at the end of the summer of 1914 the final truck was purchased, resulting in the equipment shown in Table I. During the year 1914 the electric trucks handled the entire haulage for the plant with the exception of the coal hauling, which was performed by teams under an existing contract during the first part of the year.

With the exception of the 0·5 ton and the 1 ton machine, all the trucks can be used with demountable bodies when desired. These bodies are of two types, one for handling periodicals, paper, &c., and the other for handling coal. The former type of demountable body has been designed primarily for the 3·5 ton trucks, but it is capable of carrying 5 ton loads and can be used with the 5-ton trucks by dropping the body in the centre of the truck platform. The demountable coal bodies were designed for use with the 5-ton trucks, but can be employed on the 7-ton truck. The hauling of coal from the storage plant forming part of the warehouse to the main plant is done at night, thus keeping the trucks in almost continuous operation at times. The coal bodies are of the side-discharge type, with funnel-shaped bottoms. They are not entirely self-unloading because the height of side necessary to accomplish this is greater than the distance from the ground to the overhanging portion of the coal pockets from which the trucks are loaded. From the dropped



Electric Truck with Detachable Coal tipping Body.

through holes in lugs attached to the body frame and through registering holes in the platform serve to keep the body of a truck in place. The bodies are mounted on the trucks at the garage, where two differential chain-falls fitted with special arms for lifting the bodies are provided.

The warehouse of the company is a four-story building situated at Washington-avenue and South Eleventh-street. The rear side and one end of the ground floor are so built as to cover spur tracks from the Pennsylvania Railroad. The rolls of paper are removed from the freight cars, the floors of which are level with the warehouse platform, by means of a 1-ton differential chain block mounted on a travelling I-beam running on I-beam tracks hung from the second-floor girders.

At the printing works there is provided an inner court equipped

OSRAM Drawn Wire Lamps
for Motor Car Lighting.



TUDOR
ACCUMULATORS
FOR ELECTRIC VEHICLES.



AMBULANCE WITH TUDOR BATTERY.
Port of London Authority—4 Vehicles. City of London Corporation—2 Vehicles.

BATTERIES FOR COMMERCIAL VEHICLES, PLEASURE CARS, OMNIBUSES, &c.

LIGHTEST IN WEIGHT—HIGHEST IN EFFICIENCY.

Maintenance undertaken at Moderate Mileage Rates.

THE TUDOR ACCUMULATOR CO., Ltd.,
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with a glass roof and bottom doors for the transportation of rolls of paper and the shipping of waste paper. Some mail is handled from the court and the remainder from a bay on the Sansom-street side of the building. Here electric hoists mounted on carriages operating on I-beams, placed at right angles to the edge of the plat-

Table I.

Number of trucks, in tons	Load carried to plant.	Load carried from plant.
1	7	Paper from warehouse 1·1 miles distant.
1		Money from bank. First-class mail.
5	7	Paper from warehouse. Five-ton trucks also haul coal at night from warehouse.
1	3	Picks up ink, paste, &c., also empty freight bags from freight yard.

Periodicals to post office wharves and railroad

First-class mail.

Small freight, &c.

* The 3·5 ton trucks handle all paper until its amount exceeds their rating, when the 5-ton and later the 7-ton trucks are also employed. The periodical load is heaviest during the interval from the 10th to the 20th of any month. To balance the truck service during the intervening periods more paper than is required for immediate use is carried to the plant and stored for use during periods of maximum periodical load.

Table II. *Expenses for the Year* 1914.*

Maintenance of tyres	$2,803.58
Maintenance of battery†	269.28
Repairs‡	3,401.88
Grease and oil	50.00
Energy at about 4 cents per kilowatt-hour	3,482.65
Depreciation (10 per cent. for machinery)	5,820.12
Interest (6 per cent.)	314.52
Drivers' wages	8,221.72
Supervision	2,410.00
Garaging and washing	3,940.32

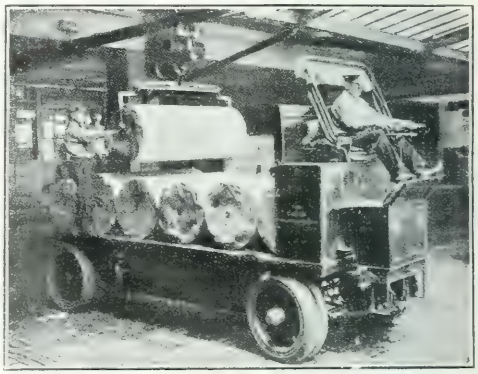
* In comparing all of these figures it must be remembered that only two of the trucks have been in service longer than 18 months. Overhead expenses are not given here, but are taken into account in computing the saving of 13·6 cents per ton.

† Five reserve batteries are included.

‡ A general overhauling is included.

form and projecting beyond it, are employed for handling paper. The rolls of paper are picked up by a balanced horizontal arm with which the hoist is equipped, the ends of the arm being bent downward so as to fit into the ends of the hollow steel core around which the paper is rolled.

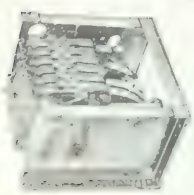
Upon being removed from the truck the rolls of paper are not deposited on the unloading platform, but are lowered to the basement storeroom through a hatch directly under the hoist's I-beam. The driver and one man can unload or load the average paper truck truck in a minimum time of 10 minutes. As a result the combined



Electric Truck for Paper Haulage.

loading time at the warehouse and the unloading time at the plant is only about 20 per cent. of the total time of a round trip, which averages about 50 minutes. Baled waste paper is carried by the trucks on their return trip. This paper is hoisted from the baling machine in the basement to the loading platform by means of an electric elevator.

The illustrations show the construction and methods of handling demountable bodies. These bodies are lifted at the plant by means of triplex hoists, which move parallel to the platform and also permit the vertical movement. The bodies are loaded while suspended by means of hand trucks, which in turn receive their supply of periodicals from an elaborate system of conveyors. A short steel plate is used to bridge the distance between the edge of the platform and the edge of a body while loading. The bodies are placed on the trucks by simply lowering them and detaching the hoisting chains. They are removed in the reverse manner. In this way the loading time of a

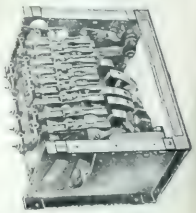


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FOR EVERY ELECTRIC VEHICLE

IGRANIC

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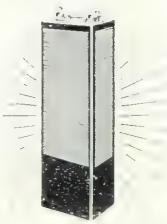


F8 Controller.

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON, S.W.

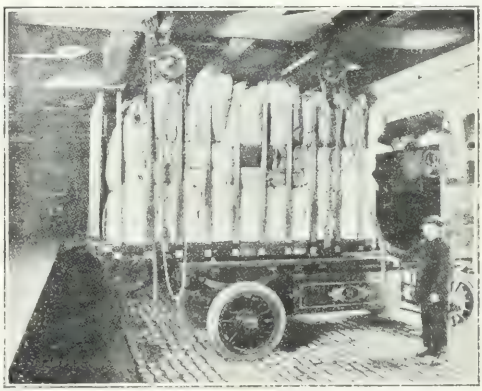
3.5 [illegible] truck has been reduced from 18 minutes to about three minutes. At present the demountable body offers no advantage at the post office, wharves or railroad depots, as equipment to handle it has not been installed. Efforts are being made, however, to obtain the [illegible] of installing the necessary apparatus at the depot and wharves, and if the negotiations result in such an installation, the time of the round trip of a truck will be considerably reduced. The greatest delays, of course, occur at wharves, where the inefficient dock employees and the inefficient methods of handling freight, drays, &c., are responsible.

The negotiations with the railroad company are for the entire use of a portion of its platform sufficient for the unloading of three trucks at the same time and for the erection of two overhead cranes for the removal of demountable truck bodies. In this way it would be possible for a truck to have its body lifted and, during the unloading thereof, to proceed to another of the three positions to receive an empty body.

The garage is a one-story building approximately 78 ft. by 125 ft., constructed of brick with a steel roof. The entire front portion of the building to a depth of approximately 50 ft. from the front wall is utilised as garaging space for the trucks. The rear of the building is divided by brick and brick and wood partitions into rooms as follows: Battery room, stock room, pit and repair room, truck-washing room, locker and toilet rooms, office, machinery room and boiler room. The repair room is 24 ft. wide and is provided with two drained truck pits which when not in use are covered by plank tops. The vehicle washing room is of interest in that, in addition to ceiling lamps, it is equipped with four special lighting units for illuminating the under portions of the trucks. One of these units is placed in each corner of the room. Each consists of a triangular



DETACHABLE BODY READY FOR PLACING IN POSITION.



ELECTRIC TRUCK WITH LOADED BODY LOWERED ON TO TRUCK.

"Ironclad Exide"
(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.

GUARANTEED FOR TWO YEARS.



Its record for the past four years stands as absolute proof of the correctness of its design. It is unquestionably the battery for commercial service. It is reliable day in day out every day in the year. It is conservatively rated and can be discharged on emergency up to practically anything that other current carrying parts of the equipment can carry.

WILL STAND HEAVY BOOSTING CHARGES.

ITS LIFE IS BETWEEN TWO AND THREE TIMES THAT OF AN ORDINARY FLAT PLATE.

THE RATE AT WHICH IT CAN BE RECHARGED DEPENDS ONLY ON WHAT HAS BEEN TAKEN OUT AND IS IRRESPECTIVE OF ITS SIZE.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION, MANCHESTER.

LONDON OFFICE: 39, VICTORIA STREET.

water by means of circular pieces of glass forming part of the front faces of the triangular boxes.

reverse-power relay is provided for opening the circuit-breakers in case the direct-current voltage should fall below that of the batteries being charged. The motor of the motor-generator set is wound for 125 volts, the voltage at the batteries being varied from about 110 volts to 120 volts during charging by means of rheostats in each charging circuit and by varying the generator voltage. One panel of the switchboard is devoted to the control apparatus for the motor-generator. Each of the other three is made up of three horizontal sections, each of which controls two battery-charging circuits, thus giving a total of 18 charging circuits. This type of board was adopted so that charging sections can easily be added as the fleet of trucks is increased.

A watt-hour meter is provided on the charging panels for each charging circuit. Each meter has two scales, one showing the amount of energy supplied to the truck during any desired period of time and the other showing the amount of energy supplied during a charge. In this way actual costs records of energy consumption can be maintained and the comparative efficiencies of the trucks determined. The battery-charging circuits are run in conduit near the tops of the walls, passing downward at outlets to a point about 6 ft. above the floor, where long cables are attached. When not in use these cables are kept off the floor by throwing them over hooks fastened to ropes suspended from the roof trusses and weighted at the other ends sufficiently to overbalance the weights of the cables. The suspended charging cables have been protected from the danger of being struck by trucks by the erection on the floor at each end of the garage of wood bumpers approximately 2 ft. wide.

The trucks and batteries are examined daily, and there has never been an interruption in the service. Fifteen sets of batteries are maintained for use with the 10 larger trucks, thus affording opportunity for repairs, &c., without putting a truck out of service and permitting the substitution of another battery in case of long con-

THE ELECTRIC TAXI.

Probably the best example of electric taxi development in the United States is in Detroit, the home of the petrol car. The Detroit Taxicab & Transfer Co. is now operating a fleet of 10 electrics, which will shortly be increased to 70 or more. The first electric with which this company experimented showed a mileage of 1,375 miles in one month, and by [illegible] had run 12,000 miles and had proved its utility beyond doubt. The next few months will also witness an initial installation of the electric taxicabs on a large scale in New York. The company responsible for this introduction will, it is expected, extend its services on a large scale in all the principal cities in the United States.

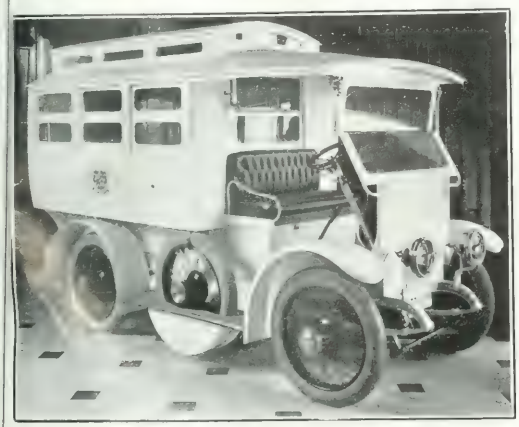
Mr. E. P. MacDowell, Motor Taximeter Co., New York, recently stated that he had found that one of the most uncertain expenses in operating the petrol taxicab is the cost of damage and accident claims. The use of excessive speed by chauffeurs in streets where traffic is congested, coupled with the carelessness of pedestrians, is a source of bad accidents in New York. He stated, with regard to the electric cab, that with several months of tests over stiff hills and in city traffic, he had maintained an average of 59 miles on a single charge. Experience has shown that the average daily mileage of an active taxicab for a 10-hour day is about 35 miles, which is well within the capacity of one battery charge. With the charging facilities now available, the electric taxi may be boosted at relatively high current while waiting at stands for calls, a fact which ensures almost unlimited daily mileage. It is also possible to operate the electric taxicab 20 or more hours a day with two shifts of chauffeurs. But this method, although tried in the operation of petrol taxicabs, has never proved successful. The economy of long-hour operation of electric vehicles is therefore evident. Experiments with several makes of electric cabs for the past few months have shown that they can be operated for something in excess of 20 per cent. less cost than a petrol car. They are well constructed, and there is continuous improvement in design and speed. They are much lighter in weight than formerly. A lower rate of insurance is a matter which will further reflect the economy of operations. Owing to the positiveness of control of the electric, collisions are reduced to a minimum, and insurance companies will give preferential rates.

ELECTRIC VEHICLE PROGRESS

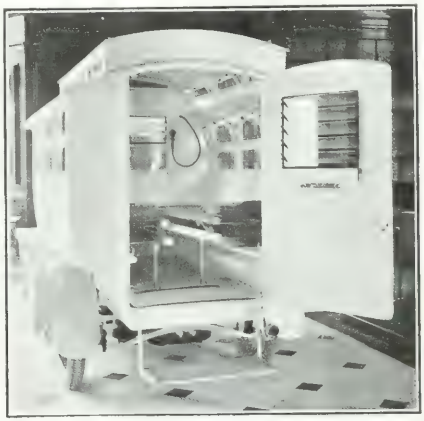


A NEW ELECTRIC AMBULANCE.

The illustrations show the exterior and interior views of an electric battery ambulance, recently supplied by Carters, the ambulance specialists, for the City Corporation of Durban, South Africa. While the makers have proceeded on definite and well-known lines in regard to the chassis, the mounting of the vehicle and the design of body with the interior accommodation are new and offer many advantages. The chassis is of a type identical with two of those now in use in the City of London, with Greenwood & Batley's



General View of Electric Ambulance.



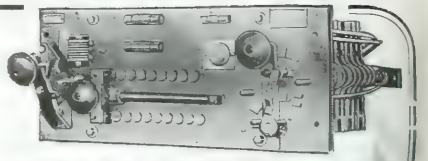
End View of Ambulance showing Stretcher Arrangement.

8 h.p. twin motor and Tudor Ky. B.9 type battery. The car is fitted with six speeds forward, reverse and electric brake, in addition to hand and foot brakes. It is mounted on Rudge Whitworth steel detachable wheels, complete with spare wheel, and 820 × 120 Dunlop pneumatic tyres (three steel studded). The body of the car, framing, exterior and interior panelling, is of teak throughout, specially built to withstand the climatic conditions of Durban, and the car is finished in white Ripolin. The interior is lined aluminium, and finished like the exterior in white Ripolin. Special ventilation is obtained by the adoption of a lantern roof with opening glass frames along each side and ends, special window fasteners to the main window frames, and in addition glass louvred windows in metal frames in the front end of the car and in the door at back. The car is intended for general use in Durban, and provides accommodation for two invalids or injured, the stretchers being fitted with Carters' patent extension gear enabling the patient to be placed in the ambulance without the necessity for the attendant climbing up into the car. The accessories include a metal aseptic detachable seat inside the car for nurse or attendant, metallic speaking tube for communication with driver, a metal case containing complete first aid equipment, and a plated rack containing water, and stimulant bottles, &c., in metal cases. This is, we believe, the first electric motor ambulance to be used in South Africa, and in view of its completeness and the excellent lines which have been followed, it is quite safe to predict that other municipalities will follow suit. It would be difficult to see, with the facilities at present available, where this car could be improved upon, and it is to be hoped that it will arrive safely at its destination. We shall be interested to hear from our friends on the other side with a report of progress, when this car has been placed in commission, and has been in use long enough to be thoroughly tuned up.

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for Motor Car Lighting.



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at present Battery Charging Requirements
WITHOUT LOCKING UP CAPITAL
is very desirable : the user who installs
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Unit Type Battery Charging Panels. It is a reality.
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THE ELECTRIC STEVEDORE.

BY [illegible]

In America the greatest of the modern electric industrial tools is found in the necessity for an automatic device efficient enough to cope with the increasing transportation of baggage and freight and with growing commercial industries. As termini became larger and baggage rooms, post offices and express depots became longer a quicker truck was demanded, and so one railway—the Pennsylvania—engaged a mechanical engineer to design an electric hand truck, as it was then called. So successful was this application of the first "electric stevedore" that it was shortly applied to other operations. When any mechanical device proves itself a labour and time saver, combining both efficiency and economy, it is only a short time before it becomes popularised, and beginning with 1911, only four years ago, various developments of the industrial electric truck rapidly followed each other. To-day over 1,000 of these modern carriers are used in the United States and Canada. The average layman has but a small conception of the tremendous amount of work being done on piers, in railway termini and in industrial plants by these powerful storage battery trucks.



A Portion of the Electric Vehicle Parade—Near the "Salt Exchange" at the Horse Guards.



Mr. Wyld-Lee (centre) and Messrs. Bachl and Reyde at the Electric Vehicle Parade.

In railway termini alone where these modern electric carriers have supplanted the hand trucks it is estimated that there is a total saving of 66 per cent. The electrically propelled baggage truck has proved itself a fixed necessity. We have ceased to marvel at the speed, ease and efficiency with which these trucks piled high with trunks, bags and boxes deftly wind their way along congested station platforms from train to baggage room, doing the work that formerly required four times as much labour and twice as many trucks. In fact, we have almost forgotten the antiquated old hand truck clumsily pushing its way about congested areas with more strength than system or efficiency. A short description of the operation of an electric industrial truck will show its simplicity and safety. The controller is enclosed and an automatic cutoff switch minimises accidents. One handle is used as a controller lever and the other handle for steering. The controller returns to neutral as the hand is removed from the lever. The cut-off switch cuts off the power when the foot is removed from the brake pedal. In other words, the driver applies the brake simply by releasing the pedal [illegible] automatically.

The driver, standing erect on the end of the truck, with hands on [illegible] and foot on the brake pedal [illegible] position to guide and control the load.

The simplicity of operation does away with the necessity for having expensive operators, the average freight handler being taught to successfully operate a truck, even in congested plants or termini, in about 48 hours. The ordinary baggage truck has a capacity of 1 ton, and is used for carrying both baggage and mail. The immense increase in baggage, express and mail matter being moved by our railways demanded proportionate increase of efficiency in its handling, and slow-moving man-powered hand-trucks have gradually given way to the modern "electric stevedore."

Time studies made in manufacturing plants and at the great piers in seaport cities indicate beyond a question that "electric stevedores" will supplant the hand-truck wherever operating conditions warrant. More than this, the shipping platforms and piers of the future will be designed especially for the more efficient operation of these electrics. They already have a tremendous influence on the short haul.

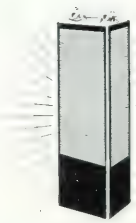
Under the old method of hand-truck operation the cost per ton of handling freight at railway termini and steamship piers was 12d., while the cost per ton for performing the same work with industrial electric trucks is but 5d. From a socialistic view, too, investigations show an important feature which particularly commends the "electric stevedore" to the operator as well as to his employer. Under the old plan the men received a wage of 8s. per day, while under the truck operating system, where men are paid on a tonnage basis, their compensation amounted to 8s. per day, or an increase of 20 per cent.

While the largest field for the "electric stevedore" is in handling baggage and freight at termini and pier they are being used to a great extent, however, in factories and industrial plants, and more and larger installations are being made continually. In shop and mill transportation, in storage warehouses, in freight transfer stations, in supply and provisioning work for railways, steamships, &c., in brick and lumber yards, in stoking in power plants, in wholesale and retail packing, shipping and receiving, and even in building operations, the industrial electric truck finds extensive application. [illegible] application of the "electric stevedore" equipped with a crane, is in laying street kerb stones. In warehouses they are used for hoisting, in packing motors, &c. Motor-car and other manufacturers are beginning to regard the electric shop truck as indispensable. Warehouses and mills are constantly finding new uses for them as the number of different types increase. The Government has adopted them for its arsenals, and a recent special application is found in the new buildings of the Boston Children's Hospital. "During its nine months of service not one dollar has been spent for [illegible] this useful vehicle," states the "Electrical World."

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON, S.W.

According as necessity has created the demand, various types of these trucks have been developed. They are made small enough to operate in the aisles of factories, and storage warehouses, to run on elevators and into freight cars, motor trucks and horse waggons, yet they carry from one to two tons, the latter being standard capacity. They possess sufficient power to haul trains of trailers, and they can climb grades that would tax the power of mules, and would be impracticable for hand-trucks. Elevating transfer trucks have been developed, by which it is possible to pick up, carry away and set down interchangeable false platforms with piles of goods on them by automatic means, thus eliminating the last item of hand labour, the loading and unloading of the trucks.

THE ELECTRIC WHEEL-CHAIR.

In a recent issue of "Electric Vehicles" it is stated that a modern battery-driven wheel chair is attracting much attention just now at the San Francisco, San Diego and Panama Expositions, where several hundred are in operation and where these are the only conveyances permitted on the grounds. The battery-driven chair is becoming very popular at Palm Beach and other resorts. "Electriquettes" are at the disposal of all visitors, who enjoy gliding about in self-propelled chairs without a pushing, panting, prattling porter. The electric is an exclusive chair, in that two passengers can enjoy independence and luxury together with complete privacy from a porter's listening ears. The chair is driven by a compact storage battery under a neat wicker dash, and recharged quite simply. The machine has a normal speed of four miles an hour, just about a walking gait, but some are built with different reductions, giving speeds ranging from 1 to 10 miles an hour, with a battery capacity sufficient to run them for eight hours on good streets.

The body is of rattan, comfortable and roomy enough "for two stout adult persons." This ¾ H.P. machine is becoming so much more popular than the one-man-power type that already several models are in use. Each has a frame of steel tubing such as is used in bicycle construction and is equipped with bicycle wheels and pneumatic tyres. The motor, gears and other mechanisms are entirely hidden by the willow body of the chair. One model is provided with an attractive sunshade. Others are built with low, open bodies, without the sunshade. All are two-passenger types, light little vehicles of neat and trim appearance, yet built as rugged as miniature trucks.

The chief feature of this motor chair lies in the extreme simplicity of its operation and the complete control under which the driver has it at all times. Anyone can step into the chair and drive off without any preliminary lessons or possibility of accident, which makes it particularly adapted for amusement parks and the like. This is made possible by a peculiar construction of the mechanism. Power is controlled by two convenient pedals. One of these releases the brake and at the same time closes the circuit, thus starting the car; the other pedal opens the circuit and simultaneously applies the brake, stopping the chair. Thus, only a simple move of the foot is required to run it. Steering is by means of a long handle like a child's tricycle. Only one gentle speed is provided, so no harm can come from collision with pedestrians or other objects, although the ease of control practically eliminates collisions and other difficulties. As an additional protection for the occupant as well as for pedestrians, however, some chairs are furnished with a guard rail in front, like the "bumper" on an automobile. When this rail comes in contact with any obstruction the current is immediately cut off and the brakes are automatically set. With the brakes set the chair cannot travel more than a few inches, and these brakes are put on when the car is stopped, remain set while standing idle, and cannot be released until the pedal is operated. The chair will not run away on grades, for no matter how steep the incline, the chair's speed cannot exceed that for which it is geared, for as soon as speed is increased by an incline, the motor starts to pull back. Chairs for board walks, expositions and other places where there are crowds, are geared to run slowly—three or four miles an hour. Those intended for use in parks or on streets have speeds ranging to 10 miles an hour. They are not, of course, intended for country roads or hill climbing. The characteristic simplicity of the electric vehicle is conspicuous in this wheel chair which permits operation by the uninitiated and makes it "fool-proof," for even when operated by unskilled and nervously inclined persons in crowded places the prompt control protects road rights and makes for "safety first."

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SIEMENS BROTHERS & CO., Ltd.
WOOLWICH.

Telegrams: "Siemens Woolwich." Telephone: City 6400 (7 lines).

CABLES & WIRES,
MOTOR-CAR LEADS
(Weatherproof, Strong, Flexible and Durable),
BATTERIES
&c., &c.

HAULING-IN CABLE.

The facility with which the electric battery vehicle can be adapted to the various classes of work in and about an electricity undertaking is illustrated in the adjoining photograph. It shows the 1-ton Edison lorry used by the West Ham electricity department being employed for the pulling of cable into underground ducts. Our friends, the Americans, have always emphasised the importance of the adaptability of the battery vehicle, but when they use it for hauling in cable they mount a more or less complicated winding gear at the back of the vehicle, and by putting the brakes on hard they keep the vehicle at a standstill and pull the cable over a sheave at the edge of the manhole. Mr. Beauchamp does it at West Ham in a more simple way. He uses the vehicle itself as the pulling medium, and runs it along the pavement or the road with the hauling rope attached to its tailboard. The first notch of the controller gives sufficiently smooth acceleration to start the cable without fear of damage either



HAULING-IN CABLE AT WEST HAM.

to the cable or the gripping tackle. There must be many other instances in which a battery vehicle could be used where a straight and steady haul is required. Of course, the method may advantageously be adopted for the pulling *out* of cables, old feeders or distributors which have a nasty habit of sticking in stoneware and iron pipes.

THE "IRONCLAD-EXIDE" ACCUMULATOR FOR ELECTRIC VEHICLES.

In these days of rapid progress in the various branches of electrical development, it is difficult to keep abreast with the various improvements which are being brought about, especially in those particular lines of the industry with which one is not directly brought in contact. This sometimes results in the impression that the state of affairs with which one was familiar possibly at some rather remote period is still to-day current practice, ignoring altogether not only the improvements in detail which in the aggregate may have resulted in a distinct advance, but also modifications of design which may still further have enhanced the value of the results obtained.

This is particularly true of such an article as the lead battery, in the manufacture and operation of which attention to detail plays such an important part. To the average person, particularly to those interested in electric vehicles, to talk of an "accumulator" conveys to their mind remembrances of flat plates. About four years ago a departure from the previous accepted design of lead plate for battery vehicles appeared when the "Ironclad-Exide" was made available, and the results of this novel departure were awaited with interest. This battery is radically different from the ordinary flat lead plate cell, which consisted of a cast grid upon which the active material is pasted in somewhat the same manner that plaster is applied to expanded metal partitions, in one flat sheet. The "Ironclad-Exide" consists of a number of vertical pencils joined top and bottom to a horizontal bar. Each vertical pencil contains a core, which is surrounded by the active material, peroxide of lead, which is in turn enclosed by a hard rubber tube having a large number of horizontal slits. These slits allow the electrolyte access to the active material, and yet are so fine as to practically prevent the washing out of the active material.

Each ebonite tube is provided with two vertical ribs, projecting on opposite sides at right-angles to the face of the plate, which serve not only to stiffen the tubes, but also act as insulating spacers, taking the place of the ribs on the wood separators used in the "Exide" batteries, and allowing the use of a plain wood diaphragm. The rubber tubes have a certain amount of elasticity, allowing them to compensate for changes in volume of the active material, due to expansion and contraction during charge and discharge. The cylindrical form of tube is well adapted to perform its function, since no amount of expansion or contraction will tend to alter its shape, and the internal strains are thus kept uniform. Another advantage is that most of the necessary electrolyte is carried within the confines of the plate itself. The negative plate used with the "Ironclad-Exide" positive is of standard "Exide" type, but of increased thickness.

The special design of the "Ironclad-Exide" possesses many advantages. Its low internal resistance enables it to discharge at high rates, which is a valuable characteristic for bad road conditions, or for hill climbing, and it possesses marked recuperative powers when standing on open circuit after over-load. Its life in actual service is claimed to be from two to three times the life of the ordinary flat plate battery under the same conditions, as is clearly seen from the results given in the following table, which we understand were obtained in actual service.

Capacity of vehicle.	Size of battery.	Battery started new.	Total miles to 4.1.14.	Total days in service.
2,000 lbs.	I.M.V.6.	15.2.11	13,511	952
..	I.M.V.6.	30.3.11	17,889	888
1,000 lb.	I.M.V.5.	11.10.11	20,895	774
.	I.M.V.5.	18.8.11	18,656	884
.	I.M.V.4.	1.9.11	14,282	802
.	I.M.V.5.	18.8.11	19,594	742
..	I.M.V.5.	19.8.11	22,970	879
..	I.M.V.4.	18.8.11	17,510	844

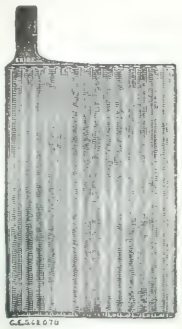
In addition, however, it has the marked advantage of being able to run for an increased period without cleaning out being required. It is chiefly on the operating side that the advantages of the "Ironclad-Exide" are apparent, as where facilities are available, it can receive a boosting charge at high rates in a short time, thus enabling its daily mileage to be increased by as much as 50 per cent. over what was possible by the older method of charging only once a day. As an example of the advantage which this method offers, reference may be made to a concrete instance of a London Cartage Company operating 2-ton delivery vans, which in regular practice distribute goods in the morning over a road distance of 35 miles, are then recharged in about 1½ hours, and make a second delivery the same day of 35 road miles, or a total for the day of 70 miles. Under the old system of charging once a day, it would be necessary in all the circumstances outlined, either to have a spare battery and change over, or else to provide a single battery of sufficient capacity for the entire day's run, but the facility of charging the "Ironclad-Exide" at

"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.

GUARANTEED FOR TWO YEARS.



Its record for the past four years stands as absolute proof of the correctness of its design. It is unquestionably the battery for commercial service. It is reliable day in day out every day in the year. It is conservatively rated and can be discharged on emergency up to practically anything that other current carrying parts of the equipment can carry.

WILL STAND HEAVY BOOSTING CHARGES.

ITS LIFE IS BETWEEN TWO AND THREE TIMES THAT OF AN ORDINARY FLAT PLATE.

THE RATE AT WHICH IT CAN BE RECHARGED DEPENDS ONLY ON WHAT HAS BEEN TAKEN OUT AND IS IRRESPECTIVE OF ITS SIZE.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION, MANCHESTER.

LONDON OFFICE: 39, VICTORIA STREET.

PARADE OF ELECTRIC VEHICLES ON THE VICTORIA EMBANKMENT, JUNE 17th, 1915.

Arranged by the Electric Vehicle Committee.

Vehicle exhibited by	Type of vehicle	Carrying capacity.	Speed on smooth, level road.	Battery. Make.	Battery. No. of cells.	Battery. Capacity in A.H.	Reference letter for method of control	Transmission.	Tyres.
			M.p.h.						
[illegible]	Walker covered delivery van	10 cwt.	14	Edison	60	220	B	Spur and idler gear in rear wheel	Solid
West [illegible] Corporation	Open body waggon	20 ,,	11/12	Ditto	60	225	B	Chain drive	Ditto
St. Marylebone Council	"Opel" covered delivery van	10 ,,	12	Hart, lead.	52	120	A	Ditto	Pneumatic
General Vehicle Co. (Ltd.)	Covered delivery van	9 ,,	15	Ironclad exide	44	133	...	Worm drive live axle	Solid
Edison [illegible] (Ltd.)	Patent automatic tipping motor van	10 ,,	12/13	Edison	60	300	C	Bevel gear jack shaft and roller chains rear wheels	Ditto
Ditto	Type G.M Edison chassis.	20 to 40	12/13	Ditto	60	225 or 300	C	Ditto	Ditto
J. Pullar & Sons, Ltd (Perth)	Covered delivery van ..... [body	20 cwt.	12	Ditto	60	300	C	Ditto	Ditto
Wolseley Motors (Ltd.)	Baker chassis with box van	20 ,,	10½	Ironclad-exide	42	157	...	Chain drive	Ditto
Ditto	[illegible]	40 ,,	9	Ditto	42	189	...	Ditto	Ditto
Croydon Corporation	Roadster passenger car ... van	3 people.	18/20	Edison	60	150	B	Worm drive live axle	Pneumatic
Poplar Borough Council	"Opel" covered delivery	10 cwt.	12	E.P.S. Co.....	44	125	A	Chain drive	Ditto
[illegible] & Isleworth Council [(Ltd.)	"Opel" light delivery van	15 ,,	14	Hart, lead.....	44	120	A	Ditto	Ditto
Hertford St. Motor Co.	[illegible]	4 people	15/20	Lead plate ...	45	150	D	Helical gear	Ditto
Krieger Electric Car- [illegible]	[illegible]	4 ,,	20	Naylor, lead .	46	175	E	Single reduction spur gear	Ditto
[illegible] Birmingham	"Millburn" Coupé .	4 ,,	20	Philadelphia, lead	20	204	...	Worm drive live axle	Ditto
Ditto	"Landaulette" Coupé	4 ,,	21	Ironclad-exide	44	137·5	...	Ditto	Ditto
Wolseley Motors (Ltd.)	Baker electric lorry .	79 cwt.	8·9	Ironclad-exide	42	...	...	Chain drive	Solid

A. Series parallel arrangement of battery in two sections with resistance steps.

B. As A, but with addition of series parallel arrangement of field coils.

C. Battery in series with series parallel arrangement of field coils combined with resistance steps in main circuit and arrangement for shunting field coils.

D. Double wound armature and two commutators. Battery permanently in series. Series parallel arrangement of armature windings and field coils combined with resistance steps.

E. 1st step. Two sections of battery in parallel and two compound motors in series.

2nd step. Same as 1st step, but shunt windings cut out, making two series motors in series.

3rd step. Battery in series and two compound motors in series.

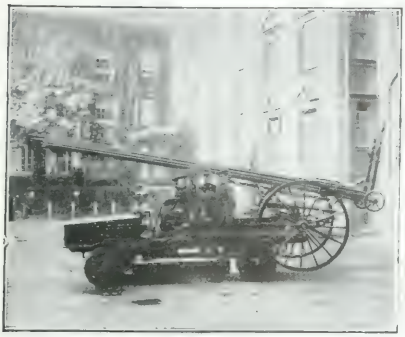
4th step. Same as 3rd step, but shunt fields cut out.

5th step. Battery in series and two compound motors in parallel.

6th step. Battery in series, shunt windings cut out.

TUDOR Accumulators

FOR ELECTRIC VEHICLES.



FIRE BRIGADE VEHICLES WITH TUDOR BATTERIES.

London Fire Brigade—11 Vehicles. Liverpool Fire Brigade—4 Vehicles. Rathmines (Dublin) Fire Brigade—1 Vehicle.

BATTERIES FOR COMMERCIAL VEHICLES, PLEASURE CARS, OMNIBUSES, &c.

LIGHTEST in WEIGHT HIGHEST in EFFICIENCY.

Maintenance undertaken at Moderate Mileage Rates.

THE TUDOR ACCUMULATOR CO., LTD.,

3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.

Works: DUKINFIELD, near MANCHESTER.

high rates renders it possible to put the battery on charge during the dinner hour, and in that time to get into it sufficient charge to duplicate the morning run, *i.e.*, 140 per cent. of the battery capacity can be obtained in one day by simply giving a boosting charge of one hour at noon.

The only factors in charging at high rates which act injuriously are gassing and heating, and these appear only when more current is being passed through the battery than the plates can utilise. The more nearly discharged a battery is, the higher charging current it can take, and by starting the charge at a high rate and tapering to a low rate at the end, a large proportion of the discharge can be put back in a very short time. Thus, if a battery is fully discharged, a boosting charge of 20 minutes will increase the capacity available by 22 per cent., and a boost of one hour will increase the capacity available by 50 per cent. Expressed in terms of mileage, this would mean that a vehicle after having given 40 miles on a complete discharge, could have its battery boosted in 20 minutes to give 9 miles additional or boosted in an hour to give 20 miles additional. The method of boosting which requires the least attention is the constant potential method at 2·3 volts per cell, which is entirely automatic and with it the commencing rate of charge of an "Ironclad-Exide" is five times the normal charging rate, but it quickly falls off as the voltage of the cells rises on charge and is reduced to the normal rate in from one to two hours from the commencement of the charge, according to the extent to which the battery was previously discharged. For charging at a constant potential of 2·3 volts per cell, a minimum of attention is required, the battery can be recharged as far as is possible at constant potential in about 5 hours, and suffers no detriment from being left on the charging circuit as the current automatically diminishes, and no harmful gassing results.

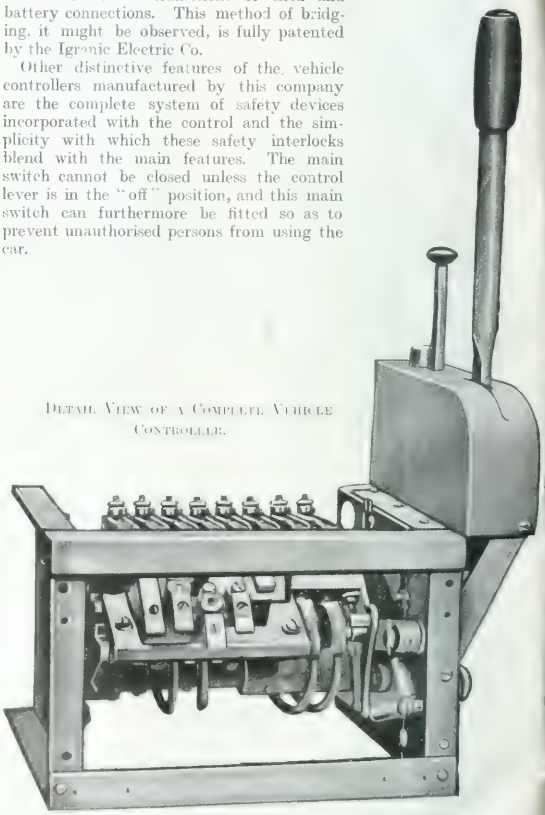
Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

ELECTRIC VEHICLES AND THEIR CONTROL.

One of the most striking and satisfactory characteristics of the electric vehicle, as compared with the petrol car, is the smooth and easy acceleration from standstill to any desired speed. There is little doubt that this smooth acceleration is to the benefit of tyres, springs and transmission, but particularly tyres, and credit must be given to the neat and ingenious controllers which have been developed for vehicle service, and which contribute in no small way to the general excellence of the modern electric, and its advantages in acceleration.

A description furnished to us by the Igranic Electric Co., Ltd., of their latest vehicle controller for double voltage operation shows that it is impossible to obtain five speeds forward or reverse, and each of these five points are economical running positions; that is to say there is no energy dissipated in resistances on any of the five running speeds. Coupled with this advantage is the further useful feature that no interruption of torque occurs when changing from any one speed to any other speed, as an ingenious system of bridging is resorted to in transitions of field and battery connections. This method of bridging, it might be observed, is fully patented by the Igranic Electric Co.

Other distinctive features of the vehicle controllers manufactured by this company are the complete system of safety devices incorporated with the control and the simplicity with which these safety interlocks blend with the main features. The main switch cannot be closed unless the control lever is in the "off" position, and this main switch can furthermore be fitted so as to prevent unauthorised persons from using the car.



DETAIL VIEW OF A COMPLETE VEHICLE CONTROLLER.

The main switch may be arranged so that application of the brakes opens the circuit, and it is then impossible to leave the car standing with the brakes on and current flowing through the motor. Some of the earlier users of the electric car will appreciate this protection against what has more than once proved a cause of fire. Reversing is accomplished by a separate lever, so that a deliberate operation is necessary to cause the car to reverse. In this point the electric follows good petrol car practice. The "Igranic" controllers are of the drum type with pressed steel frames and are strong, yet light in weight. Various types can be provided, from a controller for the fairly high-speed vehicle-de-luxe to the heavy lorry, and, unlike the change-speed levers of the petrol car, the electric controller may be operated without special training or practice. The driver has merely to concentrate on driving; speed [illegible] instinctive, and are made without fear and almost without [illegible]

[illegible] Salisbury Court, Fleet Street, in the City of London, Friday, June 25, 1915.

ELECTRIC VEHICLE PROGRESS







ELECTRIC VEHICLES FOR COLLECTION OF TOWN'S REFUSE.*

The Electric Supply Department, Birmingham, have ordered two electric vehicles of the "Mossay" type, which are to be hired by the Refuse Disposal Department, on terms agreed upon, for use in the Harborne district in the collection of house refuse from portable ash-bins. The refuse is what is termed "dry refuse," and is now collected by four horses (with one reserve horse), drawing four-wheeled wagons. It is intended that the two electric vehicles shall replace these five horses.

A day's test was made in the Harborne district with an Edison vehicle of 6 cubic yds. capacity on December 8, 1914, the work of two-horse vans being taken, and the table following shows that the work was accomplished in 8 hours 20 minutes.

The same Edison electric vehicle was also used for six consecutive days in the Lifford district under similar conditions to the Harborne test.

A third test was also made during the night in the neighbourhood of the Aston destructor in the collection of midden or privy refuse, and the work of three horses was attempted. The average weight removed by three horses in one night is 6 tons 6 cwt. The vehicle removed in less than six hours 1 ton 12 cwt. more refuse. I am of opinion that for this particular class of work, which throughout the country is a diminishing quantity, one electric could do the work of four horses. The load is obtained quickly, and the fullest advantage can be taken of the fast-travelling electric. If the "pits" are scattered and the distance to be covered considerable, the vehicle is shown to still greater advantage when compared with the slower movements of the horse.

The table gives details of this night's test.

The three tests confirmed my opinion that electric vehicles have established themselves sufficiently to justify municipalities giving their support, perhaps at present in a somewhat limited degree, to their development. I am only directly concerned in their use in the removal of house refuse, and indirectly, as a member of the Institute of Cleansing Superintendents, in their adoption for sweeping and watering of streets and collection of street sweepings.

The accepted sanitary method of storage of domestic refuse is in galvanised circular bins of a convenient size, not holding more than one week's refuse, so as to be readily portable and easily handled by the dustmen. Three trials with electric vehicles have been made in Birmingham in the removal of domestic refuse, and each trial fully

* Report by Mr. J. Jackson, superintendent of Birmingham Corporation Refuse Disposal Department, dated April 24, 1915.



A Brewer's Dray Passing the Recent Parade of Electric Vehicles on the Thames Embankment.



Electric Coupés, by Heath's Garage, Birmingham, in Electric Vehicle Parade.

Osram Drawn Wire Lamps for Motor Car Lighting.



BATTERY CHARGING RHEOSTATS



built up on the "IGRANIC" Unit System

...ed for Charging Work with Electric Vehicles. As the demand increases you just add more Units. Your plant is always complete, but always ready for extension. Write for particulars to the

IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, London.

A ... Switch ...

demonstrated that one electric could easily displace two horses. In my opinion the following reasons fully justify an extended trial of electric vehicles :—

(*a*) The cost appears to justify an extended trial.

(*b*) In this city there are 275 horses engaged in collection, with 70 in disposal work. If electrics were adopted the number of vehicles would be reduced by half.

(*c*) All the clerical labour [illegible] would also be reduced to the same extent.

(*g*) The electric vehicle can be lighted with metal filament glow lamps by current contained in the storage battery, and the superior light thus obtained would materially reduce the number of accidents which now occur in many cases through the badly lighted horse-drawn vehicles.

A horse and wagon in this city removes three wagon loads of refuse per day, which entails the vehicle stopping at approximately 150 houses per day. This at once rules out of court the petrol vehicle, which, as is well known, materially depreciates by repeated stoppages. Such is not the case with the electric vehicle, and this





These pictures, taken recently in Soho Square, E.C., emphasise the need for the battery vehicle. Not a motor vehicle, [illegible] and in the Square the pavement is ready for the stains from the horses' nose-bags.

(*d*) The supervision by outside inspectors of half the number of vehicles should be either less expensive or more effectively performed.

(*e*) The expense of accidents resulting from horses getting out of control and "moving on" whilst the dustmen are at rear of premises would be avoided.

(*f*) The littering of streets with "horse manure," and the consequent expense of cleaning same, would be considerably reduced, whilst the improvement and benefits resulting in "tidier" streets, especially in areas where the dwellings of the poor are close to the roadway, would undoubtedly assist in a reduction of "filth diseases."

[illegible] considerations are of its main features, in its adaptability for the work of refuse removal.

The operation of the cars is quite simple, and the horse drivers could, in most cases, be readily trained to drive them. The local conditions of all places should be taken into consideration when organising a scheme of collection, as they vary considerably. In Birmingham the "flat system" of dwellings is a negligible quantity, the dwelling houses being practically all self-contained. There are few back streets, and the refuse is stored in the bins at the rear

	Loads.	Time taken on outward journey.	Time loading.	Weight removed.	Time taken on inward journey.	Time loading and travelling.	Approximate distance covered.	Time tipping load.
[illegible]	3	[illegible]	6 hours 15 mins.	Not ascertained	1 hour 5 mins.	7 hours 55 mins.	16 miles	30 [illegible]
[illegible]	[illegible]	12 mins.	2 hours [illegible]	[illegible]	22 mins.	2 hours 38 mins.	5·3 miles	10 mins.

[illegible] Night Soil on the Night of December 10, 1914.

	Loads.	Time taken on outward journey.	Time loading.	Weight removed.	Time taken on inward journey.	Time loading and travelling.	Approximate distance covered.	Time tipping load.
[illegible]	4	40 [illegible]	3 hours 31 mins.	7 tons 18 cwt. 1 qr.	35 mins.	4 hours 46 mins.	18·3 miles	28 mins.
[illegible]	[illegible]	10 [illegible]	53 mins.	1 ton 19 cwt. [illegible]	9 mins.	1 hour 12 mins.	4·6 miles	7 mins.

[illegible] Left depot for first load 11.20 a.m. Meal [illegible] between 2nd and 3rd loads. Arrived at depot after four loads 5·5 a.m.

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON, S.W.

of the houses, and in many cases a considerable distance down the gardens. As a result, it has to be carried by the dustman in nearly all cases a considerable distance. The trials with electric vehicles proved that three dustmen and a driver were necessary, the driver helping to lift the bins on to the wagon. The number of loaders required, however, would have to be ascertained according to the conditions peculiar to the district in which the men were working.

The trials in this city proved that the "travelling" of the vehicles was only 30 minutes per load, as against two hours in loading, and the men were enabled to take their meals under proper conditions, instead of a "snack" in the streets. It may be argued that where more than three journeys are run and the men are not travelling to the depot to get their meals, the time might be occupied in bringing out the full bins on to the footpath. It must be borne in mind that in nearly all cities the portable bins belong to the householders, and must, therefore, be returned to their proper places after emptying. I have visited all the principal cities of Great Britain, and many on the Continent, and am decidedly of the opinion that such a method is not an acceptable or desirable one in large centres of population, and that the ratepayers prefer to pay a little more for the work than tolerate such an unsightly and insanitary system. Anyone who has watched the rag pickers or sorters in certain Continental cities, and

	Edison, 3 tons. Capacity, 8 yds.	Mossay, 2½ tons. Capacity, 6 yds.	Mossay, 3 tons. Writer's revised estimate assuming that 3 tons is carried.	Two horses, harness and wagons, 3 tons.
Capital or First	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Cost of electric vehicle, complete with chassis, battery, tyres & motors	1,075 0 0	650 0 0	...	...
Cost of two horses, harness and wagons	...	...	...	250 0 0
	£1,075 0 0	£650 0 0	...	£250 0 0
Running Cost per Week per Week	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Wages of driver	1 15 0	1 15 0	1 15 0	...
Electrical energy at ½ per unit	0 9 9	0 8 0	0 9 9	...
Tyres, assuming a 10,000 miles life	0 14 7	0 10 0	0 14 7	...
Repairs, replacement and maintenance of chassis	0 6 8	0 8 0	0 9 7	...
Battery upkeep, &c. Edison gives guarantee at end of 60,000 miles, or equal to eight years' running, that all cells shall be capable of developing full rated capacity. Mossay's provide for batteries being renewed every two years	0 4 6	1 2 6	1 2 6	...
Insurance	0 4 0	0 4 0	0 4 0	...
Miscellaneous—viz., garage expenses, viz., washing, body repairs, cleaning, &c.	0 7 6	0 7 6	0 7 6	...
Depreciation on basis of 10 years' life and interest on capital outlay at 4 per cent. per annum	2 9 1	1 4 5	1 9 5	...
Wages of loaders: Electric vehicle (three at 30s. per week)	4 10 0	4 10 0	4 10 0	...
Two cash wagons (two at 30s. per week)	...	...	...	3 0 0
Hire of two horses and vehicles in the city of Birmingham	...	...	...	7 4 0
	£11 1 1	£10 ...	£11 2 1	£10 4 0

[illegible] this country, must be convinced that it is not desirable that encouragement should be given to people to earn their livelihood in such a way.

I was favourably impressed with the electrical tipping arrangement on the Edison vehicle. This is an electrically-operated device, put into action by a simple reversing switch. A small electric motor [illegible] the bodywork, and thence [illegible] through the medium of a reduction gear and square threaded screw of ample proportions. The body is provided with rollers [illegible] which travel in a [illegible] of special profile, such that when the body is pushed backwards a tilting motion is also given to it. This arrangement possesses the advantage that the bodywork is stable in all positions, whilst the centre of gravity travels almost horizontally; thus the amount of energy used for tipping and the time taken for the process are greatly reduced as compared with other mechanical methods in use. The highest point of the sides of the wagon should not be more than 5 ft. from the ground, in order that the loaders may readily tip the refuse into the wagon.

I have obtained the figures given in the foregoing table from estimates by the makers and as a result of our own tests. It will be noticed that there is a considerable difference in first cost between the two vehicles under consideration, but the net financial results are approximately equal, and especially so if the capacity of the two vehicles is taken into consideration. It should be noted that the "Edison" vehicle is rated to carry a load of 3 tons, as against 2½ tons with the "Mossay" vehicle. A fair comparison would, therefore, appear to be as follows:—

	First cost.	Weekly cost.
[illegible]	£780	£11 2 4
[illegible] vehicle	1,075	11 1 1
[illegible] horse-and-vehicle	250	10 4 0

With the Edison tradesmen's body is also provided an electrical tipping arrangement, in place of a hand-worked screw tipping gear on the Mossay vehicle, which is valued by the makers at about £50. A weekly wage of 35s. has been allowed for, being an advance of 5s. on the amount paid to horse drivers.

It has been decided to have Ironclad Exide batteries in the two Mossay vehicles on order in place of the ordinary lead type. These are made by the Chloride Electrical Storage Co., Manchester, and I am informed that there are several thousands of them at work in America. They are, as regards performance, about half-way between the lead battery and the Edison battery, and the advantage of them is that they can be charged on a constant voltage with a tapering current, and consequently require no regulation and no attention when on charge, as is the case with the ordinary lead battery. The Electric Supply Committee have decided to maintain the batteries themselves in order to ascertain exactly the cost of upkeep, and a reliable figure should be obtained at the end of two years, and the sinking fund to be set aside is estimated to be sufficient to renew the batteries. A costing system of all work in the Refuse Disposal Department is in operation, and a fair trial will be given the electric to demonstrate its superiority over the horse.

BATTERY 'BUSES IN LOUGHBOROUGH.

The claims of the electric battery 'bus are slowly receiving recognition at the hands of both electric tramway managers and even of petrol 'bus companies. In each case it must be admitted that the war has occasioned a dearth of petrol and petrol-electric 'buses, and has also put a premium upon the production of these vehicles in any quantity. Meantime, the travelling public still represents a considerable proportion of the population, and its desire to ride rather than walk has been in no way diminished by the war. In industrial areas where engineering works and factories are producing the "sinews of war" there are hundreds and sometimes thousands who must be taken to and from the scene of their labours. Where this traffic demand is now existing it is not likely to fall off during the war or afterwards, and it should be met in every way possible by 'bus or tramway undertakings.



[illegible] Electric 'bus.

[illegible] Mr. Parkinson and Mr. Pemberton [illegible] Loughborough Road Car Co., on the left.



The Chassis at the Top of Highgate Hill, near the Archway.

The Loughborough Road Car Co. have had in operation for a number of years a fleet of petrol and petrol-electric 'buses carrying passengers in and around Loughborough and district. The chief engineer of the company, Mr. W. H. Allen, is also the borough electrical engineer, Loughborough. He has, therefore, developed a strong fancy for the battery 'bus, having regard to its successful operation in Brighton, Southend, South Shields, York, &c., he decided to make a preliminary trial with one 'bus. He took delivery of the chassis on the last day of the I.M.E.A. Convention (June 19th), after it had been exhibited in the vehicle parade on the Embankment the day before. We were given the opportunity of a run on the



At Top of Barnet Hill.
(Note driver in background walking his horse.)

"box" seat as far as Luton, and took a number of photos, of which several are reproduced herewith. The running was quite smooth,

Luton to Northampton.

Left Luton 4:45 a.m. Arrived Northampton 8:10 a.m. 3 hours 25 minutes.

	Milometer.		A.-H. meter.		A.-H. per car-mile.		Units per car-mile.		Units input to booster.
[illegible]	96·1	...	234	...			—	...	—
[illegible]	60·0	...	420	...			—	...	—
	36·1	...	186	...	5	...	0·6	...	0·8

Left Northampton 2:5 p.m. Arrived Loughborough 5:55 p.m. = 3:50 hours.

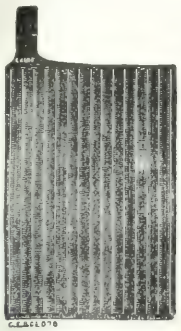
[illegible]	139·0	...	180	...			—	...	
[illegible]	96·1	...	420	...				...	
	42·9	...	240	...	5·59	...	0·672	...	0·896

"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.

GUARANTEED FOR TWO YEARS.



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THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION, MANCHESTER.

LONDON OFFICE · 39, VICTORIA STREET.

and though the speed on hills was low, it was not uncomfortably so. The following particulars, kindly supplied by Mr. Allen, relate to the running of the chassis from Luton to Loughborough via Northampton:

Since the vehicle has been fitted with a single deck 'bus body it was given a trial run to Sutton Coldfield, and the details of this run are also given.

Left Loughborough 6.5 a.m., arrived Sutton Coldfield 9.55 a.m.; actual running time 3 hours 50 minutes. Distance as per milometer, 34·5; current consumed (*i.e.*, units input to motor booster), 44·4; units per mile, 1·23.

[NOTE.—Three passengers were carried in addition to the driver, and the first 13 miles (Loughborough to Ashby) were all uphill. In addition there was a strong head wind all the way and no stops were made.]



LUCAS BATTERY BUS PUT INTO SERVICE BY LOUGHBOROUGH ROAD CAR CO.

Return Journey.—Left Sutton Coldfield 7 p.m., arrived at Ashby 9 p.m.; left Ashby 9.25 p.m., arrived at Loughborough 10.20 p.m.; actual running time 2 hours 55 minutes. Distance as per milometer, 34, current consumed (*i.e.*, units input to motor booster), 35; consumption per mile, 1·05.

[NOTE.—No wind experienced on return journey, and advantage of a downhill run from Ashby to Loughborough.]

VEHICLE DEMONSTRATIONS IN BIRMINGHAM.

With a view to making the commercial electric vehicle better known in the greater Birmingham area, Mr. J. P. Kemp (for some years resident engineer, Summer-lane Electricity Works, Birmingham Corporation) has taken down there a ½-ton Edison G.M.C. lorry. He will be making trial runs on behalf of prospective clients for these vehicles during the next two weeks.

We accompanied Mr. Kemp as far as Luton on the vehicle, and we give below his own account of the journey onwards and of his experiences in the Birmingham area. They are extremely instructive.



MR. J. P. KEMP AT THE WHEEL OF THE ½-TON LORRY WHICH HE IS NOW DEMONSTRATING IN BIRMINGHAM.

and indicate a keen interest on the part of industrial and commercial firms in the Birmingham district.

"On returning to the power station at Luton I found that the batteries were fully charged up (in the 3½ hours), and forthwith I made tracks for Rugby. The only delays that I had on the road were those due to giving lifts to various soldiers and others, who

TUDOR Accumulators

FOR ELECTRIC VEHICLES.



ELECTRIC OMNIBUS—BRIGHTON AND HOVE.

About 16 Electric Omnibuses have been in regular service for the past six years, and TUDOR Accumulators have been employed exclusively.

THE TUDOR ACCUMULATOR CO., LTD.,
3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.
Works: DUKINFIELD, near MANCHESTER.

appeared very appreciative. I got to the B.T.H. works in Rugby 55½ miles from Luton at about 9 p.m., and as the battery charge taken at Luton was 21 units at 1d., 1s. 9d., this runs out at 0·378d. per mile. My total journey for the day would be 103 miles. The batteries were again charged up at Rugby, and on the following morning I ran through to Birmingham. On the way I timed myself over a distance of 8 miles, and did this in exactly 30 minutes. This would equal an average speed of 16 miles per hour.



[illegible] the Lorry at Luton

The [illegible] not exactly light, as I had about 400 lb. weight of [illegible] on board.

[illegible] arranged in Birmingham I have given demonstration runs [illegible] of the loading time, and the car has been the object of much interest on the part of the people here. With the kindly assistance of Mr. W. E. Mabey, the commercial engineer of the Electric Supply Department, I have also arranged for interviews with [illegible] engineers and secretaries of many more [illegible] to-morrow to-day to give further runs with passengers.

I have delivered goods for the following people: Furniture to Edgbaston for Messrs. Holliday & Sons; 10 cwt. load of mixed articles to the Hamstead Collieries, Great Barr, for Messrs. Cannings (Ltd.), a load of groceries to Harborne for the Birmingham Co-operative Society. And to-day the car has been transporting sugar between the factory and workshops for Messrs. Cadburys (Ltd.) at Bournville.

"I have made frequent trips up Gough-street, Birmingham, which has an average gradient of 1 in 5·5, and demonstrated that the machine can be stopped and re-started on this with impunity. There is, therefore, no hill in this district which it will not climb with ease and certainty, loaded or otherwise. To show the simplicity with which this vehicle can be handled, in some demonstration runs the car was driven by my wife alone, and since its arrival here it has been driven by about 25 different people, 20 of whom had never driven any kind of car, and most of whom had no licences to drive. With an ordinary petrol vehicle this would be absolutely impossible.

"I got my wife to drive the vehicle to Bournville this morning, about 5 miles out of the town, and the chief engineer (Mr. Barrow) to whom I gave a short demonstration run, had two of his staff down to examine the vehicle very critically. As the result of this examination, they appeared to be very satisfied, and I then loaded up with about 15 cwt. of sugar and carried this from the warehouse to the factory, a short run of about ⅝ mile, and after seeing the behaviour of the vehicle and the condition of the road, I told them that they could quite safely, if they wished, carry a 1-ton load on it. I find that they subsequently carried several loads of 1 ton of sugar and four men, making a total load of about 25 cwt. This, therefore, should satisfy them that the vehicle and the battery is thoroughly well up to its work.

"In the run given for the Co-operative Society on the 22nd inst., with the 10 cwt. load of groceries, the vehicle went to Harborne and back in exactly one hour, the total distance of 8·6 miles being through continuous traffic; a quarter of an hour of the time was taken for unloading (and losing the way). The average speed (through traffic) would, therefore, be over 11 miles per hour. This appeared to satisfy them very well."

THE INDUSTRIAL TRACTOR.

It has occurred to engineers who have studied the problem of expeditious and economical goods handling that in such cases the solution lies in the use of one or several electrically-driven tractors designed for large tractive effort so as to be capable of hauling a train of ordinary four-wheeled hand trucks, such as are commonly in use at goods yards and warehouses. This type of tractor can be employed continuously without losing any appreciable time waiting for loading or unloading. Thus a group of the ordinary trucks are loaded in the warehouse or shipping room and assembled into a train. As soon as ready the tractor draws up and pulls the train to the railroad cars or into the shop hold, returning with a train of empty trucks ready to be reloaded. In the meantime another batch of trucks has been loaded and made ready for the tractor. In unloading cars, vessels or drays, the same procedure is followed, the tractor being in constant active service and thus earning the largest return on its investment.

The tractor serves admirably also in hauling partly finished goods from one department to another in large manufacturing plants. In all these uses, it reduces the cost of handling goods, since hand trucking is practically eliminated. A comparatively small number of stevedores, loaders, unloaders or checkers is required. The goods are also handled with much greater dispatch.

The electric tractor designed particularly to meet the conditions discussed in the foregoing is now on the market. This tractor is built primarily to pull, and has no provision for carrying anything but the operator, storage battery, controller and motor. It is a compact and ruggedly built machine with channel-iron riveted and welded frame. The battery box accommodates any standard storage battery trays and any battery selected by the purchaser may be installed. The battery is to have a capacity of 250 ampere-hours. By placing the battery box directly over the two rear wheels, which are the drivers, maximum tractive effort is obtained. A heavy-duty Westinghouse motor with ball bearings is used; it has liberal overload capacity. The controller provides for four speeds forward and two reverse. The handle of the controller is automatically locked when the driver leaves his seat. Power is transmitted from the motor to the rear axle direct through a worm-gear drive.

On the rear axle are two contracting brakes with a friction surface of 130 sq. in. These brakes are controlled by a pedal. Their bands are lined with wire-woven asbestos. The rear driving wheels and [illegible] steering wheels are of pressed steel and equipped with extra large solid rubber tyres rigidly pressed on. All wheels have roller bearings. Steering is by a lever direct to the front wheel fork.

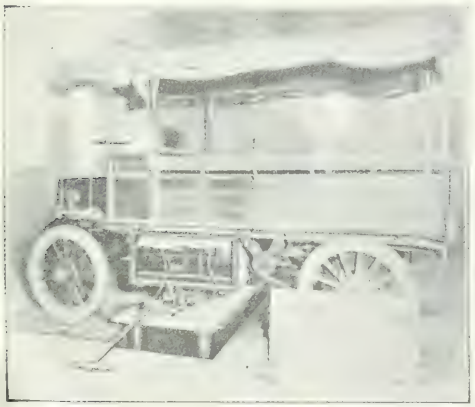
ELECTRIC VEHICLE PROGRESS



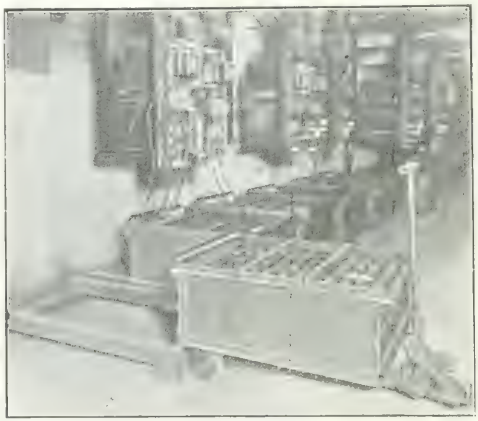
THE BATTERY SERVICE SYSTEM IN PRACTICE.

It is frequently argued by the opponents of the electric battery vehicle that the moderate mileage obtainable on one charge of the battery places the vehicle at a great disadvantage by comparison with petrol or steam-operated machines. The introduction of satisfactory boosting methods in conjunction with types of batteries which can be charged for short periods at a high rate has increased the daily mileage range of commercial vehicles, but it is probably only in the nature of a stopgap. Then, again, the high cost of the battery-propelled vehicle by comparison with the moderate capital outlay required, even for a fleet of petrol cars, is a further handicap upon its wider employment. The most obvious remedy for this mileage deficiency is a battery exchange system whereby vehicles can be placed on normal delivery service and discharged batteries replaced as and when required without delay for either boosting or recharging. Naturally, a system of this character can best be experimented with in a country in which there is a large number of electric vehicles in operation. It is instructive to note that American central station engineers have applied themselves to this problem, and from a report recently published in the "Electrical World" we gather that the battery service system has been successfully applied in seven American cities. The central station undertaking is the moving spirit in putting the system in operation, and the seven cities referred to are Hartford, Boston, Baltimore, San Francisco, Fall River, Worcester and Spokane. The General Vehicle Co. has co-operated with these undertakings in putting the method on a practical basis.

From the vehicle users' point of view there are many advantages attaching to this system. In the first place, any business house or industrial undertaking which is confronted with certain specific transport problems prefers to be troubled as little as possible with the purely mechanical features of its delivery department. As a matter of fact, every commercial industrial organisation is desirous of purchasing not so much vehicles as transportation facilities, and in the case of the electric vehicle probably more than of any other type it is possible to put forward a practicable proposition which will meet this demand, unusual though it may appear to be in the field of practicable automobilism. The vehicle itself, apart from the battery, is extremely simple, and small repairs to the driving equipment, brakes, tyres, controllers, bodywork, &c., can be entrusted to comparatively unskilled labour. It is only with the battery that the



Charged Battery wheeled by Truck on to Hydraulic Lift and raised under Vehicle.

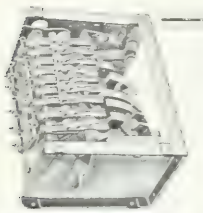


Charged Batteries on Special Trolley, ready for Transfer to Vehicle.

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DRAWN WIRE
Lamps

For Motor Car Lighting — the Entirely Made in England Lamps





DON'T WASTE POWER
on your Vehicle Controllers

'IGRANIC'



Electric Vehicle Double Voltage Controllers are so scientifically designed that they give easy and perfect control without wasting power in either armature or field resistances. We shall be glad to give full particulars at your request.

IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, London.

Prices per month.

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte**; and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON, S.W.



A Front View of Electric Battery Watering Cart at Blackpool.

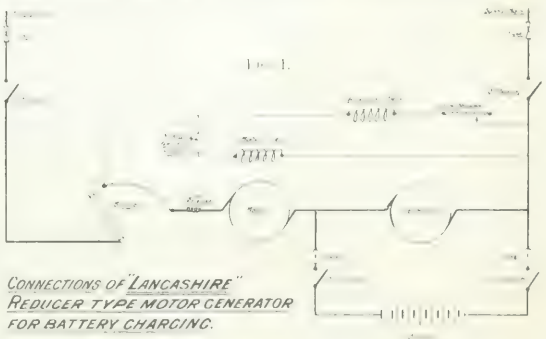
Glover & Sons, of Warwick. The sprinklers are in front of the vehicle and spread the water 21 ft., putting sufficient water on the road when travelling at a speed of 10 miles per hour. The vehicle battery is to be charged from the plant at the Destructor Works.

SOME NOTES ON VEHICLE BATTERY CHARGING.

During the past few years the electric battery vehicle has become steadily growing in popularity, and as a large number of industrial motor will be needed to replace those constructed for war service, no doubt a considerable proportion of the new vehicles will be "electrics." When a public electricity supply is available, it is rarely advisable to instal independent generating plant for the purpose of charging batteries, as the public supply is usually cheaper and far more reliable than the private.

Where alternating-current supply mains only are available, the engine must be connected to direct-current for charging the

Method of transforming voltage.	Supply volt age.	Total power consumed per hour.	Cost of power.	Efficiency of transformation.
		B.O.T. units.		
Resistance ...	500	9·0	5·0 power supplied.	20·0 %
	440	7·9	4·4	22·7
	220	3·8½	2·2	44·5
Motor-generator	500	2·3·8	1·32	76·0 %
	440	2·3·8	1·32	76·0
	220	2·3·8	1·32	76·0 %
"Lancashire"...	500	2·2·4	1·25	80·6 %
Reducer type .	440	2·2·1	1·23	81·5 %
Motor-generator	220	2·0·7	1·15	87·0

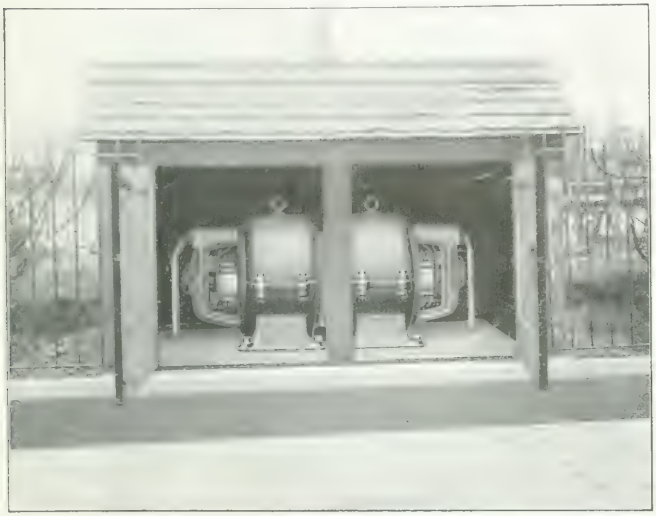


CONNECTIONS OF "LANCASHIRE" REDUCER TYPE MOTOR GENERATOR FOR BATTERY CHARGING.

SIEMENS BROTHERS & CO., Ltd.
WOOLWICH.
Telegrams: "Siemens Woolwich."
Telephone: City 6400 (7 lines).

CABLES & WIRES,
MOTOR-CAR LEADS
(Weatherproof, Strong, Flexible and Durable),
BATTERIES
&c., &c.

rectifier, and resistance in the battery circuit; (2) rotary converter. in series across the supply mains. One of the machines runs as a motor and drives the other machine as a generator, the latter machine giving the voltage required for charging purposes. Fig. 1 shows the connections for the reducer set. The switchgear is as simple as that of the plain motor-generator, and the voltage supplied to the battery can be readily adjusted by means of the shunt regulator. No series resistance is used in the battery circuit.



A "Lancashire" reducer set has three main advantages over a plain motor-generator—viz., (1) The efficiency is considerably higher, about 4 to 12 per cent. Accordingly the current bill is reduced by this amount. Efficiency of reducer set

$$\frac{\text{volts(motor)} \times \text{effic.(motor)} \times \text{effic.(generator)} - \text{volts (generator)}}{\text{volts (supp'y)}}$$

Efficiency of motor-generator set = effic. (motor) × effic. (generator).

2. It is cheaper and has lower capital charges on it.

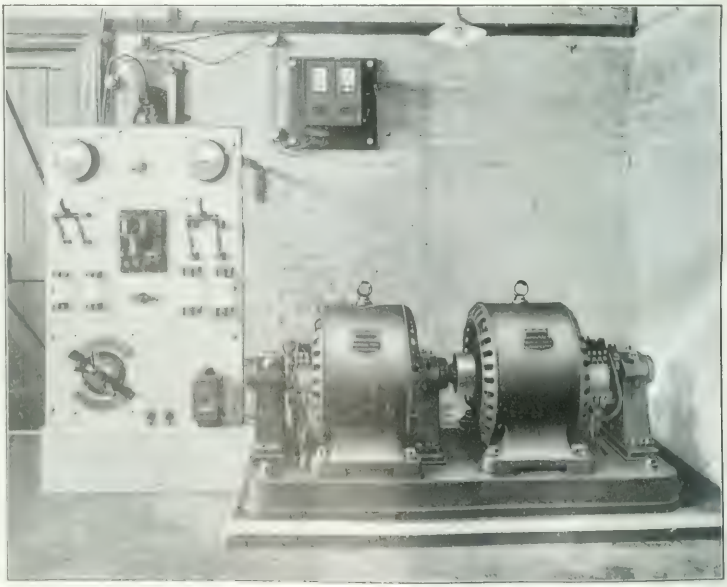
3. It takes up considerably less space.

The "Lancashire" reducer set is a self-contained arrangement for vehicle battery charging, and may be installed at the most convenient charging place. It is suitable for use at power stations, garages, loading or unloading platforms, tram termini, &c. The illustration in Fig. 2 well indicates the compactness and adaptability of the "Lancashire" reducer set. It may be built into an out-house by the road side at the end of a

direct-current supply mains are 500, 440 or 220 volts, and are reduced or transformed to that required for battery charging, either by (1) circuit or (2) the employment of a motor-generator set.

An instructive comparison between the results obtained by these from direct-current supply is shown in table on previous page.

that greatly exceed the battery volts. In practice the motor-generator has proved without rival in reliability and efficiency for the charging of vehicle batteries from either direct or alternating-current current, however, an increase in that of the ordinary motor-generator



"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.

GUARANTEED FOR TWO YEARS.



Its record for the past four years stands as absolute proof of the correctness of its design. It is unquestionably the battery for commercial service. It is reliable day in day out every day in the year. It is conservatively rated and can be discharged on emergency up to practically anything that other current carrying parts of the equipment can carry.

WILL STAND HEAVY BOOSTING CHARGES.

ITS LIFE IS BETWEEN TWO AND THREE TIMES THAT OF AN ORDINARY FLAT PLATE.

THE RATE AT WHICH IT CAN BE RECHARGED DEPENDS ONLY ON WHAT HAS BEEN TAKEN OUT AND IS IRRESPECTIVE OF ITS SIZE.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION, MANCHESTER.

LONDON OFFICE: 39, VICTORIA STREET.

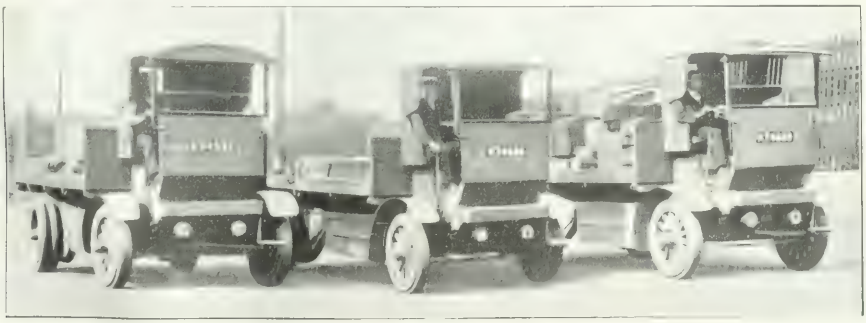
tramway route, and used for charging up the batteries before the vehicles make the return journey. Fig. 3 shows a vehicle charging set, together with the switchgear for its control. This set is installed at a tramway depot, and is used for charging electric 'buses.

The advantages of installing independent charging plant are: (1) Increased daily mileage. If the daily mileage is short, it is sufficient to charge the battery during the night, when the current can sometimes be purchased at reduced rates. But, if it be desired to run a greater distance per day than that corresponding to one complete battery discharge, the battery must be charged at intervals during the day. By giving the battery frequent short charges at high rates the voltage, and consequently the speed, is maintained and the efficiency is increased, also a greater daily mileage is possible. The "Lancashire" reducer set gives heavy charging currents. (2) Minimum delay. The electricity supply station is often some considerable distance away from the vehicle storing or loading shed, and thus numerous unprofitable journeys must be undertaken unless independent charging plant is installed. Occasionally there will be additional delay owing to more vehicles awaiting a charge at the electricity station than can be served at the same time. By the installation of a "Lancashire" reducer set at the loading or unloading platform the battery may be charged whilst the vehicle is standing prior to the next journey. (3) Garages. There is a great field for the establishment of electrical garages where the batteries of electric vehicles may be charged and generally attended to. The "Lancashire" reducer set is without rival for garage service. The charging voltage may be readily adjusted to suit any vehicle battery.

The foregoing notes are taken from a new pamphlet (No. 156) which is being issued by, and may be obtained on application from, the Lancashire Dynamo & Motor Co., Trafford Park, Manchester.

WOLSELEY-BAKER ELECTRICS IN SERVICE.

The adjoining illustrations indicate that the electric battery vehicle is being given an opportunity of proving its merits for heavy haulage work in this country. We show a side view of a 3½-ton electric van



[THREE 3] WOLSELEY-BAKER ELECTRICS, PART OF A FLEET IN SERVICE OF VICKERS, LTD.

TUDOR
ACCUMULATORS
FOR ELECTRIC VEHICLES.



AMBULANCE WITH TUDOR BATTERY.
Port of London Authority—4 Vehicles. City of London Corporation—2 Vehicles.

BATTERIES FOR COMMERCIAL VEHICLES, PLEASURE CARS, OMNIBUSES, &c.

LIGHTEST IN WEIGHT HIGHEST IN EFFICIENCY.

Maintenance undertaken at Moderate Mileage Rates.

THE TUDOR ACCUMULATOR CO., Ltd.,
3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.
Works: DUKINFIELD, near MANCHESTER.

A fleet has recently been supplied to the Dunlop Rubber Co. The body work of the vans was supplied by the Dunlop Company themselves. Three 3½-ton electric lorries which form part of a fleet supplied to Vickers (Ltd.), Erith, are also illustrated. All these vehicles are in daily service hauling very heavy loads and are, we understand, giving complete satisfaction.

The Wolseley-Baker electric is a standardised vehicle of the single motor type, with undershung battery. The motor, which is mounted immediately forward of the rear axle, drives a countershaft through an enclosed morse chain. From the counter-shaft the transmission

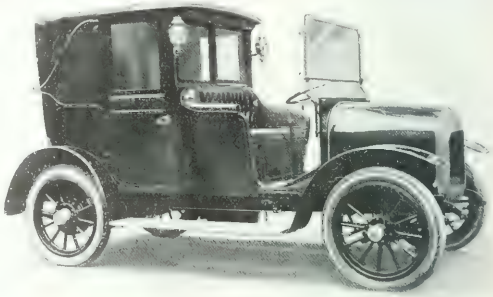
Midway between the front and rear wheels is the battery crate which receives the battery (of the Ironclad Exide type) in two sections, each of 22 cells. It is not necessary to remove the battery from the vehicle during the charging operation.

The controller, which is placed under the footboard, is operated by a lever immediately below the steering wheel. The controller operating spindle is concentric with the steering column, and, at its lower end, is provided with a mitre gear wheel which engages with a similar wheel mounted on the horizontal spindle of the controller. The controller is designed and constructed to provide five forward speeds and three reverse speeds.

The normal speed of these vehicles is up to 12 miles per hour, and the mileage range on one charge of the battery is 40 to 45. The batteries are designed so as to take a boosting charge should it be necessary to increase this mileage during the day. Particulars of these interesting vehicles can be obtained from Wolseley Motors (Ltd.), Adderley Park, Birmingham.

ELECTRIC TAXI-CABS.

The accompanying illustration shows an interesting type of Edison accumulator taxi-cab, which was designed by Mr. J. F. Monnot in conjunction with the famous firm of De Dion Bouton, Paris. The vehicle in question is intended to seat four people inside and a driver and additional passenger outside. It is propelled by an Edison accumulator of 60 cells, giving an ampere-hour capacity of 225 ampere-hours at an average voltage of 72 volts, equivalent to a



kilowatt hour capacity of 16, or thereabouts. This can be increased to about 18·5 kw.-hours on overcharge, and suffices for a run of 50 miles on one charge. By means of boosting the daily mileage could be brought up to 85 miles, a distance quite sufficient for normal taxi-cab service within the City limits.

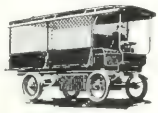
The weight of the vehicle is about 34 cwts., and its top speed 20 miles per hour. It is driven by a single 15 ampere motor direct



DUNLOP RUBBER CO.

[illegible] the outbreak of war unfortunately brought this interesting experiment to a temporary standstill, but later on it is hoped to run a fleet of Edison accumulator taxi-cabs having certain improvements in [illegible] has indicated.

ELECTRIC VEHICLE PROGRESS




"ELECTRIC" MILK DELIVERY.

One of the most interesting cases of the use of the electric vehicle for milk delivery is that in which a 2,000 lb. wagon is owned by Mr. W. F. Griswold, Hartford, Conn., a dairy farmer located 7 miles from the charging station. Mr. Griswold has a farm at Rocky Hill, and has nearly 100 cows producing more than 1,000 quarts of milk daily, which is distributed by two routes in Hartford. The longest route was 25 miles, on which was delivered about 625 quarts of milk and cream, and serving this in the summer three horses were used, each making 25 miles for two days and resting the third day. In winter four horses were used, each pair working alternate days. On the other route the work was not as hard and the animals could be worked fairly regularly in summer, and alternated in winter, as conditions required.

Milk was delivered each day at the store of the Boston Branch Grocery, which operates the largest number of electric wagons in service in Hartford. After observing these for a considerable period, and learning of the battery service system, Mr. Griswold ordered a 2,000 lb. wagon, which was delivered July 18, 1914. This machine has been operated each day since delivery, being driven by a son of the owner, and each day at noon the battery is exchanged. The mileage at this season is approximately 25 a day.

The young man serves 325 customers, which means almost as many stops. With a boy he leaves the farm at 6 o'clock and is back by 1:30. A typical load was 22 cases of 12 quarts, 12 cases of 20 pints, in bottles, four 40-quart, one 30-quart, and two 10-quart cans. This was a total of 594 quarts of milk and cream, weighing, with the containers, about 2,500 lb. The wagon is driven under a shed at the farm, there not even being a garage.

During the period of the year when the crops are harvested, the wagon is loaded with produce or fruit and makes a second trip to Hartford, this bringing the mileage for the extra trip days to 40 or 45, but during the winter the route alone is covered. The monthly mileage will range from 750 to 800 in winter and from 150 to 200 miles more in the warm weather. Since the electric wagon was purchased the number of horses used for the farm has been reduced from 16 to 10, so the machine can be regarded as practically replacing six horses. Since the wagon has been in use but one delay, for a half-hour, has been experienced, and the driver says that he never could have done as well with animals.

This is but one example of many in Hartford. It is chosen because it represents hard operating conditions as is evident from the figures —a route of 25 miles with 325 stops to be covered in 7½ hours—the wagon starting with 25 per cent. overload and going its route for seven days a week with only a single half-hour delay within the first eight months. Contrast this hard, wearing service with the service or operating conditions of a wholesale grocer's truck, for example. It might travel but 25 miles, not in 7½ hours, but in 10 hours, over good city pavements and have to make only 100 stops. Obviously, if a high-grade electric truck can beat the horse on a milk round where operating conditions are abnormal, it can give the horse even a better run for its money on congested city streets. For the electric is at its best in the thick of the traffic. The electric is more than a shunting engine but it isn't a through goods engine. That honour falls to the petrol truck. The trouble is that a lot of firms have been burning up money by using the through goods engine in the yard, namely, the city, forgetting that about 80 per cent. of all the average city hauling can be done by the electric truck.

MILEAGE SERVICE OF ELECTRICS.

The following table, recently published in "Electrical Merchandise," is indicative of the class of service which commercial electric battery vehicles ranging in capacity from ½ ton to 5 tons are capable of giving. The figures relate to 45 vehicles in the district of the Hartford (Conn.) Electric Light Co., and are typical of good average daily conditions over very indifferent roads on which electric commercial vehicles can be operated. Since its introduction about two years ago, we understand that most of the vehicles enumerated in the table are operated on the battery exchange system, whereby the user has facilities for replacing a discharged battery for a charged one, the operation of changing taking only a few minutes.

Months in service.	Miles run to Feb. 1, 1914.	Months in service.	Miles run to Feb. 1, 1914.
5	5,539	17	7,728
28	25,241	7	8,632
16	11,129	6	6,209
31	23,176	12	9,399
42	19,538	16	12,198
17	8,754	16	11,462
10	6,649	43	14,625
32	19,851	32	21,397
20	8,619	43	39,907
16	9,265	16	10,649
31	23,807	19	16,073
27	14,067	22	19,[illegible]
17	18,248	20	13,034
20	5,204	7	3,268
7	3,335	39	31,077
4	3,073	16	10,249
32	18,922	16	12,629
6	1,484	6	3,708
6	3,498	16	15,040
32	25,584	6	4,160
15	10,480	32	21,115
6	5,597	6	4,749
5	1,943		

Osram
DRAWN WIRE
Lamps

For Motor Car Lighting — the Entirely Made in England Lamps



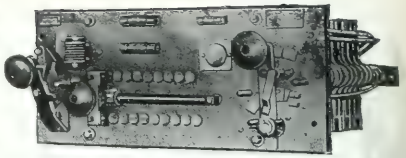
BATTERY CHARGING EQUIPMENT.

IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street, London.

WITH A GROWING INDUSTRY
there is often costly scrapping of inadequate plant. For Battery Charging No.37 boat-ers this is averted by the

IGRANIC

Unit Type Charging Panel. As the demand grows, you just add more units to keep pace with it. That isn't the only point in their favour as pamphlet No 627 will show. May we send you a copy?

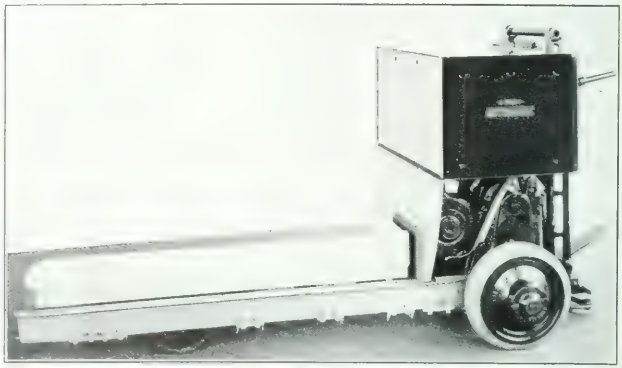


A complete unit with self-contained resistance

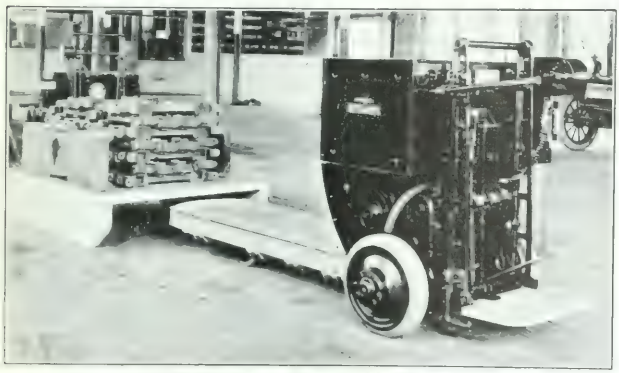
AUTOMATIC ELECTRIC TRUCKS.

The problems of the transport of raw and semi manufactured material are extremely acute in factories covering a large ground area. Numerous attempts have been made by means of telphers, overhead runways and narrow gauge trolley lines to cope with this difficulty. Experience has proved that anything in the nature of a railway, either with the rails above or at ground level, is too inflexible for general workshop application. Almost superhuman efforts are required to bring the goods, especially when they are heavy individual pieces, into contact with the means of transportation. It is not surprising that manufacturers should eagerly turn to the electric battery truck to furnish a means of transport of the go-anywhere type. The truck being battery propelled is entirely independent of external sources of energy while it is in operation, and it may be run right up alongside of the material or goods which it is desired to move from one point to another.

While the ordinary industrial electric truck is extremely useful in this connection, it is, perhaps, for certain classes of transport work a disadvantage that it



SIDE VIEW OF AUTOMATIC ELECTRIC TRUCK.



TRUCK READY TO BACK UNDER LOAD

where required. We understand that this method of transportation is meeting with great favour. It has the important merit of conferring extreme flexibility upon the works transportation system. It saves laying down of railway lines in the shops, and it confines the real wear and tear to the driving portion of the truck itself.

The control is undertaken from a platform at the motor end of the truck, the driver having in his left hand the controller for forward and reverse motion, and in his right hand the steering mechanism. The brakes are operated by pedal boards, and an arrangement is fitted whereby the current is promptly cut off between the motor and the controller as soon as the driver vacates the platform. The battery is the standard Edison A 4 type, and has a capacity of 150 ampere-hours. The truck will support a maximum load of 2 tons and has a normal speed of 1 to 6½ miles per hour.

The frame is of two steel beam sections extending the entire length of the platform, and is supported by four spiral springs, each of which is

[illegible] while it is being loaded. With a view to overcoming this difficulty, Messrs. Edison Accumulators are introducing a type of automatic electric truck which is shown in the adjoining illustration. The front end of the truck chassis is utilised to accommodate the motor, controller, battery and driving wheels. At the back end is a single wheel placed in the centre of the frame, which is extremely narrow, and which accommodates the oblong platform, which can be raised and lowered as required. It will be seen that this is made sufficiently narrow to pass under a low platform, which is of substantial construction and designed to carry heavy weights. The underside of this platform is entirely clear, the platform itself being supported by thick side members. The automatic truck is backed under this platform by the operator, and as soon as it is in position the centre portion is raised and the weight is then taken by the truck itself. The transporting of the load [illegible] is then an extremely easy matter, and by lowering the centre portion of the [illegible] can be deposited exactly

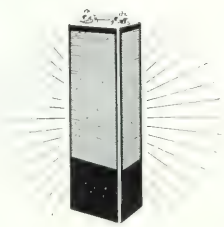


LOAD [illegible] TRANSPORT BY ELECTRIC TRUCK.

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON, S.W.

encased within a malleable iron box, and transfers the load direct to the axles. The axles are of rigid type under the frame. The rear or driving wheels are 16 in. diameter and the front wheels are 10 in. diameter. The wheels are mounted on annular roller bearings, and are fitted with solid rubber band tyres.

The motor is placed underneath the battery compartment, and is double geared with four accurately cut spur gears to a floating axle. All gears are enclosed in a steel case and fitted with annular bearings and run in an oil bath.

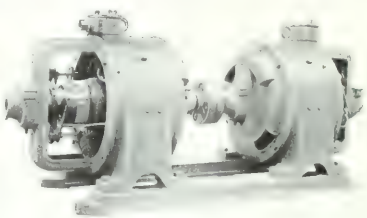
The controller is of the drum type, specially designed for these trucks, eliminating all arcing in operation. The current cannot be applied to the controller without first releasing the brake, which automatically closes the circuit switch. The moment the current is cut off the brakes will set automatically and remain set until the circuit-breaker is again closed, at which time the band brake is automatically released. The controller is operated by a lever moving in a vertical plane, giving three speeds forward and three speeds reverse. The loading platform is 23 in. wide by 4 ft. 4 in. long, and is covered with sheet steel. The height from the floor is 10 in. with the lift lowered. The platform is raised by means of an electric lifting device operated by an individual motor using power from the truck battery. Power for lifting is obtained by means of planes operated by worm and worm gear. The time to elevate the platform loaded with 4,000 lb. is about five seconds. The height of lift is from 3 in. to 4 in. The dimensions are:—

Length over all	8 ft. 1 in.
Length of platform	4 ft. 9 in.
Turning radius	5 ft. 8 in.
Width of platform	1 ft. 11 in.
Wheel base	4 ft. 4 in.
Wheel track, front wheels	0 ft. 9 in.
Wheel track, rear wheels	2 ft. 6 in.
Height top of battery box	3 ft. 8 in.
Height of platform	0 ft. 10 in.

B.T.H. REDUCER SET FOR CHARGING BATTERY VEHICLES.

We illustrate herewith a B.T.H. reducer set for charging the batteries of electric vehicles. This set is similar in all particulars to the reducer sets supplied by the company since 1910 for cinematograph theatres, as the same type of machine will meet the requirements of both industries.

These sets for battery charging are of small size, high quality and are thoroughly reliable. The small size is a matter of importance where space economy is a consideration. These reducer sets offer an economical means of voltage transformation for battery charging, except in those cases where the supply circuit has an earthed neutral. In such cases motor generator sets have to be used, unless special



B.T.H. Reducer Set.

precautions are taken. The most advantageous supply voltage is approximately twice the required output voltage, and the advantage of the reducer connections becomes less marked as the differences between the supply and the required voltages increase. The British Thomson-Houston Co., Rugby, will furnish prices and particulars.

"TRANSFER" TRUCKS.

For a number of years the terminus managers of the New York, New Haven & Hartford Railroad at Boston have been struggling with the question of how best to handle "Transfer," or through goods coming to that terminus from many nearby stations, there to be moved from its inbound houses to its outbound houses for loading to destination. During the past, considerable experimenting has been done with petrol and electric trucks, and as a result the company has installed two electric trucks of 5 ton capacity to be used in this work. After nearly two years' experience with electrics, the

economic and efficient operation of the electric trucks, which they have submitted to the Electric Vehicle Association of America. Previous to the installation of these trucks they were using about 37 goods cars for shifting at a daily expense of 45 cents each, or a total daily expenditure of 65s. The company now uses only one of these "shifters." Under the present method, each electric truck carries approximately 35 tons per day, going between houses that are from ¼ to ⅔ of a mile apart and making an average of 12 miles per day. Under this plan, a great deal of delay to the freight is saved and a considerable amount of operating expense. So far, the mechanical upkeep of the electrics has amounted to less than $1.00 per month, the company garaging and caring for the electrics themselves. Each truck has a driver, who is also a checker, the freight being handled by men at various freight houses. Each one has a clear loading space of 6 ft. by 15 ft. with stakes, side opening, high seat and three bow hoods. With the above loading space, on their mixed freight hauls they carry from 9,200 lb. to 10,000 lb. conveniently.

ELECTRIC VEHICLES FOR LAUNDRY DELIVERY.

That the electric vehicle is especially adapted to house-to-house delivery and other transportation requirements demanding frequent stops is evident from the fact that the department stores, bakeries, breweries, laundries, &c., have adopted its use on a large scale. In fact, the largest delivery fleets in the world are chiefly composed of electric vehicles. It is significant that these fleets are a result of repeated orders extending over a period of 10 to 15 years, and are successfully meeting specifications of transportation engineering experts.

One reason why electric vehicles compose such a high percentage of transportation fleets is that large organisations usually approach their transportations problems from a practical engineering point of view. Unfortunately, thousands of smaller concerns and individuals buy motor delivery waggons, with but a small conception of their suitability for a particular service the individual often qualifying himself as an expert because, perchance, he drives a car himself, and therefore thinks himself capable of judging automobiles and solving transportation problems. If this type of purchaser would submit his delivery problems to a competent authority he would rarely find his choice substantiated. He usually has but a loose and hazy idea of delivery costs, and will, perhaps to flatter his judgment, considerably underestimate the true cost. The percentage of motor operators who really know the cost of this service is small.

The Electric Vehicle Committee, while promoting the sale and use of electric vehicles to all applications, is in addition conducting investigations ascertaining lines of business particularly suited to the electric. As soon as these applications become thoroughly known, the operating costs and other data are systematically distributed to users in that class.

One of the industries which has been under investigation for some time is the laundry business. In no other delivery service can the electric be applied to better advantage than in laundry service. Not only are its inherent simplicity of operation, and cleanliness, features which every laundry delivery service should have, but also its satisfactory performance and economy of operation in a house-to-house delivery, are points which should appeal strongly to the business man. The experience with a fleet of 18 electric delivery waggons over a period of three years has recently been given by a laundry proprietor, who states :—

"The experience of my laundry with electric delivery waggons has been quite successful. I am fully convinced that the electric is the best thing for house-to-house delivery. After three years' experience, during which time we have added to our fleet gradually so that we now operate 18 electrics, with two more on order, I feel that I have ample opportunity to observe the results of electric delivery service, and compare them with other methods of delivery. We bought our first electric three years ago, and it gave such excellent results that when the time came to enlarge our equipment I decided to dispose of our horses and waggons and buy electrics. To have continued with horse-drawn vehicles would have meant an investment of £3,800 for new stables alone, exclusive of new waggons and more horses.

"The 18 electrics have not only done the work of the 40 horses which I formerly owned, but also take care of unusually heavy increase in business. I employed three stablemen to tend my horses as against one mechanic now, who not only attends to the mechanical parts of the electrics, but looks over the motors in the laundry. The sure road to success in a business of this kind is [illegible] by parkades. I consider the current that we charge our electrics with is a by-product. As in most large laundries where everything is run by electricity, we generate our own power. We have found that the amount of water we can heat during the day is not sufficient for our needs, so we found it necessary to heat water at night for the next day's washing. At the same time we charge our electric vehicles with the current generated for heating the tanks of water, so that I consider the electricity with which we charge our batteries a by-product. The distilled water which we use for our nickel-iron batteries is another by-product—the condensed steam from the hot water used for ironing. I estimate that we operate our entire fleet of 18 electrics for £14 per month—cost of the additional coal for generating current. This represents an expenditure of less than 16s. per month for the energy necessary to propel each 1,000 lb. delivery waggon. On a 300-day-a-year basis, this figures the low cost of 8d. per day per car for current.

"As a matter of general interest to the laundry man, by careful managing and by utilising every possible by-product, we have done £40,000 worth of business on a coal bill of £100. I operated my electrics under this plan, at a general average of £2 per month per car. As my electric delivery waggons average 20 miles per day during this period, and figuring on 300 working days to the year, it will be noted that the cost for current per mile was about 1d.

"I have just paid £3. 4s. for repairs on our first electric, which we have used constantly for over three years, and that was for new chains and sprockets. Compare this slight expense with the bills for waggons and harness repair, horse shoeing, veterinary service, &c. We are saving something over £120 a month by operating electrics. The initial cost is comparatively large, yet when the extreme longevity of the electric—10 to 15 years or more—is considered, the cost per year is low. In addition, I consider the advertising value of the electric in the laundry business worth considerably more than the interest would be on the initial cost. A clean, attractively-painted, smooth-running, silent electric is the best advertiser in the world for the laundry business.

"The batteries which we use in our electrics are the nickel-iron type, and although the manufacturer guarantees them for four years, I am counting on getting about eight years out of mine. Just to prove to myself the longevity of this type of battery, I bought at auction a £240 battery which had been used over four years for £56. With a little cleaning and fresh solution, I have been using this same battery for 1½ years, and expect to get considerable more use from it. Tyres, I find, will last from 1½ years to 2 years on an electric. The averag life of the tyres on six petrol trucks, which we use for long hauls, is from three to four months. As someone has said, an electric never wears out. With the present excellent standardisation of parts, it is possible to always substitute new parts as soon as the old ones wear out.



[illegible] 5 TONS BALLAST CAPACITY OPERATING ON RAIL[illegible] [illegible] OF DUMPING CARS ON THE COMMONWEALTH [illegible] PIER BOSTON, MASS.

"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.

GUARANTEED FOR TWO YEARS.



Its record for the past four years stands as absolute proof of the correctness of its design. It is unquestionably the battery for commercial service. It is reliable day in day out every day in the year. It is conservatively rated and can be discharged on emergency up to practically anything that other current carrying parts of the equipment can carry.

WILL STAND HEAVY BOOSTING CHARGES.

ITS LIFE IS BETWEEN TWO AND THREE TIMES THAT OF AN ORDINARY FLAT PLATE.

THE RATE AT WHICH IT CAN BE RECHARGED DEPENDS ONLY ON WHAT HAS BEEN TAKEN OUT AND IS IRRESPECTIVE OF ITS SIZE.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION, MANCHESTER.

LONDON OFFICE: 39, VICTORIA STREET.

THE POPULAR ELECTRIC TRUCK.

The electric battery truck is now becoming a popular object at the principal railway termini in the London area, and also at several of our principal ports. The steamship companies, now that they have given this efficient aid in transportation a trial, are ordering trucks in considerable quantities. One of the adjoining illustrations shows 10 Edison battery trucks which are being put into service by the Cunard Co. These trucks are each capable of sustaining a load of 2 tons, and they may also be used for hauling purposes. It will be observed from the illustration that the battery and the whole of the controlling gear are enclosed in a steel compartment, which is placed above the chassis of the driver's end of the truck.

The controlling mechanism embodies the usual safety features by which the current is cut off as soon as the brakes are applied or at the moment that the driver steps off the control platform. In order to assist the loading and unloading of goods there is provided at the end of the truck opposite to the control platform a hinged tubular steel gate. This is designed to fall down, and thus furnish an inclined way up which cases, barrels, packages, &c. can be rolled or pushed. When the truck is fully loaded the gate is raised to a vertical position, in which it is securely locked.

The driver can face in either direction—that is to say, he can, if it is more convenient, look over the loaded truck rather than away from it. This particular method of driving is shown in another illustration, which depicts two fully-loaded trucks being driven up an inclined way out of the hold of a ship. A single motor is used for tractive purposes, and this drives by Morse chain on to a jack shaft, from each end of which the power is transmitted to one set of wheels by side roller chains. The normal speed on the level is from 1½ to 5 miles per hour according to the load.

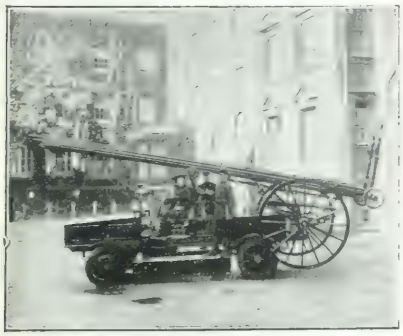


Loaded Battery Trucks Leaving Hold of a Ship.



Ten Edison Battery Trucks Supplied to the Cunard Co.

TUDOR
Accumulators
FOR ELECTRIC VEHICLES.



FIRE BRIGADE VEHICLES WITH TUDOR BATTERIES.

London Fire Brigade—11 Vehicles. Liverpool Fire Brigade—4 Vehicles.
Rathmines Dublin Fire Brigade—1 Vehicle.

BATTERIES FOR COMMERCIAL VEHICLES, PLEASURE CARS, OMNIBUSES, &c.

LIGHTEST in WEIGHT HIGHEST in EFFICIENCY.

Maintenance undertaken at Moderate Mileage Rates.

THE TUDOR ACCUMULATOR CO., LTD.,

3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.

Works: DUKINFIELD, near MANCHESTER.

TRACTOR TRUCKS.

[illegible] steel-frame driven truck [illegible] used [illegible] electric locomotive [illegible] considerable interest in the [illegible] The [illegible] shows an Edison battery truck which [illegible] purchased by one of the English railway companies.



[illegible]

[illegible] The length of the tractor is 6 ft. 11 in., and the width 3 ft., height [illegible] 2 ft. 10 in. The weight of the tractor unloaded, complete with battery, is 2,400 lb.

The battery is made up of 40 Edison A4 150 A.H. cells, divided equally and placed in two groups at the end of the truck, above the chassis frame. The motor is a series wound 40-volt machine, carried on a sub-frame at one end of the chassis. It is provided with rubber bearings, and has, we understand, a considerable overload capacity. It drives by Morse silent chain a jackshaft in the centre of the chassis, and from each end of this shaft one set of wheels is driven by side roller chains. The four wheels are 16 in. diameter, and are shod with solid rubber band tyres.

The steering is by wheel mounted horizontally on a steering column immediately behind the front battery compartment. A dished metal seat is provided for the driver, and at his left hand is the lever operating the drum-type controller. Immediately in front of him is the pedal which actuates the brakes, and at the same time switches the current off or on. When the brakes are applied the current from the battery is entirely interrupted. The controller provides for three speeds forward and reverse, and the speed varies from 1 to 5½ miles per hour on the level.

This tractor will, in addition to its own load, pull trailers loaded with 5 to 10 tons.

THE HUMAN ELEMENT.

In practice the drivers of horse vehicles can be transformed in a day or so into trustworthy drivers of electric vehicles. There is no reason, therefore, to discharge the old hands, many of whom have served well for years and deserve something better than to be sacrificed for a machine. The introduction of mechanical power is usually resented by the workers, because they see their occupation gone and themselves replaced by a new band of skilled men. Neither the private employer nor the municipal department need, however, have any qualms on that score when a change to electric haulage is intended. The veterans will do admirably at the steering wheel of an electric vehicle.

In some cases the old horse driver may feel a sentimental regret at giving up the reins for wheels and levers. But regrets of that kind are seldom lasting, and they will not be proof against experience of the ease and convenience of driving an electric vehicle. Possibly the sentiment may have something to do with the conviction in the driver's mind that he ought to be paid more for driving a machine than a horse, although a horse is ever so much more difficult to manage than an electric vehicle. It is a good plan, therefore, to offer horse drivers an increase in wages when the change takes place. The economy of the electric vehicle over the horse is so great that a fair increase can easily be given; it makes the driver contented and encourages him to treat the electric vehicle with the same respect as he would a horse with no vice.

The next few years will see a transformation in street traffic. Practically the whole of the traffic in towns, cities, and suburbs will in the course of the next few years be entirely handled by motors. This is a change which will make for the benefit of the horse, of public health, and of all the amenities of city life. Its full value depends, however, on a large part being played by the electric vehicle, because it alone is silent in running, and free from smell or other nuisance. It is precisely the town and suburban traffic now handled by horses that presents the best field for the electric vehicle, owing to the moderate speeds and the out-and-home character of the [illegible]

Most changes in the direction of machinery have certain drawbacks. But no one would regret the substitution of electric vehicles for horse-drawn ones. Least of all, the lover of horses. The conditions of traffic on city streets have become a serious and increasing strain on horseflesh, and it will be an improvement in every way when local haulage is completely in the hands of clean, noiseless, and economical electric vehicles.

[The Electric Vehicle.]

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Printed and Published by GEORGE TUCKER at the Electrical Printing and Publishing Offices, 3, Salisbury Court, Fleet Street, in the City of [illegible] on Friday, [illegible]

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